



Indo-Pacific Resource Guide

November 2019



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The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project planning activities, pilot projects, and reverse trade missions while creating sustainable infrastructure and economic growth in partner countries.

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1 INTRODUCTION

The U.S. Trade and Development Agency helps companies create U.S. jobs through the export of U.S. goods and services for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project preparation and partnership building activities that develop sustainable infrastructure and foster economic growth in partner countries.

This guide was prepared to provide U.S. companies and exporters an overview of infrastructure projects across the information and communications, transportation, energy, and public health sectors in the Indo-Pacific region primarily over the next three years.

Currency amounts converted from local currencies to United States Dollars (USD) have been done using the current exchange rate at the time of preparation of this guide. Due to fluctuations in currency values, different levels of engineering and cost estimation completion for different projects, and different timing of cost information publication, the monetary values within this report should be considered as approximate. Unless explicitly indicated otherwise, all currency values are listed in United States Dollars (USD).

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INTRODUCTION

USTDA has sponsored the preparation of this Multi-Sector Resource Guide for the Indo-Pacific Region in an effort to assist U.S. companies in learning more about potential commercial opportunities within the region's Information and Communications, Transportation, Energy, and Public Health sectors. This guide presents a profile for each sector, with 70 project profiles distributed across these sectors from the six countries.

2 Information and Communications Technology

Sector Overview: Information and Communications Technology (ICT)

The relative importance of the Information and Communications Technology (ICT) sector in the countries of interest in this Resource Guide (India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam), today varies widely, yet all have aggressive programs to expand both at home and in export markets. Malaysia, Vietnam, and the Philippines have established ICT-heavy trade positions for goods substantially larger than world averages (*Figure 1*). India and the Philippines have established strong services export positions due to the combination of low labor costs and the availability of educated sectors of their populations (*Figure 2*), a category Vietnam does not report.

Figure 1: ICT Goods Exports and Imports, 2017¹

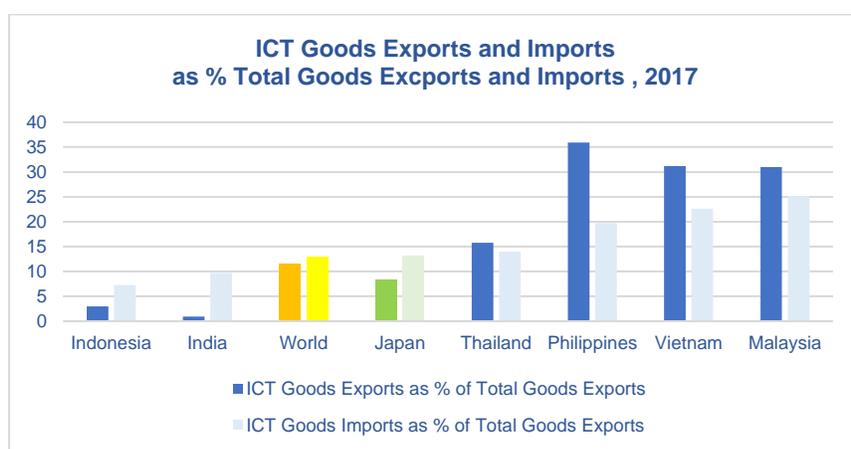
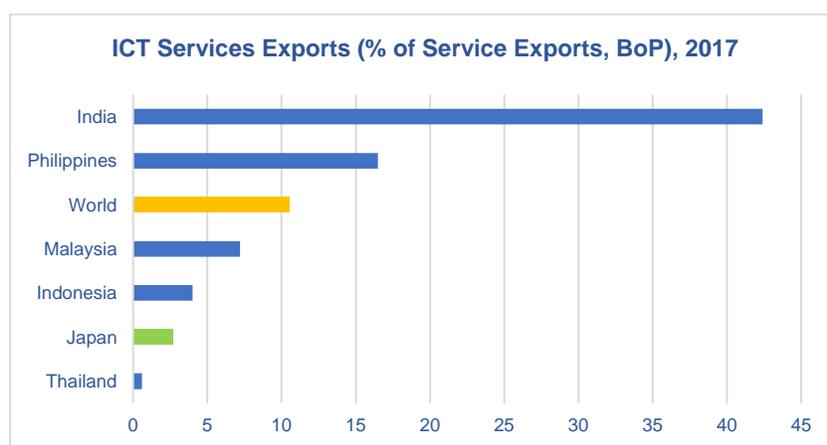


Figure 2: ICT Services Exports Share of Total Service Exports²



¹ World Bank

² Ibid

Developing digital economies offer numerous benefits for Asian countries:³

- Government: infrastructure development with fewer hurdles and less capital
- Business: encourage trade, ease of access to global markets
- Consumer: connectivity, mobility and social networks (e.g., in 2016, India, the US, and Indonesia were numbers 1, 2 and 4 globally in terms of Facebook users and 1, 2, and 3 for Twitter)

Five high-growth ICT segments for the Resource Guide countries are reviewed following.

Communications Networks

Communications Networks span the transfer of personal, enterprise, media, and government information using the internet, telephone lines, mobile telephone networks, TV and radio broadcasting, and satellites. The sector is vast and varied in terms of technology, users, infrastructure, software, and hardware. Key infrastructure segments number greater than 10 (*Table 1*).

Table 1: Communication Network Infrastructure Segments

Segment	Focus
Internet (backbone)	Principal data routes to connect continents, countries, and regions – wireless and wired
Fixed Broadband/Last Mile	Wired connections for regions, cities and last mile to homes, businesses and data centers
Mobile Telecommunications	Cellular networks providing wireless broadband internet and communications services
Communications Satellites	Space-based network and information services
Network Infrastructure	Other infrastructure such as WiFi networks, VoIP (voice over internet protocol), et al
Data Centers	Facilities managing data storage, retrieval, processing, and networking
Cloud Computing	Virtual data center services with typically less security
Software: Systems and Application	Automation software for computers/devices and tools for users including mobile apps
Application Programming Interface (API)/Integration	Allow various platforms, systems, applications to connect, work together and share information
User Devices	Phones, tablets, computers and communications devices
Internet of Things (IoT)	Physical items such as machines, sensors, robots, consumer products, vehicles, environments, et al., operated using an internet connection

Communications networks can be wired, wireless, or a combination of the two and may be as simple as the connection of devices within a home or as complex as serving millions of subscribers

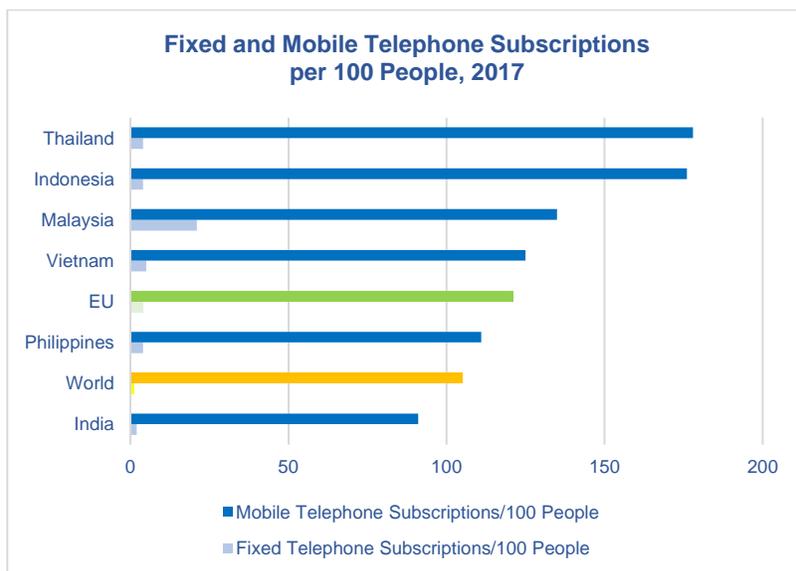
³ Deloitte

globally. Component products and services of communications networks include: hardware (cable – both copper and fiber optic, routers, switches, wireless access points, communication devices, power hardware including batteries); software (network protocols, device operating systems and firmware, security/encryption, and various application software); and services (design, programming, installation, operation, security, and maintenance/technical service).

Given the broad scope of the Communication Networks segment, it is difficult to get a precise estimate of its size. As a proxy, the global telecommunications market, alone, reached nearly \$3 trillion in 2018, with a 5-year projected compound average growth rate (CAGR) of 6.4 percent. Technology changes rapidly in this segment – e.g., the current transition from 4G to 5G cellular communications, decline of pay-tv with advent of e-Sports, rise of Software as a Service (SaaS) and related business models (Business Process (BPaaS), Platform (PaaS) and Infrastructure (IaaS)), adoption of cloud, edge and serverless computing versus traditional data centers, et al.

In the Indo-Pacific region, growth has been faster than world averages by at least two-fold, with the individual countries covered in this Resource Guide (India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam) currently at different levels of technology and adoption. All but India have mobile telephone penetration above world levels, with all but India and the Philippines exceeding earlier-developed economy (EU as a proxy) levels (*Figure 3*). Similarly, the Resource Guide countries, with the exception of Indonesia and India, exceed world levels of population share using the internet (*Figure 4*) with Malaysia exceeding EU levels as of 2017. The only area in which the Indo-Pacific region lags earlier-developed economies is in the use of fixed broadband (*Figure 5*), whose advantages include reliability/less latency (lagging) and lower cost for similar download limits; however, this situation is mostly an artifact of historic infrastructure development timing, with technology advances rapidly eroding cost and performance differentials.

Figure 3: Fixed and Mobile Telephone Subscriptions per 100 People, 2017⁴



⁴ CIA Factbook

Figure 4: Percent of Population Using the Internet, 2017⁵

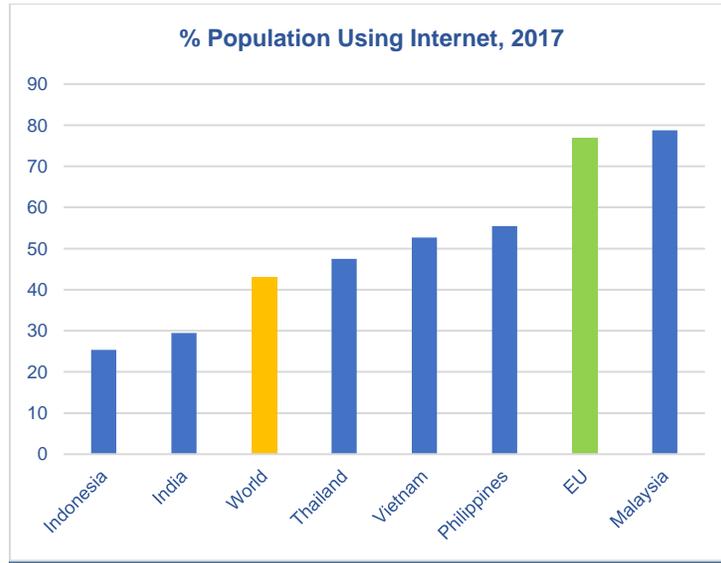
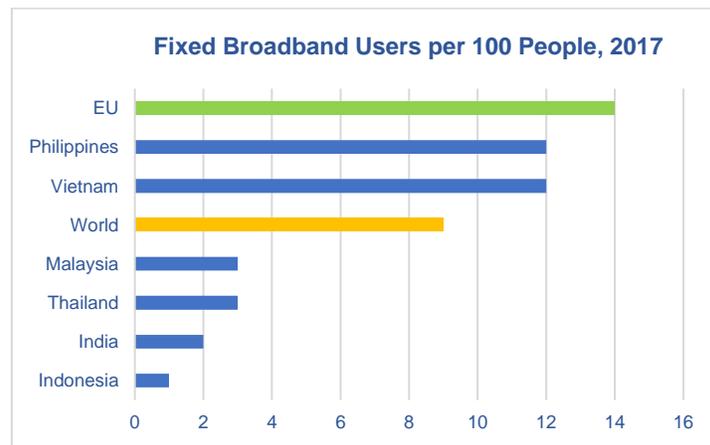


Figure 5: Fixed Broadband Users per 100 People, 2017⁶



Data Centers

Data centers store and assist in the retrieval and processing of large amounts of critical data. The global data center business is estimated at \$135B globally with a projected CAGR of 4 percent through 2023. Demand for new data centers in the Resource Guide region is driven by government initiatives toward modernization/infrastructure development and employment, along with the growth of private enterprise. Projected Data Center CAGR of 14 percent is expected in the Indo-Pacific region during the same period. The Resource Guide countries currently host 277 data centers, with India home to more than 40 percent (*Figure 6*).

⁵ Ibid

⁶ Ibid

Figure 6: Data Centers in Indo-Pacific Region⁷



Data centers segment by:

- Type - enterprise, managed services/outsourcing, colocation, wholesale, and cloud
- Density - low, medium, high, and extreme
- Vertical served - government, telecom and IT, banking and finance, healthcare, et al
- Nature of infrastructure –nature of electrical, mechanical and IT systems incorporated
- Tier (I-IV) - uptime/downtime/redundancy

Technology is changing rapidly in this sector with the development of artificial intelligence (AI), edge and serverless computing, and SaaS (software-as-a-service/online subscription models), which move away from historic data centralization. Data center participation opportunities include design, construction/infrastructure, power, cooling, and other environmental control.

Smart Cities

A smart city is a highly digitally connected municipality using information and communication technologies (ICT) to increase operational efficiency, share information with the public, and improve both the quality of government services and associated citizen welfare. Initiatives typically focus first on infrastructure development such as reliable electric supply, robust IT digitation and connectivity, and efficient public transportation. Efforts surrounding citizen safety and security, public housing, healthcare, and education, may be added.

The ASEAN Smart Cities Network (ASCN), a cooperative effort initiated in 2018, has created a list of twenty-six pilot smart cities for development across the region. Additional smart cities are also under development by India, as well as several beyond the pilot cities in Indonesia, Malaysia, Philippines, and Thailand (Table 2).

Smart cities can begin as simply as installing Smart Street Lighting and build toward high levels of interconnectedness for nearly every city function. Because of the large capital requirements to make a city “smart,” many initiatives are undertaken by public/private partnerships. As well, in

⁷ Cloudscene.com

the Resource Guide countries, foreign governments and businesses (e.g., the United States, Japan, and South Korea) have been partners/supporters.

Table 2: Indo-Pacific Smart City Initiatives

Country	ASCN Pilot Cities	Other Smart Cities	Government Initiative
India	N/A	Funding in tranches – 98 total over a five-year period: Capital cities Business and industrial centers Culture and tourism sites Port cities Education and healthcare hubs	<i>Smart Cities</i> Ministry of Housing and Urban Affairs
Indonesia	Jakarta Makassar (South Sulawesi) Banyuwangi (Java)	Surabaya Bandung	<i>100 Smart Cities Initiative</i> Ministry of Communications and Informatics
Malaysia	Kuala Lumpur Kota Kinabalu (Sabah) Kuching (Sarawak) Johor Baharu (Johor)	Selangor Cyberjaya & Putrajaya Melaka Penang	<i>Smart Cities</i> Communications & Multimedia Commission (MCMC)
Philippines	Manila Cebu Davao	Clark City	<i>Smarter Philippines</i> Department of Science and Technology
Thailand	Bangkok Chonburi Phuket	Chiang Mai Khon Kaen Rayong Chaochengsao	<i>Thailand 4.0</i> (<i>100 Smart Cities in Two Decades</i>) Ministry of Digital Economy and Science
Vietnam	Danang Hanoi (Nhat Tan-Noi Bai) Ho Chi Minh		Ministry of Information and Communication

Smart Street Lighting

Demand for Smart Street Lighting is today, driven primarily by the building and expansion of smart cities, where Smart Street Lighting is often the first step. Various sources estimate the global Smart Street Lighting market at approximately US\$8B in 2018, with a CAGR of 15 percent from 2019-2025. The Asia Pacific Region is roughly 25 percent of the global market and is expected to experience the fastest growing demand for Smart Street Lighting, with a CAGR of 28 percent, over the same period.⁸

The Indo-Pacific region has been a leader in adopting wireless street lighting (*Figure 9*). However, both wired and wireless are likely to co-exist. Wired street lighting uses programmable logic controllers, which are more secure than the Bluetooth used for wireless, yet the systems are more costly and time-consuming to install, as they require greater available infrastructure. Wireless requires less supporting infrastructure, uses less energy, and, hence, decreases both cost and carbon

⁸ Technavio

emissions. As well, wireless can offer added-value lighting and surveillance applications. The market includes the following segments: network components, connectivity, and lamps.

Figure 9: Wireless Street Lighting in Action in India⁹



Electric Vehicle (EV) Charging Networks

The global Electric Vehicle Charging Infrastructure (EVCI) market is estimated at \$8.5B by various sources, with a CAGR of 30-40 percent over the period 2019-2025. Government intervention to support the adoption of electric vehicles, primarily through tax credits and subsidies, is largely driving growth. Due to regulatory requirements, growth is expected to be fastest in Western Europe, while Asia offers the largest prospective market longer term.

In the Resource Guide countries, activity on adoption of electric vehicles ranges from Malaysia's limited government EV incentives to date, to the Indonesian government's current road-mapping effort aimed at having 20 percent electric vehicles by 2025, to India where the government began an aggressive program to ensure 100 percent of vehicles were electric by 2030 but is reportedly now considering a new target between 30-40 percent, while only 8,000 of its 150MM drivers indicate interest in owning electric vehicles, according to Bloomberg.

There are three types of EV charging infrastructure (*Table 3*). While focused most heavily on developing EV infrastructure in Western Europe, Western vehicle producers are beginning to establish EV charging in Asia, primarily China. Even the oil company, BP, has entered a joint

⁹ Smart Energy International

venture with Chinese rideshare company Didi Chuxing to build a charging network in China. Activity by Western interests in the Resource Guide countries, to date, has been less pronounced.

Table 3: Electric Vehicle Formats and Charging Protocols

EV/Charging	Advantages	Disadvantages
Vehicle Types		
Plug-In Hybrid Electric Vehicles (PHEVs)	Gasoline and electric hybrid Range flexibility	Less range than AEV solely on battery
All Electric Vehicles (AEVs)	Solely powered by electricity	Short-range Even shorter in cold climate
Charging Protocols		
Level 1 – Slow Charging (120 V)	Low-cost installation Low impact on electric utility peak demand surcharges	Slow charging 3-5 miles of range/hour
Level 2 – Fast Charging (240V)	Faster charge time (10-20 miles range/hour) More efficient than Level 1 for charges ,1 hour	Installation costs higher than Level 1 Higher impact on electric utility peak demand surcharges
Level 3 – DC Fast Charging/ CHAdeMO and SAE CCS (480V)	Charge time much reduced (similar to gasoline refueling)	Costly infrastructure Competing standards High impact on electric utility peak demand surcharges Cold weather operation challenges

Conclusion

The ICT sector in the Indo-Pacific region is one of robust business opportunity and continuing technological change. Communications networks, data centers including cloud regions/farms, smart cities and Smart Street lighting all offer prospects for U.S. technology, products, and services. The rate of adoption of electric vehicles (EV) and their charging stations (EV Charging) is less certain. Early success will be largely dependent on government initiatives and the assertiveness with which vehicle and gasoline providers support changes and entice consumers away from conventional passenger cars.

Indonesia New Capital City – Smart City		
	SECTOR	ICT
	SUBSECTOR	Smart Cities
	LOCATION	Kalimantan, Indonesia
	PROJECT VALUE	Up to \$33 billion, ICT \$2 to 3 Billion

PROJECT SUMMARY

Indonesia is in the planning stages for moving its capital city from Jakarta on the island of Java to the island of Borneo. The new capital, whose name has not yet been announced, will be constructed from the ground up, using smart city technology, taking advantage of advances in information and communications technologies, and placing a strong emphasis on efficiency and environmental responsibility. The first phase of the capital’s relocation is scheduled for completion in 2024.

PROJECT DESCRIPTION

In August 2019, Indonesia’s President, Joko Widodo, announced that the country would move its capital from Jakarta, located on Java, to an as-yet-unnamed city in East Kalimantan, on the island of Borneo. The new city will be located on 180,000 hectares of government-owned land, between the cities of Balikpapan and Samarinda (*Figure 1*). The overall cost for Phase 1 of moving the capital is expected to be approximately \$33 billion. The city is planned to accommodate a population of 1.5 million people.

The core of the city will occupy 6,000 to 10,000 hectares and serve as the seat of government. It will also contain housing for many of the federal employees and their families. The core city center that will be developed under Phase 1 is planned to accommodate 150,000 to 200,000 inhabitants initially. After the completion of the core, the rest of the metropolitan area will be developed across a total of 40,000 hectares.

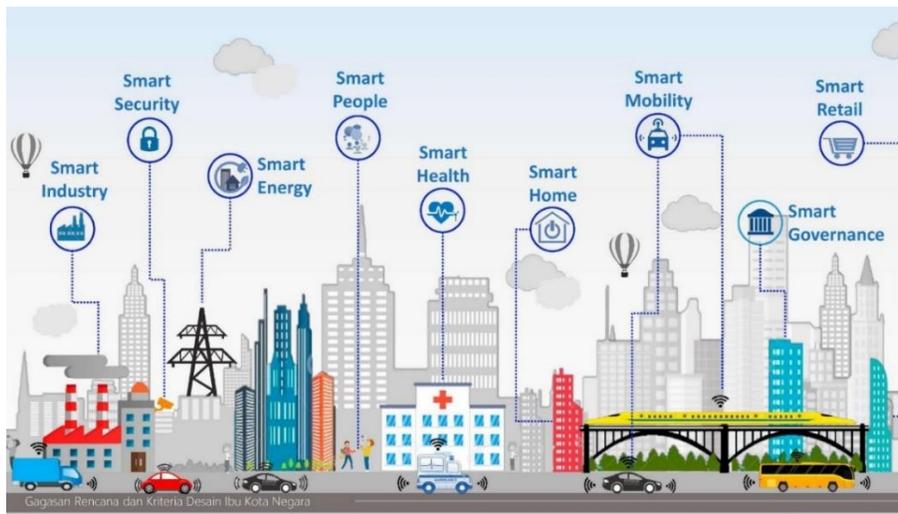
The rationale for moving the capital includes overcrowding in the city of Jakarta, the subsidence of the city, and the frequency of natural disasters, including floods, earthquakes, and tsunamis. The location of the new capital is an area with limited seismic activity, helping to reduce the risk of devastating earthquakes. Additionally, by moving the capital to another island, the proponents expect that some economic development and population expansion will shift away from Java to another island, contributing to the overall well-being of the population and offer more opportunities in Central Indonesia.

Figure 1: Location of the New Capital of Indonesia¹⁰



Indonesia's national government is committed to making its new capital a smart city, using international standards for information and communications technology. Key areas of focus where smart technologies (Figure 2) will be incorporated include energy, healthcare, mobility, personal homes, industry, and government. It will be an integrated capital, calling on modern, technologically advanced solutions across all sectors, with the goal of serving as a model for city development efforts in the future.

Figure 2: Planned Smart Cities Technologies for the New Capital¹¹



¹⁰ Source: BBC

¹¹ Source: Bappenas

At present, the country’s Ministry of National Development Planning (Bappenas) is the lead organization for the new capital’s planning and development. They are working in coordination with all line ministries, particularly the Ministry of Public Works, to ensure that the city is effectively planned, functional, and environmentally focused. Once Indonesia’s new Cabinet ministers are installed later in 2019, a new Agency or Board will be established at the national level that will be the primary decision-maker for advancements in the new capital.

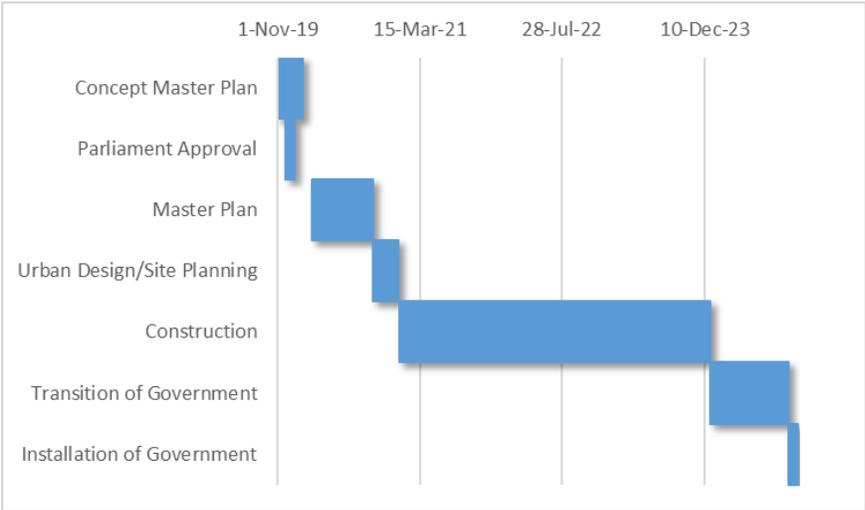
As there is little or no infrastructure at the planned location for the new capital, the logistics for getting equipment and materials to the site will pose a logistical challenge. New roads and access points will need to be constructed to facilitate the overall construction and expansion of the city. The existing airport in Balikpapan will be expanded from its current capacity to accommodate the planned increase in passenger and cargo traffic.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Phase 1 of the project has begun, with a projected end date of 2024. All of the design and planning for the new city is scheduled to conclude by the end of 2020, with construction beginning in 2021. The first phase of construction will focus on the central core area of the capital, and be completed within 3 years. The government is scheduled to move and begin operations in 2024 (Figure 3), coinciding with the conclusion of President Jokowi’s term in office.

Final approval is needed from the new Parliament for this project, which is proceeding simultaneously with the planning process. Parliamentary approval is expected by the end of 2019, which will be followed by the revision of the national law that governs the location and operation of the capital. Should Parliament choose not to approve the capital’s move, the government will be faced with three options: 1) continue to work with Parliament to seek approval; 2) continue to develop the city plan, but not relocate the capital at this time, or 3) abandon the project altogether.

Figure 3: Project Timeline¹²



¹² Source: Bappenas

PROJECT COST AND FINANCING

The cost of Phase 1 of the construction and move is expected to be approximately \$33 billion. The ICT investment will be between five and ten percent of the project cost. The project will be financed through a variety of mechanisms, including government resources, private investment, and public-private-partnerships (PPP). Approximately 50 to 60 percent of the financing is expected to come through PPPs, while 20 percent will be provided by the government, and the remaining 20 to 30 percent will come from the private sector.

U.S. EXPORT OPPORTUNITIES

Significant opportunities exist for U.S. firms offering smart city solutions. Planning for integration of smart city technologies has already begun and will continue through all phases of development of the city. These smart city technologies can be incorporated into all public buildings, as well as new residences and commercial structures.

Already, there has been significant interest from firms and governments based outside of the United States, including Korea, China, India, Russia, Australia, and multiple European countries. In October 2019, the U.S. firm, McKinsey, was selected to develop the master plan concept and is currently in financial negotiations with Bappenas.

Possible opportunities for U.S. firms operating in this space include:

- Internet backbone
- Data centers, management, and analysis
- Smart meters
- Wireless telecommunications equipment
- Cellular network
- Intelligent transportation solutions
- Traffic management systems
- Public safety communications
- Smart street lights
- Cybersecurity solutions
- Building controls
- HVAC systems
- Water and air monitoring systems
- Distributed energy resources
- Smart grid solutions
- Smart water meters
- Smart elevators
- Battery storage solutions
- Healthcare solutions

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Advanced Metering Infrastructure (Smart Meters)		
	SECTOR	ICT
	SUBSECTOR	Advanced Metering Infrastructure (AMI)
	LOCATION	Malaysia
	PROJECT VALUE	\$290 million

PROJECT SUMMARY

The Advanced Metering Infrastructure (AMI) project aims to install smart electric meters to permit monitoring and management of power usage in all homes in Malaysia. The current goal is to install 9 million smart meters by 2026. The initiative is nationwide and endorsed by Suruhanjaya Tenaga (the nation's energy commission). AMI is being implemented in peninsular Malaysia by Tenaga Nasional Berhad (TNB), the electric power utility, and in Sabah and Sarawak by their state electric utilities.

PROJECT DESCRIPTION

Malaysia has a well-developed electric grid network with relatively low distribution losses in Peninsula Malaysia through electric utility Tenaga Nasional Berhad (TNB). With continued economic growth, the Malaysian government is concerned with potential electricity shortages. The Advanced Metering Infrastructure (AMI) project does two things:

1. Enables efficient usage and distribution of electricity
2. Strengthens stakeholder coordination and collaboration within the Malaysian energy sector

AMI is included in the 11th Malaysian Plan (2016-2020) among strategies for encouraging sustainable energy usage to support economic growth.

TNB is the largest electricity utility in Malaysia, with a customer base of eight million and assets totaling \$20 billion. TNB is positioning to become a future-forward grid (i.e., automated and fully digitized). Elements of TNB’s strategy (*Figure 1*) to achieve this include:

- Investments in advanced metering infrastructure (AMI) and grid automation for advancement in network reliability and efficiency
- National grid growth to become one of the smartest and most automated/digitally-enabled grids globally
- Ensuring maximum efficiency and reliability of the grid

- Transforming customer experience and offerings through embedding innovations, especially digital ones, into the grid (Figure 2)

Figure 1: TNB Smart Grid Strategy¹³

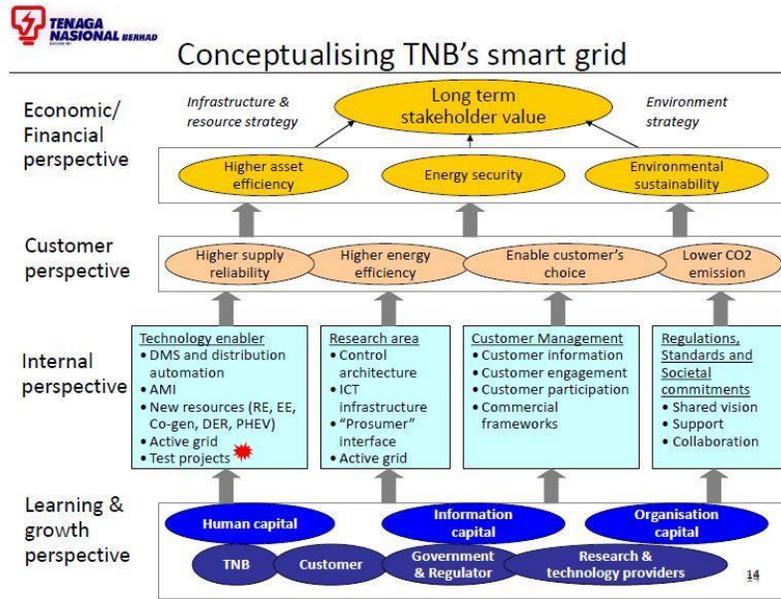


Figure 2: Grid System in Malaysia¹⁴



¹³ Tenaga Nasional Berhad

¹⁴ Ibid

The TNB AMI program implementation is occurring as incentive-based regulation, with each tranche called a Regulated Period (RP). Currently, TNB is implementing RP 2 (2018 to the end of the year 2020). By the end of 2020, TNB plans to have 1.5 million meters installed. Currently, there are 270,000 installed meters, with 266,000 (97 percent) auto-billing.

RP3 starts in 2021 and runs for 3 years. RP4 follows in 2024 with an endpoint of 2026, with the overall goal to complete installation of 9 million meters. In addition, TNB will continue to roll out apps on consumption data and energy budgeting.

Malaysian energy and ICT regulators involved in oversight of AMI include:

- Suruhanjaya Tenaga Energy Commission (<https://www.st.gov.my>)
- Tenaga Nasional Berhad (<https://www.tnb.com.my>)
- Malaysia Communications and Multimedia Commission (<https://www.mcmc.gov.my>)
- Sirim (<http://www.sirim.my>) (meter testing and certification)

Smart meters are also considered important to Malaysia's climate change goals, so the Ministry of Energy, Science, Technology, Environment, and Climate Change (MESTECC) (<https://www.mestecc.gov.my>) has advisory responsibilities.

Electric service is not as developed in the states of Sabah and Sarawak on the island of Borneo, where there are numerous power availability and reliability projects ongoing alongside smart metering. With the increase in economic activities and the development of new industrial areas, power demand will increase in tandem here. TNB is not present in Sabah or Sarawak, where Sabah Electricity Sdn Bhd and Sarawak Energy, respectively, are the electric utilities.

PROJECT COST AND FINANCING

The AMI project as a whole is budgeted for \$290 million. TNB funds smaller projects internally and has a formal tender system for AMI suppliers. For larger projects, debt financing is available and typically arranged through local banks. Last year, TNB was successful in raising \$2.4 billion of Sukuk (Islamic bonds).

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for AMI IT infrastructure include project management and:

- Hardware
 - Servers for Enterprise Service Bus (ESB)
 - Network Operations Hardware
 - Meters
- Software and Systems Integration
 - AMI Head End
 - Application Servers & Database Servers

- Meter Data Management System
- Data Analytics Software
- Licensing and Maintenance Contracts

The AMI tender process is streamlined and automated as an e-Tender Process. TNB and Suruhanjaya Tenaga both publicly request tenders online and may also advertise in newspapers. The supplier process can be found on the TNB website: <https://www.tnb.com.my/doing-business-with-tnb/suppliers/>

All foreign AMI participants are required to be aligned with a local company. Foreign AMI participants have included companies from the U.S., Europe, India, and China. Foreign companies often employ a local agent to stay current on upcoming projects.

U.S. company, Trilliant, will deploy its smart communications platform as part of TNB’s multi-year upgrade to its smart meters and AMI infrastructure. Trilliant is a leader in RFMesh technology, which offers flexibility for connections in dense urban areas, fitting Malaysian needs.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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National Fiberisation and Connectivity Plan		
	SECTOR	ICT
	SUBSECTOR	Communications Networks
	LOCATION	Malaysia
	PROJECT VALUE	\$5.2 billion

PROJECT SUMMARY

The National Fiberisation and Connectivity Plan (NFCP) is the Malaysian government’s five-year plan (2019 to 2023) to “provide its citizens with robust, pervasive, high quality, and affordable digital connectivity.” The project is 50/50 government and private industry-financed. Its goals are to expand the existing Malaysian fiber optics communications network, improve internet connectivity and speed, and reduce user costs across Malaysia. By 2023, 98 percent of the country is expected to have internet access with a minimum average speed of 30Mbps.

PROJECT DESCRIPTION

The intent of the NFCP is to double connectivity speeds at half the access cost to the Malaysian population. In addition, Malaysia wishes to rapidly adopt 5G as its communications network standard and use the network to permit development and deployment of Industrial Revolution 4.0/Internet of Things (IoT) applications to create wealth and employment.

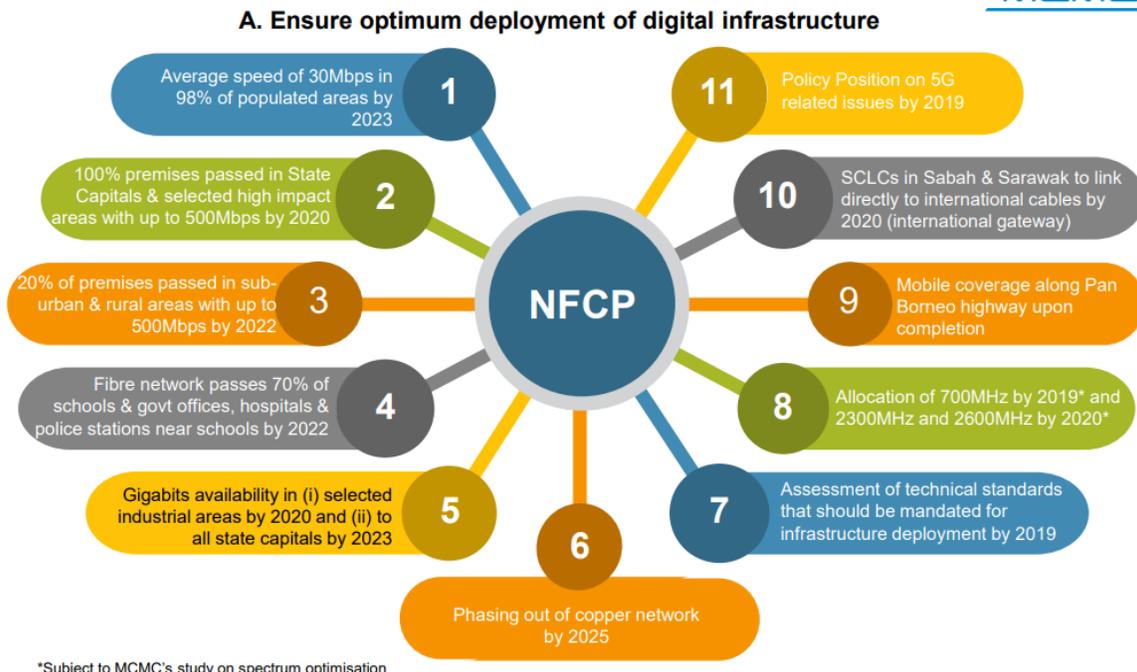
As of 2017, Malaysia led the Indo-Pacific region in the share of its population using the internet, at 78.8 percent. The country ranked third, behind Thailand and the Philippines, in the number of mobile telephone subscriptions per 100 persons at 135, suggesting many Malaysians already use multiple devices. However, similar to Thailand, Malaysia lags global levels for fixed broadband access.¹⁵ While Malaysia has rapidly digitized, some segments of the population have limited internet and cellular communications access. Certain industries and areas of the country are in need of better service.

The NFCP focuses on the development of communications infrastructure to meet the national objectives through a series of project targets (*Figure 1*). Generally, the agenda is to establish a modern, reliable and fast communications network (5G where feasible and the focus of this profile) across Malaysia and then to build a competitive presence as a leader in 5G technology and its applications to Industry 4.0/IoT (see National Fiberisation Plan – 5G profile).

¹⁵ CIA Factbook

Figure 1: NFCP Targets¹⁶

Targets for NFCP (1/2)



Major Malaysian participants in NFCP are Malaysia's electric utility company, Tenaga Nasional Berhad (TNB) and Telekom Malaysia (TM), where:

TNB provides access to the fiber cable backbone already laid in many areas in Peninsular Malaysia for TNB's own use for SCADA (supervisory control and data acquisition) systems, which allow remote electric utility metering. This existing infrastructure is being used to support coincident communications fiberisation along the electric grid (*Figure 2*), where feasible. TNB has a tender system in place for current and prospective suppliers. TNB does not service the Borneo-island-located states of Sabah and Sarawak, however.

TM offers integrated telecommunications services, including solutions from fixed telephony to mobility, content, Wi-Fi, and smart services. It is the country's incumbent fixed-line broadband operator operating under the Unifi brand. TM operates under three key business segments: unifi (broadband), TM One (business-to-business services for the enterprise and public sectors), and TM Global (domestic wholesale connectivity for local service providers).

A key challenge to achieving the base infrastructure goals of NFCP is "last mile" connectivity, i.e., delivering service from main trunk lines to individual user sites. The TNB lines serve well areas near transmission lines and main substations, but connectivity to homes and businesses in

¹⁶ Malaysia Communications and Multimedia Commission

rural areas is limited. In certain areas of Malaysia, the last mile is far more than a mile with a limited number of users.

Figure 2: Grid System in Malaysia¹⁷



PROJECT STATUS AND IMPLEMENTATION TIMELINE

NFCP is a five-year project running from 2019 through 2023. The broader associated growth from digital enablement is expected to continue for years, particularly deployment of 5G infrastructure to enable Industry 4.0/IoT applications.

NFCP project implementation is based on two pillars. The first is the series of infrastructure projects to be undertaken over the period of 2019-2023 throughout the country. This portion of the project includes leveraging fiber optics, wireless, and satellite technologies to provide an accessible, low-cost means of connecting all Malaysian citizens to the national communications network. The second portion of the project (covered in another profile: National Fiberisation - 5G) involves the deployment of this infrastructure nationwide for better quality mobile broadband, improving the competitiveness of the Malaysian telecommunications industry, promoting infrastructure sharing, and development of high value/employment-adding applications.

Specific subprojects and timing, as tied to overall project objectives, are provided in the preceding section (Figure 1).

¹⁷ Tenaga Nasional Berhad

PROJECT COST AND FINANCING

Overall, the NFCP project cost is \$5.2 billion (RM21.6B). The effort is structured as a 50:50 public/private initiative.

NFCP is supported by numerous elements of the Malaysian 2020 budget, announced on October 11, 2019, intended to accelerate the transition to a digital economy, including:

- \$5.15 billion to be invested in NFCP through MCMC
- \$60 million to prepare broadband access via satellite technology improving connectivity in rural Malaysia, especially Sabah and Sarawak
- \$50 million to accelerate infrastructure for public buildings, particularly schools and industrial parks
- 5G Ecosystem Development Grant of \$12 million
- \$6 million matching grant to spur pilot projects around applications such as drones, autonomous driving, blockchain-based on fiber, and 5G
- Tax incentives up to 10 years for E and E companies transitioning into the 5G digital economy and Industry 4.0
- \$131 million for Smart Automation matching grants to 1,000 Malaysian manufacturing and 1,000 services companies, to automate business processes
- Enforcement of the Mandatory Standards for Access Pricing (MSAP) to reduce broadband prices by 49 percent
- 10-year income tax exemption for IP-generated income from patents and copyright software based on the Modified Nexus Approach, which requires substantial research and development activities to be undertaken in Malaysia
- \$1.2 billion over five years (divided into equal annual tranches from 2020-2024) in customized investment packages for foreign Fortune 500 and Tech Unicorn companies wishing to participate with operations sited in Malaysia

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for network infrastructure include (*Table 1*):

Table 1: U.S. Export Opportunities – Malaysia NFCP Fiberisation/Communication Network

Network	Last Mile/User	Software/Services
Antennae	DOCSIS	Data centers/cloud farms
Core infrastructure	Componentry	Convergence software
Chips/arrays	GPON	Security support services
Componentry – switches, hubs, attenuators, repeaters, amplifiers, filters, phase shifters, bridges	Devices – handsets, modems, routers, servers	Infrastructure support services/MANO systems
Satellites	Drones/Robots	Analytics/machine learning

U.S. companies with technological leadership advantages fare well in Malaysia (Table 2). The country regularly assesses key technologies from the U.S., Europe, Japan, Korea, and China and actively seeks platform and disruptive technologies.

Table 2: U.S. Companies in Malaysia – Communication Network Capabilities

Company	Technology Capabilities
Amazon	Cloudfront (content), cloud IoT applications, telco (U.S.), drones
Cisco	Cloud-to-client, open roaming, converged software-defined network
Google	Cloud computing, devices, drones
Hewlett Packard	vRAN (virtual radio access networks), 5G core networks, devices
Intel	5G/edge computing chipsets, network cards, network platforms
IBM	Phased array 5G modules; cloud, security and infrastructure support services; analytics and machine learning

CONTACTS

Project Sponsor	U. S. Trade and Development Agency	U.S. Commercial Service
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National Fiberisation and Connectivity Plan: 5G		
	SECTOR	ICT
	SUBSECTOR	Communications Networks
	LOCATION	Malaysia
	PROJECT VALUE	\$5.2 billion

PROJECT SUMMARY

The development of 5G communications capability in Malaysia is part of the government’s National Fiberisation and Connectivity Plan (NFCP). 5G development is initially focused on high impact areas as a part of NFCP’s objectives to simultaneously improve internet connectivity while reducing access costs. As well, 5G is intended to enable broad use of the Internet of Things (IoT).

PROJECT DESCRIPTION

The development of 5G communications capability in Malaysia is one part of the NFCP agenda to improve connectivity and communications speed while reducing costs. The nation’s goal is to double speeds while halving access costs. The program is led by the Malaysian Communications and Multimedia Commission (MCMC).

5G technology offers substantially higher communication speeds (20 times or more) than the current standard 4G technology, using radio frequencies higher than 30GHz versus 4G’s of under 6GHz. As a result, 5G has lower latency (i.e., less download lag), a consideration important in video gaming, streaming movies, and other high-content applications. Unlike current 4G networks, 5G uses different antennae, different frequencies, and a more flexible architecture (*Figure 1*).

5G simplifies the interconnection of multiple devices, making it desirable for a variety of IoT applications. Malaysia is aggressively pursuing becoming an IoT/Industrial Revolution 4.0 global leader. Accordingly, MCMC has identified numerous development targets to utilize 5G infrastructure for IoT (*Figure 2*).

Key targets of the 5G network infrastructure roll-out, including “last mile” connections are:

- State capitals
- High impact areas (e.g., industrial parks)
- Public buildings (schools, hospitals, police stations, libraries)
- Underserved communities

As part of the broader NFCP, a joint public/private initiative between MCMC and local telecommunications companies (telcos), MCMC has developed a 5G task force, including numerous public and private entities (*Figure 3*). Malaysian electric power utility, Tenaga Nasional Berhad (TNB), has been heavily involved, as its electric power lines provide existing infrastructure and a useful pathway for optical cable installation (much of which is already in place except in Sabah and Sarawak, where TNB is not present). Participation for foreign companies is feasible through both public sector initiatives and via cooperation with private sector participants in the 5G infrastructure supply chain.

Figure 3: MCMC 5G Task Force Working Groups²⁰

No	Group	Areas	Chair	Members
1	Business Case	User trends, requirements and demand study, 5G adoption, job creation, GDP growth, etc.	Representative from the Federation of Malaysian Manufacturers (FMM)	FMM, Crest, MyloTA, MARDI, MAI, MPOC, MAMPU, MDEC, MIGHT, MOE, MMU, UTM
2	Spectrum Management and Allocation	Allocation at ITU, APT and Malaysia, required bandwidth to support national targets, identify spectrum bands for Malaysia, etc.	Representative from Celcom	Celcom, Digi, Ericsson, Huawei, Maxis, TM, Umobile, ZTE
3	Infrastructure	Requirements and coverage for optimum 5G deployment for different services, gaps analysis on current networks, costs, challenges, right-of-way, etc.	Representative from Maxis	Maxis, Celcom, Cyberview, Edotco, JKR, PJC, TIME, TM, TNB, TNB-IT, Umobile, Digi
4	Regulatory	Technical standards to be adopted, optimum number of mobile operators, accommodating future business models for network providers and relevant stakeholders	Representative from Digi	Digi, Celcom, Cyberview, Edotco, Khazanah, JKR, MTFSB, Maxis, KKMM, KPKT, Perbadanan Putrajaya, TIME, TM, Umobile

PROJECT STATUS AND IMPLEMENTATION TIMELINE

It is the country’s intention to demonstrate its early commitment to 5G, by rapidly deploying testbeds and nationwide demonstration projects, to position the country as one of the leaders of 5G adoption in the world. Malaysia is anticipated to reach 20 percent of total cellular connections using 5G by 2025.

The first Malaysian 5G trials were launched in Putrajaya (the government center) and in adjacent Cyberjaya (a key city in Malaysia’s Multimedia Supercorridor) in April 2019. By July 2019, additional trials were launched in Terengganu, Perak, Kedah, and Labuan, all of which had fiber-ready networks.

The NFCP project and associated 5G activities will be ongoing, with successive 5G tests and rollouts over the period 2019-2023. It is expected that fiber-ready areas will be developed first, while the broader NFCP efforts address and create the necessary infrastructure in areas lacking

²⁰ Malaysian Communications and Multimedia Commission

optical fiber capabilities. Development of target 5G deployment sectors (see *Figure 2* above) that will provide economic growth and employment as a result of/enabled by 5G will be ongoing.

PROJECT COST AND FINANCING

The 5G project is an important part of the NFCP, a public/private initiative, for which \$5.2 billion in government funding has been allocated. Other public funding includes:

- \$12 million for development of the 5G ecosystem
- MIDA High Impact Fund matching grants to Industry 4.0 (IoT) projects
- Other development agency grants and matching funds
- Various tax credits and deductions

Individual infrastructure and IoT application subprojects are available to be undertaken either in concert with MCMC or directly with or as a private enterprise in Malaysia.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for 5G infrastructure include (*Table 1*):

Table 1: U.S. Export Opportunities – Malaysia 5G

Network	Device	Software/Services
Antennae	Servers	Data centers/cloud farms
Core infrastructure	Modems	Convergence software
Chips/arrays	Routers	Security support services
Componentry – switches, attenuators, amplifiers, filters, phase shifters	Radio base stations	Infrastructure support services/MANO systems
Satellites	Drones	Analytics/machine learning

Several U.S. companies with 5G technologies are already present in Malaysia (*Table 2*).

Table 2: U.S. Companies in Malaysia – 5G Capabilities

Company	5G Interests
Amazon	Cloudfront (content), cloud IoT applications, telco (U.S.), drones
Cisco	Cloud-to-client, open roaming, converged software-defined network
Google	Cloud computing, devices, drones
Hewlett Packard	vRAN (virtual radio access networks), 5G core networks, devices
Intel	5G/edge computing chipsets. network cards, network platforms
IBM	Phased array 5G modules; cloud, security and infrastructure support services; analytics and machine learning

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Negeri MVV 2.0 High Tech Park Development		
	SECTOR	ICT
	SUBSECTOR	High Technology
	LOCATION	Negeri Sembilan, Malaysia
	PROJECT VALUE	\$70 billion

PROJECT SUMMARY

Malaysian Vision Valley 2.0 (MVV 2.0) is a \$70 billion mega-project encompassing Port Dickson and Seremban in Negeri Sembilan. The state-led, private-sector-driven development envisions a world-class metropolis that is competitive, inclusive, clean, and green and attracts international and local investors. The master developer is Sime Darby Property Bhd. MVV 2.0 focuses on four pillars: high tech industry, services and tourism, education and skills-based research, and logistics, aviation, and maritime hub-related activities.

PROJECT DESCRIPTION

MVV 2.0 envisions a world-class metropolis, in Negeri Sembilan, driven by public-private partnerships. Phase 1 (Figure 1) includes six projects, with the high-tech industrial park to be developed first. The projects are:

- High-Tech Industrial Park
- Integrated Transport District
- Specialized and Integrated Logistics Services
- World Knowledge City
- Biopolis and Wellness City
- Tourism District and Bird/River Sanctuary

Figure 1: Malaysia Vision Valley 2.0²¹



Negeri Sembilan is near Kuala Lumpur (Figure 2) and Petaling Jaya, where the project's master developer, Sime Darby Property Bhd., is headquartered. Sime Darby Property was created through the integration of the real estate businesses of Golden Hope Plantations, Kampulan Guthrie, and Sime Darby, a global leader in trading and logistics.

Figure 2: MVV2.0 and Surrounding Area²²



The project focuses on the creation and growth of four pillars:

- High tech industry
- Services and tourism

²¹ The Edge

²² Ibid

- Education and skills-based research
- Logistics, aviation, and maritime hub-related activities

A Comprehensive Development Plan (CDP), publicly available and promoted as MVV 2045, lays out land zoning and development for environmental enhancement, accessibility, infrastructure, livability, and industries within MVV 2.0. A Memorandum of Understanding was signed with Malaysian Green Technology Corporation for collaboration on the adoption and implementation of green concepts and green technology enablers. The governing body for this initiative is a state agency, MVV Secretariat (MVVS).

MVV 2.0 is part of the Malaysian Government's National Physical Plan for 17 Promoted Development Zones. In particular, MVV 2.0 aims to position the Seremban and Port Dickson districts as extensions to Greater Kuala Lumpur. Malaysia specifically seeks to create job opportunities and attract more investors for the high tech, clean, and green sectors.

The Physical Plan Development Zone dovetails with the Digital Free Trade Zone (DFTZ). Digital free trade zones are a strategic initiative promoted by the Malaysia External Trade Development Corporation (MATRADE) and driven by the Malaysia Digital Economy Corporation (MDEC). The objective is to intensify Malaysia's ability to participate in cross-border e-commerce and to establish Malaysia as a regional e-commerce fulfillment hub to drive exports from Malaysian small-medium enterprises. Current partners in DFTZ are:

- eBay: B2C -- targeting the U.S., Europe, Australia
- Alibaba: B2B -- targeting globally
- eRomman: B2C -- targeting the Middle East

MVV 2.0 and DFTZs are similar to other Malaysia Free Trades Zones in terms of growth opportunities and foreign company collaboration. In the early years of Malaysia free trade zones, pioneering multinationals (MNCs) such as Intel, National Semiconductor, HP, Clarion, AMD, Bosch, and Litronix made a largely agrarian landscape into a high-value product hub. In turn, the presence of these MNCs stimulated the development of local supporting companies such as Pentamaster, Globetronics, and Vitrox. These win-win relationships have endured in the country.

Malaysia has further supported these objectives with a new initiative included in its 2020 budget, released on October 11, 2019, providing for incentives for Fortune 500 companies and Tech Unicorns (earlier-stage tech companies with market values greater than \$1 billion). For a period of five years, a total of \$1 billion (split into annual tranches over the period 2020-2024) will be available in customized packages for large foreign companies investing at least \$1.2 billion in Malaysia. Target investment areas for these funds include high technology, manufacturing, creative, and economic sectors.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

This is a 30-year project with six projects in Phase 1. A Master Plan is already completed and Sime Darby has begun to attract private investors and tenants for the high-tech park. Last month,

Nestle announced plans to expand its MILO (chocolate and malt mix) factory as a global Center of Excellence in the district. Significant construction is expected to be underway in a few years.

PROJECT COST AND FINANCING

MVV2.0 has an expected cost of \$70 billion over thirty years. Most Malaysian infrastructure projects are financed at 30 percent equity and 70 percent debt. Major local and global banks have been active in infrastructure financing. This project will attract primarily private investors for whom numerous incentives exist.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities for MVV2.0 will take two forms:

1. Site development-related products and services for building and construction; information and communication technology and certain forms of transportation; as well as specialized industrial equipment suitable to business tenants of the site
2. Participation in the operation of the site as a supplier or tenant

U.S. companies with leadership advantages in high tech, green and clean technologies will be uniquely suited to this project, with a choice of business model options. For example, Malaysia is an attractive location for U.S. companies to establish regional distribution centers to serve the growing Southeast Asian market. Malaysia regularly assesses key technologies from global players from the U.S., Europe, Japan, Korea, and China, and seeks platform and disruptive technologies. This opens opportunities for licensing, joint ventures, and other business approaches.

CONTACTS

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Davao Smart City Program		
	SECTOR	ICT
	SUBSECTOR	Smart Cities
	LOCATION	Davao City, Philippines
	PROJECT VALUE	\$60 million (estimate)

PROJECT SUMMARY

Davao’s smart city program has two initial priority areas:

1. Improving emergency response capability
2. Intelligent transport and traffic systems with security

PROJECT DESCRIPTION

Davao is the third most populous city in the Philippines. It has been selected to be part of the ASEAN Smart Cities Network, catalyzing a long-term smart city digital planning program. City planners recognize that modern information infrastructure is essential to maintaining public safety, improving emergency response times, and addressing urban traffic challenges.

Davao City envisions to create a community that harnesses digital connectivity and technological advancement in providing high-quality living and a safe and secure environment for its residents. Specific goals of the smart city program include:

- strengthen its safety and security measures
- enhance public service delivery
- bolster domestic and international linkages and relations

Davao’s smart city program is a key element of broader municipal objectives to drive economic growth and achieve sustainable development.

Davao City’s initial smart city program has two specific project areas:

1. Improving emergency response capability
2. Intelligent transport and traffic systems with security

Improving Emergency Response Capability

Davao City was the first municipality in the Philippines to have established a Public Safety and Security Command Center (PSSCC). The PSSCC was founded in 2010 with the following functions:

- Orchestrates all undertakings relative to safety and security
- Provides security, safety and risk management
- Ensures efficient utilization of people, information, technology and intelligent solutions
- Center for all coordination efforts
- Lead a multi-agency approach mechanism

The PSSCC sits at the center of three organizational clusters within the Davao City administration:

- Emergency Response Cluster (including 911 and medical and fire first responder dispatch)
- Safety Cluster (including traffic and transportation management, and urban video surveillance)
- Security Cluster (police and security forces)

The PSSCC is not a police or internal security organization but coordinates with those departments through the customary performance of its duties.

The PSSCC is the focal point of emergency response for both natural disasters and man-made threats:

- Terrorist activity in Davao City accelerated markedly following a September 2016 bombing at the Roxas Night Market, which killed 15 people and wounded 70.
- The Philippines experiences an average of 20 tropical cyclones per year, often accompanied by tidal surges, major river flooding, mudslides, and collapsed structures. The toll on life and property can be considerable.
- As the country sits on the Pacific Rings of Fire, at the meeting point of three tectonic plates, earthquakes are also common.

Specific elements of the smart city project to upgrade the PSSCC include:

- Converged Command and Control - A unified, multi-agency technology and operational management framework to coordinate data, procedures, and communications to improve real-time situational awareness and ensure public safety and security.
- Unified Digital Communication Systems – Integration of all analog and digital radios, smartphones, messaging systems, data and text sharing, and shared document and video management to ensure interoperability among local and national safety and security agencies.
- Intelligent Surveillance Systems – Installation of additional intelligent Internet Protocol-based CCTV cameras and the introduction of advanced video analytics.
- Data Analytics and Solution Integration – Improved knowledge sharing among safety and security agencies through database integration with analytical capability and integration of

government and non-government systems (fire alarm, panic button, digital signage sirens, etc.), including improved mapping.

- ICT Network Infrastructure – Rehabilitation and expansion of fixed broadband and radio networks to ensure maximum communications capacity and radio coverage.
- Cybersecurity – Comprehensive upgrade to the cybersecurity platforms and mechanisms to ensure data protection and integrity at all phases in emergency operations, data management, and communications.
- Sensors and Internet of Things – Following the global trend toward a “sensing city,” Davao would like to progressively introduce smart sensors to monitor potential environmental hazards and incorporate received remote data into its overall situational awareness.

Intelligent Transport and Traffic Systems with Security

The objective of Davao’s second smart city project is to efficiently address current traffic conditions in the city with the aid of modern technology by reducing travel time by 50 percent within city limits by the year 2025.

Among the greatest transportation and traffic management challenges facing the city are:

- ***Weak traffic signal system*** -- Davao City’s Traffic Signalization System was implemented from 2004 to 2010, and many traffic lights are not in working order, raising the ire of the public and impairing safe traffic flow. The original system was never fully configured. Data generated by the system is retained by the solution contractor but is not accessible to city planners. A more dynamic system is required for improved congestion control.
- ***Limited integration of traffic signalization with emergency operations*** -- The PSSCC and the city’s traffic management unit are not able to control traffic signals to coordinate emergency response, for example, by opening traffic signals to accommodate ambulances or fire trucks during emergencies.
- ***Aging camera and traffic surveillance system***. The camera network coverage needs to be expanded and capabilities upgraded to accommodate license plate readers for contact-less violation management and fare collection. Additionally, cameras need to accommodate intelligent analytic functions for public safety operations performed by other departments utilizing the traffic camera video feeds.
- ***Limited parking management***. Davao has no paid parking program or violation protocol on city streets and consequently has essentially no source of revenue from parking fees. The absence of parking fines also negatively impacts traffic street traffic flow. The city seeks to introduce a paid parking regime, including smart or meter-less parking, with video and/or remote sensors to manage parking spots.

Specific elements of Davao’s smart city traffic management project include:

- ***Transport & Traffic Management Monitoring Center*** – new and upgraded ICT systems to monitor and manage all transport and traffic issues and concerns in the City
- ***Intelligent Traffic Signal System*** – more advanced traffic management system to augment the current 67 traffic lights and signals at key intersections, as well as address the growing challenges in the traffic situation in the city

- ***Intelligent Transportation System*** – leverage artificial intelligence and big data to manage and administer city traffic as well as the high priority bus system
- ***Secured Transport Terminals*** – video surveillance for commuter safety
- ***Integration with National Government Transportation Projects*** – interconnection and coordination with the interprovincial train system

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Davao City and USTDA signed a grant agreement on September 27, 2019, to fund a technical assistance project to initiate Davao’s smart city program. The expected duration is four months. Implementation of the smart city program is expected to require approximately 5 years.

PROJECT COST AND FINANCING

Implementation of the first two smart city projects is expected to require approximately \$60 million. The technical assistance funded by USTDA will result in a more reliable estimate. Davao City is expected to examine multiple sources of implementation financing for the anticipated smart city projects.

U.S. EXPORT OPPORTUNITIES

Potential U.S. exports for this smart city program include:

- **Hardware:** Sensors, field devices, digital cameras, cabling, routers, switches, servers, and workstations
- **Software:** video management/analytics, data integration, and traffic management
- **Services:** Enterprise architecture design, functional and technical design, implementation and deployment services, and smart city strategy

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Philippine Cloud Computing Center of Excellence		
	SECTOR	ICT
	SUBSECTOR	Data Center
	LOCATION	Quezon City, Philippines
	PROJECT VALUE	To be determined

PROJECT SUMMARY

The Philippine Department of Information and Communications Technology (DICT) is committed to moving much the government’s computing needs to the cloud. Many challenges are involved in migrating to the cloud. To resolve barriers and facilitate the adoption of cloud computing, DICT will establish a Cloud computing Center of Excellence (CCOE). USTDA is providing a technical assistance grant to help DICT to design and implement the CCOE.

PROJECT DESCRIPTION

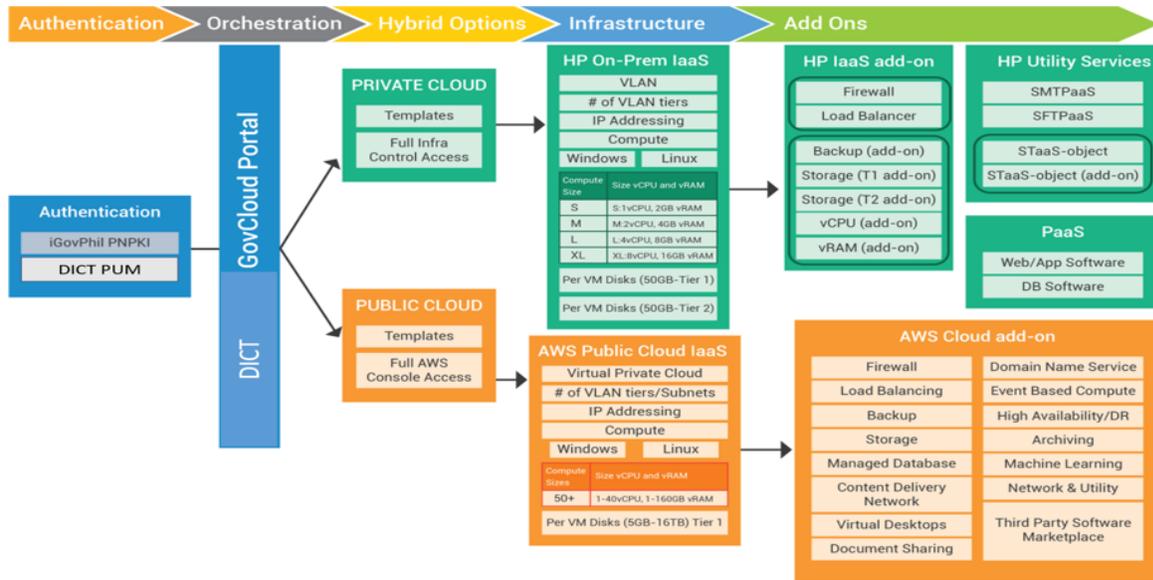
The Philippines adopted a Cloud-First strategy in early 2017 to accelerate the migration to shared computing facilities and cloud-based delivery of software and information technology (IT) services. The policy clearly states that government agencies shall adopt cloud computing as the preferred ICT deployment strategy for their own administrative use and delivery of online government services. The uptake of cloud services by the Philippines government departments, however, has been slow. DICT currently uses cloud computing at two government data centers (*Figure 1*).

The benefits of cloud for public sector transformation are many and well-documented, including:

- Increased, on-demand access – unilaterally provisioned, as needed, computing capabilities such as server time and network storage
- Resource pooling – share and serve computing resources with multiple consumers dynamically reassigning according to demand.
- Flexibility and elasticity –add and subtract capacity as needed in IT departments
- Cost savings –eliminate initial upfront expenditures for hardware, software, and development tools with cloud computing, monitor and manage resource usage, customers pay only for the computer resources they use
- Increased effectiveness –benefit users with a higher level of service and reliability, reduced the threat of network outages, and more immediate response to emergencies
- Greater resilience –enable agencies to manage risks better and reducing the impact of any single event

- Rapid implementation – launch projects more quickly as a result of more flexible procurement and certification processes, and increase the selection of services, tools, and features
- Energy efficiency – pool resources to allow departments to maintain their own dedicated IT infrastructure, leading to fewer servers and less energy consumption

Figure 1: DICT Cloud Computing Architecture²³



Cloud computing introduces a significant shift in how technology is obtained, used, and managed, including a new procurement process that trades capital expenses for variable expenses. In this respect, cloud is not merely a new technology - it also involves fundamental changes in business processes, budgeting, and solution innovation.

Migrating workloads to the cloud is a challenge for any organization, requiring extensive planning and structured methodologies to redesign and move workloads from private servers onto managed clouds, implement best practices, and monitor performance over time.

To assist the cloud adoption process, governments often establish a Cloud Center of Excellence (CCOE) to provide advisory services to help departments with their planning and migration:

*A Cloud Center of Excellence is a cross-functional team of people responsible for developing and managing the cloud strategy, governance, and best practices that the rest of the organization can leverage to transform the business using the cloud. The CCoE leads the organization as a whole in cloud adoption, migration, and operations. It may also be called a Cloud Competency Center, Cloud Capability Center, or Cloud Knowledge Center.*²⁴

²³ DICT

²⁴ Cloud Management Report 2017, http://click.cloudcheckr.com/rs/222-ENM-584/images/ccoe_whitepaper%20%282%29.pdf

Functions of the Philippine CCOE will include:

- Institute governance measures for cloud
- Simplify procedures and remove blockages to procurement
- Remove restrictions on the use of offshore services and data storage
- Provide advisory services to assist all departments in adopting cloud faster
- Work with security agencies to address key security concerns
- Negotiate commercial agreements with cloud providers to enable agencies to access their services with a single price book and standard terms and conditions
- Raise awareness on cloud best practices and showcase examples of early adopters to drive transformation
- Develop technical competency at DICT
- Network agency practitioners and encourage sharing and reuse of good practice.

USTDA and DICT have signed a grant agreement to fund the design and implementation of the Philippine CCOE.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

A CCOE is not a permanent agency, but rather, a team that facilitates migration to cloud computing solutions. The CCOE's functions will likely require the team to be in place for 3 to 5 years.

The technical assistance to design the CCOE, funded by USTDA, will commence in the first quarter of 2020 and have a duration of approximately 4 months.

PROJECT COST AND FINANCING

The anticipated costs of setting up and running the CCOE are expected to be small compared to the costs involved in computing. At this time, the Philippine government is estimated to spend approximately \$750 million to \$1 billion per annum on ICT equipment and services. Cloud computing would forego a sizeable percentage of this existing budget, being replaced by variable costs for cloud access and processing.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities exist for large, integrated cloud service providers. Cloud services are available according to different business models, including:

- Infrastructure as a service
- Platform as a service
- Software as a service.

Additional U.S. export opportunities exist from specialized applications for government agencies and functions, often marketed as software as a service.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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PEA Smart Grid		
	SECTOR	Energy / ICT
	SUBSECTOR	Smart Grid/Cities
	LOCATION	Chonburi, Thailand; Nationwide
	PROJECT VALUE	Est. \$110 million +

PROJECT SUMMARY

Following the successful implementation of numerous pilot studies, the Provincial Electricity Authority (PEA) of Thailand is moving forward with its plan for the wide-scale implementation of smart grid technologies. These technologies will be employed both in the field and at the PEA headquarters to ensure higher quality and more consistent and reliable service. The implementation will take place in stages, continuing through 2036.

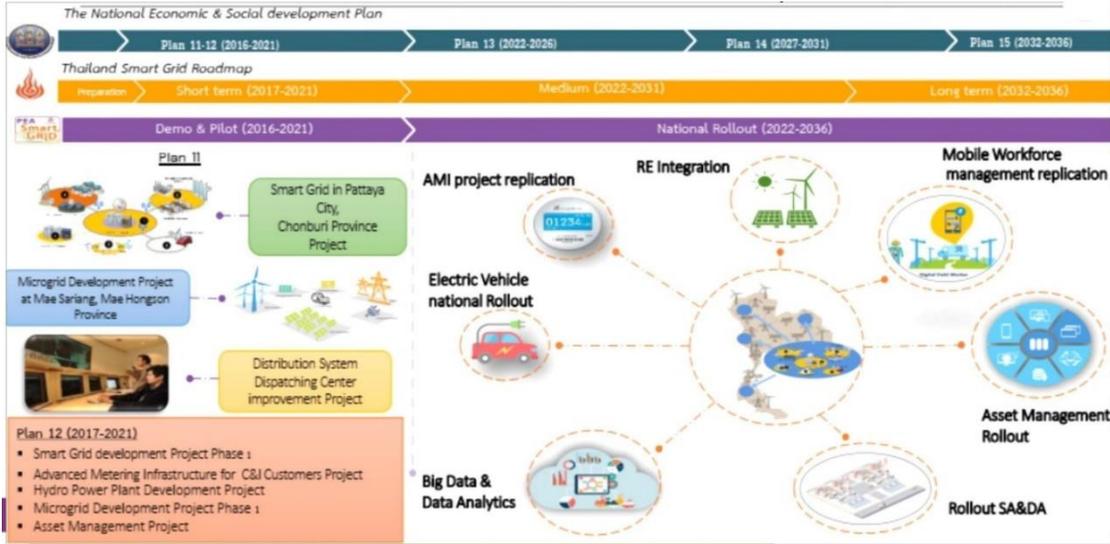
PROJECT DESCRIPTION

PEA is in the process of implementing its Digital Roadmap (2018-2022), with the aim of becoming a Digital Utility by 2022, in line with Thailand’s overall “Thailand 4.0” policy. Within this, the utility has taken steps to pilot smart grid activities with the goal of a larger, countrywide implementation by 2036, along with immediate steps to improve their own ability to manage the overall system (*Figure 1*). PEA has approximately 20 million customers nationwide.

At present, PEA is in the process of replacing and upgrading its SCADA system. The current system is set up with 12 control centers spread across the country, reporting to headquarters. However, the new system will transition from this decentralized model of operations to a centralized structure through the creation of a data center at PEA’s headquarters in Bangkok to handle all of the data points for each of the 12 control centers. PEA has finalized the bidders' list for this process and is waiting for the Board of Directors’ approval to sign the contract with the selected turnkey vendor.

Taking note of the importance of cybersecurity, PEA plans to augment this centralized SCADA system with tools to protect the network and ensure against unauthorized access. A tender will be issued to develop cybersecurity tools on top of the installed system using North American standards and specifications. These security tools will not only protect communications and data between headquarters and the control centers but also between headquarters and the substations. PEA is in the process of moving to unmanned substations that will require a robust monitoring and security system. Presently, 340 of 600 substations have been outfitted with remote capabilities.

Figure 1: PEA Smart Grid Roadmap²⁵



In addition to this system, PEA is concluding a smart meter pilot project in Chonburi that involved 120,000 Itron meters. This advanced metering infrastructure (AMI) pilot will be expanded on a turnkey basis under Phase II to target 700,000 residential customers and 70,000 commercial and industrial customers. The 700,000 customers will be focused on the larger cities that PEA serves, including Chiang Mai, Hat Yai, Korat, and Khon Kaen. Phase III of the AMI rollout will bring the total number of residential users up to 3 million, and all electro-mechanical meters will be phased out. Initially, the AMI infrastructure is planned to be installed on a turnkey basis. In the future, the AMI infrastructure may be tendered separately from the meters themselves.

Two pilot studies have been planned for remote communities to test microgrid applications. Following the completion of the pilot, a greater rollout is anticipated. In Mae Hong Son in the Northwest portion of the country and in the southern area of Hat Yai, similar projects will be installed. They will consist of the following infrastructure: 3 MW battery; 5x1 MW diesel generator; 4 MW solar PV; microgrid controller; communications package; and grid interface. These grids will help to ensure the continued supply of quality electricity to some of the more remote areas and support the development of large-scale infrastructure, including the new airport being built in the Hat Yai area.

Finally, grid improvements are planned for the overall PEA network and will be implemented following the installation of the SCADA system. A study will be undertaken to determine what elements need to be upgraded to support the smart grid system. Key areas that will be targeted include: upgrading overall IT systems, developing solutions to integrate renewable energy technologies into the grid better, upgrading conductors; and ultimately burying many transmission lines, particularly in cities labeled “smart cities.”

²⁵ Source: PEA

PROJECT STATUS AND IMPLEMENTATION TIMELINE

PEA is currently in the process of conducting pilot programs and larger-scale implementation of smart grid technologies and solutions. The upgrade of the SCADA system at headquarters is scheduled to start in late 2019, following the final Board of Directors' approval, with the turnkey vendor provider having already been selected. Following the installation of this system, it is anticipated that a follow-on opportunity to enhance the cybersecurity of the system will be tendered.

The large-scale replacement of meters with smart meters will begin in 2020. After the completion of the pilot program in Chonburi, Phase II of this program will target 700,000 residential customers and 70,000 commercial and industrial facilities. A public hearing will be scheduled ahead of the commercial and industrial rollout. Phase III will then target an additional 2.3 million residential users, with the remaining 17 million PEA customers retaining their digital meters. Phases II and III will get rid of electro-mechanical meters.

The pilot studies for microgrids in Mae Hong Son and Hat Yai will begin in 2020, following the completion of public hearings. The Mae Hong Son project is targeted for Q1 of 2020, with Hat Yai to follow soon thereafter. Wider scale implementation of these microgrids will be evaluated at the completion of the pilot studies.

PROJECT COST AND FINANCING

The overall cost for the smart grid implementation is being developed and will be based on the scale of implementation. The SCADA system upgrades and microgrid pilot project costs will be determined based on bids submitted by vendors. A budget is being determined for the procurement of the necessary AMI metering infrastructure to target the three million residential customers and for the 70,000 commercial and industrial customers. Customers will not see an increase in cost in their down payment to PEA for a smart meter when installing AMI. The overall cost for PEA's smart grid implementation will be passed through to the customers as part of the overall tariff structure.

U.S. EXPORT OPPORTUNITIES

PEA's smart grid implementation activities will take many forms, including installation of a SCADA server, replacing meters with AMI, cybersecurity upgrades, unmanned substations, grid upgrades, and community microgrid solutions. Itron, based in the U.S., provided the smart meters for use in the AMI pilot project in Chonburi. Additional elements, including electric vehicles and the existing architecture and infrastructure to support them, will come later.

Specific opportunities for companies to become involved with PEA's smart grid activities include:

- Inverters
- Batteries

- AMI and associated infrastructure
- Communications equipment
- Cybersecurity solutions
- Racking for solar panels
- Servers
- Remote cameras and sensors

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Thailand Central Rail Station Smart City		
	SECTOR	ICT
	SUBSECTOR	Smart Cities
	LOCATION	Bangkok, Thailand
	PROJECT VALUE	\$5 billion

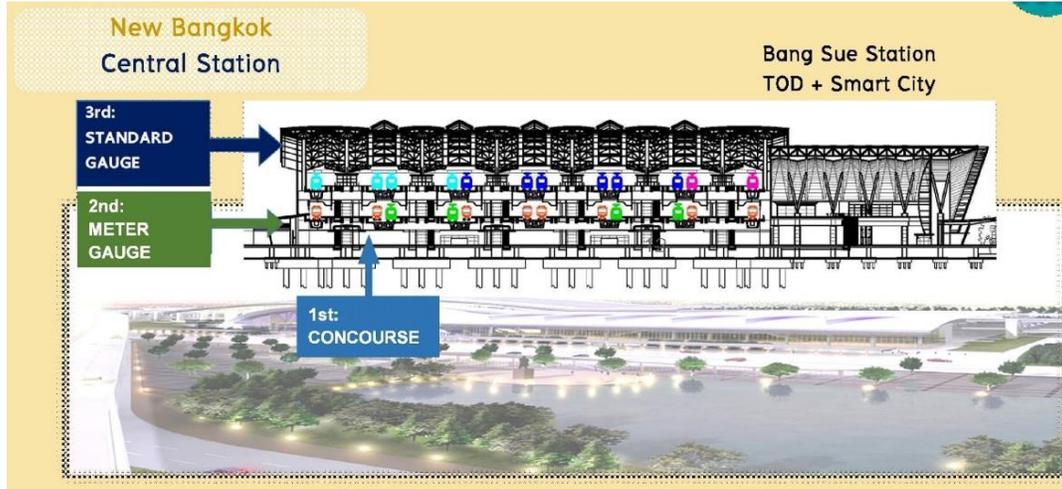
PROJECT SUMMARY

As Thailand continues its massive rail network improvement plan, it is constructing a new central rail station for \$366 million that will serve as the hub for rail movements throughout the country. The area surrounding the station has been planned as a smart city and will be developed using integrated technologies to enhance commercial and residential activities. The station will open in 2021, with areas of the smart city development targeted for completion at the same time and its completion by 2031. Overall, the smart city is expected to require approximately \$5 billion.

PROJECT DESCRIPTION

Thailand is in the process of building a new central rail hub in Bangkok, the Bang Sue Grand Station (*Figure 1*), as part of its overall network expansion and modernization effort. The new hub will be more centrally located and offer easier access to areas within Bangkok and outside of Bangkok. It will also connect with existing and planned urban rail transport systems, allowing for easier access to and from the station. The new rail hub will offer connections to 10 rail lines, three high-speed rail routes, and the urban transport lines (*Figure 2*).

Figure 1: New Bangkok Central Station²⁶



To support this new station, the State Railway of Thailand (SRT) will develop the 372 hectares surrounding it into a smart city community based on smart growth planning principles. The area will be divided into seven zones, providing areas for a smart business complex, MICE areas and a sports complex, government offices, commercial areas, residences, and green spaces.

Figure 2: Bang Sue Central Station Construction²⁷

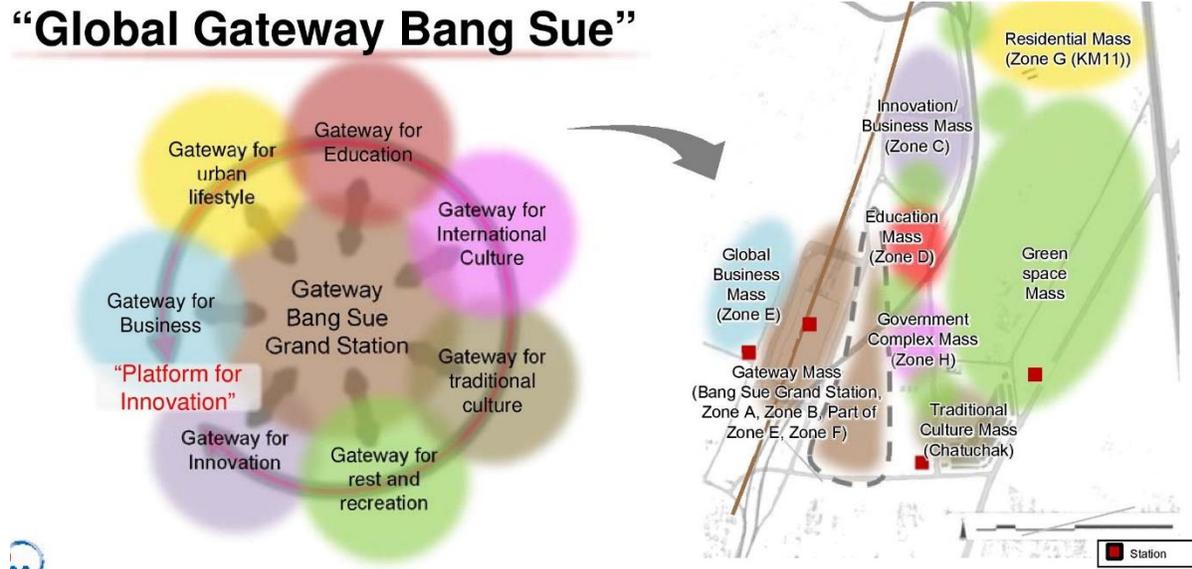


²⁶ Ministry of Transportation

²⁷ Unique Engineering and Construction

Figure 3: Global Gateway Bang Sue Construct²⁸

“Global Gateway Bang Sue”



The smart city will be developed in line with the master plan that is being finalized. Within that, it will target seven different “smart” elements to be incorporated into the design and construction of the area: smart environment, smart economy, smart energy, smart governance, smart living, smart mobility, and smart people.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The master plan is scheduled for presentation to SRT in November 2019. It was funded and undertaken by Japanese planning firms. SRT will meet then with the Japanese team and devise a smart city implementation plan based on the Plan’s contents.

The first phase of this development is anticipated to be the commercial and office buildings that are directly associated with the transportation facility. Phase one is targeted for 2017 to 2024. The second Phase, extending through 2029, will develop a center for the meetings, incentives, conferences and exhibition (MICE) center, a sports complex, retail facilities, and residential and office space. Finally, Phase three will add additional housing units through 2031.

The Bang Sue Grand Station will open in January 2021 for red line operations, with testing scheduled for the second half of 2020. Once the rail station is operational, significant effort will be made to finish the smart city development quickly. A fully developed smart city across all 372 hectares is planned for 2031, with segments of the city being developed prior to that.

²⁸ JICA

PROJECT COST AND FINANCING

SRT will work with a financial advisor to develop a Special Purpose Vehicle (SPV) that will form a joint venture tasked with managing and operating the smart city. As this would be the first time that an SPV would be used in Thailand, SRT is seeking guidance from advisors regarding its establishment. Once the SPV has been established, implementation will begin in detail in line with the master plan that has been developed.

The overall cost of developing the Bang Sue Grand Station is \$366 million, while the development of the surrounding smart city is anticipated to be a total of \$5 billion through 2031. Financing for the smart city will be driven by a public-private-partnership model, with a joint venture company made up of the SPV and the private sector, developing and operating the city for 30 years under a build-operate-transfer (BOT) contract. At the conclusion of the contract, the ownership of the property development will revert to SRT ownership.

U.S. EXPORT OPPORTUNITIES

Significant opportunities exist supporting the development of Thailand's new central rail station for U.S. firms offering smart city solutions. The area around the new station is being built from the ground up, with no existing framework, and planning for the integration of smart technologies and processes has already begun through the Master Plan. Numerous opportunities to participate in the project are available to U.S. firms with appropriate technologies and requisite experience. Initially, firms with experience in providing financial advisory services will be greatly in need. Possible opportunities for U.S. firms operating in this space include:

- Financial services
- Internet backbone
- Data centers and open data platform
- Smart meters/AMI
- Energy management system
- Wireless telecommunications equipment/cellular network
- Intelligent transportation solutions
- Smart street lights
- Smart home and building systems
- Renewable energy technologies
- Traffic management systems
- Cybersecurity solutions
- Building controls
- HVAC systems
- Water, wastewater and air monitoring systems
- Smart grid solutions
- Smart elevators
- Battery storage solutions
- Healthcare solutions

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Da Nang Smart City Program		
	SECTOR	ICT
	SUBSECTOR	Smart Cities
	LOCATION	Da Nang, Vietnam
	PROJECT VALUE	\$95 Million

PROJECT SUMMARY

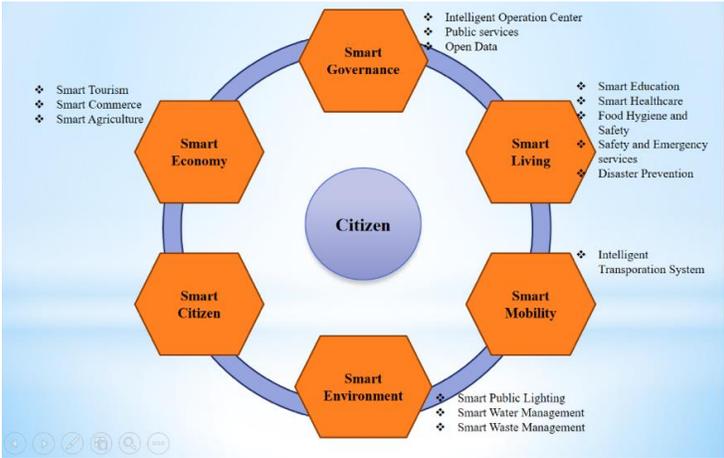
The Da Nang Smart City Program is an ambitious plan by the municipal government to implement, by 2030, six key smart city elements:

- Smart Governance
- Smart Living
- Smart Mobility
- Smart Environment
- Smart Citizen
- Smart Economy

PROJECT DESCRIPTION

Da Nang’s Smart City Program focuses on six sectors to enhance the livability of the metropolitan area (*Figure 1*).

Figure 1: Da Nang Smart City Key Elements²⁹



²⁹ Da Nang People’s Committee

Da Nang's Smart City Program is divided into three clearly defined phases:

By 2020: Smart City Preparedness

The goal of this phase is to establish smart infrastructure and databases that serve as a shared platform for smart city applications. Some of the main program elements for this initial period are:

- ***Expand the Metropolitan Area Network (MAN)*** -- connecting all municipal agencies and departments. The city's data center will expand the capacity to deploy databases and smart applications.
- ***Form a Centralized, Multitasking, Supervising, and Operating Center (Phase 1)*** -- connect and analyze interdisciplinary data, provide socio-economic and urban indicators, and support decision making on smart city management and operations, especially in emergency situations.
- ***Upgrade the Traffic Monitoring System*** -- install smart cameras, centralized and autonomous traffic light control, online traffic portals, and centralized environmental monitoring systems (sea, river, lake, waste water, and air).
- ***Develop Background Databases (Commercial, Residential, Institutional, GIS)*** -- begin to assemble specialized data by building a shared, interconnected data platform (applicable to land, construction, environment, and labor data); initiate a system to trace the origins of certain essential foods in Han market.
- ***Pilot Smart Tourist Cards***
- ***Upgrade Education Data*** -- including automation of the databases of teachers, students, and electronic transcripts.
- ***Improve Electronic Health Records and Database*** -- pilot one smart hospital.
- ***Pilot a Smart City Model in Lien Chieu District*** -- add several smart urban clusters including High-Tech Park, Software Park No. 2, Centralized IT Area.

2020 to 2025: Smart Municipal Applications

The objective of this period is to improve and "smarten" the applications that will have been developed and piloted in the previous stage to serve businesses, citizens, and visitors. The intent is to transform traditional urban management to succeed in the digital era. Main program elements during this growth period are:

- ***Finalize the Centralized, Multitasking Monitoring, Operating, and Processing Center Piloted in Phase 1*** -- integrate data analysis and smart prediction functions to serve data-based urban management.
- ***Deploy Cloud Computing and Other New Technologies to Da Nang Data Center*** -- ensure big data services, information security, and disaster backup.
- ***Implement Environmental Monitoring System*** -- complete chain traceability supporting system.
- ***Complete Most Specialized Databases*** -- ensure information sharing among municipal departments as a basis to create smart applications.
- ***Finalize Deployment of Sector Aids*** -- smart travel cards, electronic learning materials, virtual labs, smart classrooms, smart hospital model, and online medical care.

- **Complete Model Smart City in Lien Chieu District** – also complete smart urban clusters in technology zones; evaluate the model and replicate in other districts.

An example of a smart municipal application is a smart water system. The following is a sample statement of objectives for such a system:

In the context of rapid urbanization, climate change, and environmental degradation, efficient water resource utility is crucial to enhance the quality of life while ensuring sustainability in Da Nang. The city aims to improve water supply, drainage, and wastewater treatment for higher water quality and reliability and lower operational costs by:

- *Upgrading the water network*
- *Installing a Supervisory Control and Data Acquisition (SCADA) system*
- *Implementing a smart water management platform*
- *Integrating data and analysis using the platform solution*

By 2030: Smart Community Applications

The diverse, widespread ICT infrastructure and the data warehouse obtained during the earlier phases will be the main driving forces to promote the development of a smart city. The program will take advantage of innovative data-based entrepreneurship, analytic applications such as machine learning, artificial intelligence, and virtual reality. These advanced technologies will be applied to support authorities, businesses, and citizens to improve management and administration efficiency, streamline operations, enhance competitiveness, and create new motivations for development.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Da Nang Smart City Program was announced in 2018. It is presently in its early stages.

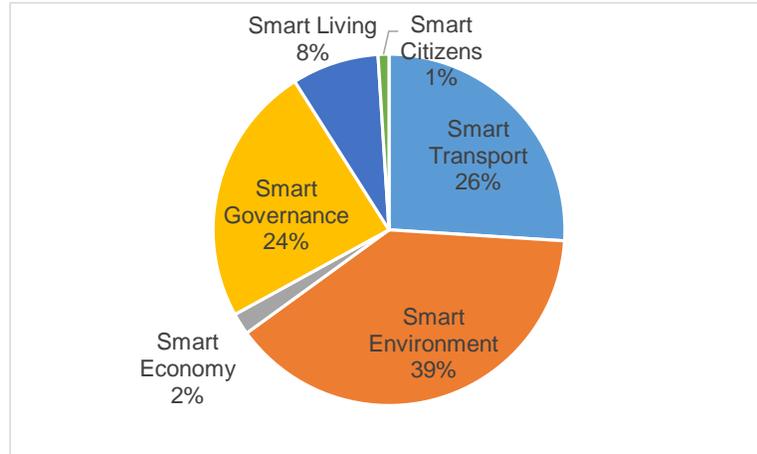
The three phases, detailed above, are programmed over the implementation timeline to 2030:

- By 2020: Smart City Preparedness
- By 2025: Smart Municipal Applications
- By 2030: Smart Community Applications

PROJECT COST AND FINANCING

The Da Nang city government has estimated the budget for implementing the Smart City Program to be VND2.14 trillion (approximately \$95 million). This budget covers the first two phases of the program through 2025 (*Figure 2*). Implementation costs beyond 2025 have not yet been estimated.

Figure 2: Da Nang Smart Cities Budget – Phases 1 and 2³⁰



U.S. EXPORT OPPORTUNITIES

Considerable U.S. export opportunities exist for basic ICT infrastructure to implement the smart city program, including:

- Smart Communications Technology Layer (e.g., fiber, point to point, wireless)
- Software and Licenses (cloud computing, big data management systems, smart city platform solutions)
- Cloud Infrastructure: servers, hardware
- GIS System
- Data Center / Storage
- Command and Control Center

Additional export opportunities exist for each smart application, for example:

- Smart Mobility: intelligent traffic control, smart parking, intermodal Smart Signage, and Smart cards, electric vehicles
- Smart Water Utility: smart metering, supervisory control, and data acquisition
- Emergency and disaster detection and management

³⁰ Da Nang People's Committee

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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3 TRANSPORTATION INFRASTRUCTURE

Sector Overview: Transportation Infrastructure

To meet the infrastructure needs, maintain growth momentum, and respond to climate change, \$26 trillion will be needed across developing countries in Asia between 2016 and 2030. This translates to annual infrastructure investments of approximately \$1.7 trillion per year (*Table 1*). More than 30 percent of that amount will be to support transportation infrastructure (*Table 2*). Investments in transportation infrastructure have been significant to date, but far below necessary levels for the Indo-Pacific region’s continued economic growth and its population’s demand.

*Table 1: Infrastructure Investment Needs in the Asia Pacific Region (2016 – 2030)³¹
(\$B, in 2015 prices)*

	Baseline Total	Percent of GDP	Climate Adjusted Total	Percent of GDP
Central Asia	33	6.8	38	7.8
East Asia	919	4.5	1,071	5.2
South Asia	365	7.6	423	8.8
Southeast Asia	184	5.0	210	5.7
The Pacific	3	8.2	3	9.1
Asia & Pacific	1,503	5.1	1,745	5.9

*Figure 2: Infrastructure Investment Needs by Sector (2016 – 2030)³²
(\$ billion in 2015 prices)*

	\$ Billion	Percent of Total
Power	995	57
Transportation	558	32
Telecommunications	157	9
Water & Sanitation	35	2
Total	1,745	100

³¹ Ibid.

³² Ibid.

New Technologies for Sustainable Transportation

The use of and planning for the incorporation of technologies and solutions that will not only improve efficiency but also minimize the impact of transportation on the environment is significant in the Indo-Pacific region. Increased use of biofuels (both for aviation and road transport), electric vehicles and supporting infrastructure, expanding options for urban transport, port automation, and integration of intelligent transportation systems (ITS) into city planning, are all contributing to more sustainable transportation. Ride-sharing applications also are becoming increasingly popular and are an effective method to reduce the number of vehicles on the often-congested roads in the region. In some areas, however, ride-sharing is subject to regulatory restrictions.

The countries included in this Resource Guide are all targeting new technologies to support greener development and greater transportation efficiencies. Two significant examples are the Hyperloop in India and the construction of the new “forest” capital city in Indonesia (*Figure 1*).

Figure 1: India’s Hyperloop and Indonesia’s New Capital City³³



Financing Transportation Infrastructure

As countries look to finance the infrastructure investments described above, increasingly, they are looking to the private sector to supply a portion of the necessary capital. Many of the projects highlighted in this Resource Guide aim to be developed under a Public-Private-Partnership (PPP) model, a method of financing that is increasingly popular. In 2017, in the transportation sector at a global level, private participation in infrastructure (PPI) investments nearly doubled from 2016. Railway projects also overtook roads as the primary subsector for private sector investment in transport.

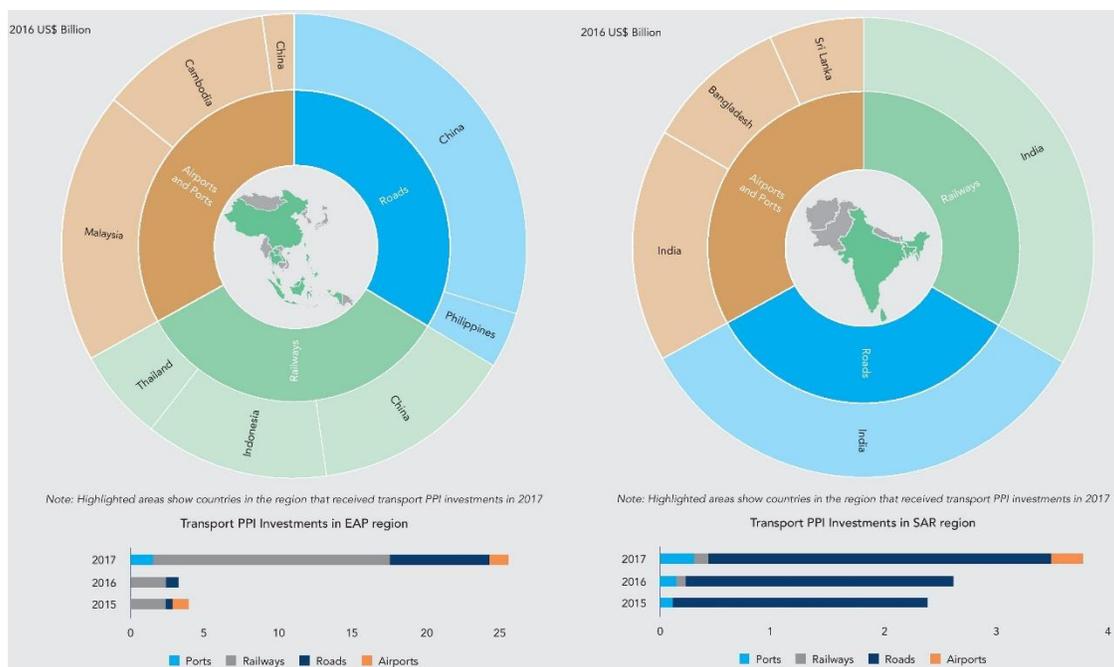
Within the Indo-Pacific region, India, Indonesia, Malaysia, the Philippines, and Thailand have all received significant private sector investments in the transport sector. These investments have included airports and marine ports, roads, and railways (*Figure 2*).

³³ Olivesgreen, NewsHub

Aviation

As GDP growth rates rise across the region, and tourism continues to boom, each of the countries represented in this Resource Guide is working to develop and enhance its aviation infrastructure to support both domestic and international sources of revenue. Existing airports are being expanded, new airports are being constructed, and new technologies are being implemented to more efficiently utilize current capacity. This growth represents a substantial opportunity for US exporters to target aircraft sales, design services, communications and navigation technologies, and safety and security solutions.

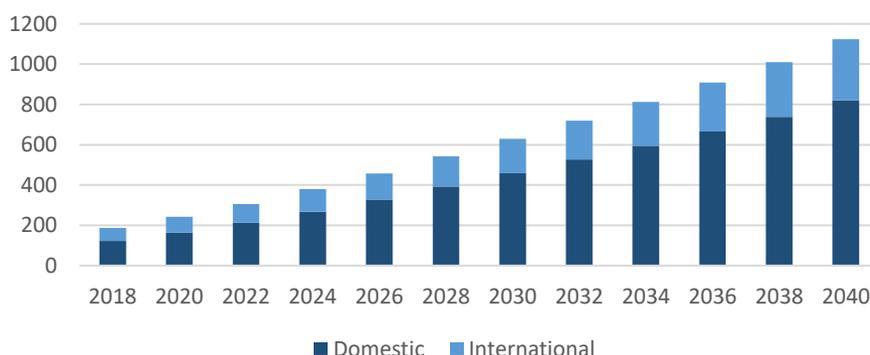
Figure 2: Private Sector Investment in the Transport Sector in the Indo-Pacific Region (2015 – 2017)³⁴



In India, which recently became the third-largest aviation market, behind the United States and China, in terms of passenger throughput, the government is embarking on a large-scale plan to bring aviation “to the masses.” The Indian government has embarked on a regional connectivity plan that will allow greater access to air travel for a market that has shown double-digit growth recently (*Figure 3*).

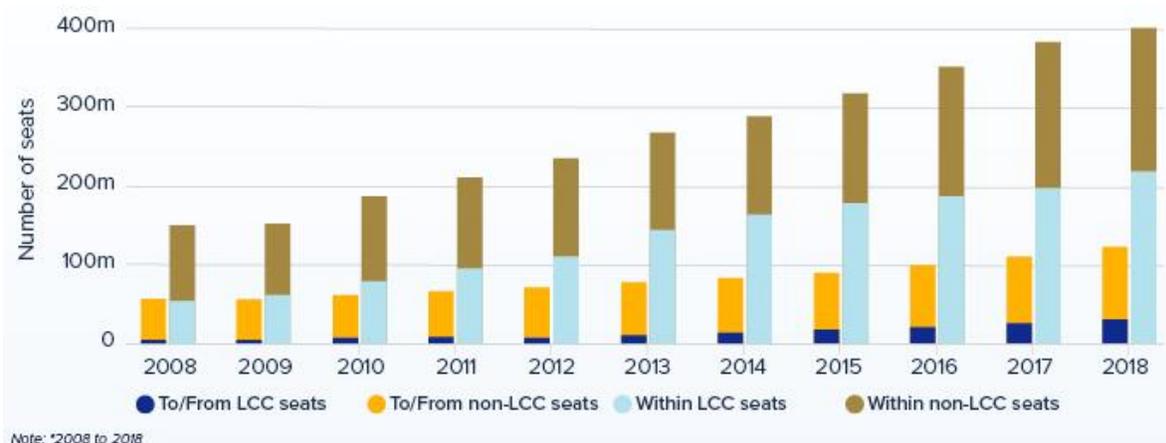
³⁴ The World Bank

Figure 3: Total Air Passengers to/from/within India (millions)³⁵



In Southeast Asia, growth in air travel has largely been driven by the availability of low-cost carriers (LCC) and increasing passenger and cargo traffic with China. Seat capacity in the region has grown from 200 million in 2008 to nearly 530 million in 2018, with LCCs representing approximately 200 million seats of that growth (Figure 4). For the five Southeast Asian countries represented in this Resource Guide, the overall domestic passenger market in 2018 was over 220 million annual passengers, with Indonesia accounting almost half. LCCs accounted for at least 50 percent of the domestic markets and between 30 and 40 percent of the international market in each of the countries.

Figure 4: Southeast Asia Low-Cost Carrier and Full-Service Carrier Annual Seat Capacity³⁶

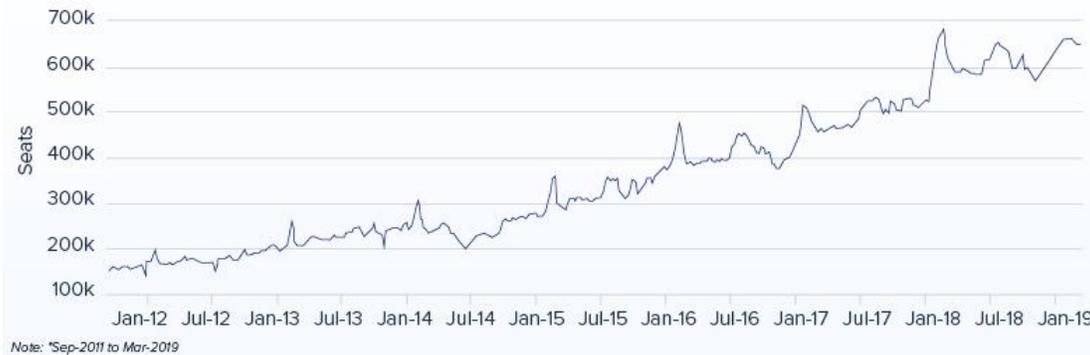


Air transport links between Southeast Asia and China have quadrupled since 2011 (Figure 5). Because of growing domestic traffic, there is an urgent need for improved infrastructure to support demand.

³⁵ Vision 2040 Civil Aviation Industry in India; FICCI and KPMG

³⁶ CAPA – Centre for Aviation; OAG

Figure 5: Southeast Asia – China Weekly One-Way Seat Capacity³⁷
(September 2011 – March 20019)



Due to increasing traffic volumes from both international and domestic sources, all of the civil aviation authorities in the region are working to enhance capacity through efficiency. Using collaborative decision making (CDM) and enhancements to air traffic management capability, each country will be able to better manage its airspace and the growing number of aircraft within. As the regional market continues to grow, each country is adapting to new challenges and technologies relevant to their air transport needs. Key among these is the increasing prevalence of unmanned aircraft systems (UAS, i.e., drones). At the same time that regulatory structures are being developed to manage UAS activities, infrastructure, including vertiports, is being built to incorporate them into daily life better.

Surface Transportation

In total, Asia has more than 79,000 kilometers of a rail network, either planned or under construction. More than half of this amount is in the Indo-Pacific region (Table 3). The region is rapidly developing new high-speed rail, urban transport, and traditional freight rail, along with associated infrastructure such as signaling and rolling stock purchases. Each of the countries represented in this Resource Guide has significant rail investments underway.

Table 3: Indo-Pacific Region – Upcoming Rail Projects and Investments³⁸

Country	Upcoming Rail Projects, km	Upcoming Project Cost, \$ billion
India	37,882	284.2
Indonesia	2,200	25.0
Malaysia	1,180	28.4
Philippines	1,800	17.1
Thailand	4,308	50.0
Vietnam	550	19.0
TOTAL	47,920	423.7

³⁷ Ibid.

³⁸ Asia Pacific Rail 2020: The Future of Rail in Asia

For road transport, between 2005 and 2015 (where data was available), the use of motor vehicles increased significantly, with the Indo-Pacific region seeing a 13 percent per year expansion³⁹. Motor vehicle fleets are doubling every 5-7 years across cities in Asia. With this growth comes increased traffic congestion and greater possibility for accidents, both of which have a negative effect on economic growth. Estimates⁴⁰ suggest road congestion results in a 2-5 percent reduction in GDP for Asian economies annually as a result of lost time and higher transport costs. Further, up to 80 percent of the air pollution in the region's cities is attributable to transport.

To manage these challenges, the countries in the region and others supporting their economic development are exploring a variety of solutions. These options include the expansion of public transportation systems, the use of non-motorized transport, integrated urban transport planning, demand management to limit congestion, and utilizing traffic engineering/management systems. When combined with the expanding network of rail, roads, highways, and toll-roads being constructed across the region provide numerous opportunities for US companies to support further surface transportation development.

Figure 6: Road Congestion in the Philippines⁴¹



Maritime Transportation

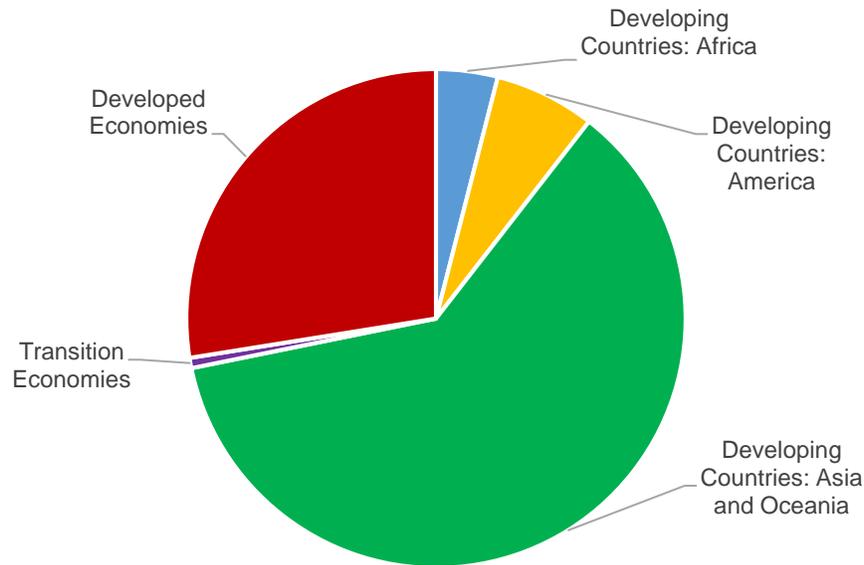
Globally, in 2017, there was 753 million twenty-foot equivalent (TEU) of containers handled by ports globally, the overwhelming percentage (61 percent) of which were in Asia and Oceania (including China) (*Figure 7*). The region enjoyed a 6 percent rate of growth over 2016, the highest rate in the past five years.

³⁹ OECD

⁴⁰ ADB

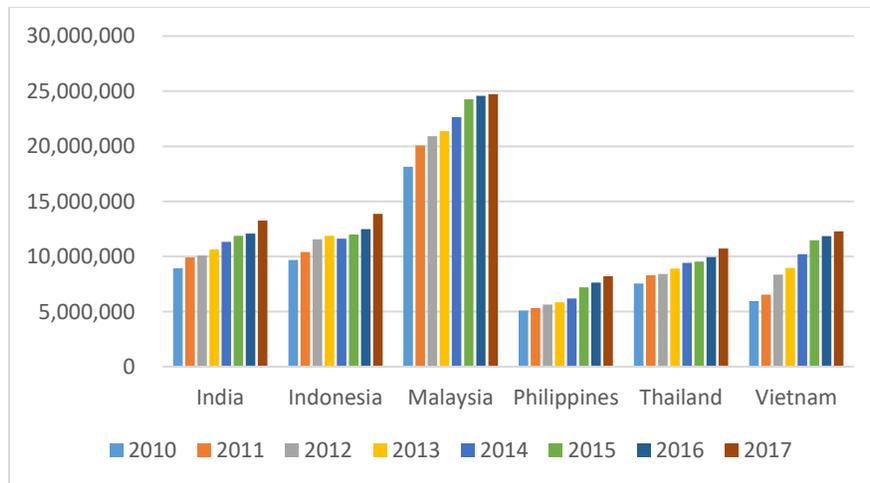
⁴¹ Global Road Safety Partnership

Figure 7: Containerized Port Traffic (million TEU) by Groups of Economies (2017)⁴²



Each of the countries showcased in this Resource Guide has shown steadily increasing TEU throughput growth from 2010 to 2017 (Figure 8).

Figure 8: Annual Container Port Throughput (TEU) for Selected Economies, 2010 – 2017⁴³



Because of the increased demand for containerized cargo, shipping lines are using larger and larger vessels. Larger vessels require the expansion of ports to accommodate their size and draft. At the same time, archipelagic countries like the Philippines and Indonesia rely heavily on sea traffic as a cost-effective means for domestic shipment of cargo and passengers. All of these factors, along with increasing volumes of gas and other fuel being imported through maritime terminals, combine

⁴² United Nations Conference on Trade and Development (UNCTAD)

⁴³ Ibid.

to require significant investments in infrastructure by port operators. This Resource Guide highlights multiple opportunities for US firms to become involved with port sector development and expansion across the Indo-Pacific region.

Summary

The Transportation sector in the Indo-Pacific region is an attractive opportunity for U.S. interests. Demographics and continued economic development favor continued strong growth in transportation for both people and cargo. The region is a leader in marine transport. Air and rail transport demand is growing rapidly with passenger incomes and the development of manufacturing and service industries, which create additional cargo shipment demand. Road transport, too, is growing, and many cities in the region are plagued by traffic jams and resulting pollution due to insufficient roadway capacity for the rapidly growing number of vehicles using them. U.S. technology capabilities fit well to support Indo-Pacific growth in Transportation.

Bhanupali-Bilaspur-Beri New Rail Line		
	SECTOR	Transportation Infrastructure
	SUB SECTOR	Railways
	LOCATION	Bhanupali, Punjab Bilaspur & Beri, Himanchal Pradesh
	PROJECT VALUE	\$1.03 billion

PROJECT SUMMARY

The project involves the construction of a new 63.1-kilometer railway line from Bhanupali to Beri via Bilaspur in the states of Punjab and Himachal Pradesh. It was declared a national project on August 8, 2007, by the Union Government due to its strategic importance. It was later approved by the Railway Board in April 2008. The project is 34 percent complete or under construction, with the balance yet to be put to bid or commence. The project is expected to be operational in 2026.

PROJECT DESCRIPTION

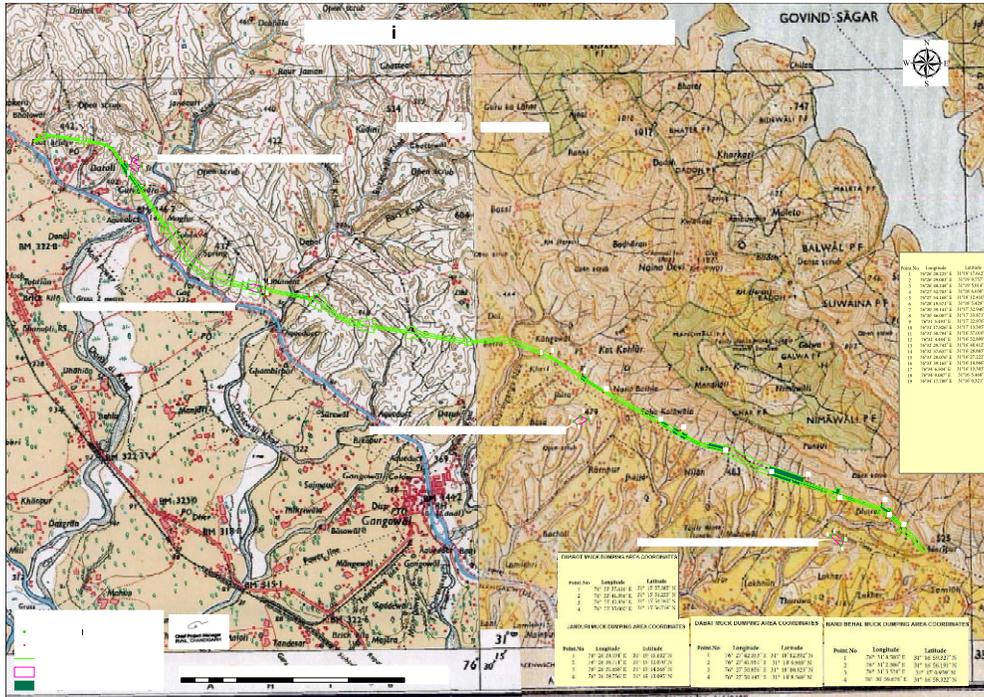
Indian Railways is among the world’s largest rail networks, encompassing 115,000 km, including the daily operation of 12,617 passenger trains, 7,421 freight trains, 7,349 stations, and transporting 23 million travelers and 3 million tonnes (MT) of freight. India's railway network is recognized as one of the largest railway systems in the world under single management. Investor-friendly policies have been formulated to attract investments and foreign direct investment to improve the infrastructure for freight and high-speed trains. At present, several domestic and foreign companies are looking to invest in Indian rail projects. In the next five years, the Indian railway market is expected to be the world’s third-largest, accounting for 10 percent of the global market.

Across this network, priority areas for investments include: enhancing network capacity and upgrading rolling stock in the northeast, complete electrification of all routes, creating dedicated freight corridors and high-speed corridors, replacement and maintenance of old tracks, upgrading stations, and creating new stretches of the railway and related infrastructure in the frontier areas.

The Bhanupali-Bilaspur-Bena new rail line project is designed to connect the state of Himachal Pradesh with the rest of the railway network. The construction of this 63.1 km line, which includes significant bridges and tunnels, is 34 percent complete. The project will connect the rest of the country to the national frontier. It will be implemented in phases, with Phase I composed of the Bilaspur-Dharot section (20 km), while Phase II is the remaining 43 km. Earlier, the project was

being executed by Northern Railways (NR) but was later transferred to Rail Vikas Nigam Limited (RVNL) in December 2014.

Figure 1: Alignment of the Bhanupali-Bilaspur-Bena Rail Line⁴⁴



Initial bids and contracts were issued for the railroad section stretching from the 0 km mark to the 20 km mark. This included the following:

- The bids for the construction of foundations, substructure and superstructure, river training/ protection activities, earthwork, and allied works for five important railway bridges for the project were opened in September 2019. This work is expected to be completed in 2021, at an estimated cost of \$104 million (10 percent of project value).
- The bids to provide the related project management consultancy (PMC) services were opened in October 2019. The work is expected to be completed in 36 months at an estimated cost of \$2 million (0.2 percent of project value).
- In February 2019, contracts worth \$570,000 were issued for the detailed design and project management consultancy (PMC) services for related minor bridges, tunnels, and structural formations. The period of completion of this work is 38 months, in addition to six months of defect liability period (DLP) testing.
- In April 2019, a contract for the construction of seven tunnels and related minor bridges and associated infrastructure worth \$66 million was awarded.

⁴⁴ Source: <http://forestsclearance.nic.in/>

- In June 2019, bids were invited for the construction of foundations, substructures and superstructures along with river training/protection activities and supporting civil engineering for five railway bridges over Donal Khad, Dabatwali Khad, Balaknath Khad, Dharot I Nala and Dharot II Nala, with the bids to be awarded in October or November 2019. The work is expected to be completed in 24 months, at an estimated cost of \$104 million. Recently, bids were invited for related project management consultancy (PMC). The last date for bid submissions is in October 2019. The work is expected to be completed in 36 months, at an estimated cost of \$2.26 million.

Bids and contract awards for the remaining 43 kilometers of railroad, infrastructure, technical work/engineering, and project management will commence shortly.

Contact details for organizations already involved with the construction of this line include:

Consultant	Contact Details	Scope of Work
RITES Limited	RITES Bhawan, No.1, Sector 29 Gurgaon, Haryana, India Ph +91 124 2571666 www.rites.com	Detailed investigation of the land acquisition proceedings
AECOM India Private Limited	5th Floor, Tower-B, Building No-10, DLF Cyber DLF Phase-II Haryana, India Ph +91 124 4830250 www.aecom.com	Providing detailed design and project management consultancy (PMC) services for the construction of tunnels and works related to minor bridges and formation on approaches of such tunnels from 3.5 km to 20 km of the project.
Geological Survey of India (GSI)	27, J.L. Nehru Road Kolkata, West Bengal, India Ph +91 33 22861676 www.portal.gsi.gov.in	Detailed geological investigation of the site for construction work
Data Technosys (Engineers) Private Limited	T. F. – II, Asha Apartments-I, 19, Ram Mohan Rai Marg Lucknow, Uttar Pradesh, India Ph +91 522 404303 http://datatechnosys.com/	Providing project management consultancy (PMC) services for the construction of roadbed, major and minor bridges including fabrication, erection, and launching of open web steel girders from 0 km to 3.5 km, general electrical works, and other allied works
Department of Anthropology, Panjab University	Sector 14 Chandigarh, Punjab, India Ph +91 172 253 4299 www.puchd.ac.in	Preparation of social impact assessment report

PROJECT STATUS AND IMPLEMENTATION TIMELINE

This project is expected to be completed in December 2026. It was declared a national project in 2007 and gained Railway Board approval in 2008. Through 2016 to 2017, civil engineering, geotechnical surveys, project management consultancy, and tunnel work were awarded for approximately 20 km of the 63 km project – nearly 34 percent of the total project distance. The RVNL has initiated the process to commence bidding and planning for the remainder of the project distance.

PROJECT COST AND FINANCING

The cost of the project is \$1.03 billion or about \$16.3 million per kilometer. The Ministry of Railways (MoR), and the State Government are funding the project in a 75:25 ratio. Part of the funding will be provided by the Ministry of Finance (MoF).

U.S. EXPORT OPPORTUNITIES

U.S. firms will have opportunities to bid for EPC contracts for the majority of the project, 66 percent of which has not been built or commenced construction. In addition, opportunities exist in the areas of station development, track safety and maintenance equipment, mechanical and electro-mechanical signaling equipment, parking and depot systems, communication modules, automatic gate equipment, dynamic track stabilizer machines, energy regulators, switch and control gears, railway track scientific instruments, and isolators.

Rail projects will require local representation, either through an agent, distributor, manufacturing partner, or associate. This will also help U.S. companies position their tenders for success, sustain cost competitiveness, and meet local requirements.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Rail Vikas Nigam Limited (RVNL) Plot No. 25, First Floor, August Kranti Bhawan, Bhikaji Cama Place R. K. Puram 110066 New Delhi, India www.rvnl.org</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Kevin Toohers ktoohers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Renie Subin renie.subin@trade.gov</p>

Chennai Metro Rail Phase II		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Urban Transport
	LOCATION	Chennai, Tamil Nadu, India
	PROJECT VALUE	\$10.15 billion (excluding rolling stock)

PROJECT SUMMARY

Chennai Metro Rail Limited (CMRL) is the special purpose vehicle (SPV) formed by the Government of India (GoI) and Government of Tamil Nadu (GoTN) with equal equity participation for a two-phase implementation of the Chennai metro project. Phase I is operational and nearly complete, while Phase II will be completed by 2026 and include 116 stations over 118 kilometers. The cost for Phase II is estimated at \$10.14 billion.

PROJECT DESCRIPTION

The Chennai Metro Rail Limited (CMRL) is a joint venture between the Government of India and the Government of Tamil Nadu, which built and operates the Chennai Metro, serving the city of Chennai, Tamil Nadu. The system commenced service in 2015 after partially opening the first phase of the project. Phase I was finally commissioned completely in February 2019. The current operational network consists of two color-coded lines with a length of 45 km. It is the third-largest metro system in India after the Delhi Metro and the Hyderabad Metro.

Phase I – Mostly Completed: This 45 km transit system is now operational, encompassing 32 stations and 2 corridors – corridor 1 has a length of 23.1 kilometers, while corridor 2 is 22 kilometers. The system has a mix of underground and elevated stations and uses standard gauge rails. The service operates daily between 04:30 and 23:00, with a varying frequency of 10 to 20 minutes. As of August 2019, about 111,000 people use the service on a daily basis. There are 42 trains with four coaches each (168 coaches) operating in this first phase. It has a depot at Koyambedu with 15 km of ballastless tracks, along with maintenance workshops, stabling lines, a test track, a washing plant for the trains, an Operational Control Centre (OCC), ultrasonic bird repellents and bird strobe lights to prevent birds from entering the depot. An elevated depot at Wimco Nagar is under construction to maintain and park trains running between Washermanpet and Wimco Nagar. The elevated depot covers an area of 3.5 hectares, with the ability to station 12 trains. There are plans to build a multi-story commercial building above this depot.

Phase II – in Planning: This Phase will have three corridors, 116 stations, and 118.3 km of line. CMRL anticipates approximately 1.9 million passengers daily, running 138 trains at four to ten-minute intervals when the full system is commissioned in six years. The system will also take over the existing Chennai Mass Rapid Transit System by 2021, which would be upgraded to operate using the rolling stock of the Chennai Metro.

Figure 1: Rolling Stock of Chennai Metro Rail⁴⁵

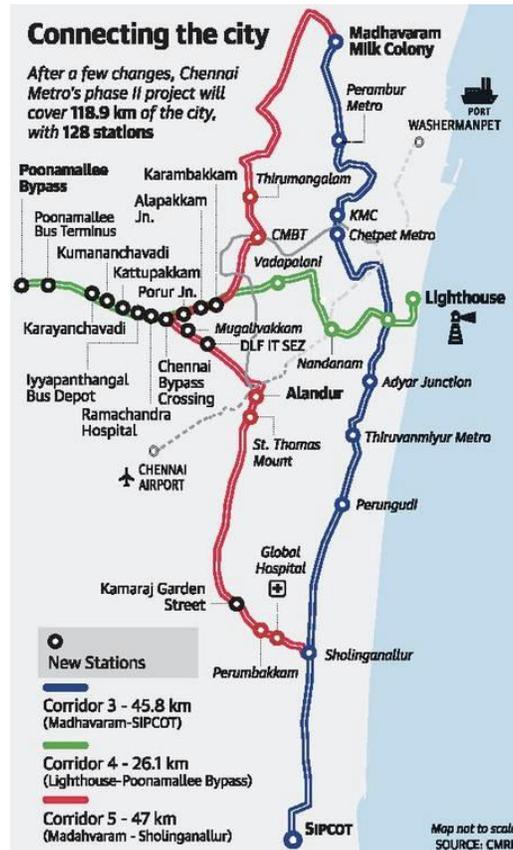


The details of the three corridors of Phase II are the following:

- **Corridor III (47.25 km):** Corridor III will originate at Madhavaram and run to SIPCOT 2, connecting 12 stations. Of the total length, a 19.3 km section will be underground, while 20.9 km between Adyar to Siruseri will be elevated. The estimated cost of the corridor is \$2.63 billion, and it is planned for completion by the end of 2021. At a later time, the corridor will be extended by 9 km to Red Hills.
- **Corridor IV (27.05 km):** This will be an underground corridor, with a depot at Poonamallee Bypass. The plan is for 13 stations from Lighthouse to Poonamallee Bypass, with a cost of \$1.24 million. It is expected to be completed by the end of 2026. An extended section to Sriperumbudur won't be completed until after 2035.
- **Corridor V (44.6 km):** This corridor will connect Madhavaram to Sholinganallur. It will have 14 km of elevated tracks and 20.7 km of underground tracks. It has a projected completion date of the end of 2026, at an estimated cost of \$2.44 billion. There are also plans to extend the corridor by 14.7 km to Wimco Nagar at a later date.

⁴⁵ Financial Express <https://images.financialexpress.com/2019/05/cats-1531.jpg>

Figure 2: Three Corridors of Phase II⁴⁶



The overall project scope will include the following:

Early Stage (Selection process from 2019-2020, with work scheduled over a 24-72 month period)

- General Consultants
- Design consultancy works
- Geo-technical investigation by drilling boreholes, collecting and testing samples and submission of reports
- DDC (Detailed Designing Consultancy) for works and services: Detailed design and drawings for civil, architectural, mechanical electrical and plumbing (MEP), tunnel ventilation systems (TVS), ventilation air conditioning (VAC) systems, and track works covering the alignment and underground stations (including cut and cover box, U-section and switch over ramp).

The above are in the EOI/RFQ bidding and shortlisting phase for different sections, which is likely to continue over the next 12 months.

⁴⁶ The Hindu www.thehindu.com

Late Stages (2020-2026)

- Design, manufacture, verification, delivery, installation, testing, commissioning, operational acceptance, and technical/maintenance support, including training of personnel for telecommunication systems.
- QR code-based ticketing system using mobile and paper tickets and NFC based open-loop payments for ticketing system and also for providing maintenance services to the existing automatic fare collection system (AFCS).
- Supply, installation, testing, commissioning, and training of electrical and mechanical (E&M) works including electrical, ventilation, and air conditioning systems (VAC), fire protection, SCADA works at depots.
- Construction and Civil Works under EPC: Construction of elevated viaduct for standard gauge twin-track metro rail, elevated stations, including architectural finishing, plumbing, roofing, signages, design of temporary works, traffic diversion, utility shifting and all associated works excluding pile caps.
- Design, manufacture, verification, delivery, installation, testing, commissioning, and technical/maintenance support, including training of personnel for a complete, integrated power supply system and overhead equipment.
- Installation, testing, and commissioning of a ballastless track of standard gauge in elevated, underground sections.
- Design, manufacture, installation, testing, and commissioning (including integrated testing and commissioning) of escalators, including maintenance for two years during defect liability period (DLP) at stations.
- Design verification and validation, manufacture, supply, delivery, installation, testing and commissioning (including system acceptance testing, integrated testing and commissioning and operational acceptance), including supply of operation and maintenance manuals, training of operation and maintenance personnel, supply of spares, special tools and maintenance tools and assistance for maintenance during the defect liability period, comprehensive annual maintenance for complete integrated underground stations, air conditioning systems (VAC), tunnel ventilation systems (TVS), electrical and SCADA works at each station.
- Engineering and maintenance management services for stations, including egress shaft and associated tunnels for underground stations.
- Supply of fastening system for rails in ballastless tracks.
- Supply of UIC-60, IRS-T-12-2009 (60E1 profile) head hardened rails of grade 1080 and UIC-60, IRS-T-12-2009 (60E1 profile), grade 880 , turnouts of UIC-60, IRS-T-12-2009 (60E1 profile) and head hardened rail grade 1080 in ballastless tracks.
- Installation, testing and commissioning of a ballastless track of standard gauge in elevated, underground sections and depots along with supply and installation of buffer stops.
- Facility management services to mechanical, electrical, and plumbing (MEP) systems for stations, cut and cover tunnels, administration buildings, and depots, as well as depot machine maintenance.
- Real-time monitoring solutions and installation of Intelligent Transport System (ITS).
- Feasibility studies for extensions.
- Coaches: Design, manufacture, supply, testing, commissioning, and training.
- Developing rooftop solar capacity at stations and maintenance depots.

Early-stage contracts for general consultancy, design consultancy, DDC, and geotechnical surveys for many sections have been awarded or are underbids. Some of the selected organizations include firms from the U.S., Italy, Singapore, India, Spain, and Malaysia.

Chennai Metro Rail Limited (CMRL) is likely to privatize O&M of the Chennai Metro Rail Project Phase II after the completion of construction.

The state government is planning to extend the Chennai Metro rail network across the city and two neighboring districts. A consultant has also been appointed to identify the possible corridors for this expansion. Their report, submitted to the state government, identified six new corridors with a length of 101 kilometers. However, these corridors will likely be developed after 2035.

Key organizations already involved with the Chennai Metro Rail Phase II include:

Name of Consultant	Contact Details	Scope of Work
RITES Limited	RITES Bhawan, No.1, Sector 29, Gurgaon Haryana, India Ph +91 124 2571666 www.rites.com	Conducting the preliminary environment impact assessment (EIA) and preparation of DPR
CDM Smith Inc	IIA, Selvaraj Palani Towers, Door No. 81, Valluvarkottam High Road, Nugambakka Chennai, Tamil Nadu, India Ph +91 44 28211655 www.cdmsmith.com	Feasibility study for the project

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In September 2019, NITI Aayog, a government think tank, and the Department of Economic Affairs (DEA) granted approval to CMRL to seek loans from international banks for implementation of the project. In June 2019, CMRL began soil testing for the project and Corridor II. This work is expected to be completed by the end of 2019. The construction work on tunnels for the Madhavaram-SIPCOT section is expected to begin by January 2020 and is expected to be completed by 2025. After completing these priority sections, work on the remaining 66.8 km section will begin.

PROJECT COST AND FINANCING

Initially, CMRL planned to develop three metro corridors in Phase II, covering a total of 72 kilometers at an estimated cost of \$5.3 billion. However, the project was revised twice, and now the planned project is 118.9 kilometers at the cost of \$10.14 billion.

The project received a soft loan from the Japan International Cooperation Agency (JICA) and is further supported by both the state government and the central government of India. Additional

financing is expected via international banks. On December 21, 2018, the Government of India (GoI) signed an Official Development Assistance (ODA) loan agreement with JICA for the first project loan tranche worth \$700 million and had approved funding for 52.01 km of track and infrastructure. The estimated cost of this length is \$6.02 billion of which, the loan assistance from JICA will be approximately \$2.97 billion. The JICA financing stipulates that 30 percent of the components - trains and signaling systems – must be purchased from Japanese companies, leaving 70 percent of the project open for non-Japanese companies.

In March 2019, CMRL received in-principle approval from four international financing agencies, the Asian Development Bank (ADB), New Development Bank (NDB), European Investment Bank (EIB), and World Bank (WB), for funding the remaining 66.8 km of this project. Along with these banks, CMRL is also in talks with the Asian Infrastructure Investment Bank (AIIB) for funding. About \$1.52 billion is expected to be approved by the end of 2019. The state government has allocated funds worth \$394 million for the project under the state budget 2019-20, and work will go ahead as planned. Of the total cost, the cost of construction is estimated to be around \$6.32 billion, while the remaining will be required for land acquisition and other expenses.

U.S. EXPORT OPPORTUNITIES

The project offers opportunities for U.S. firms beyond the 30 percent commitment to Japanese companies for signaling and train component imports. In addition, the project cost indicated above does not include the cost of completely built units (CBUs)/coaches. For this project there will be opportunities for U.S. firms in future sections for the design and equipment for telecommunications systems, design and supply of E&M systems, signaling packages including supplying traffic signals (i.e., traffic signal heads, controllers and cabinets, as well as the installation of new traffic signals at several intersections), fire protection and SCADA systems, integrated power supply packages, architectural drawings, design and supplies of escalators, ticketing systems, open-loop payments systems, Real-time monitoring solutions and systems, Intelligent Transport Systems (ITS) and station development, including security and surveillance equipment, and instrumentation packages. It is unlikely that coaches will be imported into India.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Government of India (GoI) 3/F National Informatics Centre, A-Block, CGO Complex Lodhi Road New Delhi 110003 India www.india.gov.in</p> <p>Government of Tamil Nadu Secretariat, Fort St. George Chennai, 600009 Tamil Nadu, India www.tn.gov.in</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Kevin Toohers ktoohers@ustda.gov</p> <p>USTDA U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Renie Subin renie.subin@trade.gov</p>

Colachel Port		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports and Shipping
	LOCATION	Kovalam, Tamil Nadu
	PROJECT VALUE	\$3.2 billion (\$1.24 billion, Phase I)

PROJECT SUMMARY

The project involves the development of a greenfield port at Colachel (Enayam/Kovalam) village in Kanyakumari district of Tamil Nadu (Southern India) for container transshipment. It will be developed as a public-private partnership (PPP) with the V.O. Chidambaranar Port Trust (VOCPT) being the project sponsor. It will be executed by a special purpose vehicle (SPV) having an initial equity investment from VOCPT, Chennai Port Trust (ChPT), and Kamarajar Port Limited (KPL). The total estimated cost of the project is \$3.2 billion. Phase I of the project will be spread over an area of 217 hectares and be completed by 2023 to 2024.

PROJECT DESCRIPTION

The Indian maritime sector has been the backbone of the country’s trade and continues to witness significant growth. To harness India’s long coastline as a driver of the economy, the Government of India has embarked on the ambitious Sagarmala Program to promote port-led economic growth and development.

The program envisions unlocking potential waterways and coastline by investing \$130 billion across 415 projects, aiming to boost merchandise exports by \$110 billion and generating around 10,000,000 direct and indirect jobs. The capital will be used for the following:

- Building new mega ports
- Modernizing India's existing ports
- Developing 14 Coastal Economic Zones (CEZs) and Coastal Employment Units
- Enhancing port connectivity - road, rail, multi-modal logistics, pipelines, waterways
- Promoting coastal community development

These projects under this Sagarmala program are expected to have the following impact:

- Mobilization of over \$61.6 billion of infrastructure investment

- Double the share of inland and coastal waterways in the modal mix
- Yield cost savings of \$5.3 to 6.1 billion in logistics annually
- Boost merchandise exports by \$110 billion
- Create four million new direct jobs and six million indirect jobs

Container shipment routes to/from Europe and the US are the most significant for India, based on current cargo traffic (combined approximately 60 million TEUs). Africa-bound traffic, although smaller (approximately 10 million TEUs), is expected to grow at a faster rate (six to seven percent per year) over the next few decades. While most of the transshipment trade happens on the Southeast Asian and Middle East routes, the South Asian location (including the southern tip of India) is the most efficient location for the transshipment of cargo moving to Africa, EU, or the East Coast of the United States.

As part of this, the Colachel Port, along with several other greenfield ports, have been identified for development. It is located between Kovalam and Keelamanakudi villages in Kanyakumari District, 26 kilometers from the East-West International Shipping Route. The approach channel under the project will be 2,980 m long and 400 m wide. The entire port will be developed on reclaimed land along the seaside coastline, using dredged materials. Colachel has a natural deep draft, making it viable for servicing large-sized vessels. There will be no population displacements or land acquisition envisioned for port construction.

The project will serve as a key gateway container port for Indian cargo and reduce the logistics cost for exporters and importers in South India. It will also have the potential to become a container transshipment hub for global East-West trade.

Figure 1: Potential Locations Being Considered for New Port⁴⁷



⁴⁷ Source: TYP SA Consultants <http://environmentclearance.nic.in>

According to the Detailed Project Report (DPR), the project will be developed in three phases. Phase I will cost about \$1.2 Billion and is expected to be operational by 2023-24. On completion, the Integrated Container Transshipment Terminal (ICTT) will have a capacity of 6.25 million TEUs.

The proposed project envisages the following:

- Construction of breakwaters
- Dredging and reclamation
- Container berths with provision for additional multipurpose/dry bulk berths
- Harbor draft of 16 m, capable of handling 18,000 TEU-capacity container vessels and Capesize coal vessels. Coal traffic is expected to begin in 2022. A solid bulk terminal is included in Phase 2 development to cater to this cargo.
- A port comprising 6 km of breakwater and 5 km of piers, with an anchor depth of 20 m, covering an area of 330 hectares (completion in 2030)
- A port designed for triple E class container vessels and 120,000 deadweight tonnage (DWT) capacity, Capesize solid bulk vessels
- High capacity road and rail links to the corresponding networks
- A container terminal having automation technology for container handling equipment
- The Port's terminal facilities are planned with a semi-automated terminal port handling system, equipped with Super Post Panamax cranes with a minimum outreach of 65 m.
- The container yard will have an automated rail-mounted gantry container crane (A-RMG) system, with other stacking areas for empty containers and a rail yard.
- A total of 9 ship-to-shore (STS) cranes, 44 A-RMG cranes, 16 shuttle carriers, 2 rail-mounted gantries (RMG) cranes for the rail yard, 2 reach stackers (RS) and 4 tractors
- 5,112 loaded container slots, 432 reefer container slots, and 600 empty container slots.
- A 200 m berth for ancillary vessels such as tugs, pilots and mooring launches
- Maintenance workshop, Marine operations building, Administration building, Entry/Exit. It will also have a police station, a customs office, and an administrative building. Other buildings might be added in future stages of the design process.

Figure 2: Main Elements and Figures of the Port⁴⁸

Description	Units	Phase 1 (2018-2020)
Berths (total)	meter	1,400
Container (2 berths)	meter	800
General Cargo (1 berth)	meter	400
Ancillary Vessels (1 berth)	meter	200
Terminals/Yards	hectare	93
Container (2 berths)	hectare	41
General services and multipurpose areas	hectare	19
Industrial area	hectare	33
Breakwaters	meter	4,630
Rubble mound	meter	2,140
Vertical	meter	2,490
Dredging and Reclamation	cubic meter	10,123,273

TYPSA, in consortium with Boston Consulting Group, undertook a preliminary study for the project. A DPR on the project has been submitted to the Ministry of Shipping (MoS) for approval.

Figure 3: Berth Capacity Calculations⁴⁹

Description	Unit	Value
Handling/TEU Ratio		1.5
Mean vessel size	TEU	6,450
Container Handling per Vessel	N	1,750
Container Handlings per Crane	No	30
Unproductive time at berth per vessel	hr	3
Mean number of cranes per vessel	No	4.5
Crane work hours per day	Hr/day	21
Peak berth utilization	percent	70
Peak/mean season occupation ratio		1.1
Total capacity per berth	TEU/yr	803,295
Number of berths		2
Terminal capacity	TEU/yr	1,604,208
Capacity per meter of berth	TEU/M/yr	2005

⁴⁸ Ibid.

⁴⁹ Ibid.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

According to the DPR, the project will be developed in three phases. Phase I will involve a cost of about \$1.24 billion and is expected to be operational by 2023 to 2024 (*Figure 4*). A Special Purpose Vehicle (SPV), Kanyakumari Port Limited, was formed in March 2019 for implementing the project. Kanyakumari Port Limited is a three-way joint venture (JV) between V.O. Chidambaranar Port Trust (VOCPT), Kamarajar Port Limited (KPL) and Chennai Port Trust (ChPT). Studies sponsored by the SPV are in process and will form the basis for the Government of India's launch of an international tender process. Since there are no land or people displacement issues, the project should move ahead as planned. The detailed design stage is expected shortly, and work associated with all other aspects of dredging and construction and contracting will soon follow.

Figure 4: Colachel Port – Phase 1 Layout⁵⁰



Figure 5: Colachel Port – Phases 2 and 3 Layout⁵¹



PROJECT COST AND FINANCING

The project cost estimate is \$3.2 billion and will be executed by an SPV, Kanyakumari Port Ltd. This SPV has an initial equity investment from VOCPT, Chennai Port Trust (ChPT), and Kamarajar Port Limited (KPL). The nodal agency is VOCPT. The SPV will be responsible for

⁵⁰ Ibid.

⁵¹ Ibid.

developing the port infrastructure including dredging and reclamation, construction of a breakwater, and ensuring connectivity links.

U.S. EXPORT OPPORTUNITIES

The government has introduced various fiscal and non-fiscal incentives for enterprises that develop, maintain and operate ports, inland waterways, and shipbuilding in India. In this sector, 100 percent Foreign Direct Investment is permitted. Specific opportunities for U.S. firms would include the following:

- Planning, Design, and Construction Management Services in general and specifically for dredging services and equipment
- Design and implementation of semi-automated terminal port handling systems
- Terminals, berths and related infrastructure
- Design, manufacture, verification, delivery, installation, testing, commissioning, operational acceptance and technical/maintenance support, including training for telecommunication systems and security and hazard management systems
- Design and implementation of Port Management Systems
- Architectural detailing and technical support services
- Spill Contingency planning and disaster management planning
- Engineering and Project Management Services
- Cargo management software and fiber optics
- Mechanization components, including ship loaders/unloaders, STS/ARMG/RTG/RMG/Cranes, Ship-to-Shore cranes, RMS stackers, and dredgers, Cutter Suction Dredger (CSD), railing suction hopper dredgers and reclaimers, stackers/reclaimers, berth equipment, port security equipment, cold storage equipment

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>V.O. Chidambaranar Port Trust Tuticorin, Tamil Nadu 628004 India +91 46 1235 2290 www.vocport.gov.in</p> <p>Chennai Port Trust 1 Rajaji Salai Chennai, 600001 Tamil Nadu, India +91 44 2536 2201 www.chennaiport.gov.in</p> <p>Kamarajar Port Limited No. 23, First Floor, P.T. Lee Chengalvaraya Naicker Maaligai, Rajaaji Salai Chennai, 600001 Tamil Nadu, India +91 44 2525 1666 www.ennoreport.gov.in</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toothers ktoothers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Mr. Sham Shamsudeen sham.shamsudeen@trade.gov</p>

Delhi-Gurgaon-Rewari-Alwar RRTS – Phase I		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Urban Transport (Rail)
	LOCATION	Delhi; Gurgaon, Haryana; Rewari, Haryana; Alwar, Rajasthan
	PROJECT VALUE	\$3.67 billion

PROJECT SUMMARY

The Delhi–Alwar Regional Rapid Transit System (RRTS) is a proposed 164 km long, semi-high speed rail corridor connecting Delhi, Gurgaon, Rewari, and Alwar. It is one of the three rapid-rail corridors planned by the National Capital Region Transport Corporation (NCRTC). The whole corridor has a planned outlay of \$5.5 billion, of which the Phase 1 project of 106 km is expected to cost \$3.7 billion. Phase I is targeted for completion by December 2024.

PROJECT DESCRIPTION

The National Capital Region (NCR) is a 35,000 km², multi-state region with the National Capital Territory of Delhi (NCT) as its center. The NCR is comprised of the entire NCT and some parts of the neighboring states of Haryana, Uttar Pradesh, and Rajasthan. To enhance the connectivity within the NCR, the National Capital Region Planning Board (NCRPB) has proposed connecting urban, industrial (SEZs/industrial parks), regional, and sub-regional centers through a fast, rail-based Regional Rapid Transit System (RRTS). The objective of this system is to reduce commuter dependence on road-based transportation.

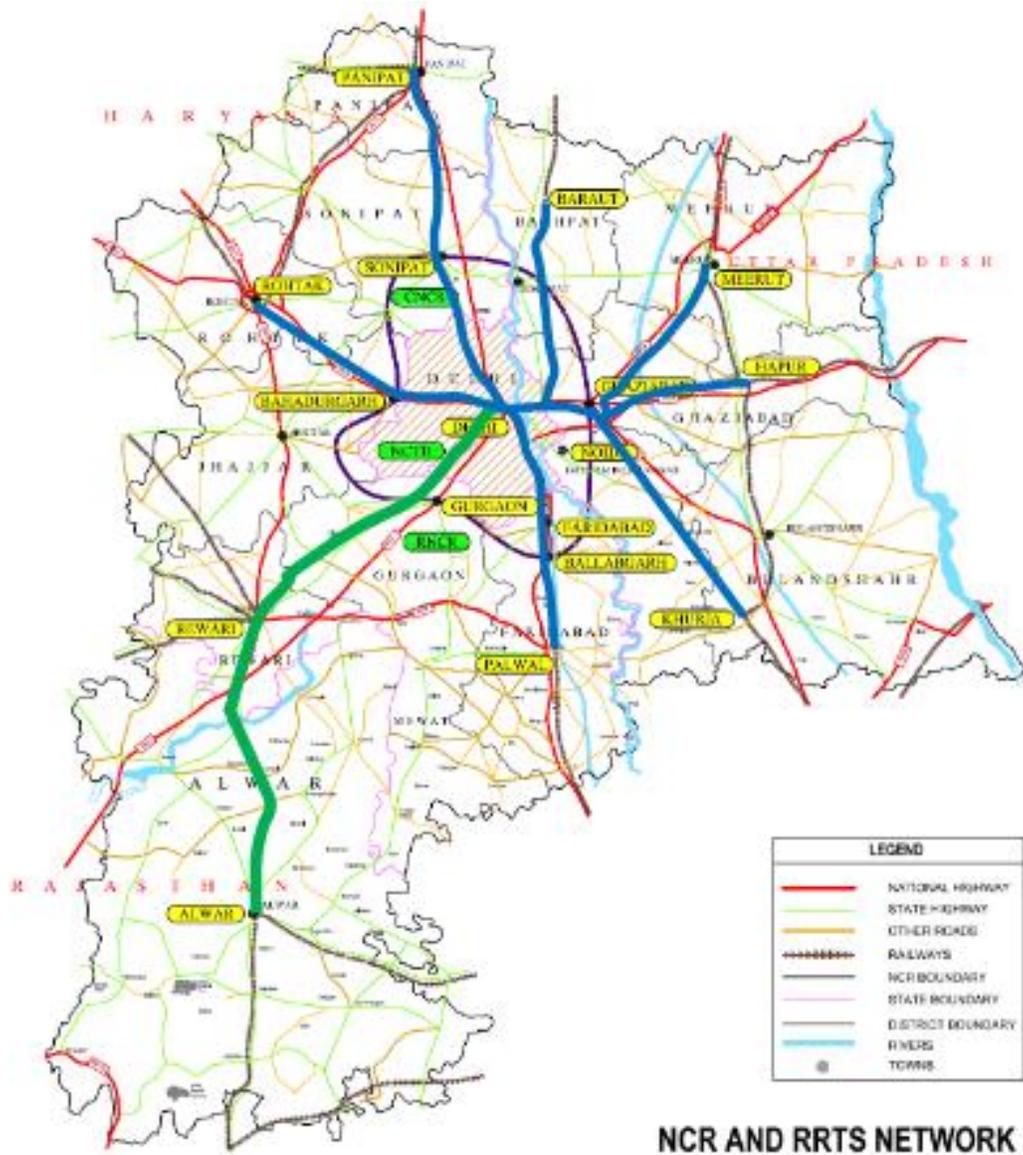
The NCRPB developed an Integrated Transportation Plan for NCR, which projected the need for eight rail-based rapid transit corridors to enhance the efficacy of the NCR transportation system through 2032. The proposed corridors radiate from the NCT across the NCR area and terminate at “Rest of NCR” (RNCR) towns, which are the NCR exit nodes. The NCR experiences a flow of approximately 350,000 passenger cars daily, and the RRTS will help reduce travel delays and congestion resulting from commuter traffic.

The eight corridors identified by the Integrated Transportation Plan are:

- **Delhi – Gurgaon – Rewari – Alwar (158 Km) (DGRA Project Corridor)**
- Delhi – Ghaziabad – Meerut (67 Km)
- Delhi – Sonipat-Panipat (89 Km)

- Delhi – Faridabad-Ballabgarh-Palwal (60km)
- Delhi – Bahadurgarh- Rohtak (70 Km)
- Delhi – Shahadra-Baraut (56 Km)
- Ghaziabad – Khurja (61 Km)
- Ghaziabad – Hapur (57 Km)

Figure 1: The NCR and RRTS network⁵²



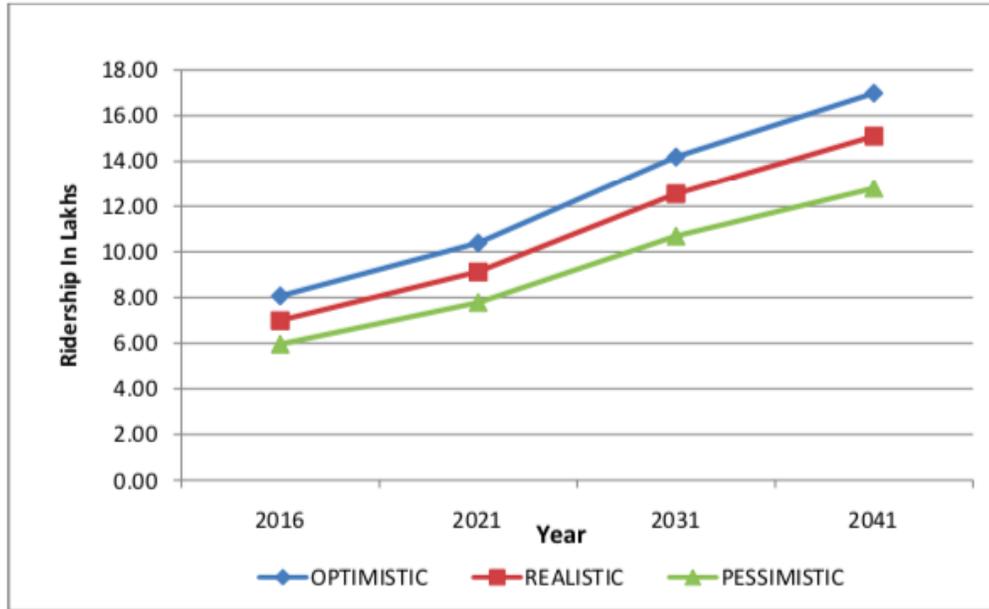
The DGRA RRTS will be implemented in three stages.

- Phase I: Delhi-Gurgaon-Rewari-Shahjahanpur-Neemrana-Behror (SNB) Urban Complex
- Phase II: SNB Urban Complex to Sotanala

⁵² Feasibility Study and DPR for Delhi-Gurgaon-Rewari-Alwar RRTS Corridor

- Phase III: SNB Urban Complex to Alwar

Figure 2: Traffic Comparison and Scenarios for RRTS⁵³



The 106 km Delhi-Gurgaon-SNB corridor will be elevated for 71 km (encompassing 11 stations), while the remaining 35 km (encompassing 5 stations) will be constructed underground, mostly in Delhi and Gurgaon. This corridor will converge with other RRTS corridors in Sarai Kale Khan and will be inter-operable, facilitating commuter movement from one corridor to another without the need to change stations.

With a maximum speed of 160 km/h and an average speed of 105 km/h (three times faster than the existing metro), the distance between Delhi and Alwar will be covered in 104 minutes. This corridor would pass through industrial hubs of Manesar, Bawal, and Neemrana.

Feasibility work for the project was completed by The Urban Mass Transit Company in 2010 and approved by the planning board in 2012. The project was transferred to the NCRTC in 2017, which was formed for project implementation with an authorized capital of about \$15 million, of which 50 percent is owned by the Central Government through the Ministry of Urban Development (MoUD), Ministry of Railways (MoR) and NCRPB and 50 percent is owned by the state governments of Delhi, Uttar Pradesh, Haryana, and Rajasthan.

⁵³ Feasibility Study and DPR for Delhi-Gurgaon-Rewari-Alwar RRTS Corridor

Figure 3: Daily Boarding at Stations within RRTS⁵⁴

S.No	Station Name	2016	2021	2031	2041
1	ISBT Kashmere Gate	20390	24540	33095	44340
2	New Delhi RS	26030	32855	42495	54280
3	Sarai Kale Khan (Nizamuddin)	38000	44520	66395	84950
4	INA	24955	31275	47545	55515
5	Dhaulakuan	6000	9270	10140	11565
6	Mahipalpur	66035	87320	131110	145720
7	Cyber City	58210	83760	114145	125675
8	IFFCO Chowk	44760	44655	57535	67105
9	Rajiv Chowk (G)	25285	47105	57035	67145
10	Manesar	46765	61085	87410	96520
11	Panchgaon	24785	34290	38715	44440
12	Dharuhera	29375	33995	40680	45000
13	BTK	59395	76510	93535	115185
14	MBIR	24625	28865	34960	48050
15	Rewari	68000	99795	140735	161165
16	Bawal	62980	82240	135835	167035
17	SNB	38805	46915	61205	93305
18	Khairthal	18615	23155	32150	39285
19	Alwar	15320	20340	30690	44380
	Total	698330	912490	1255410	1510660

Details for the project include the following:

- Track Gauge: Twin tracks of 1,676 mm broad gauge.
- Train operating speed of 160 kph, with a design speed of 180 kph for passenger use only.
- Traction System and Rolling Stock: 1x25 kV AC single phase 50 Hz overhead catenary traction system. Air-conditioned lightweight, stainless steel Electrical Multiple Units, each unit of three comprising two motor cars and one trailer car; Six car trains - DMC-TC-MC-MC-TC-DMC
- Rolling Stock: EMU, Light Weight, stainless steel coaches, 3.66 m wide X 24 m long
- Axle Load: 20 metric tons
- Signaling and Train Control Systems: 3rd generation continuous automatic train control (CATC) System with Distance to Go signaling; AFTC for Train detection; Track to Train Data transmission; CATC systems to maintain the desired train frequency; Radio based TETRA and Optical Fiber Cables (OFC) for the telecommunication and passenger information systems; CATC systems consisting of Automatic Train Protection (ATP); Automatic Train Operation (ATO); Automatic Train Supervision (ATS); Cab Signaling along with ATP, ATO, ATS; Station interlocking adhering to CENELEC SIL-4 standards
- Automatic fare collection systems, which can be integrated with Common Mobility Cards
- Extensive use of IT railway operations, maintenance, traction power control, MIS.

⁵⁴ Feasibility Study and DPR for Delhi-Gurgaon-Rewari-Alwar RRTS Corridor

- Interoperability of all the RRTS corridors to enable seamless travel to all four destinations, in addition to cost reductions through economies of scale in the procurement of equipment and coaches.

NCRTC signed an Indo-Spanish technical cooperation (government-to-government) agreement with Administrador de Infraestructuras Ferroviarias (ADIF) to provide technical advice on specific issues, as well as technical training and collaboration related to track, signaling, rolling stock, safety, multi-modal integration, and station design. Overall the project will entail the following:

Early Stages (2019-2022)

- General and Design Consultancy
- Geotechnical investigations
- Conducting final location survey, topographic survey and other miscellaneous survey works
- DDC (Detailed Designing Consultancy) for works and services - detailed design and drawings for civil, architectural, mechanical electrical and plumbing (MEP), tunnel ventilation systems (TVS), ventilation air conditioning (VAC) systems, track work alignment, and underground stations

The above are in the EOI/RFQ/bidding and shortlisting phase for different sections and likely to continue over the next 12 -36 months.

Later Stages (2020-2024)

- EPC Construction and Civil Engineering: Construction of track, stations including architectural finishing, plumbing, roofing, signage, design of temporary works, traffic diversion, utility shifting, and all associated works excluding pile caps
- Miscellaneous Civil Works: Construction/reconstruction of small structures, road repairing, drain repairing and construction, small utility diversion, miscellaneous electrical work, and other associated activities
- Design, manufacture, verification, delivery, installation, testing, commissioning, and technical/maintenance support, including training of personnel for a complete integrated power supply system, including overhead equipment
- Installation, testing and commissioning of a ballastless track of standard gauge in elevated and underground sections and depots along with supply and installation of fastening systems, head hardened rails, buffer stops
- Design, manufacture, verification, delivery, installation, testing, commissioning, operational acceptance, and technical/maintenance support, including training of personnel for telecommunication systems
- Supply, installation, testing, commissioning, and training of electrical and mechanical works including electrical, VAC systems, fire protection, SCADA works at depots, stations, and tracks
- Design verification and validation, manufacture, supply, delivery, installation, testing, commissioning (including system acceptance testing, integrated testing and commissioning and operational acceptance) along with supply of operation and maintenance manuals, training of operation and maintenance personnel, supply of spares, special tools and maintenance tools and assistance for maintenance during the defect

liability period, comprehensive annual maintenance for a complete integrated underground stations, VAC, tunnel ventilation systems (TVS) along with electrical and SCADA works at all stations

- Electrical and mechanical management services for stations, including egress shaft and associated tunnels for underground stations
- Facility management services to mechanical, electrical, and plumbing (MEP) systems for stations, cut and cover tunnels, administration buildings, depots, and depot machine maintenance
- Real-time monitoring solutions and installation of Intelligent Transport System (ITS).
- Coach: Design, manufacture, supply, testing, commissioning, and training
- Design and implementation of the ticketing system, automatic fare collection systems (AFCS)
- Design, manufacture, installation, testing, and commissioning (including integrated testing and commissioning) of escalators at stations, including maintenance for two years during the defect liability period (DLP)

Key organizations that have been involved with this project to date include:

Name of Consultant	Contact Details	Scope of Work
Urban Mass Transit Company Limited	5th Floor, A Wing, IFCI Tower, 61-Nehru Place New Delhi, India Ph +91 11 41606074 www.umtc.co.in/	Feasibility study and detailed project report (DPR)
Delhi Metro Rail Corporation (DMRC)	Metro Bhawan, Fire Brigade Lane, Barakhamba Road New Delhi, India Ph +91 11 23417910 http://www.delhimetrorail.com	Project consultant
JURONG Consultants (India) Private Limited	JURONG House, 1/5 Palace Road, Bangalore, Karnataka, India Ph +91 80 2220 7292 http://www.jurong.com/	Preparation of master plan for the project
CEG Test House and Research Centre Private Limited	B-11(G), Malviya Industrial Area, Malviya Nagar Jaipur, Rajasthan, India Ph +91 141 4046599 www.cegtesthouse.com	Detailed geotechnical investigation work from chainage 23.4 km to 71 km in IDPL Complex-Dharuhera section of Phase I

Name of Consultant	Contact Details	Scope of Work
RITES Limited	RITES Bhawan, No.1, Sector 29, Gurgaon, Haryana, India Ph +91 124 2571666 www.rites.com	Conducting detailed geotechnical investigation works for the elevated sections from chainage 71 km (Dharuhera) to 106.4 km (SNB) of Sarai Kale Khan (SKK) to SNB stretch
SS Solutions	AS-4/11, Sreenagar Pally, 54 Feet Road (near Ashiyana Bhavan), Benachity Durgapur, West Bengal, India	Conducting final location survey, topographic survey and other miscellaneous survey work for the Sarai Kale Khan (SKK) to SNB stretch

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The public transport travel demand model was prepared in 2017, followed by a variety of surveys, technical studies, and a detailed project report. In August 2019, bids were invited for a detailed design consultant (DDC) encompassing the civil, architectural, and electrical and mechanical works for three elevated stations and an elevated viaduct between the IDPL Complex ramp (Gurugram) and the Rajiv Chowk ramp. The last date for bid submission was extended to October 31, 2019. There is no information on further delays in these bid submissions. The work is likely to be completed in 30 months from the contract awards. DDC bids for other stations and sections will be invited in the near future, followed by contracting for all other works as per schedule. All approvals are in place, and the project is expected to be on schedule.

PROJECT COST AND FINANCING

The total cost of the project is \$3.67 billion, an approximate cost of \$35 million/km. Of the total project cost, around 20 percent will be funded by the central government and 20 percent by the respective state governments, with the remaining 60 percent funded in the form of financial assistance from multilateral funding agencies.

U.S. EXPORT OPPORTUNITIES

U.S. firms will have opportunities in planning, design and engineering services along with technology and goods needed for, rail line design, signaling, power supply and traction, auxiliary power supply networks, signaling, telecommunication and fare collection systems, ventilation and air conditioning systems, depot facilities and workshops, underground and elevated stations, security and surveillance equipment, locomotives and coaches, supervisory Control and Data Acquisition (SCADA) Systems, IT systems for railway O&M, and traction power controls, and MIS.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>National Capital Region Transport Corporation (NCRTC) 7/6 Siri Fort Institutional Area August Kranti Marg New Delhi, 110049 India www.ncrtc.in</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Kevin Toohers ktoohers@ustda.gov</p> <p>USTDA U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Renie Subin renie.subin@trade.gov</p>

Itanagar (Hollongi) Greenfield Airport		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Itanagar (Hollongi), Arunachal Pradesh
	PROJECT VALUE	\$155 million

PROJECT SUMMARY

A greenfield airport is to be developed in two phases in Hollongi, near Itanagar, in the Papum Pare district of Arunachal Pradesh. The Project, as proposed, is expected to cost \$155 million. Completion of Phase I will permit the operation of ATR-type aircraft. Phase II involves the operation of larger aircraft (e.g., Boeing 737) and will be based on the growth of air traffic.

PROJECT DESCRIPTION

India’s civil aviation market is the third-largest in the world after China and the United States. It is the fastest-growing domestic aviation market in terms of the number of domestic tickets sold and passengers carried (*Figure 1*). At \$30 billion, civil aviation comprises 1.5 percent of the Indian economy and supports 7.5 million jobs. Domestic air passenger traffic has grown at double-digit rates for 50 consecutive months. Passenger demand is expected to triple to 500 million journeys in the next 20 years⁵⁵. This level of growth will drive demand for 2,300 aircraft worth \$320 billion over this same period, as well as new airports to service them.

Recent initiatives to support the growth of the Civil Aviation sector include:

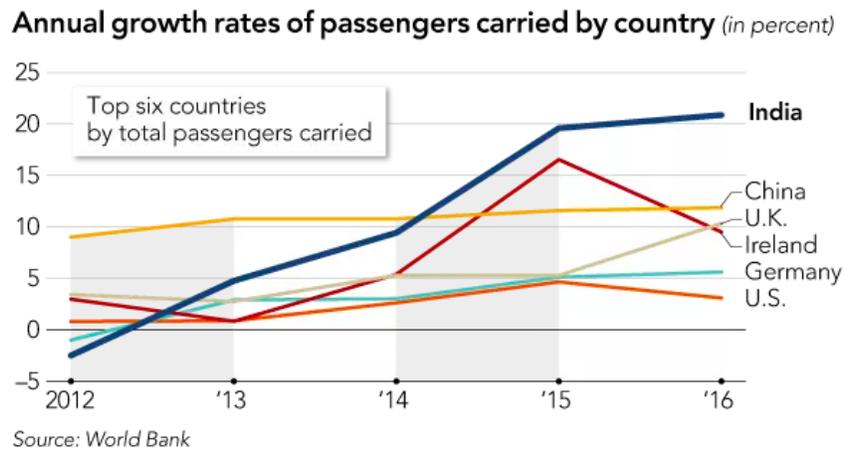
- Regional Connectivity Scheme – ‘Ude Desh ka Aam Naagrik’ (RCS-UDAN)
- Provision of \$600 Million, with budgetary support of the Indian Government for a revival of 50 unserved and underserved airports and airstrips

RCS-UDAN is a regional airport development connectivity scheme of the Government of India, with the objectives of "letting the common citizen of the country fly." Its intent is to ensure the provision of affordable air travel, while simultaneously spurring national economic development and job growth through air transport infrastructure development. The initiative aims to expedite the development of India's nearly 425 unserved, underserved, and most underdeveloped regional airports to provide regularly scheduled flights. Under the RCS-UDAN program, the Airports

⁵⁵ International Air Transport Association, 2018

Authority of India (AAI) proposes to build a greenfield airport at village Hollongi, Yupia tehsil, Papum Pare district, Arunachal Pradesh, near Itanagar.

Figure 1: India Rate of Air Passenger Growth⁵⁶



The site lies between the Kokila (eastern side) and Hollongi (southwest side) rivers and is approachable from National Highway -52A. Latitude and Longitude of the reference point for the proposed airport are 26°58'12"N and 93°39'53"E.

Figure 2: Artist's Rendering of Hollongi Airport⁵⁷



⁵⁶ World Bank

⁵⁷ Source: AAI video – Hollongi

Within a 10 km radius of the site, there are no areas protected under international conventions or national or local legislation for their ecological, landscape, cultural, or other related issues that might prevent the project. There is a stream passing through the project site. Drupong Reserve Forest is located 0.5 km to the north of the planned project. An artist's rendering (Figure 2) is provided below:

The scope of work includes detailed design and construction of the following:

- New runway construction (2300m x 45m, 08/26 magnetic)
- Construction of apron, taxiway and ramp area
- Terminal building (capability of handling 200,000 passengers concurrently at peak hours (100 inbound/100 outbound))
- Cargo complex and hangar
- Fire station
- Air traffic control (ATC) tower/technical block
- Electrical and mechanical (E&M) workshop
- Medical center
- Doppler very high-frequency omni range (DVOR) navigation system
- NDB (nondirectional beacon) building
- Pump house building
- Electrical substation
- Ground lighting including runway edge lights
- Passenger side amenities including a hotel/convention center, 150-vehicle car park, and approach road
- Airside infrastructure including baggage handling and hangar
- Operation and Maintenance (O&M) of electrical installations for a period of seven years including a defect liability period (DLP) of two years

The project faced roadblocks in its implementation due to delays in finalizing the project site. In June 2016, the state government suggested that the Ministry of Civil Aviation (MoCA) convene a committee to re-assess (for the 3rd time) the techno-economic feasibility of two potential targeted locations, Hollongi and Karsingsa. The MoCA Committee report identified Hollongi as the most suitable site for technical, environmental, and financial reasons. Hollongi has received necessary clearances from the Ministry of Home Affairs (MoHA), Ministry of Defence (MoD), and Ministry of Finance (MoF).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Environmental clearance (EC) and approvals by the Ministries of Civil Aviation (MoCA) and Finance (MoF) were granted in December 2018 and January 2019, respectively. The foundation stone was laid for the project in February 2019.

RFQs have been issued, and bids were re-invited for the selection of an engineering, procurement, and construction (EPC) contractor for the project. The final date for submission of bids was August 26, 2019, which was later extended to September 9, 2019. Two firms have submitted bids

and await selection. Following the selection of the EPC firm, subcontracting for design, equipment, and specialized services will occur at appropriate points during the construction phase.

Following construction, contracts will be set for MRO, communications systems, security systems, and air & terminal operations. MoCA has set March 31, 2022, as the deadline for completion of the project.

PROJECT COST AND FINANCING

The project cost is \$155.15 million, with a cost escalation of \$60 million. The Ministry of Development of North Eastern Region (MDoNER) and the North Eastern Council (NEC) will provide \$29 million for the project. The Central Government, enabled by the Airports Authority of India, will supply the balance.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include:

- Terminal design services and equipment
- ATC systems design, installation packages, and equipment
- Avionics packages
- GPS Aided GEO Augmented Navigation (GAGAN) system
- Navigation systems design and equipment
- Jet Bridges
- Baggage handling systems

Subsequent to construction, additional opportunities will be available for:

- Safety and security systems
- ICT and digital systems
- Maintenance Repair Operations (MRO) facilities and inventory
- Airport rescue firefighting equipment
- Engineering services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Airports Authority of India Rajiv Gandhi Bhawan Safdarjung Airport New Delhi, India www.aai.aero Mr. R. Radhika GM(Commercial) radhika@aai.aero</p>	<p>Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Ms. Alissa Lee alee@ustda.gov</p> <p>U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Nisha Wadhawan Nisha.wadhawan@trade.gov</p>

Jammu – Baramulla Railway		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Railways
	LOCATION	Jammu and Kashmir, India
	PROJECT VALUE	\$4.11 billion

PROJECT SUMMARY

The project is a 356-kilometer railway line to join the Kashmir Valley with the Indian Railways (IR) network from Jammu to Baramulla via Udhampur, Katra, and Qazigund, providing an alternative and a reliable transportation system to Jammu & Kashmir. Declared as a National Project, the Jammu-Udhampur section was inaugurated in April 2005. The remaining portion from Udhampur to Baramulla, also known as the USBRL Project, with a route length of 292 km, is in various stages of progress. The project is 45 percent complete, and the remainder of the project is expected to be fast-tracked.

PROJECT DESCRIPTION

The 356 km Jammu–Baramulla railway line is being constructed to connect the Kashmir Valley to the Jammu railway station and, subsequently, to the rest of the country. It is in the jurisdiction of the Firozpur railway division of the Northern zone of Indian Railways (IR). The project has had a long history, with serious progress only being made after it was declared a National Project of India in 2002. The sections from Jammu to Katra and Banihal to Baramulla have been built and are operational. The track from Katra to Banihal is to be completed by 2021. This project is fairly complex due to terrain challenges, and will require the construction of 62 major and minor bridges and 35 tunnels.

The length from Udhampur to Baramulla is 292 km and has been divided into three sections (*Table 1*).

Leg 1 - Udhampur-Katra (25 km), Completed: This section, was executed by Northern Railways (NR) at an estimated cost \$163 Million and involved nearly 11 km of tunnels, 9 major bridges, 29 minor bridges and 10 roads over bridges (RoBs)/road under bridges (RuBs) in addition to 3.89 million tons of earthwork. The tallest bridge in this section is 85 m high (Br. No. 20), and the longest tunnel is 3.15 km long. The rail line enables pilgrims to reach one of the highest religious tourist points in India (Vaishno Devi shrine) and travel directly to the Katra base camp. The Katra Railway station was equipped with modern facilities with escalators, elevators, VIP

lounge, a fully air-conditioned hotel, shopping lounge, multi-cuisine restaurant, and large parking areas. The construction work on the project was completed in February 2014 and became operational on July 4, 2014.

Table 1: Elements of the Udhampur to Baramulla Rail Line⁵⁸

Item	Udhampur -Katra	Katra- Qazigund	Qazigund -Baramulla
Route length (km)	25	129*	119
Bridges	38	62	811
Tunnels Length (km)	10.90	103.00	0
Max height of bridge	85 m	359 m	22 m
Longest tunnel (km)	3.15	10.96	-
Station	3	10+1	15
Max Curvature	2.75 ^o	2.75 ^o	2.75 ^o
Max. height of Bridge	85 m	359 m	22 m
Longest span	154 m Steel Girder over Jhajjar River	467 m Steel Arch over Chenab River	45 m
Longest Tunnel	3.15 km	10.96 km	-
Max Depth of Cutting	20 m	40 m	
*This project has various special & unique features and several firsts for Indian Railways.			

Leg 2 - Katra-Qazigund (129 km), Under Construction: The section is slated for completion in 2021/2022 with an investment of \$3.4 billion, of which \$3.18 billion is estimated for the Katra-Banihal section while the remaining \$249 million has been spent on Banihal-Qazigund section. This section is fairly complex due to high elevations, including a 1,315m-long bridge to be built at the height of 359 meters.

Leg-3 - Qazigund-Baramulla (119 km), Completed: This section executed by IRCON, falls in the Kashmir Valley, and is surrounded by the mountain ranges. The entire section was commissioned in 2009 at an estimated cost of \$513 million.

The execution of the completed work had been divided among three agencies as follows:

- Northern Railway for the first 5 km (25 km-30 km), extending from Katra to Banganga. The scope of work involved the construction of the Banganga Bridge and tunnels T-8 and T-9.
- Konkan Railway Corporation (KRCL) for the next 67 km (30 km-100 km), involved the construction of the Chenab bridge (Br. No. 44) and the Anji Khad Bridge (Br. No. 35). The 1,315m long Chenab Bridge, with a central span of 467 m and 359 m above the river, is located 65 km from Katra, Jammu, and Kashmir, has been the responsibility of Afcons Infrastructure.

⁵⁸ IRICEN www.ircen.gov.in/projects/622/DESIGN.pdf

Figure 2: Alignment Plan of the Jammu – Baramulla Rail Line⁵⁹



⁵⁹USBRL <http://usbri.org/usbri.pdf>

- IRCON International Limited for the next 57 km (100 km-168 km), with construction divided into 6 zones; Zone I (100 km-110.2 km), Zone II (110.2 km-120.3 km), Zone III (120.3 km-125.2 km), Zone IV (125.2 km-134 km), Zone V (145.7 km-152.6 km) and Zone VI, an 11 km tunnel (India's longest and Asia's second longest) .

Work that has begun already or is in process in the Katra-Qazigund section includes the following:

- The main arch of the Chenab river railway bridge, which entails carrying the heavy segments from two ends of the bridge (Kauri and Bakkal) and the world's longest cable crane arrangement.
- Detailed design consultancy (DDC) services for tunnel ventilation and safety, along with electro-mechanical works for the specified tunnels.
- Supply, installation, and monitoring of instrumentation during the construction of the specified tunnels.
- Design, supply, installation, testing, and commissioning of 132/25 kV, 21.6/30.24 MVA, ONAN/ONAF (double transformer) traction substation in specified sections.
- Manufacturing, supply, transportation, and delivery of prime quality of UIC 60 kg 1080 grade head Hardened class A rails as per IR standard specification for flat bottom rails IRS-T-12-2009.

Figure 3: Elements of the Jammu – Baramulla Rail Line⁶⁰



⁶⁰ Times Now News www.timesnownews.com

- Provision of electrical and mechanical (E&M) systems including supply, erection, testing and commissioning of 33 kV and 11 kV HT power cable networks, GIS substations, DG sets, tunnel ventilation systems, tunnel lighting, supervisory control, and data acquisition (SCADA) systems and firefighting system.
- Design, supply, alteration, modification, installation, testing, and commissioning of existing electronic interlocking (EI) based signaling and telecommunication (S&T) systems, including TPC communications to suit reinforced earth (RE) at specified stations.

Future bid packages to be issued are anticipated to include:

- Design of broad gauge ballastless tracks, including supply, installation, testing, and commissioning in the Katra-Dharam section at 39.201 km, 42.21 km, and from 51.935 km to 61.687 km of the project. The period of completion of work is 24 months.
- Design of broad gauge ballastless tracks including supply, installation, testing and commissioning in Katra-Dharam section from 91.2 km to 101.632 km
- Manufacture, supply, transportation, and delivery of prime quality of UIC 60 kg 1,080-grade head hardened class A rails as per IR standard specifications for flat bottom rails IRS-T-12-2009 (with the latest A and C slips) at Katra, Reasi, Kauri, Dugga and Sangaldan for the Katra-Dharam section of the project.
- Provision of electro-mechanical (E&M) systems which includes supply, erection, testing and commissioning of 33 kV and 11 kV HT power cable networks, gas-insulated substations (GIS), DG sets, tunnel ventilation systems (TVS), tunnel lighting, supervisory control and data acquisition (SCADA) systems and firefighting systems, for tunnels T-6, T-9, T-10, T-11 and T-12 from 39 km to 61 km in Katra-Dharam section of the project.
- The widening and strengthening of the existing approach roads between Digdole and Bajmasta from 0 km to 9.8 km for construction of new Adit-Urnihal to tunnel T-49 A, in Katra-Banihal section of the project.

Consultants who have worked on the project to date include: Bernard Ingenieure, Austria, (Detailed design consultancy and construction supervision of tunnels between 110 km and 125 km); Lombardi Engineering India Private, Switzerland (Supervision consultancy services; Detailed design consultancy of E and M works and construction supervision of tunnels including 3-D monitoring and associated works between 110 km and 125 km); Italferr S.p.A., Italy (Detailed design and construction supervision of one major river bridge on the Katra-Banihal section); Flint & Neill Limited, U.K (Proof checking of designs and drawing and providing technical guidance for important bridge across on Katra-Banihal section).

PROJECT STATUS AND IMPLEMENTATION TIMELINE

While this project initially experienced delays, it is now advancing on a fast track. The project is physically more than 45 percent complete. The construction of the Chenab River Bridge is likely to be completed by July 2020, while the Katra-Banihal section is expected to be completed by July 2021. Pre-construction surveys, geotechnical investigations, alignment studies, design of ventilation systems, fire escapes, emergency rescue, and other related electro-mechanical (E&M)

systems are in progress. Supervision consultancy and E&M design services for several of the tunnels, bridges, and sections are underway, as well.

On September 25, 2019, bids were invited for the design of a broad gauge (BG) ballastless track, including supply, installation, testing and commissioning in the Katra-Dharam section of the project (92.54 km to 101.63 km). Bids were due for submission on October 31, 2019. The Union Government has also approved the extension of the Jammu-Baramulla Railway Line to Kupwara and the Central government has recently approved an updated survey for the new Baramulla-Kupwara rail link.

Further bids for the supply of various materials, equipment, and services mentioned above are expected over the next 24 months.

PROJECT COST AND FINANCING

This is a Government of India project, sponsored by Northern Railways. The current cost estimate for the project is \$4.11 billion.

U.S. EXPORT OPPORTUNITIES

U.S. firms will have several opportunities to participate in this project, with a significant portion of the work on the railway still to be accomplished before commissioning. Specific opportunities exist for station development, signaling, track safety and maintenance equipment, electrification packages, technology provision for fog-safety and train protection and warning systems, geotechnical investigations, alignment studies, E&M design consultancy, construction supervision of tunnels and bridges, services with respect to general arrangement drawings (GADs), supply & installation of monitoring instrumentation, and design of broad-gauge ballastless tracks. U.S. firms will have opportunities to bid for EPC contracts, as well. Rail projects require local representation, either through an agent, distributor, manufacturing partner or associate. This will also help U.S. companies position their tenders, gain cost competitiveness, and meet local requirements.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Jewar (Greater Noida) Greenfield Airport		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Jewar, Uttar Pradesh
	PROJECT VALUE	\$2.32 billion

PROJECT SUMMARY

A new international airport is proposed to be constructed in Jewar, in Greater Noida, the National Capital Territory, in the Gautam Budh Nagar district of Uttar Pradesh. The Jewar airport is a greenfield project located 72 km from the existing Delhi airport. The project will be developed in four phases.

The plan is to build a two-runway airport by 2022 or 2023 and then, at a future date, to extend it to a 7,200-acre, 6-runway airport, with a passenger-handling capacity of 70 million passengers per annum (MPPA) and cargo-handling capacity of 3 million metric tonnes per annum (MMTPA). The project will be implemented by Noida International Airport Limited (NIAL) with shares owned by four governmental agencies. Planned investment is \$2.317 billion. The project will be structured as a public-private partnership (PPP) on a Design, Build, Finance, Operate and Transfer (“DBFOT”) basis.

PROJECT DESCRIPTION

The Indian aviation sector has been growing at a rate of 20 percent per year over the last four years, the fastest-growing aviation sector in the world. India ranks seventh in air traffic and is expected to move to third by 2023 or 2024, overtaking the UK, Japan, Spain, and Germany⁶¹. India has one of the largest aircraft order books globally, with pending deliveries of over 1,000 aircraft.

The Indian Vision 2040 for the aviation sector was unveiled recently. It plans for 200 airports, and a financial commitment of \$40 to 50 billion will be required to handle a minimum of 1.1 billion passengers.

To meet the growing demand, NextGen Airports for Bharat (NABH Nirman), a program for easing regulations to attract global airport construction companies, as well as a possible public listing of the airports, was launched to create enhanced airport capacity over the next 10 to 15 years. To raise

⁶¹ IATA Air Traffic Study

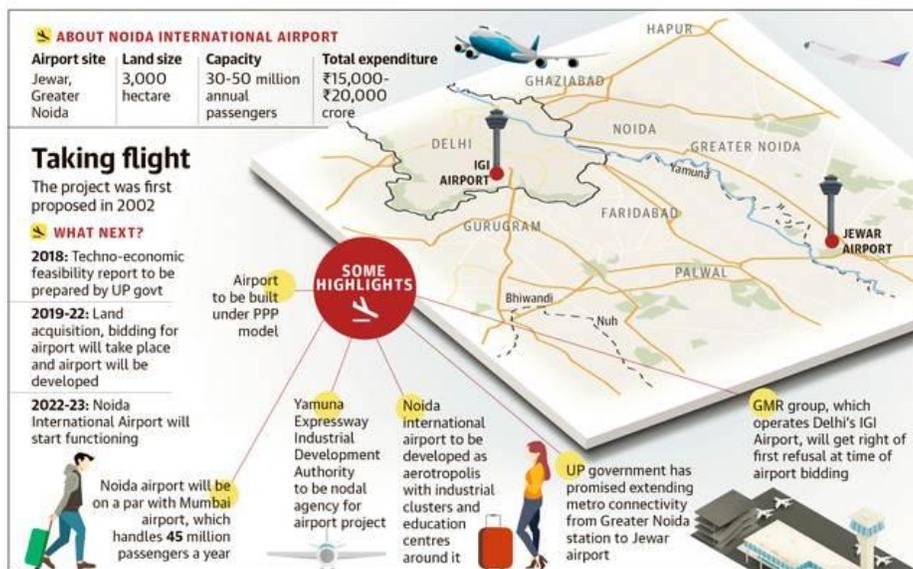
capital for airport expansions, Airports Authority of India (AAI) plans to privatize six airports - Ahmedabad, Jaipur, Lucknow, Guwahati, Thiruvanthapuram, and Mangaluru.

The expansion of airport capacity in the National Capital Region (NCR) is of importance, as a second international airport is much needed to ease the load at Indira Gandhi International Airport (IGIA) in New Delhi. Jewar Airport, strategically located in the NCR, will provide much-needed, additional regional capacity. The plan is for the proposed airport at Jewar to operate in a systematic way with IGIA, so that when IGIA experiences constraints in peak hours, spill-over traffic from IGIA can be diverted to Jewar to balance the system. Air Navigation Services (ANS), meteorological services, and other operational services will be harmonized with IGIA to maintain the optimum level of efficiency and capacity for both airports.

Jewar Airport was first announced in 2001. For multiple reasons (political, land issues, etc.), there was indecisiveness about this project. Due to capacity constraints at IGIA, coupled with recent political alignment between the new (Modi) Central Government and the Uttar Pradesh State Government, there is now a commitment to bring this project to fruition.

The project (*Figure 1*) is being advanced by an aggressive civil aviation policy and the completion of a techno-economic feasibility report (TEFR) prepared by Price Waterhouse Coopers (PWC). Yamuna Expressway Industrial Development Authority (YEIDA) has been appointed as a nodal agency by the Government of Uttar Pradesh (GoUP). A land requirement of 1,441 hectares has been identified for Phase I of the project.

Figure 1: Jewar (Noida) Airport⁶²



The airport will be built in four phases (*Table 1*) and eventually spread over an area of 5,000 hectares. Upon completion, passenger-handling capacity will stand at 70 MPPA, and cargo-

⁶² Thgim.com

handling capacity will reach 3 MMTPA. In addition, about 30 to 40 percent of total revenue at Indian public-private partnership (PPP) airports is contributed by non-aeronautical sources.

Table 1: Jewar Greenfield Airport Development Phases⁶³

Development Period	Phase	Period	Design Year	Passengers (MMPA)	Cargo (MMT)	Gates
FY 2020-22	1	FY 2023-27	2028	12	0.75	24
FY 2028-30	2	FY 2031-32	2034	30	1.0	40
FY 2033-35	3	FY 2036-37	2039	50	1.5	68
FY 2037-39	4	FY 2040-50	2044	70	3	85

Key elements of the project's first phase are described below (*Table 2*):

Table 2: Phase 1 - Key Project Elements⁶⁴

Facilities (1st Phase)	
Sl. No.	Details of items
1	Runway 4150 x 60 for Code 'F' Code F, precision approach, Runway 10/28- Cat III, fully supported by Cat III ILS and approach lighting and visual aids.
2	Parallel End to End Taxiway Taxiway with two rapid exits conforming to Code F and Cat III requirements.
3	Apron for 4Code E/F and 21 Code C Aircraft with built in capacity to accommodate up to 5 Code E aircraft
4	Terminal Building for peak 2750 passenger capacity (Total Floor Area of 90,000 sq.m., Swing Gate operation)
5	Fire Station (Category 9)
6	Air Traffic Control Building
7	Isolation Bay
8	Operational Wall
9	Cargo Terminal Building (50,000 sq.m.)
10	Maintenance Building
11	Management Building
12	Security Staff Building
13	Energy Building
14	Property Boundary Wall
15	E & M Facilities
a	Power House
b	Electrical Substation
c	Distribution Substation
d	AGL and Visual Aids to support Cat III operations
e	METFARM

⁶³ NIAL

⁶⁴ Ibid.

Upon completion of the four phases, the Jewar airport will have six runways and become India's largest airport. As envisioned, Jewar Airport will also be one of the world's largest airports. Only O'Hare International Airport (ORD) and Dallas/Fort Worth International Airport (DFW) will be larger, with eight and seven runways, respectively. Currently, IDIA has the highest number of runways in India, with three.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

YEIDA has acquired a total of 923 hectares of land for the greenfield airport project. On August 6, 2019, 80 hectares of farmland were completely acquired and transferred to YEIDA. This completes the first tranche of land acquisition.

The State Cabinet approved the bid document for the project in May 2018. The Ministry of Environment, Forest and Climate Change (MoEFCC) has provided necessary approvals. The inception report for the project is expected to be submitted by Wildlife Institute of India (WII) by the end of October 2019.

In May 2019, NIAL invited Phase 1 Requests for Proposal (RFPs) for the development of the project on a PPP basis, at an estimated cost of \$677 million. The last date for submission of bids was October 30, 2019. Bids will be opened in November, and project work is expected to start by March 2020. The scheduled commercial operation date for the project is April 1, 2023.

Each phase of construction is expected to require 36 months. Bids will be issued during each project phase for the selection of a PPP partner. Subcontracting will be done by each PPP to secure relevant services and supplies.

PROJECT COST AND FINANCING

Based on the Master Plan, the capital expenditure for the full project is estimated at \$2.32 billion. The development will be divided into four phases:

- Phase 1 - \$550 million
- Phase 2 - \$520 million
- Phase 3 - \$599 million
- Phase 4 - \$644 million

The greenfield airport project will be overseen by Noida International Airport Limited (NIAL), and the State government and Noida Authority will own an equity stake of 37.5 percent each. The Greater Noida Industrial Development Authority (GNIDA) and YEIDA each will have a stake of 12.5 percent. The project is to be structured as a PPP.

Land acquisition will be made by YEIDA/NIAL. Haryana Urban Development Corporation (HUDCO) has agreed to provide a loan of \$441 million at an interest rate of 10.5 percent, while the National Capital Region Planning Board (NCRPB) has agreed to provide loans worth \$74 million at an interest rate of 7.5 percent. To pay land compensation to farmers, YEIDA has secured

a loan of \$1.25 million sponsored by four banks: HDFC, Indian Bank, Oriental Bank of Commerce, and Canara Bank. The State has released a \$147 million fund to YIEDA for the acquisition of 1,000 hectares of agricultural land for Phase I.

The selected bidder will incorporate as a Special Purpose Vehicle (SPV) under the Companies Act, 2013 and will execute an agreement with the Government Authority (Shareholders Agreement), providing for the issue and allotment of one non-transferable equity share of the company (the “Golden Share”) in favour of the Government Authority. The Concessionaire will be responsible for the design, engineering, financing, procurement, construction, operation, maintenance, and transfer of the greenfield airport project under the provisions of a concession agreement.

U.S. EXPORT OPPORTUNITIES

As a greenfield airport, this project presents many opportunities for U.S. companies that offer design, engineering, and project management services. Particularly in need will be design and services related to:

- Air traffic control (ATC)
- Facilities
- Utilities
- Engineering
- Electrical
- Lighting
- Ground-side
- Air-side
- Communications
- Passenger services

The Jewar Airport passenger terminal, as planned, will be a state-of-the-art, visible, and an iconic landmark. The intent is to create a unique, futuristic building. U.S. design and architecture firms, as well as other arts-related organizations, may have opportunities here.

Retail design and operations opportunities are likely to exist vis-a-vis shopping and the duty-free area. Here, there will be needs for concessionaires, designers, retail-management and maintenance, repair, and overhaul (MRO) service providers.

With respect to equipment and supplies, opportunities span aviation and airport-related goods. Products required will include:

- Advanced lighting systems
- Jet bridges
- Navigational aids and lighting systems
- Distance measuring equipment (DME)

- VHF omnidirectional radio range (VOR)
- Instrument landing systems (ILS)
- Visual aids including precision approach path indicators (PAPIs)
- Runway lights
- Communications systems
- Terminal security systems (metal detectors, body scanners)
- Closed-circuit television(CCTV)/cameras
- Access control systems
- Ground-handling equipment
- Fire-fighting trucks and emergency vehicles
- Baggage and cargo handling equipment

Several U.S. companies have already expressed interest in participating in the development and operation of the greenfield airport at Jewar. For example, The Boeing Company has expressed interest in setting up a maintenance, repair, and overhaul (MRO) facility on the airport site. Similarly, VT Systems (now ST Engineering North America) has indicated interest in developing an MRO unit in nearby Meerut city.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Noida International Airport Ltd. OFFICE NO. 1-15 BLOCK P-2-SECTOR, OMEGA -1, Greater Noida, Gautam Buddha Nagar 201308 Uttar Pradesh India Mr. Shailendra Kumar Bhatia, Chief Nodal officer info@nialjewar.com	U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Alissa Lee alee@ustda.gov U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Mehnaz Ansari mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Commercial Service The American Centre 24 Kasturba Gandhi Marg New Delhi, 110 001 India Ms. Aileen Crowe Nandi Senior Commercial Officer office.newdelhi@trde.gov

Kolkata Airport Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Kolkata, West Bengal
	PROJECT VALUE	\$147 million

PROJECT SUMMARY

The Airports Authority of India (AAI) is planning to develop a new terminal building as part of the second phase expansion of the Kolkata airport (located in the state of West Bengal), at the cost of approximately \$147.06 million. In the completed Phase 1 expansion, a new terminal was constructed and integrated with the old domestic airport terminal. In phase 2, the old international terminal will be demolished to make way for the new 70,000 square meter terminal building. Additionally, the security hold area (SHA) will be expanded, and new jet bridges will be added. The new terminal is expected to house only domestic flights while a large portion of the existing integrated terminal will be allotted to international flights.

PROJECT DESCRIPTION

The Indian aviation sector has been growing at a rate of 20 percent per year over the last four years – the fastest growing aviation sector in the world. It is the third-largest civil aviation market globally, behind the United States and China.

India recently unveiled its Vision 2040 for the aviation sector. Achieving this vision will require the construction of approximately 200 airports and a financial commitment of \$40-50 billion, to achieve the objective of handling 1.1 billion passengers annually. The NextGen Airports for Bharat (NABH) Nirman initiative was launched to create enhanced airport capacity over the next 10 to 15 years. To raise capital for airport expansions, Airports Authority of India (AAI) plans to privatize six airports - Ahmedabad, Jaipur, Lucknow, Guwahati, Thiruvanthapuram, and Mangaluru.

In addition to these infrastructure improvements, efforts are being made to upgrade other aspects of the aviation sector in order to improve the overall aviation ecosystem. For example, the government is targeting enhanced passenger experience at the airport as one area of focus. In October 2018, the Ministry released its policy on biometric-based digital processing of passengers at airports called "Digi Yatra." The government also launched an upgraded version of the Air Sewa 2.0 web portal and mobile app, providing a variety of real-time information to the flying public.

The government also unveiled a drone (UAS) policy to ensure that drones used domestically are manufactured in India, thereby enhancing local economic development. At the same time, the government is focused on leveraging technologies such as artificial intelligence to improve the flying ecosystem.

Figure 1: Air Traffic Growth in India⁶⁵



Kolkata Airport, also known as Netaji Subhas Chandra Bose International Airport, is located in Dum Dum, West Bengal, in the eastern part of India, approximately 17 km from the city center. It is one of the top ten airports in India, handling 350 flights per day, and according to Airports Council International (ACI), is among the fastest-growing in the world. It is controlled and operated by AAI.

Due to large and continued growth in traffic, AAI created a multi-decade expansion blueprint at Kolkata. In Phase 1 (inaugurated in January 2013), the existing international and domestic terminals were integrated into a single, six-level, L-shaped, 233,000 m² passenger terminal. The reconfigured terminal building was inaugurated four years ahead of initial projections and contains 18 jet bridges, 45 parking bays, and a capacity to handle 24 million passengers per year. AAI is now planning to initiate Phase 2, increasing capacity by 9 million passengers per year at an estimated cost of \$147 million.

The Phase 2 expansion plan encompasses the following:

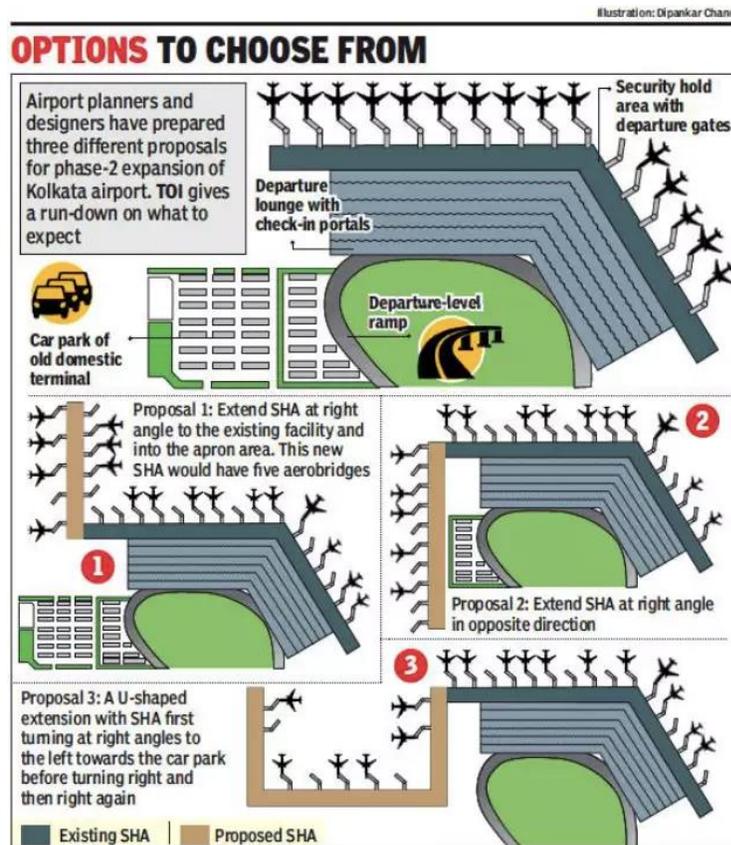
- New terminal – estimated 70,000 square meters
- Increase in passenger capacity/year – 9 million
- New jet bridges in the terminal – 10
- New parking bays – 15

The old domestic terminal will be demolished to create space for the new one. The designs being considered are both ‘L-’ and ‘U-’ shaped and will add boarding gates and jet bridges. With the

⁶⁵ India Infrastructure Research

added jet bridges, 200 flights will be able to offer direct boarding, doubling the current capacity of 100. The security hold area (SHA) lounge to the left of the existing terminal will be expanded, and additional boarding gates will be added. The new facility will cater to category C and higher aircraft (Boeing 737 and 787; Airbus A319, A320, A321).

Figure 2: Designs Under Consideration for the New Terminal⁶⁶



Landrum & Brown, a U.S.-based firm specializing in aviation planning and development, has reviewed the master plan and has recommended changes based on the utilization of the facilities.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The AAI Board has approved the demolition of the old terminal for the end of 2019. However, approval of the new terminal design is not anticipated until early 2020. The selection of a contractor and construction would follow soon thereafter.

⁶⁶ TOIIMG <https://static.toiimg.com/photo/imgsize-505471,msid-68759151/68759151.jpg>

PROJECT COST AND FINANCING

The total cost of the project is estimated at \$147 million. Airports Authority of India (AAI) is solely funding the project.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include the following:

- Terminal design services
- Terminal equipment and airport systems design and services including augmentation and provision of:
 - Public address system and car calling system
 - Surveillance closed-circuit TV system (SCCTV)
 - Flight Information Display System (FIDS)
 - Baggage x-ray systems
 - VHF FM sets
- Firefighting systems
- Advanced lighting systems
- Baggage handling systems
- IT and Terminal communication systems
 - Passive and active networking components
 - Access Control System
 - Information and communications technology (ICT) and digital systems
 - AI and other digital enablement systems and services
- Jet bridges design and supply
- Parking bays design and services
- Escalators
- Customer experience enhancement plans and services.
- Engineering and architectural services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Mumbai Pune Hyperloop		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Rail (Hyperloop)
	LOCATION	Mumbai, Maharashtra
	PROJECT VALUE	\$10.3 billion

PROJECT SUMMARY

The project involves the development of a hyperloop transportation system connecting Mumbai and Pune in the state of Maharashtra. The full corridor is planned to run approximately 140 kilometers, connecting Central Pune, Navi Mumbai International Airport (NMIA), and the city of Mumbai. Phase I of this project will cover 117.5 kilometers from Bandra Kurla Complex, Mumbai to Wakad, Pune. It will entail an investment of approximately \$10.3 billion and will be implemented on a build, operate, and transfer (BOT) basis under the public-private partnership (PPP) model. Pune Metropolitan Regional Development Authority (PMRDA) is the nodal agency, and Virgin Hyperloop One (VHO) and DP World FZE are the promoters of the project.

PROJECT DESCRIPTION

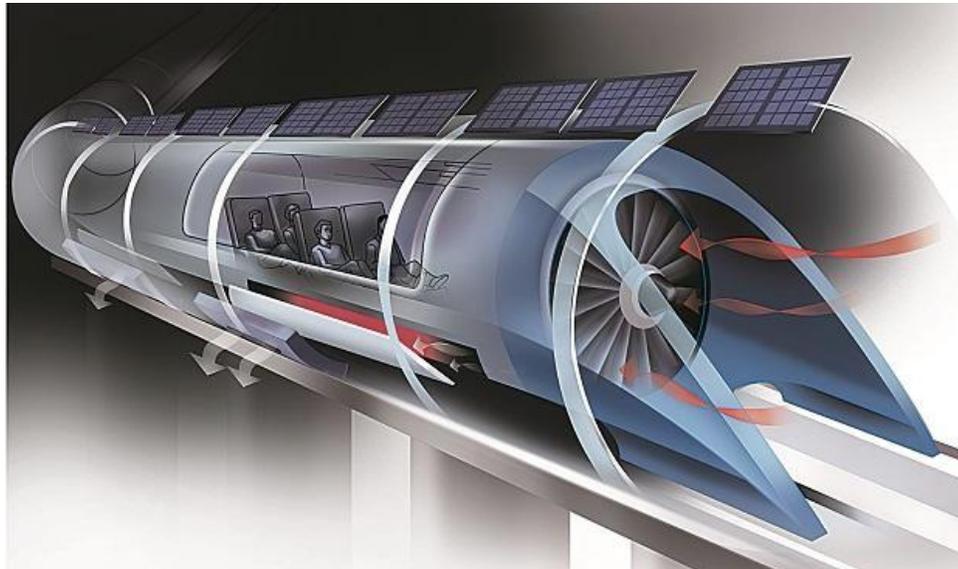
The idea of a hyperloop was first presented in a white paper in 2013 by billionaire entrepreneur Elon Musk, founder of SpaceX and Tesla. A hyperloop involves levitating pods “zipping” through specially built tubes raised on pylons (*Figure 1*). Magnets are used to levitate the pods, and powerful pumps are used to remove most of the air inside the tubes, allowing the pods to move under conditions of very low friction. The capsules are expected to be similar in size to passenger buses. The hyperloop is designed to be energy efficient and reach speeds as high as 1,120 km/hour.

Virgin Hyperloop One, USA, (formerly Hyperloop One) was established in 2014, as one of the leading companies developing hyperloop technology. The Maharashtra Government has announced that a consortium of Virgin Hyperloop One (VHO) and global ports owner DP World is the preferred operator to build "the first hyperloop transportation system in the world."

All routes between the cities of Mumbai and Pune in Maharashtra are extremely busy, with an estimated 75 million passenger journeys annually between the two cities. This figure is expected to increase to 130 million by 2026. The average passenger rail trip between the cities is approximately 3.5 hours. The project is anticipated to significantly reduce the travel time to an estimated 25 minutes between the twin cities, and the system is anticipated to be capable of

supporting 150 million passenger trips annually. It also has the potential to rapidly transport palletized freight and light cargo between the Mumbai Port and Pune.

Figure 1: Conceptual Design of the Hyperloop⁶⁷



The project was proposed by the Ministry of Roads, Transport and Highways (MoRTH) in 2016, with the Ministry inviting the Space Exploration Technologies Corporation (SpaceX) to develop the pilot project. Following company reorganization and re-naming, a Memorandum of Understanding (MoU) was signed by VHO and the Pune Metropolitan Region Development Authority (PMRDA) to conduct a preliminary feasibility study that would identify high-priority routes and analyze the high-level economic impact and technical viability of a hyperloop transportation system in Maharashtra (*Figure 2*).

Figure 2: Indian Hyperloop⁶⁸



⁶⁷ BS Media

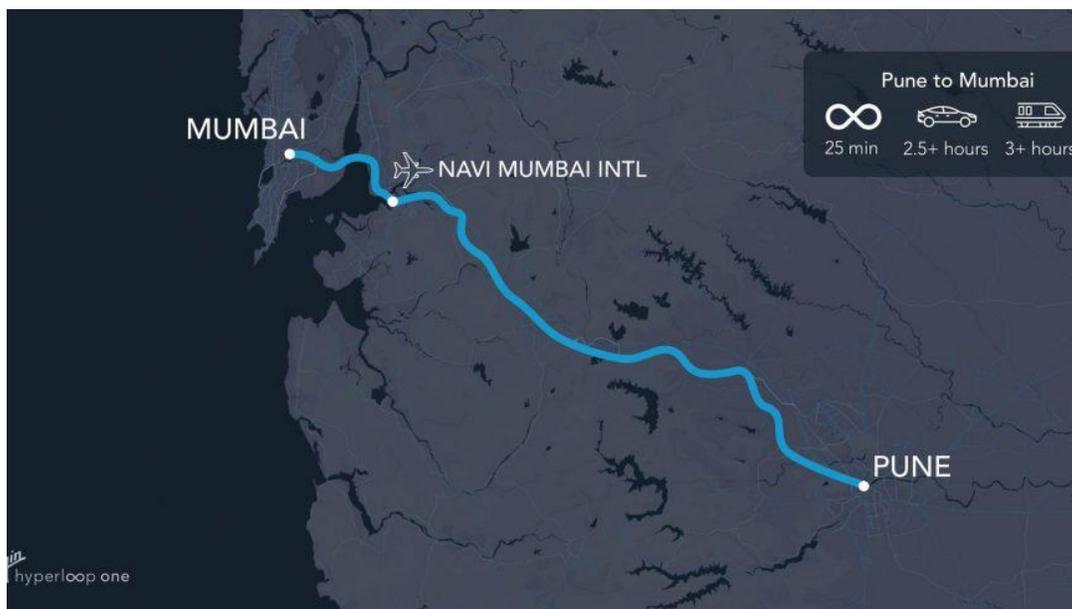
⁶⁸ Asset Type

Procurement for the project is anticipated to take place in two phases:

- **Phase I:** Development of an 11.8 km long operational demonstration track built between two points on the route. This pilot will serve as a platform for testing, certifying, and regulating the system for commercial operations. Anticipated cost: \$700 million.
- **Phase II:** will include the complete construction of the entire Pune-Mumbai route.

Futures proposed expansions of the project include linking central Pune with the New Pune International Airport and connecting Jawaharlal Nehru Port in Mumbai with Pune's industrial economic zones (*Figure 3*).

*Figure 3: Projected Hyperloop Alignment*⁶⁹



The state government has accorded the project the status of ‘Public Infrastructure Project.’ These projects demonstrate not only economic viability, but also have positive impacts on society, employment, quality of life, capacity easing within urban areas, and general public benefit. At the same time, the developer of Public Infrastructure Projects is able to tap into preferential policies to accelerate development. With this designation, land acquisition is completed by the Government, rather than the private sector developer, environmental clearances are fast-tracked and financing can be accomplished through multiple routes, including PPP, government viability gap funding, government bridge financing, extended-term loans, soft loans from multilateral agencies, and loans from banks and financial institutions. The Central Government will decide under which Act this project will fall and will also decide whether or not amendments can be made to the new Metro Rail Policy Act 2017. This will determine the appropriate path for compliance and regulatory elements to be overcome and avoid future policy-related delays.

⁶⁹ CN Traveller <https://media.cntraveller.in/wp-content/uploads/2018/02/mumbai-pune-hyperloop-route-866x487.jpg>

Through a government resolution (GR), the Maharashtra Government approved the implementation of this project, utilizing a Swiss Challenge model. The original project proponent (OPP) - the consortium of DP World FZE and VHO - will publish a detailed project report (DPR), which can be challenged by any other bidders (if any). The final bidder will then be decided by the Maharashtra Government. This method is applied for technologies that are unique and where no other technology suppliers are known, ensuring that no objections are raised later with respect to any regulatory non-compliance. It is not anticipated that any other bidder will emerge during the Swiss Challenge.

PricewaterhouseCoopers Private Limited (PwC) is the financial consultant and transaction advisor for the project. Their scope of work includes reviewing the feasibility study and DPR to be submitted by the consortium of DP World FZE and VHO, appraising the project, developing a revenue model and project structure, preparing the bidding documents, and assisting the authority in the bidding process. Additional stakeholders in this project include:

Project Promoters and Shareholders

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2. DP World FZE
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Ph +971 48815555
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Concessioning Authority

Pune Metropolitan Regional Development Authority (PMRDA)
Survey No. 152-153, Maharaja Sayaji Gaikwad Udyog Bhavan, Aundh
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Ph +91 124 4620000
<http://www.pwc.com>

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In July 2019, the Maharashtra State cabinet approved the appointment of a consortium of DP World FZE and VHO as OPP for the implementation of the project. Currently, PMRDA has submitted the feasibility study of the project to the Indian Institute of Technology-Bombay to finalize the connecting point in Mumbai for the project. Meanwhile, a sub-committee appointed by the state government will submit the final proposal for the implementation of the project to the Maharashtra Infrastructure Development Enabling Authority. The construction work on Phase I is likely to commence over the next 12 months, with an estimated date for completion of 2023. Phase II is expected to be completed in five to seven years.

PROJECT COST AND FINANCING

The estimated cost of the project is \$10.3 billion. The project will be entirely funded by the private sector.

U.S. EXPORT OPPORTUNITIES

This project implementation is being led by a U.S.-based company. U.S. firms are well placed to be suppliers of high-end equipment and services associated with tracks, signaling, pods, electrical equipment, design, engineering services, monitoring & information technology, networking, robotics, and communication. The project involves a direct foreign investment equivalent to \$10.3 billion.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Virgin Hyperloop One 2159 Bay Street Los Angeles, CA USA www.hyperloop-one.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toohers ktoohers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Renie Subin renie.subin@trade.gov</p>

Paradip Port – Western Dock Development		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Paradip, Odisha, India
	PROJECT VALUE	\$300 million

PROJECT SUMMARY

Paradip Port is a major Indian port located in the eastern Indian state of Odisha, near the confluence of River Mahanadi and Bay of Bengal. The Western Dock project involves both deepening the port and the construction of Western Dock Captive (WDC) berths to handle cape-size vessels. The project has an estimated cost of \$300 million. The proposed berths will have a handling capacity of 25 million metric tonnes per annum (MTPA) and will be developed on a design, build, finance, operate, transfer (DBFOT) basis, managed, and financed as a public-private partnership (PPP).

PROJECT DESCRIPTION

India has a vast coastline of over 7,500 km, with 13 major ports and approximately 200 lesser ports scattered along its eastern and western coasts. The Paradip Port, operated by Paradip Port Trust (PPT), is one of India’s major ports. It lies in the state of Odisha on the east coast of the Bay of Bengal. Its site is about 210 nautical miles south of Kolkata and 260 nautical miles north of Visakhapatnam.

During the 2017-2018 year of operations, Paradip Port handled 102 million metric tonnes of cargo, including:

- Crude oil
- Petroleum, oil, and lubricant products
- Iron ore
- Thermal and coking coal
- Chrome ore, charge chrome and ferrochrome
- Manganese ore and ferromanganese
- Limestone
- Hard coke
- Ingots, molds, billets and finished steel, as well as scrap
- Fertilizers and fertilizer raw materials
- Clinker

- Gypsum
- Assorted project cargo and containers

Paradip Port is built on an artificial lagoon protected by two breakwaters (*Figure 1*). The port's approach and entrance channels have a minimum depth of 17.1m, allowing a wide range of vessels to be serviced up to a maximum length overall (LOA) of 260m. The port has six berths able to handle fully loaded Panamax vessels.

The existing port cargo capacity is 118.5 MTPA. With the emergence and rapid development of industries in Pradip's hinterland, however, there are needs both to expand port capacity rapidly and to enable service of Cape-size vessels. Traffic projections indicate capacity shortfalls will begin in 2020 (*Table 1*).

*Figure 1: Existing Paradip Port Layout*⁷⁰



⁷⁰ Paradip Port Trust

Table 1: Master Plan Traffic Projections at Paradip Port⁷¹

Cargo Handled	I/E	Current Capacity (MTPA)	2020		2025		2035	
			Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)	Projected Traffic (MTPA)	Capacity Augmentation required over current (MTPA)
Coal - Export	E	33.21	95.00	61.79	135.00	101.79	200.00	166.79
Coal - Import	I	12.10	22.30	10.20	26.50	14.40	37.00	24.90
Breakbulk	I/E	14.76	11.64	0.00	17.03	2.27	28.81	14.05
Iron Ore	E	6.39	6.50	0.11	7.50	1.11	10.00	3.61
Fertiliser	I	7.50	5.60	0.00	7.00	0.00	10.50	3.00
Crude/ POL	I	54.50	35.20	0.00	41.80	0.00	47.50	0.00
Total		128.46	176.24	72.10	234.83	119.57	333.81	212.35

The overall Paradip Port project, for which environmental clearance has been received, includes:

- Inner harbor expansion
- Berth mechanization
- **Western Dock Expansion** (this project)
- Outer Harbour Development

The full port expansion project, to be developed in phases, is expected to provide 13 new deep draft berths, two of which will be part of the Western Dock Expansion. The new berths will cater to cape-size vessels of up to 225,000 deadweight tonnage (DWT). The project will be implemented under the Sagarmala scheme of the Ministry of Shipping (MoS), a program intended to optimize logistics in India by unlocking the potential of its waterways and coastline.

At present, Paradip Port Trust has two docks, Eastern Dock and Central Dock, with a total of 14 berths. With significant growth in traffic, vessel congestion has increased, despite efforts to improve throughput and productivity with mechanization. To meet immediate additional berth requirements, Paradip Port has initiated the development of the Western Dock, which is currently in the project bidding process.

Initially, PPT had planned to develop the outer harbor during the first phase of the project, and the Terms of Reference (ToR) for carrying out the environmental impact assessment (EIA) studies on the outer harbor were finalized by the Ministry of Environment, Forest and Climate Change (MoEFCC) in April 2017. Subsequently, it was decided that the outer harbor will be addressed in the second phase, leaving the inner harbor/**Western Dock**, to be implemented in the first phase.

Overall, capacity will be increased to 25 MTPA upon completion of two phases, with Phases I and II each adding capacities of 12.5 MTPA. The Phase I Scope of work includes development,

⁷¹ Master Plan, Paradip Port http://sagarmala.gov.in/sites/default/files/10.Final_Master_Plan_Paradip.pdf

operation and maintenance (O&M) of the Western Dock, of dimensions of 490 m x 280 m, complete with berths and mechanized ancillary facilities, for a concessionary period of 30 years.

A non-conventional dock layout, eliminating the need for a second swinging basin, and 20-meter high stockpiles are planned due to the tight land constraints. Dry excavation has been suggested (in place of dredging), as a more cost-effective option, enabling the reuse of excavated material.

The detailed project report (DPR) was prepared by Aurecon Group in January 2019, and the layout of the project was prepared by the Indian Institutes of Technology (IIT) - Madras.

Key consultants on the project are:

- Indian Institute of Technology (IIT): project layout
- McKinsey & Co.: techno-economic feasibility study (TEFR)
- AECOM India Pvt. Ltd.: a techno-economic feasibility study (TEFR)
- National Environmental Engineering Institute (NEERI): environmental impact assessment

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The environmental clearance and necessary approvals for the project have been received. The required land is already available within the Port Trust. Phase I is expected to be completed in 36 months; work on Phase II will begin two years after the commissioning of Phase I, with a planned completion period of 24 months.

PPT had originally planned to develop this facility by selecting a bidder who would be a Port Dependent Industry (PDI) entity and would do the detailed engineering. At the initial RFQ stage, bidders were required to submit broad details of their project proposals, and overall layout drawings, as well as a pricing mechanism, predicated on a volume throughput, including a Rupees per Metric Tonne fee to be realized by PPT.

On October 12, 2018, Request for Qualifications (RFQs) were issued for the selection of project developers. The due date was extended twice. By August 2019, only three firms, Tata Steel Limited (TSL), Adani Ports and Special Economic Zone Limited (APSEZ), and Essar Ports Limited (EPL) had bid.

Following this process, the Department of Economic Affairs submitted an objection, arguing that qualification criteria were unduly restrictive, limited competition and that the bid process had led to no interest from bidders unconnected to the Paradip Port Trust. It was further noted by Niti Ayog, Planning Commission, Government of India, that if the port is developed as a PPP, bidding need not be restricted to PDIs. After further review by the Shipping Ministry and the PPT, the Shipping Ministry will finalize revised bidding criteria, and the PPT will then invite new bids during the first half of 2020.

PROJECT COST AND FINANCING

The Western Dock is a \$300 million project and part of a larger PPT port development initiative. Bid criteria are under review and are expected to be released for rebid during the first half of 2020. The project will be structured as a Private Public Partnership. Financing details will be provided by mid-2020.

U.S. EXPORT OPPORTUNITIES

The potential export opportunities for U.S. firms will be to work with the PPP partner in providing:

- Detailed engineering and design services
- Dry excavation services and equipment
- Layout/facility planning and management services
- Construction management services
- Supply of terminal management and berthing aids
- Software and user training
- Port security technology and training
- Bulk cargo management equipment, including:
 - Silos
 - Front-wheel loaders
 - Conveyor belts
 - Grab-type ship unloaders
 - Piping systems
 - Storage tanks

There will also be longer-term supply opportunities for:

- Cargo management software
- Yard trucks
- Conveyors and material handling equipment
- Mobile cranes
- Harbor mobile cranes (HMC)
- Pay loaders, dumpers, spreaders, and track hoppers

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Project Implementation Office Admin Building Paradip Port Trust Odisha -754 142 India Superintending Engineer (H) Project Implementation Office sehpioppt@gmail.co www.paradiport.gov.in</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Mr. Kevin Toohers ktoohers@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Centre 24 Kasturba Gandhi Marg New Delhi, 110 001 India Mr. Sham Shamsudeen Sham.shamsudeen@trade.gov</p>

Hang Nadim International Airport		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Batam, Indonesia
	PROJECT VALUE	\$250 million +

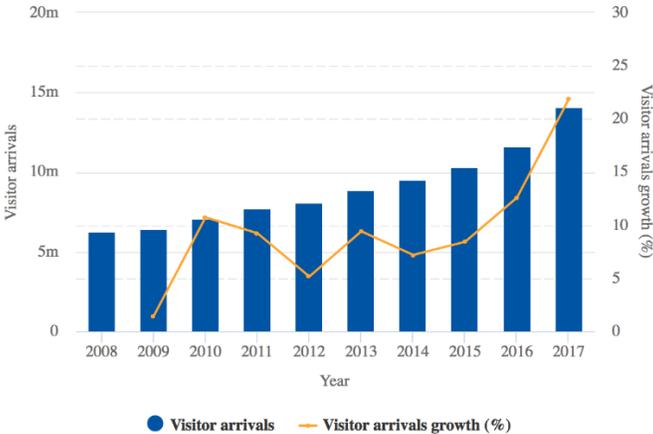
PROJECT SUMMARY

The Hang Nadim International Airport is currently experiencing greater passenger traffic flows than it was designed to handle. To manage expected future volumes, an expansion plan, including refurbishing the existing terminal and constructing a new terminal, will be undertaken. The expansion plan will cost approximately \$250 million, with construction slated to begin in 2020 and operations commencing in 2022.

PROJECT DESCRIPTION

The aviation market in Indonesia is the largest in Southeast Asia. With 61 scheduled and unscheduled commercial airlines in operation, Indonesia has the second fastest growing aviation industry, behind China. The tourism trade plays a large part in this growth, and given its archipelagic geography, the overwhelming majority of visitors arrive by air.

Figure 1: Annual Visitor Numbers to Indonesia (2008-2017)⁷²



⁷² CAPA – Centre for Aviation; BPS Statistics Indonesia

As passenger levels increase, Indonesia has also seen increasing load factors on aircraft arriving from overseas. In 2017, the load factor for all airlines was the highest since 2007/2008 and continued an upward trend that began in 2014. Nearly all of Indonesia’s airports are operating above their load capacity.

Figure 2: Scheduled International Traffic for Indonesian Airlines and Load Factor (Millions of Passengers)⁷³

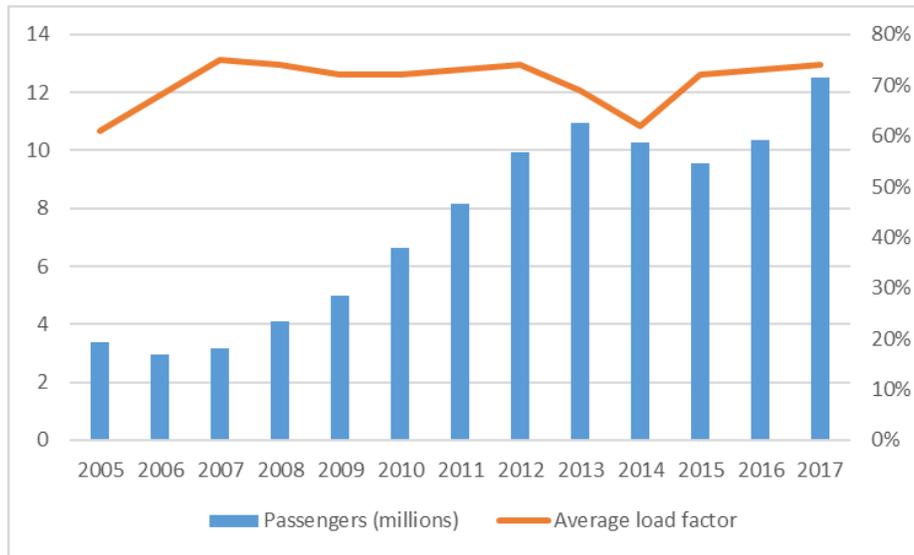
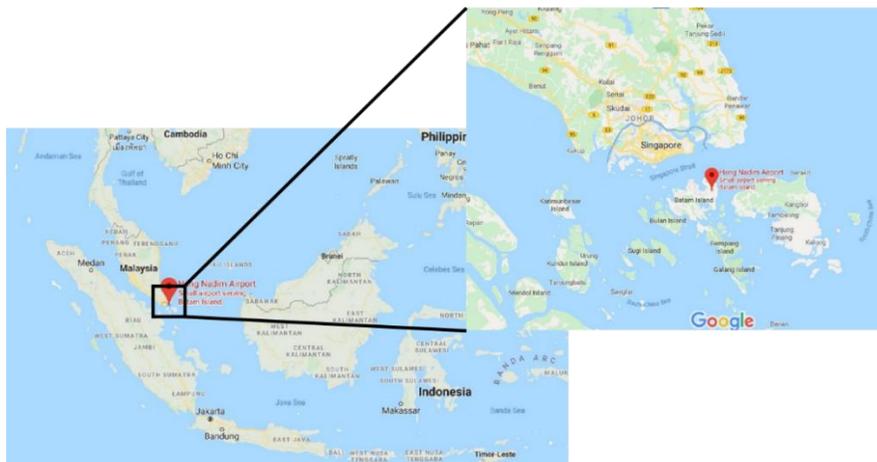


Figure 3: Hang Nadim International Airport Location⁷⁴



To further boost tourism and enhance regional economic development across the country, the government of Indonesia has launched the “Ten New Balis” program. It is designed to increase tourism revenue to eight percent of GDP, increase foreign exchange income, and increase local

⁷³ Ibid.

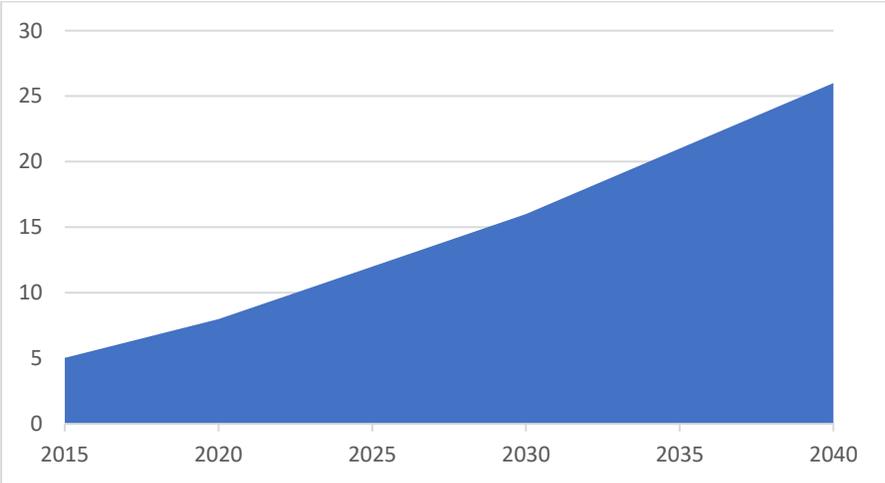
⁷⁴ Google Maps

employment. Through this campaign, air travel is expected to increase as more visitors arrive in Indonesia, necessitating the improvement and expansion of existing aviation infrastructure.

The Hang Nadim International Airport (BTH) in Batam, Indonesia, in the Riau Islands, was originally developed to accommodate overflow planes from Singapore’s Changi Airport in case of an emergency. The airport has a current capacity of five million passengers/year and boasts the longest runway in Indonesia. (The runway is the second-longest in Southeast Asia, behind Malaysia’s Kuala Lumpur International Airport).

In 2016, BTH saw a passenger throughput of more than six million passengers, with projections that future volumes will continue to exceed the facility’s capacity. Over the 2011 to 2016 period, the airport also witnessed a CAGR of 11.32 percent for aircraft movements, resulting in 48,620 movements in 2016. As such, the airport operator, Batam Indonesia Free Zone Authority (BP Batam), will undertake an expansion and upgrade project to ease overcapacity and facilitate future passenger throughput that could be as high as 30 million passengers/year by 2045.

Figure 4: Historical and Projected Passenger Flows at Hang Nadim International Airport⁷⁵



The airport expansion project will be made up of the following components:

- Refurbishing and expanding the existing passenger Terminal 1 and airside facilities, will accommodate up to 10 million passengers/year;
- Constructing the new passenger Terminal 2 and associated airside facilities to accommodate up to 10 million passengers/year; and
- Relocating the cargo terminal.

BTH is located inside a free trade zone and surrounded by more than 1,700 hectares of freehold land controlled by BP Batam, a unit of the Ministry of Finance. This structure will allow for the expansion of the airport to move forward with little concern regarding land availability. The area

⁷⁵ BP Batam

immediately surrounding the airport will be developed under an aerotropolis model, serving as a domestic and international logistics hub.

The expansion of the BTH airport has been listed in the *Initial Rolling Priority Pipeline of Potential ASEAN Infrastructure Projects under the ASEAN Master Plan on Connectivity 2025*. This list, developed by ASEAN in conjunction with the World Bank and the ASEAN-Australia Development Cooperation Program Phase II, highlights projects that create the necessary infrastructure to accomplish the vision for connectivity in the region. As part of this pipeline, additional studies may be undertaken to determine appropriate funding/financing options and further clarify economic prospects and identify associated risks.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The airport expansion is currently in the pre-qualification phase, with an award to the winning consortium expected near the end of 2019 and financial close in early 2020. Following this award, construction would begin in 2020 over a period of two years. The newly-expanded airport is expected to open for operations in 2022.

The following organizations have been involved with the development of the airport thus far:

- Implementing Facility – PT SMI (Persero)
- Legal Consultant – Hermawan Juniarto
- Financial Consultant – PricewaterhouseCoopers (PwC)
- Technical Consultant – Mott McDonald

PROJECT COST AND FINANCING

The airport expansion project is expected to cost at least \$250 million.

It will be structured as a public-private partnership (PPP), with the private sector responsible for the design, build, financing, operation, and maintenance of the facility under a 25-year concession. The winning bidder will generate a return on investment from the revenue derived from the management of airport facility services. Of note, due to Indonesian government regulations, the maximum foreign ownership for airport and airline operations is 49 percent, necessitating collaboration with a local Indonesian partner.

U.S. EXPORT OPPORTUNITIES

The expansion of the Hang Nadim airport to accommodate increasing passenger flows provides significant export opportunities for U.S. firms to provide equipment and services. The U.S. firms PwC and Mott McDonald have already been engaged to support preparatory activities. At the same time, the United States and Indonesia maintain an active Aviation Working Group designed

to drive cooperation between the U.S. and Indonesian stakeholders in the aviation market. However, significant competition does exist in this space from regional competitors.

Specific opportunities for sales of equipment, technology, and services associated with the airport expansion plans include the following areas:

- Construction supervision and management
- Project management
- Engineering and design services
- Jet bridges
- Access control technologies
- Telecommunications equipment
- Security screening and monitoring technologies
- Ground handling equipment
- Baggage claim equipment
- Air traffic control and management technologies
- Cybersecurity solutions
- Runway lighting and signals
- Navigational aids
- Firefighting equipment
- Water treatment
- Power plant/supply
- Airspace planning

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Batam Indonesia Free Zone Authority Jl Jenderal Sudirman No. 1 Batam Centre, Batam Kepulauan Riau, 29400 Indonesia Mr. Horman Pudinaung horman@bpbatam.go.id	U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Alissa Lee alee@ustda.gov U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok 10330, Thailand Mr. Brandon Megorden bmegorden@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Commercial Service Embassy of the USA Jl. Medan Merdeka Selatan 5 Jakarta, 10110 Indonesia Ms. Melissa Wijaya melissa.wijaya@trade.gov www.buyusa.gov/indonesia

Indonesia Port Development		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Nationwide, Indonesia
	PROJECT VALUE	\$4 billion +

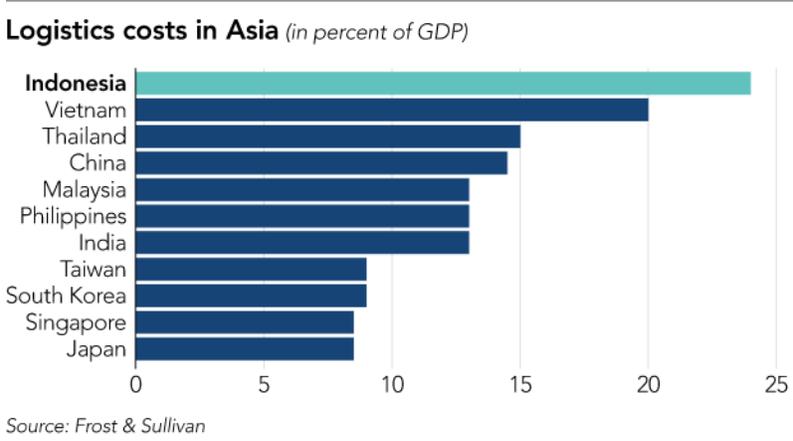
PROJECT SUMMARY

Indonesia is in the process of a massive port infrastructure development and expansion process that has been coupled with industrial estate development. These projects have been designated national priorities and have attracted international attention for financing and operation. Together they represent at least \$4 billion in opportunities and will enhance Indonesia’s internal and external connectivity and drive economic growth across the country.

PROJECT DESCRIPTION

When he assumed office in 2014, Indonesia President Joko Widodo announced a \$50 billion effort to enhance the maritime sector in Indonesia, including the development of 24 strategic ports. His plan involved linking port development to industrial estates and economic zones as a way to help reduce logistics costs, which are among the highest in Asia at 24 percent (*Figure 1*).

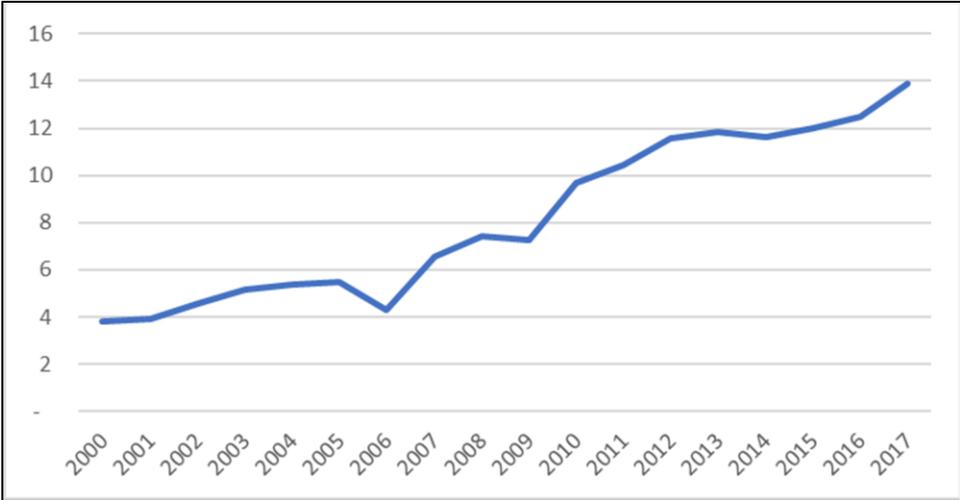
Figure 1: Logistics Costs in Asia (as a percentage of GDP)⁷⁶



⁷⁶ Frost & Sullivan via Nikkei Asian Review

Since 2000, Indonesia’s container traffic volume has been steadily rising, putting increased pressure on the need for more facilities and advanced technologies to handle the growing volumes of cargo. While there were slight decreases in 2006 and 2009, the volume of TEU traffic at Indonesia’s ports has more than tripled in 18 years. In 2017, the country’s ports saw 13.9 million TEUs, up from 3.8 in 2000 (Figure 2). However, in 2018, sea traffic accounted for only 6 percent of Indonesia’s freight traffic. A significant port expansion will be necessary if this share of cargo transport increases in the future.

Figure 2: Indonesia Port Container Volume (million TEUs)⁷⁷



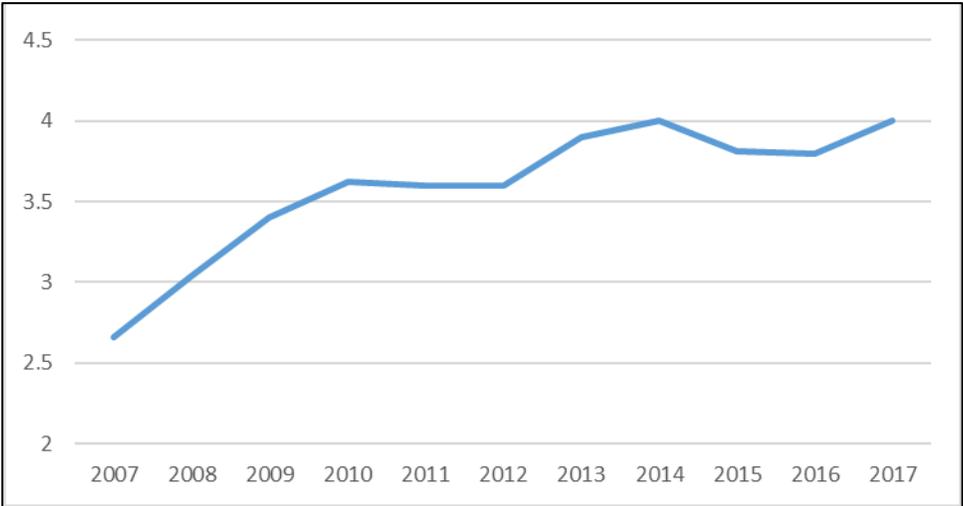
As part of the Mid-Term National Development Plan (2015-2019), the Government of Indonesia reiterated the commitment to the port sector by designating 10 port projects as National Strategic Projects. Of this number, three were designated Priority Projects by the Committee for Acceleration of Priority Infrastructure Delivery – Kuala Tanjung International Hub Seaport (North Sumatra), Bitung International Seaport (North Sulawesi), and Patimban Port (West Java). Initial work has been undertaken on all three of these ports, but additional phases and expansions are planned at these and other ports across the country.

Given its geography of 17,000 islands, maritime transport is critical to the economic development of Indonesia. The Minister of National Development Planning (Bappenas) noted earlier this year that the emphasis on infrastructure related to connectivity would continue in the upcoming 2020-2024 time period. Included in this focus will be continued seaport development. Other organizations, including the Association of Southeast Asian Nations (ASEAN), along with the World Bank and the Government of Australia, have included Indonesia port development in their list of priority infrastructure projects for the region. Both Kuala Tanjung and Kijing seaports were identified as priority opportunities for further development and investment. In addition to these projects, multiple other projects are in the planning or expansion process, including the Maspion Port (East Java).

⁷⁷ The World Bank

The quality of Indonesia’s port infrastructure has shown an upward trend since 2007, experiencing a year-on-year growth rate of 4.31 percent. According to the World Economic Forum, which evaluates the quality of a country’s port infrastructure on a one to seven scale (1=extremely underdeveloped; 7=well developed and efficient by international standards), Indonesia scores a four. This puts it below Singapore, Malaysia, and Thailand in the ASEAN region, but above Cambodia, Vietnam, and the Philippines. (Figure 3).

Figure 3: Indonesia Port Infrastructure Quality⁷⁸



PROJECT STATUS AND IMPLEMENTATION TIMELINE

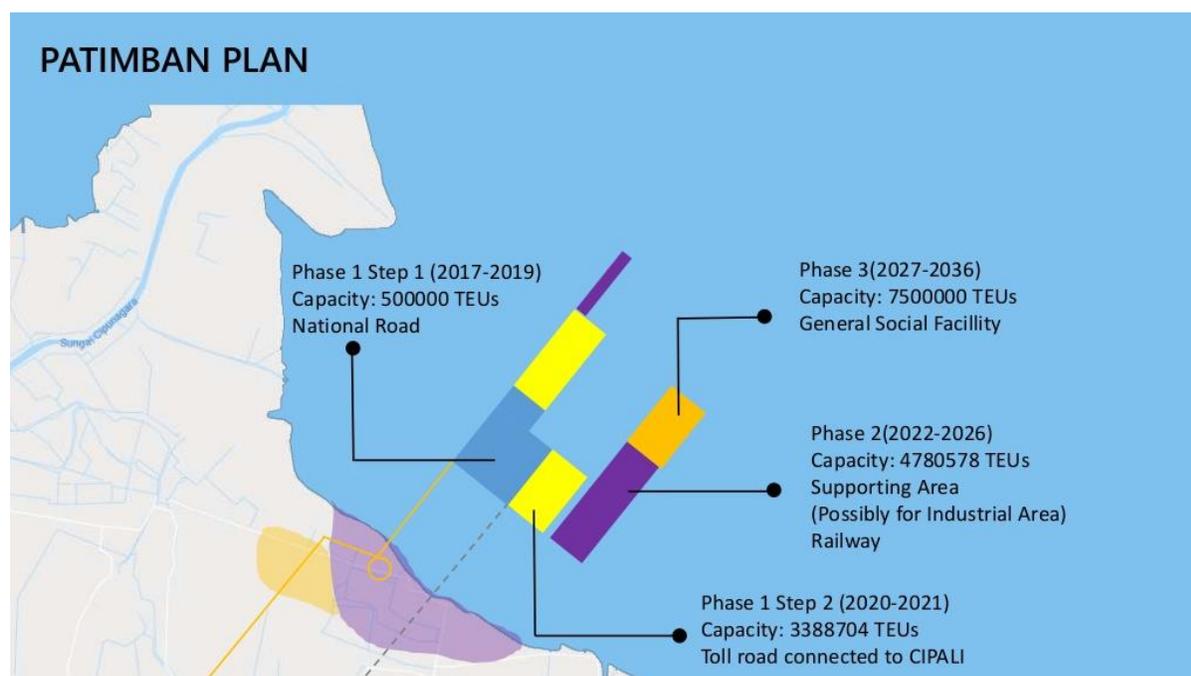
Phase 1 of the Kuala Tanjung International Hub project, considered a national Priority Project and a priority project for ASEAN, involves the construction of a Multipurpose Terminal that has already been completed and is operational as of February 2019. However, Phase 2 is in the planning process, with an expected operational date of 2022. This second phase will target the development of an integrated industrial area associated with the new port, along with a bulk terminal for dry goods. The project will act as a transshipment hub and gateway to Western Indonesia for international shipments, as well as providing connectivity to ports in Eastern Indonesia. According to the Ministry of Transportation estimates, the port’s estimated container throughput will be 12.4 million TEU by 2039, with more than 180 million tons per year of trade by 2065. Land acquisition for Phase 2 is ongoing.

In July 2019, DP World (UAE) and Indonesia’s Maspion Group signed an agreement to build a \$1.2 billion container port and industrial logistics park in East Java that will be developed in collaboration with PT Pelindo III, an Indonesian state-owned maritime services operator. The port will be designed to handle 3 million TEU per year and serve as a gateway to Eastern Indonesia. Construction on this port is expected to begin by the end of 2019, with operations underway in 2022. The port will be integrated with a 360-hectare industrial and logistics park to support the seaport’s operations.

⁷⁸ World Bank; World Economic Forum

The Patimban Port, another national Priority Project, is nearing the completion of Phase 1, with a target of mid-2020 to start operations and the end of 2020 to be fully operational. The Port is being developed through the assistance of a Japanese ODA loan. The location of this facility is in close proximity to Indonesia's busiest port, Tanjung Priok, and is designed to alleviate some of the overcapacity at that facility. Additionally, it will cater to the expected growth of logistics demand for the eastern part of West Java. The expansion of the port will be undertaken in three stages: Phase 1 - 3.5 million TEU and 600,000 vehicles; Phase 2 – expansion to 5.5 million TEU; and Phase 3 – further expansion to 7.5 million TEU (Figure 4). Subsequently, a logistics park of up to 365 hectares will be developed at the port.

Figure 4: Patimban Port expansion project⁷⁹



The greenfield Port of Kijing, identified as a priority project by ASEAN and the World Bank, is planned to be the largest port in Kalimantan, with Phase 1 planned for mid-2020 operations. The Port will be developed over the course of 4 Phases, the first of which involves 4 terminals – container, dry bulk, multipurpose, and liquid bulk. The container terminal is planned for a capacity of one million TEU and 50,000 tons/year at the multipurpose terminal, while the liquid and dry bulk terminals will have capacities of 8.3 million and 15 million tons, respectively. A 5,000-hectare special economic zone will be integrated into the port that will drive further expansions beyond Phase 1.

⁷⁹ RPX <https://www.slideshare.net/rhephialow26/patimban-analysis-for-java-logistics>

PROJECT COST AND FINANCING

The majority of these port expansion and development projects will move forward under a public-private-partnership (PPP) model. The government of Indonesia does not have the funding to develop all of these ports on their own, so they are seeking outside investors and developers. Each new port developed will be well over \$1 billion and will require additional resources to be successful. Indonesia is looking for assistance from international public sector sources of financing (i.e., JICA support for Patimban), as well as multilateral development banks and the private sector.

U.S. EXPORT OPPORTUNITIES

The U.S. port development industry is extremely robust and has the ability to supply not only equipment and technologies but also services in support of the seaport development and expansion in Indonesia. Strong competition can be expected from other actors in the region, including Japan, China, Korea, Singapore, and Australia, particularly when ODA funds are used to support individual port development/expansion. The involvement of Middle Eastern developers may drive sources of supply to that region or to Europe.

The specific opportunities for U.S. firms to get involved will vary from port to port, based on the primary cargo target, but the list below describes opportunities for U.S. exports:

- Construction supervision and management
- Engineering and design services
- Water and wastewater treatment facilities
- Waste treatment facilities
- Hazardous waste treatment technologies
- Automation solutions
- Intelligent transportation
- Access control
- Telecommunications solutions
- Cybersecurity technologies
- Dredging equipment
- Barges
- Terminal lighting
- Navigational aids
- Quay and yard cranes
- Vessel traffic management system
- Power supply equipment
- Terminal operating system
- Transtainers
- Container inspection/security equipment
- Rail signaling

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Pan Borneo Highway - Sabah		
	SECTOR	Transportation/ICT
	SUBSECTOR	Surface Transportation
	LOCATION	Sabah, Malaysia
	PROJECT VALUE	\$4 billion total \$220 million – 2020 Packages

PROJECT SUMMARY

The Pan Borneo Highway spans the Malaysian states of Sabah and Sarawak, linking them to Brunei and the Kalimantan region of Indonesia. The road is poorly developed and travel times are impeding overall economic development in the region. While not likely an opportunity for U.S. interests in basic roadbuilding labor and materials (e.g., paving, sand, and gravel), the project is large, the road is long and it presents numerous topographic challenges. Foreign technology capabilities spanning engineered materials/components, heavy equipment, and certain services are desired.

PROJECT DESCRIPTION

Two Malaysian states, Sabah and Sarawak, line the northwestern coastline of the island of Borneo. Given their history and lack of proximity to the government center, Putrajaya (on Peninsular Malaysia near Kuala Lumpur), these states have been slower to develop economically than the rest of Malaysia. One impediment to development has been limited and dated transportation infrastructure.

In Malaysia’s most recent budget, released on October 11, 2019, the development of modern infrastructure in Sabah and Sarawak was a prominent feature for the first time in 50 years. Road development was specifically cited, with \$78 million and \$54 million allocated for rural road development in Sabah and Sarawak, respectively.

The main road connecting the two states is the Pan Borneo Highway, a much larger endeavor. The concept for a trunk road connecting the two states with the nation of Brunei, also on the island of Borneo, originated in the 1960s. At that time, the road was called the Trans-Borneo Highway. In the 1970s, Malaysia, Brunei, and Indonesia developed a broader plan to construct a modern highway along the western coast of Borneo to connect Sabah, Sarawak, Brunei, and the Kalimantan region of Indonesia. This effort was dubbed the Pan Borneo Highway.

This major trunk road system is Federal Route 1 in Sarawak and Routes 1, 13, and 22 in Sabah. Today the Pan Borneo Highway is over 5300km (3300 miles) long, but large sections of it remain

a 2-lane single carriageway (*Figure 1*). For example, only 13 percent of the portion between Sarawakian cities Sematan and Lawas is a 4-lane highway. Today, that 1151km (715 miles) trip requires about 20 hours. The planned improvements to the Pan Borneo Highway should cut this time to twelve hours. Thus, the improvement of the Trans Borneo Highway is critical to the overall economic development in both Sabah and Sarawak.

*Figure 1: Trans Borneo Highway – Sabah Today*⁸⁰



The Malaysian portion of the highway is roughly 1700km (1056 miles) long, with 706km (450 miles) in Sabah and the balance in Sarawak. Road development is being undertaken in sections in both states. Each state had its own Project Delivery Partner (PDP) until 2019 when Putrajaya (the Malaysian Federal Government) took the oversight. As of late September, the project was only 21.3 percent completed versus a target of 44 percent.

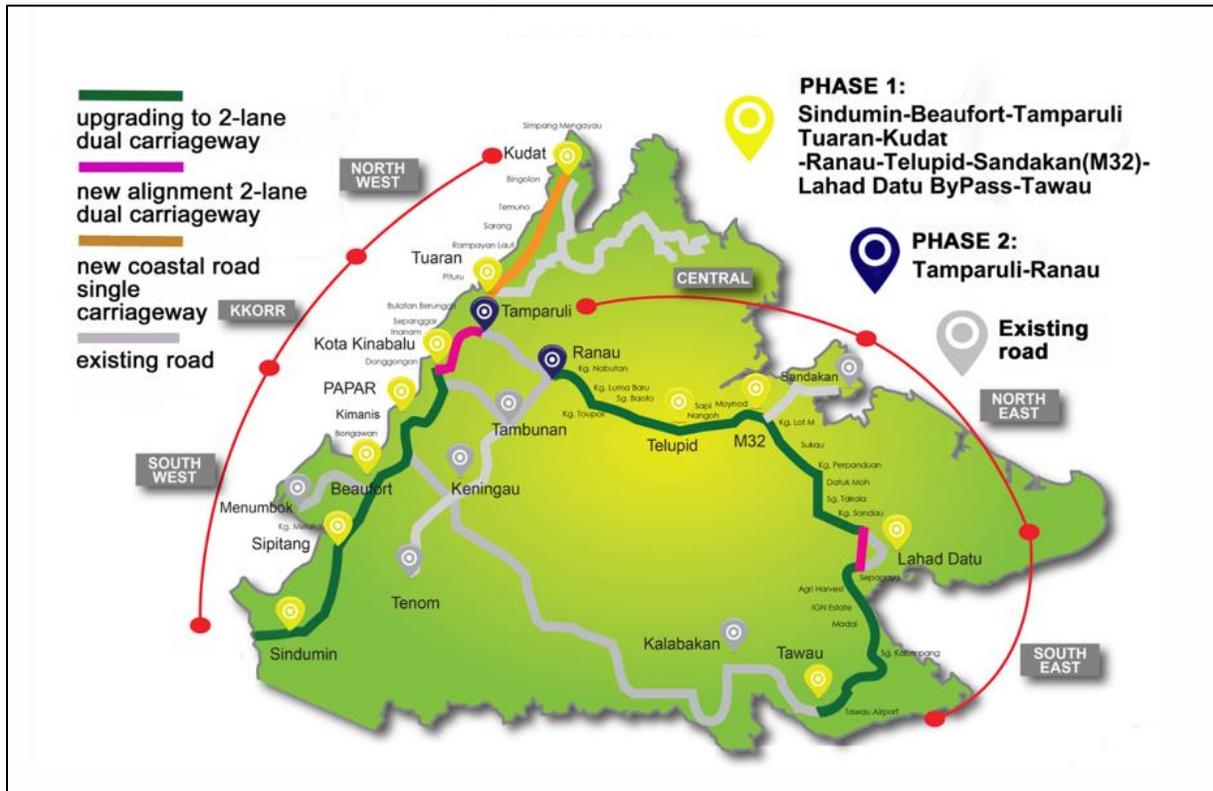
The Sabah route is pictured (*Figure 2*) and its associated economic development areas described below:

- Marine Integrated Cluster (MIC) in the southeast region (Tawau, Kunak, and Semporna)
- Palm Oil Industrial Cluster (POIC) in Lahad Datu and Sandakan
- Sandakan Education Hub (SHE) in Sandakan
- Kinabalu Gold Coast Enclave (KGCE) from Tuaran to Kudat
- Sepangar Bay Manufacturing and Logistic Cluster (SBMLC) in Sepangar
- Sabah Agro-Industrial Precinct (SAIP) in the interior south region (Papar, Kimanis, Beaufort, Keningau, Nabawan, and Tenom)
- Sipitang Oil and Gas Industrial Park (SOGIP) in Sipitang

⁸⁰ Borneo Post, YouTube

Much of the terrain in Sabah is swampy wetlands, making construction and movement of heavy equipment challenging and engineered bridge hardware necessary. Also, information and communications technology (ICT) infrastructure is not well developed or even existent in certain sections. ICT-related improvements are planned and funded under Malaysia’s National Fiberisation and Communications Plan.

Figure 2: Sabah Pan Borneo Highway Project⁸¹



PROJECT STATUS AND IMPLEMENTATION TIMELINE

Work on the Pan Borneo Highway is already underway, but the effort has been plagued by cost and timing overruns, in part due to the engineering/construction and communications challenges. As of the second half of 2019, the Malaysian Federal Government has assumed oversight of the project. Three Sabah Works Packages, valued at \$222 million, will be tendered in the first quarter of 2020, covering 60 kilometers (37 miles) between Beluran and Telupid. Upgrading of both interchanges is included.

The remaining 20 Packages are expected to be approved for tender under the 12th Malaysian Plan, which runs from 2021-2025.

⁸¹ Borneo Highway PDP Sdn. Bhd. website <http://sabahpanborneo.com/about-us/>

PROJECT COST AND FINANCING

The value of the Pan Borneo Highway project in total is just over \$4 billion. Sections to be tendered for Sabah in 2020 have a value of \$222 million. Construction is being funded, in part, by the Malaysian Federal Government, but the state of Sabah has a specific desire to attract foreign investment to ensure the success of the project and to speed progress, as the road is a bottleneck to overall economic development in the state.

U.S. EXPORT OPPORTUNITIES

The opportunity for U.S. exports is in engineered materials and components, heavy equipment, and ICT technologies that can speed construction and ensure roadway safety and durability. This project is unlikely to be an opportunity for U.S. interests in basic roadbuilding labor and materials (e.g., paving, sand, gravel). The project is large, the road is lengthy, and the area presents numerous topographic challenges requiring unique skills and engineered solutions. As well, the state of Sabah is desirous of exploring financing options and associated creative business models that can speed progress, as ground transportation infrastructure is a critical bottleneck to economic development.

U.S. export opportunities include:

- Engineered road and construction materials (access/rig mats, engineered fabrics, specialty chemicals including adhesives, coatings, and sealants)
- Heavy equipment and local MRO inventory
- Roadway safety supplies (roadside and lane identification, signals, temporary barriers, and markers)
- Highway communications and control systems (overlap with Malaysia's National Fiberisation and Communications Plan (NFCP))
- Bridge design and installation services
- Bridge hardware (hangers, overhang brackets, forms, specialized structural components)
- Smart street lighting (luminaires)
- Design and project/operations management services

The State of Sabah is also interested in and open to considering unique and creative business models that can hasten road development. Infrastructure development models such as design-build own operate transfer (DBOOT), as have been used for the development of water utilities and some toll roads, and would be welcome from foreign investors.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Sabah – Sapangar Bay Container Port Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Sapangar Bay, Sabah, Malaysia
	PROJECT VALUE	\$265 million

PROJECT SUMMARY

An expansion of the Sapangar Bay Container Port is scheduled to begin in late 2019. The two-phase project seeks to position the port as a major Brunei-Indonesia-Malaysia-Philippines BIMP-EAGA East ASEAN Growth Area (BIMP-EAGA) regional trading hub. The project is intended to aid in economic development in the region and contribute to reducing the costs of living and purchased goods for local residents. The project is valued at \$265 million and includes financial support from the Federal Government of Malaysia.

PROJECT DESCRIPTION

Unlike Peninsular Malaysia, where most ports are administered by the Malaysian federal government, the ports in Sabah are administered by the state government. Sabah is strategically located on the island of Borneo, along with intra-ASEAN and European-Asian sea trade routes. Its ports are expected to become important trading hubs for BIMP-EAGA. In conjunction with the Pan-Borneo Highway project, logistics linkages across the island of Borneo will enhance economic development and port traffic.

While Singapore remains the leading port in the region, it has little space to expand and few connections over land. Sabah is at the heart of the region where intercontinental and intra-Asian sea trade routes meet. Also, Sabah offers available and affordable land. With the development of the Pan Borneo Highway, land transportation/logistics are in the process of being made more efficient. Coupled with strong natural resource positions, Sabah is also an attractive tourist destination with growing industries in cruise and medical tourism.

In addition, the shipbuilding and repair industry is active in Malaysia but is regionally distinct by vessel focus. While shipyards in Peninsular Malaysia focus on steel and aluminum vessels for the oil & gas industry and the federal government, Sabah primarily handles steel vessels for offshore supply, tug, barge, and river ferries.

Today, Sabah has nine ports servicing 370,000 twenty-foot equivalent units (TEUs) annually (Table 1). These ports have an outgoing cargo base largely derived from agriculture and timber in

the area and are poised for growth in additional industries. Ports in Sabah are operated by a subsidiary of Suria Capital Holdings Bhd, Sabah Ports Sdn Bhd (SPSB), and administered by the state government. Numerous port expansion projects are underway in Sabah, from planning stages to active implementation (highlighted in *Table 1*).

Table 1: Sabah Ports and Development Projects

PORT	AUTHORITY	OPERATOR	STATUS (development projects shaded)
Sapangar Bay Container Port	Sabah Port Authority	SPSB	Premier transshipment hub The first expansion will start in 2019 and be completed in 2021 ~\$300 million for the initial phase SPSB open to joint-management of port for volume and connectivity
Sapangar Bay Oil Terminal	Sabah Port Authority	SPSB	Refined petroleum products and liquid chemicals Shell, Esso, Petronas
Kota Kinabalu	Sabah Port Authority	SPSB	General cargo and dry bulk Jesselton Quay development
Kudat	Sabah Port Authority	SPSB	Proximity to the Philippines General cargo and timber products \$30 M new deep-water port pre-feasibility
Kunak	Sabah Port Authority	SPSB	Crude palm oil and palm kernel
Lahad Datu	Sabah Port Authority	SPSB	Robust palm oil, oleochemical, and bio-diesel Sabah Ports prioritized for imports of bulk fertilizer Designated “Rotterdam of the East.”
Sandakan	Sabah Port Authority	SPSB	Palm oil-related products, container, general cargo, and dry bulk
Sipitang	Sabah Port Authority	SPSB	Strategic location next to Labuan Port and Brunei Sipitang Oil & Gas Industrial PARC (SOGIP) Part of the economic master plan to attract investment and stimulate port development
Tawau	Sabah Port Authority	SPSB	Multipurpose Strategic to Kalimantan region of Indonesia Considered to have the highest potential

The Sapangar Bay Port hosts both bulk liquids and container transshipment sites. The Sapangar Bay Oil Terminal (*Figure 1*) is dedicated to refined petroleum products and liquid chemicals. It is being promoted as the “oil & gas terminal hub” of Sabah, given its proximity to major oil and gas facilities, including those of Shell, Esso, and PETRONAS. A \$5 million expansion is currently underway to add more berth, as well as facilities to accommodate large tankers, including the large-scale supply of bunker and freshwater.

Figure 1: Sapangar Bay Oil Terminal⁸²



The Sapangar Bay Container Port (*Figure 2*), like most other ports in Sabah, handles general cargo and containers. Today, 70 percent of Sabah's total container traffic passes through the port, with cargo growth over several years steadily at five to six percent. While the intent is to build Sapangar Bay into a premier transshipment hub for the BIMP-EAGA region, the lack of modernized roads is constraining more rapid growth. One of the driving forces this port expansion project is to reduce the cost of living and the prices of goods for residents of the surrounding area. To fully accomplish this goal, road development, including the various tender packages described in the Pan Borneo Highway project section, will be required.

Figure 2: Sapangar Bay Container Port⁸³



A \$265 million, 2-phase expansion is slated to start in late 2019 for the Sapangar Bay Container Port. The Malaysian Federal Government, via development allocations, will participate with the State of Sabah to upgrade the Sapangar Bay Container Terminal into the envisioned major transshipment hub. The port recently added two ship-to-shore cranes.

The first phase of this expansion includes extending the port's quay from its current length of 500 meters to 1.2 kilometers. The yard will be increased from 15 to 60 hectares of land. In addition, the port will seek to secure business with mainline operators (MLOs) to fill the expansion with strategic pricing models.

In combination with the second phase, which is expected to focus on cargo handling capability and efficiency, and for which expansion funds have been specifically allocated, the Container Port expansion project will more than double cargo handling capacity from the current 500,000 to 1.25MM TEUs.

⁸² Sabah Port Authority

⁸³ Ibid.

The first-phase completion is targeted for 2023. The second phase has a target completion date of 2026. A third, long-term phase has been discussed covering the next thirty years.

Sabah ports are behind Peninsular Malaysia in terms of digital enablement. The Malaysian government has set the creation of a single integrated port community system as a priority in its ports strategy. The main objective is to simplify and reduce the formalities, documentary requirements, and procedures during the arrival, stay, and departure of ships at local ports. The desired system will streamline and integrate all the digital services of terminal operators, shipping agents, depots, haulers, merchants, forwarding agents, customs, and other services present. In the fragmented Malaysian port landscape, this may be the sector's biggest challenge. This project will take some steps to advance the digitization process.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Sapangar Bay Container expansion project includes two currently-defined phases with a third, more visionary phase, in the discussion. A Master Plan was completed in conjunction with the Federal Government in 2017. Construction is expected to begin in late 2019, with the first phase to be completed in 2023. The second phase is expected to be completed in 2026.

Overall, Sabah is less developed than Peninsula Malaysia and is aggressively inviting participation in all sectors for growth. Sabah ports are under State Government purview, and infrastructure development is needed and desired to support the region's economic growth and further port capacity expansions at Sapangar Bay.

PROJECT COST AND FINANCING

The Sapangar Container Port Expansion project has a budget of \$265 million. The Federal Government is expected to provide up to \$190 million of the cost. Port project development costs in Sabah today are typically lower than in Peninsular Malaysia. Financing is typically 30 percent equity and 70 percent debt. Major local and international banks have been active in port financing in Malaysia, and with a sukuk (bond) often being required.

U.S. EXPORT OPPORTUNITIES

Sabah port expansion opportunities are attractive to U.S. firms for several reasons:

- Established port and maritime market
- Expanding container transshipment hub
- Supporting ground logistics infrastructure plans/projects
- Growing cruise ship destination

Specific U.S. export opportunities include:

- Dock cargo handling products, services, and technologies
- Port cargo handling transport equipment
- Engineering, design and operations services
- Project development, architecture, and technical and business consulting services
- Industry-specialized port handling equipment
- Smart-port technologies (integrated port community systems and related digital solutions)

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Westports Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Malaysia (Peninsular)
	PROJECT VALUE	\$250+ million

PROJECT SUMMARY

Malaysia is expanding and upgrading several ports. Near-term expansion of Westports, the larger of Port Klang’s two ports, is expected to increase cargo handling capability by 50 percent. Port Klang is Malaysia’s largest and most international port.

PROJECT DESCRIPTION

Malaysia, as a maritime nation, is home to some of the world’s largest ports. The largest of these is Port Klang, which comprises the large and international Westports, more regional Northport, and an economic free zone.

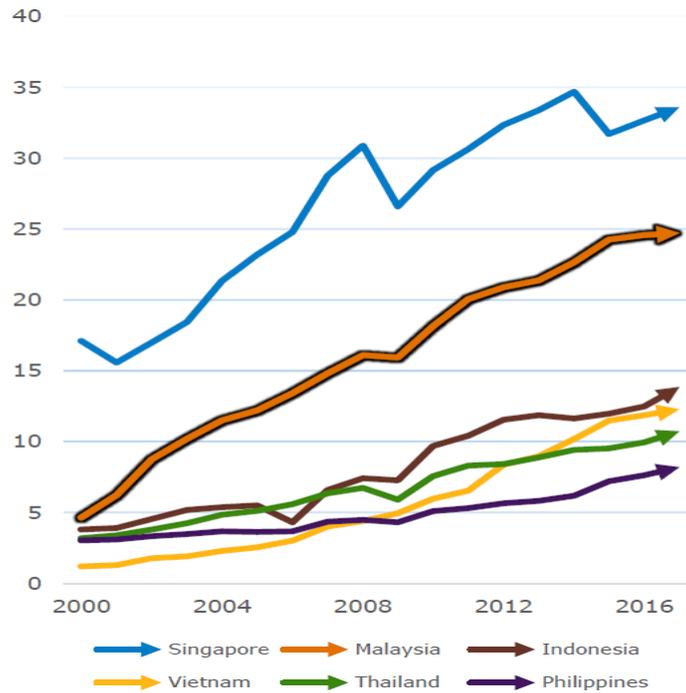
For centuries, the Straits of Melaka has been a strategic waterway in global trade. Malaysia holds the world’s fifth position in shipping line connectivity after China, Singapore, the Republic of Korea, and Hong Kong (counted separately from China)⁸⁴. The country is a key container transshipment hub in the region (*Figure 1*) and a market leader in handling and exporting oil and gas products.

Specialized ports are located in different parts of Malaysia (*Figure 2*) with oversight by government-assigned authorities, under the Federal Ministry of Transport. Ports are operated by private parties, commonly under 30-year concessions. The principal container handling ports are in Peninsular Malaysia and are supervised by the Federal Government, with bulk handling ports in Sabah and Sarawak supervised by each State Government.

Currently, Malaysia has nine federally-administered ports: Klang, Tanjung Pelepas, Johor, Penang, Bintulu, Melaka, Kuantan, Kemaman and Labuan. Several port projects are in process across Malaysia, ranging from pre-feasibility studies to active development (*Annex 1*). Focal development areas for Malaysian ports as a whole are increasing cargo sources, expanding bunker and other ship supply services, and digitization across all port functions and parties.

⁸⁴ United Nations Conference on Trade & Development

Figure 2: Southeast Asian Container Throughput by Country (Million TEU)^{85 86}



In 2018, 64 percent of Malaysia’s total cargo throughput was handled by two ports, Port Klang and Port Tanjung Pelepas. Port Klang, Malaysia’s largest port, includes Westports, Northport, and an economic free zone. Westports is a large, international, and priority of Malaysia’s transport and logistics agenda, given its global connectivity (*Figure 3*). For example, Swedish furniture retailer IKEA recently announced a \$220 million regional distribution and supply chain center at Pulau Indah, Selangor, nearby.

Figure 3: Westports Connectivity⁸⁷



⁸⁵ Twenty-foot equivalent

⁸⁶ The World Bank

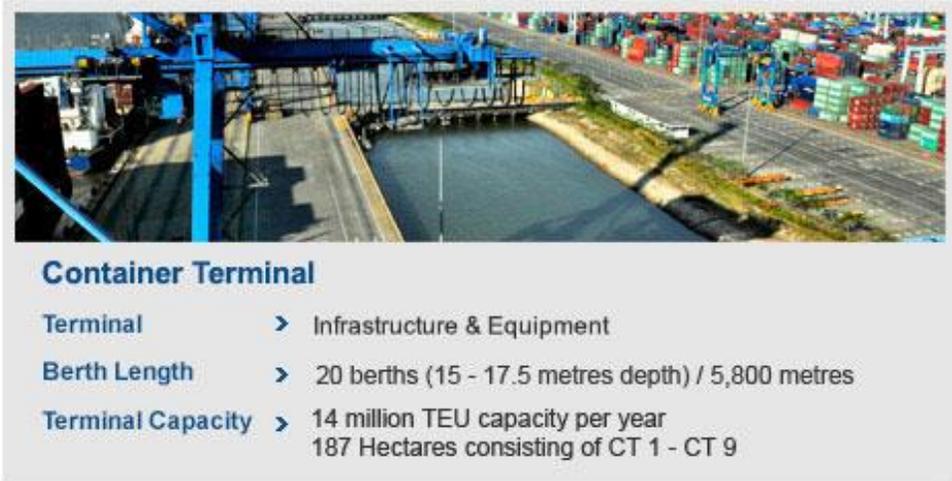
⁸⁷ Westports <http://www.westportsmalaysia.com/default.aspx>

Operated by Westports Holdings Bhd., today, Westports handles 18 percent of containers passing through the Straits of Malacca and 76 percent of containers at Port Klang. Transshipment represents 74 percent of the business mix, with the remaining 26 percent focused on gateway containers. The Westports expansion will increase port capacity by 50 percent. Westports is designated to become the country’s maritime center and bunkering hub.

The Westports expansion includes the addition of ten terminals (CT10 to CT19) beyond the current nine (Figure 4). As well, a 600-meter wharf will be developed at CT9. Advantages in both amounts of cargo handling capacity and reduction of cargo handling time (from 40 to 35 gross moves per hour) are objectives. A further objective is improving digital connectivity across all port functions and stakeholders.

The Malaysian government has set as a priority the creation of a single integrated port community. The main objective is to simplify and reduce the formalities, documentary requirements, and procedures during the arrival, stay, and departure of ships at Malaysian ports. The desired system will streamline and integrate all the digital services of terminal operators, shipping agents, depots, haulers, merchants, forwarding agents, customs, and other services present. In the fragmented Malaysian port landscape, this may be the sector that will likely require the greatest expertise from outside the country.

Figure 4: Current Westports Container Terminal⁸⁸



Westports has secured the approval-in-principle from the Government for the expansion, which will double its container-handling capacity to about 30 million twenty-foot equivalent units (TEUs) annually by 2040.

⁸⁸ Westports

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Westports has begun feasibility studies for the expansion, and the project is expected to be tendered near term. Phase 1 of the Westports expansion is slated for 2019 to 2024 and has received agreement-in-principle from the Malaysian Government.

PROJECT COST AND FINANCING

The Westports expansion has a budget of \$2.5 to \$3.5 billion. Financing is typically 30 percent equity and 70 percent debt. Major local and international banks have been active in port financing in Malaysia. Westports anticipates using a mix of internal funding, sukuk (bond), and Western forms of debt.

U.S. EXPORT OPPORTUNITIES

The Westports expansion may be attractive to U.S. firms for several reasons:

- Large established port and maritime market
- Expanding container transshipment hub
- A preferred gateway to Southeast Asia
- Market for smart port development
- Larger-scale and numerous port expansion and land development plans
- One of world's principal palm oil exporters
- Oil & gas producing and trading hub
- Offshore supply and maintenance base (Sabah & Sarawak)
- Growing cruise ship destination

Specific U.S. export opportunities for the Westports expansion include:

- Dock cargo handling products, services, and technologies
- Tugging
- Port cargo handling transport equipment
- Engineering and design
- Operations services
- Project development, architecture, and technical and business consulting services
- Industry-specialized port handling equipment
- Smart-port technologies (integrated port community systems and related digital solutions)

With the free commercial zones in Port Klang, Westports is also an attractive location for U.S. companies seeking to establish regional distribution centers to serve the growing regional market.

CONTACTS

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Annex 1

Malaysian Federal Ports and Planned Expansions

Port	Authority	Operator	Status (new developments are shaded)
Port Klang	Port Klang Authority	Westports Holdings Bhd (Hutchison Ports) Northport Sdn Bhd (MMC Group)	Westports Expansion by 50 percent Feasibility study initiated \$240-350 million
Port Carey	Port Klang Authority		Government assessing development feasibility. \$50 billion port and maritime city project
Port Tanjung Pelepas	Johor Port Authority	Port of Tanjung Pelepas Sdn Bhd (MMC Group & Maersk Group)	Expansion to double size of free zone Extend terminal ~40 percent Capacity expansion \$226 million by 2020
Johor Port	Johor Port Authority	Johor Port Sdn Bhd (MMC Group)	Upgrade facilities and improve land use Johor Port granted a 25-year concession to operate terminal of Pengerang Integrated Petrochemical Complex
Penang Port	Penang Port Commission	Penang Port Sdn Bhd (MMC Group)	\$430 million expansion of North Butterworth Container Terminal (NBCT) over 10 years \$40 million JV MMC/Royal Caribbean terminal expansion for larger cruise ships
Bintulu Port	Bintulu Port Authority	Bintulu Port Sdn Bhd	Feasibility study - expand international container terminal
Melaka Port	Melaka Port Authority	Tanjung Bruas Port Sdn Bhd (MMC Group)	Melaka Gateway Project Cruise port development completes Sep 2020
Kuantan Port	Kuantan Port Authority	Kuantan Port Sdn Bhd (IJM Corporation Bhd & Beibu Gulf Holding Co., Ltd)	First phase new deep-water port completed Phase 2 expansion berths & dry bulk yard Longer-term berth extension and container terminal
Kemaman Port	Kemaman Port Authority	Konsortium Pelabuhan Kemaman Sdn Bhd (Eastern Pacific Industrial Corporation Bhd)	N/A
Labuan Port	Labuan Port Authority	Labuan Liberty Port Management Sdn Bhd (land lease month-to-month. Operator tender in process)	Government is assessing the development feasibility of a port and an extended free commercial zone Near-term Liberty Port upgrade

BCDA Selected Pipeline Projects		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Philippines
	PROJECT VALUE	To be determined

PROJECT SUMMARY

The Base Conversion Development Authority (BCDA) in the Philippines is repurposing former military bases for civilian uses. This project profile highlights two future BCDA projects that are in the pipeline:

- A second runway at Clark International Airport
- Bataan Technology Park.

PROJECT DESCRIPTION

The BCDA is a development corporation that transforms former military bases and properties into centers of economic growth in partnership with the private sector. BCDA engages in public-private partnerships to push forward vital public infrastructure such as tollways, airports, seaports, and also major real estate developments.

Successful developments jointly with the private sector include Bonifacio Global City in Fort Bonifacio (Metro Manila), Newport City in Villamor Air Base, and vital infrastructure such as the 93.77-kilometer Subic-Clark-Tarlac Expressway. BCDA is positioning the former site of Clark Air Base (*Figure 1*) as the next investment center in Asia through high-impact projects such as the New Clark City—a new metropolis that is smart, green, resilient, and truly inclusive and the expansion of the Clark International Airport. Among its other big-ticket projects are the Subic-Clark Cargo Railway and a bus rapid transit connection.

The following are highlights of two future projects within the BCDA pipeline.

West Runway, Clark International Airport

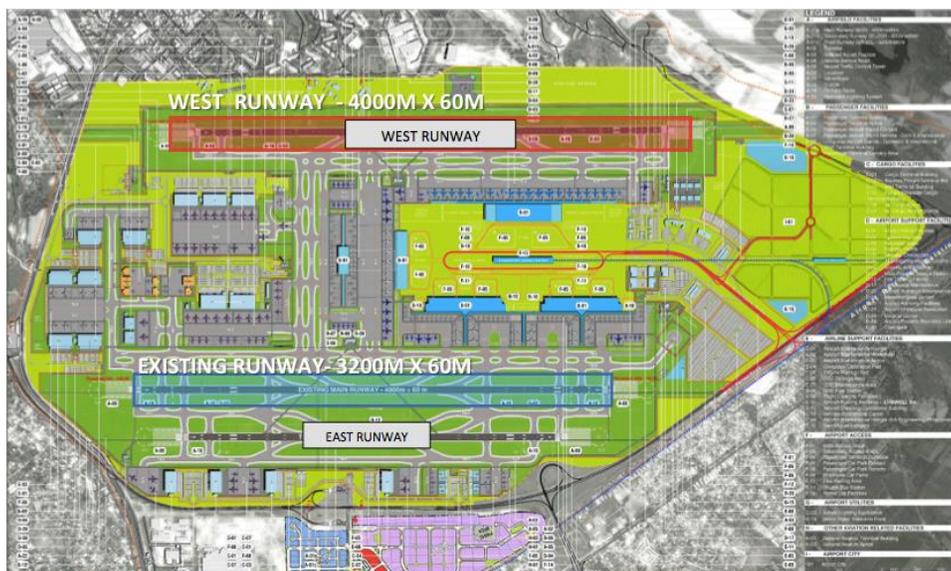
The Clark International Airport (CRK) is located within the Clark Freeport Zone (*Figure 1*). The airport serves as a gateway to the north of Luzon as it hosts 128 flights a week for 7 global airlines. It is an alternative to the main airport in Metro Manila and services low-cost domestic as well as foreign flights.

Figure 1: Clark International Airport



Present infrastructure at CRK includes one runway (3,200m long, 60m wide) and a terminal building. A new 82,600 square meter passenger terminal building is under construction. When finished in 2020, the new terminal will increase the airport capacity by 8 million passengers per year. Future expansion plans for the airport (*Figure 2*) include the construction of a second runway parallel to the existing one. The new west runway will be 4,000m long and 60m wide and equipped with category II/III instrument landing and take-off.

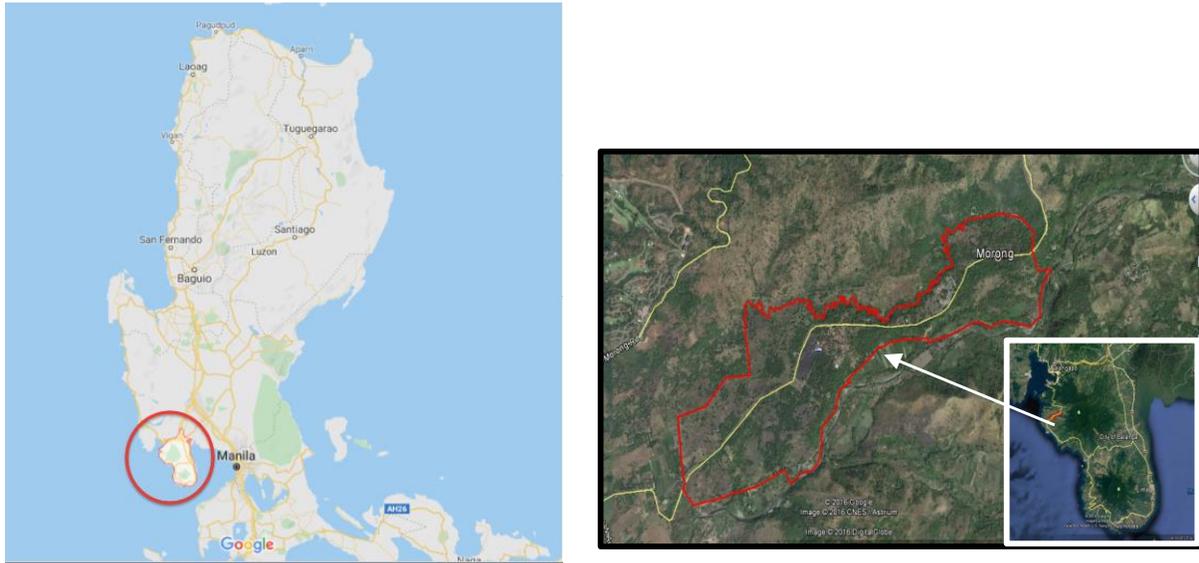
Figure 2: Configuration of Clark International Airport.



Bataan Technology Park (BTP)

BTP, a new special economic zone, will be located in the town of Morong, Bataan Province, as shown in Figure 3.

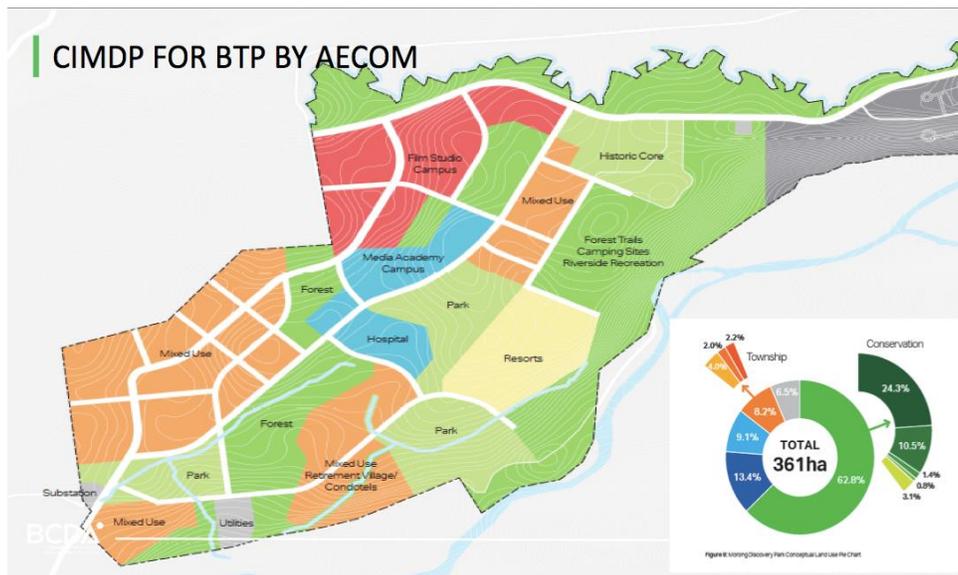
Figure 3: Location of Bataan Technology Park



BTP is a 365-hectare Special Economic Zone (SEZ) owned by BCDA. The Authority is looking for private sector partners to develop the SEZ via long-term lease (up to 50-years initial lease period plus a possible extension of an additional 25-years).

U.S. engineering firm AECOM has prepared the development plan for BTP, shown in Figure 4.

Figure 4: BTP Development Plan



PROJECT STATUS AND IMPLEMENTATION TIMELINE

The schedule for the West runway at Clark International Airport is:

- Terms of reference are being prepared during the second half of 2019
- Implementation (bidding, contracting, construction) from 2020 to 2022

The schedule for Bataan Technology Park is:

- Ongoing preparation of the Terms of Reference (TOR) for the public tender of initial 50-hectare development (mixed-use tourism and light industrial)
- Initial 50-hectare development will be opened up for tender (public bidding) last quarter of 2019 or the first quarter of 2020

PROJECT COST AND FINANCING

BCDA has not yet prepared estimates of capital expenditure for either project.

The second runway at Clark International Airport will be structured as a public-private partnership (PPP). Financing will be arranged through the PPP.

The SEZ at BTP will be developed by a private sector partner, whose responsibilities will include financing arrangements.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities at Clark International Airport are numerous, including:

- Engineering services
- Project management services
- Financial services
- Air traffic management equipment and systems
- Air navigation equipment and systems
- Jet bridges
- Access control technologies
- Telecommunications equipment
- Security screening and monitoring technologies
- Ground handling equipment
- Baggage claim equipment
- Cybersecurity solutions
- Access control solutions
- Runway lighting and signals
- Navigational aids

- Firefighting equipment

U.S. export opportunities at Bataan Technology Park include engineering and project management services as well as specialized goods and services depending on the activities of BTP occupants.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Base Conversion Development Authority 2nd Floor, Bonifacio Technology Center 31st St., corner 2nd Avenue Bonifacio Global City Taguig Metro Manila 1634 Philippines To be determined for each opportunity www.bcda.gov.ph</p>	<p>US Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Alissa Lee alee@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>Embassy of the United States of America 1201 Roxas Blvd., Manila, Philippines 0930 Mr. Greg O'Connor Senior Commercial Officer greg.oconnor@trade.gov</p> <p>Ms. Thess Sula Commercial Specialist thess.sula@trade.gov www.export.gov/philippines</p>

New Manila International Airport at Bulacan

	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Metro Manila, Philippines
	PROJECT VALUE	\$20 billion

PROJECT SUMMARY

The San Miguel Group, the Philippine multinational conglomerate with origins as a beer brewer, is developing a new airport project near Manila:

- Construction slated to begin in December 2019
- Four parallel runways
- Three terminal buildings
- Advanced airport infrastructure and transport links
- 100 million passengers per year and 240 operations per hour capacity by 2020
- \$14.5 billion budget

PROJECT DESCRIPTION

The New Manila International Airport will rise on a 2,500-hectare property in Bulacan, Bulacan province, located about 50 kilometers northwest of Manila. Figure 1 shows the project's location.

Figure 5: Location of New Manila International Airport at Bulacan



The Bulacan airport was submitted as an unsolicited proposal from San Miguel Group's infrastructure unit and approved by the National Economic and Development Authority (NEDA) Board on April 26, 2019. The Department of Transportation opened the project to competition via a Swiss challenge bidding process. The Department of Transportation issued the project's Notice of Award on August 14, 2019, and the Notice to Proceed on September 18, 2019.

The agreement, which covers a 50-year concession period, authorizes San Miguel Corporation to undertake the financing, design, construction, supply, completion, testing, commissioning, and operation and maintenance of the new airport.

The airport will open within five years. The initial build-out consists of four runways, eight taxiways, and three passenger terminals with an annual capacity of at least 100 million passengers. Figure 2 shows the layout of the new airport.

Figure 6: Layout of the New Manila International Airport at Bulacan



This is the first project in more than a decade to address worsening congestion at the Ninoy Aquino International Airport (NAIA). NAIA, which had approximately 14 million passengers more than its 31 million annual design capacity during 2018, is located in the Metro Manila cities of Parañaque and Pasay and has limited expansion options. NAIA's last major expansion was the 2008 opening of its Terminal 3, a project that experienced considerable delays.

The project will also include the construction of an 8.4-kilometer tollway connecting the airport to the North Luzon Expressway (NLEX) in Marilao, Bulacan. Figure 3 shows an artist's rendering of the proposed terminal buildings.

Figure 7: New Manila International Airport Terminal Buildings



San Miguel also confirmed plans to spend an additional US\$5 billion for the construction of an airport express train all the way to Epifanio de los Santos Avenue (EDSA), a limited-access circumferential highway around Manila. The planned train system will span some 20 kilometers. The express train is not part of the airport proposal submitted to NEDA but was added to the project after talks with airline partners. The express train would translate to travel time of only 15 minutes from EDSA to Bulacan and one hour to Makati by Expressway through the north-south connector.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

San Miguel plans to begin laying the groundworks by raising 2,500 hectares of land for the airport at the end of 2019. The construction timeline to build the first two parallel runways calls for completion within three years.

Construction of the main terminal building is set to begin in 2020 and will boast 60 boarding gates and 20 remotes that can hold and accommodate 35 million passengers per annum under Phase 1 of the airport project. The full build-out of the terminal is planned to be completed in seven years.

San Miguel has announced a Memorandum of Understanding (MOU) with airport operator Incheon International Airport Corp. (IIAC) that will work together with SMC in designing and running the airport. They have also announced another MOU to an undisclosed airline that shall relocate to the airport after it partly opens to the public in 2024. It expects 20 million passengers to use the airport on its opening date.

PROJECT COST AND FINANCING

The airport project, as approved, has a budget of 735 billion Philippine Pesos, over \$14 billion, including the budget for the express train yields a total investment budget of nearly \$20 billion. San Miguel has described the sources of financing to be a combination of debt and equity.

U.S. EXPORT OPPORTUNITIES

A wide range of U.S. export opportunities exists for large airport projects:

- Construction supervision and management
- Project management
- Engineering and design services
- Jet bridges
- Access control technologies
- Telecommunications equipment
- Security screening and monitoring technologies
- Ground handling equipment
- Baggage claim equipment
- Air traffic control and management technologies
- Cybersecurity solutions
- Runway lighting and signals
- Navigational aids
- Firefighting equipment
- Water treatment
- Power plant/supply
- Airspace planning

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Bangkok Airport Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Bangkok, Thailand
	PROJECT VALUE	Est. \$6.7 billion

PROJECT SUMMARY

Airports of Thailand (AOT) is planning for new terminal construction at Bangkok’s two main international airports in an effort to ease overcrowding at both locations. These two projects, with a combined value of \$2.7 billion, are part of a larger infrastructure improvement plan being undertaken. Both projects are awaiting final approval from the government before they can proceed.

PROJECT DESCRIPTION

The Bangkok metropolitan area is currently served by two major international airports: Suvarnabhumi (BKK) and Don Mueang (DMK), with a third (U-Tapao) under construction. In 2018, combined passenger traffic at BKK and DMK was 104 million, well above the combined capacity of 75 million. AOT, the operator of these airports, along with four others across the country, is planning to construct new facilities in both locations, along with new airports in Chiang Mai and Phuket to ease overcrowding issues and boost overall passenger handling capacity. Tourism continues to be an important factor in airport traffic, and the Tourism Council of Thailand has projected a 5.5 percent increase for 2019 over 2018 (*Table 1*).

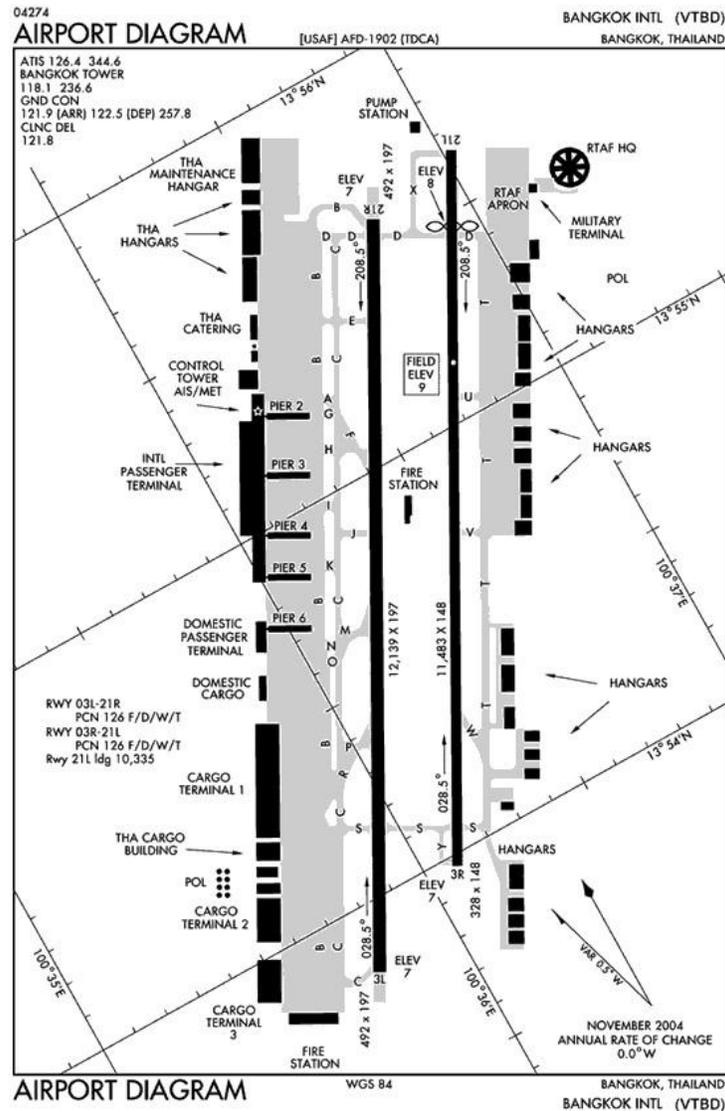
*Table 1: Airports of Thailand statistics (2018)*⁸⁹

	Passenger Volume		Aircraft Movements (flights)		Cargo and Mail (tons)	
	2018	% change from 2017	2018	% change from 2017	2018	% change from 2017
Suvarnabhumi	63,379,077	4.14%	369,476	5.41%	1,494,599	3.80%
Don Mueang	40,758,148	6.42%	272,361	6.08%	55,250	-18.48%
Chiang Mai	10,989,869	7.42%	78,210	8.63%	14,612	-17.18%
Hat Yai	4,256,107	-2.55%	29,203	-2.87%	8,440	-27.05%
Phuket	18,221,525	8.11%	118,280	11.49%	60,950	14.34%
Chiang Rai	2,867,289	14.54%	20,072	13.65%	3,545	-26.56%
Totals	140,472,015	5.53%	887,602	6.54%	1,637,398	2.65%

⁸⁹ Airports of Thailand

The DMK airport is Bangkok's older airport, first constructed in 1914 and open to commercial flights in 1924. It has undergone two previous phases of development and was planned to be closed entirely following the construction and operation of Suvarnabhumi. To manage increasing passenger flows, the airport remained open and now largely serves the low-cost carrier (LCC) market. The planned third phase of development will increase the overall capacity of the airport to 40 million passengers/year. The existing Terminal 3 will be demolished and replaced with a new international terminal that will serve 18 million passengers. Terminals 1 and 2 will also receive upgrades that will increase their capacity to a combined 22 million domestic passengers (Figure 1).

Figure 1: Layout of Don Mueang Airport⁹⁰

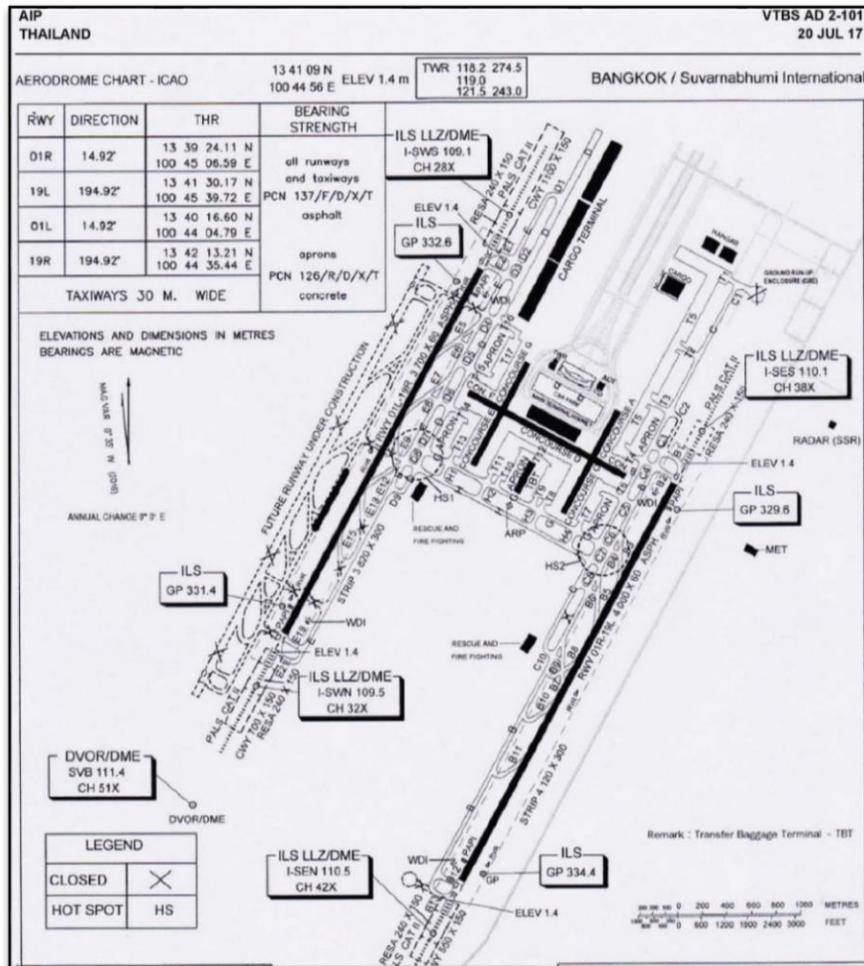


⁹⁰ Don Mueang Airport donmueangairport.com

AOT has encouraged carriers operating out of DMK to use wide-body aircraft as a means of easing congestion on the ground. With aircraft capable of carrying more passengers, fewer slots would be needed to transport all passengers. It is expected that by the end of 2019, DMK will again exceed its maximum passenger handling capacity, with projections of 41 million passengers in 2021 and 45 million passengers in 2023. Similarly, DMK’s runways have reached full capacity of 52 flights per hour. Given its location, the airport is not able to expand or construct another runway.

BKK (Figure 2) opened in 2006 with a capacity of 45 million passengers, yet it currently handles in excess of 63 million passengers per year. A second terminal has been proposed to ease existing overcrowding and is waiting on final approval from the government following disagreements over its location. The current design and location (northeast of the existing terminal) are not in line with the original master plan for the airport that was developed over 10 years ago (south of the current terminal), and discussions are ongoing about which location would be the best solution to the overcrowding problems.

Figure 2: Layout of Suvarnabhumi Airport⁹¹



⁹¹ International Virtual Aviation Organization

When the second terminal is operational, it will significantly boost the capacity of the BKK airport. The new addition could accommodate an additional 40 million passengers per year, raising overall capacity to approximately 90 million. Ultimately, through additional infrastructure expansions, the airport could see a capacity of 130 million passengers per year by 2030.

To accommodate this increase in passengers, AOT will construct a third runway at BKK in parallel with the existing western runway. The current two runways have a maximum capacity of 63 flights/hour. The addition of a third will increase that figure to 94 flights/hour. The cabinet has already approved this runway expansion, and work will soon commence on its construction.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The expansion project of DMK is in the advanced planning process. The design stage has begun, with an environmental impact assessment (EIA) under review. In late 2019/early 2020, the Ministry of Transport will ask the Cabinet to approve the project, with bidding for construction to follow. Construction will last until 2025, with operations to start later that year.

The new Terminal 2 for BKK is currently on hold as AOT reviews the impact of the proposed location. It is primarily studying whether the location would help alleviate the overcrowding at the existing terminal and the impact that it would have on transportation and traffic flows in the area. Key in the consideration is the linkage between the BKK Airport and the soon-to-be-constructed high-speed rail link connecting all three Bangkok area airports (BKK, DMK, and U-Tapao). AOT anticipates concluding its review in October 2019 and submitting the findings to the Ministry of Transportation in late 2019/early 2020 for further decisions. The EIA has already been conducted for this site. The new terminal could open as soon as 2023, pending the final decision of the government on location.

After receiving Cabinet approval for the third runway at BKK, plans are underway for its construction. The bidding and construction process will take place in late 2019/early 2020, with completion and operation scheduled for late 2021.

Planning for other airports within AOT's system is also underway. New airports in Phuket and Chiang Mai have been proposed to the government for approval. Each airport would target capacity of 10 million passengers per year, with Phuket's cost estimated at \$2.5 billion and Chiang Mai's at \$500 million. Once construction has been approved, land acquisition would require approximately one year prior to construction, followed by four years of construction at each airport. Operations could begin as early as 2025.

PROJECT COST AND FINANCING

The overall cost of AOT's airport development and expansion plan is approximately \$6.7 billion. This comprehensive figure includes \$1.4 billion for a new terminal at BKK; up to \$1.3 billion for

expansion and upgrades at DMK; \$723 million for a third runway at BKK; and \$3 billion for the construction of new airports in Chiang Mai and Phuket.

U.S. EXPORT OPPORTUNITIES

The expansion of two existing Bangkok airports to accommodate growing passenger flows provides many export opportunities for U.S. firms. Thailand is a net importer of products in the aviation sector, including aircraft, parts, maintenance services, and airport/ground support equipment. Historically, U.S.-sourced equipment and technology have been well received in Thailand. However, significant competition does exist in this space from both regional (China, Japan, Australia, and Korea) and European suppliers.

Specific opportunities for sales of equipment, technology, and services associated with the airport expansion plans include the following areas:

- Construction supervision and management
- Project management
- Engineering and design services
- Jet bridges
- Access control technologies
- Telecommunications equipment
- Security screening and monitoring technologies
- Ground handling equipment
- Baggage claim equipment
- Cybersecurity solutions
- Air traffic control and management technologies
- Runway lighting and signals
- Navigational aids
- Firefighting equipment
- Water treatment
- Power plant/supply
- Airspace planning

CONTACTS

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Map Ta Phut Port Expansion		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Port
	LOCATION	Rayong, Thailand
	PROJECT VALUE	\$1.85 billion

PROJECT SUMMARY

As part of Thailand’s Eastern Economic Corridor (EEC) plan, the Map Ta Phut port will undergo a \$1.85 billion Phase III expansion project. This expansion will result in increased handling capacity of liquids and LNG for the port that is already fully committed. The primary development within Phase III will be the construction of a new LNG receiving terminal with a capacity of at least 5 million tons.

PROJECT DESCRIPTION

Located approximately 185 kilometers from Bangkok, on the eastern seaboard of the Gulf of Thailand, Map Ta Phut port is Thailand’s largest industrial port. It is established inside the Map Ta Phut Industrial Estate, occupying an area of 1,000 rai (160 hectares). The Phase III expansion of the Port (*Figure 1*) is one of the megaprojects that Thailand is undertaking as part of its development of the EEC.

The port was established in 1992, with two liquid cargo berths and one general cargo berth. In 1999, it underwent an expansion and dredging of the channel to allow for larger ships and more cargo to flow through. Commercial operation of the country’s first 5 million tons LNG receiving terminal, operated by PTT in the Map Ta Phut port began in 2011. LNG handling capacity has subsequently increased to 11.5 million tons. In 2016, the port managed 43 million tons of cargo. The largest element of this cargo was gas and oil (57 percent), with coal representing 18 percent and chemicals another 16 percent. The port is operating at full capacity, necessitating the expansion phase that is planned.

The end goal for the Phase III expansion is to increase overall capacity from 16 million tons/year to 31 million tons/year of liquid cargo. Phase III will be developed in two separate periods by a joint venture between Gulf Energy Development and PTT Tank Terminal. The first period will involve land reclamation for an LNG terminal with a capacity of at least 5 million tons, while the second period will include the development of the seaport’s superstructure. In the future, the LNG terminal may be expanded up to 10.8 million tons capacity. Together the components of Phase III include:

- 160-hectare land reclamation for a new LNG terminal and power plant;
- Dredging the channel to a depth of 16 meters;
- Expansion of public utility systems; and
- Further implementation of vessel traffic control systems.

Figure 1: Map of Map Ta Phut Port⁹²



⁹² Industrial Estate of Thailand

Through the Thai government’s power development plan, the goal is to derive 53 percent of the country’s power from gas by 2037. This will largely be achieved through imports, as domestic production has dropped by 13.4 percent between 2014 and 2018. On the other hand, LNG imports rose from less than 2 million tons per year to 4.4 million tons per year during the same period. Some estimates note that LNG will supply 80 to 90 percent of the power sector by the end of 2037. The new terminal being developed in the Map Ta Phut Phase III expansion will allow for greater imports to meet these power requirements and result in greater energy security and stability.

Figure 2: Thailand Gas Production⁹³

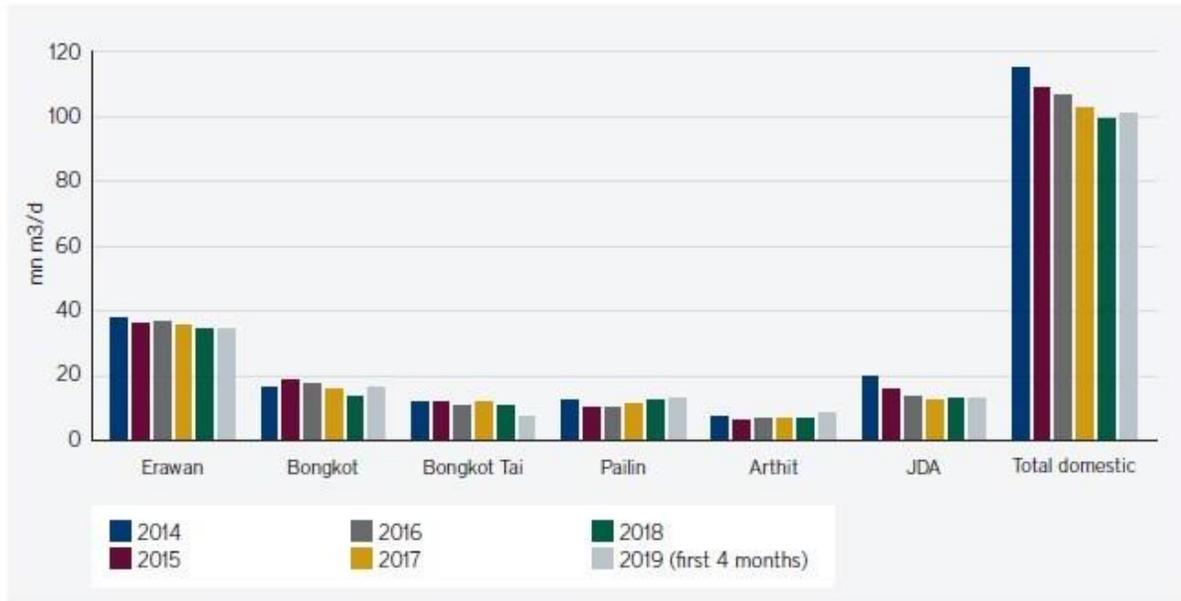
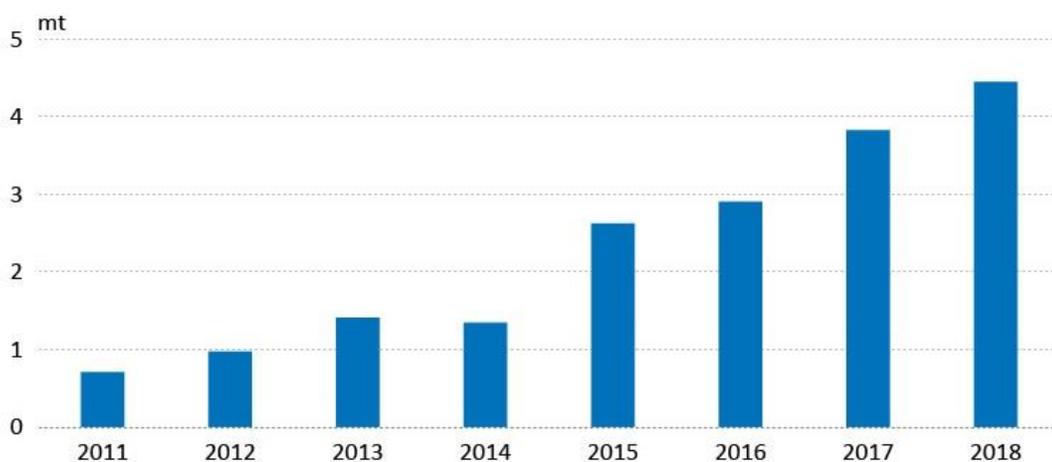


Figure 3: Thailand LNG Import Volumes (million metric tons per year)⁹⁴



⁹³ Thailand’s Department of Mineral Fuels, PTT via Petroleum Economist

⁹⁴ Thailand’s Ministry of Commerce via Interfax Global Energy

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In October 2019, Gulf MTP LNG Terminal won the bid to develop Phase III of the Map Ta Phut port. The company is a joint venture between two Thai-based firms: Gulf Energy Development (70 percent) and PTT Tank Terminal (30 percent). This project is the first of the megaprojects underway in the EEC with a signed contract for development.

The first period of this project will begin in late 2019, with operations planned to begin in 2025. It will facilitate the import of up to 10.8 million tons of LNG per year by establishing the foundation for the increase in shipments. The second period of the project, which will run from 2023 to 2025, will focus on the development of wharves and natural gas facilities to allow for LNG imports and up to 4 million tons per year of liquid cargo. The overall environmental impact analysis for the port has been completed. However, the JV operator will need to conduct supplemental analysis should new elements of the project be pursued.

PROJECT COST AND FINANCING

Combined, both periods of project development are projected to cost \$1.85 billion. The first period is estimated at \$1.6 billion, while the second period will be \$250 million.

The project will be developed under a public-private-partnership (PPP) scheme, with a 35-year duration. The Thai government will contribute \$430 million (27 percent) of the first period, with the joint venture investing the remaining portion. The joint venture anticipates receiving commercial bank financing of \$400 to \$435 million. As part of the PPP, the Thai government will be responsible for land reclamation and construction of the utility system. The JV will be responsible for the construction of the port, installation of the equipment, and port operations.

U.S. EXPORT OPPORTUNITIES

There are significant opportunities that may be available to U.S. companies with experience in the development of seaports and supporting infrastructure. The U.S. firm PwC is serving as an advisor to the EEC Office in support of the development of this project. Interested U.S. companies pursuing opportunities at this port may face competition from firms from China, Japan, Sweden, and the Netherlands who were interested in developing the port. Additionally, significant content for the earlier receiving terminals constructed at Map Ta Phut was sourced from East Asian countries.

Possible areas for engagement to develop the Map Ta Phut Phase III port include:

- Construction supervision
- Detailed design
- Power supply systems
- LNG storage tanks
- Vaporizers

- Compressors and blowers
- Pumps and auxiliaries
- Valves and controls
- Access control systems
- Telecommunications architecture
- Vessel traffic management systems
- Dredging equipment
- Tugboats and barges
- Safety solutions
- Water treatment technologies
- Control systems
- Cybersecurity solutions
- LNG

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Port of Laem Chabang		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Ports
	LOCATION	Sriracha, Chonburi, Thailand
	PROJECT VALUE	\$3.8 billion

PROJECT SUMMARY

The Port of Laem Chabang, Thailand, will undergo a \$3.8 billion Phase III expansion designed to increase its container and roll-on/roll-off cargo capability and improve domestic and international rail linkages. The port will integrate automation technologies to improve efficiencies and safety, with the goal of becoming the premier port in the region. Operation at the expanded facilities will begin in 2025.

PROJECT DESCRIPTION

As part of Thailand’s plan to develop its Eastern Economic Corridor (EEC), the Port of Laem Chabang will undergo a Phase III expansion. This represents one of the megaprojects being developed under a public-private partnership (PPP) model in the EEC. The port has an area of 2,536 acres and is located on Thailand’s eastern seaboard in Sriracha, Chonburi, approximately 130 kilometers from Bangkok (*Figure 1*).

The Port of Laem Chabang is Thailand’s largest commercial port, currently handling 54 percent of Thailand’s imports and exports. The majority of the throughput is containerized cargo, plus approximately one million vehicles. There have been two previous construction phases, resulting in a capacity to handle 11 million TEU per year. With the Phase III expansion, the Port aims for an increase of capacity to 18 million TEU, an increase in vehicle handling capacity to 3 million per year, an increase in the percentage of shipments via rail to 30 percent, and an increase in automation. It is the goal of the Port Authority for the Laem Chabang to compete with, or surpass, Singapore as the premier port in the region. The chart below (*Figure 2*) details the historical growth of container traffic through the port and the projections for the future.

Figure 1: Location of Laem Chabang Port Terminal III⁹⁵

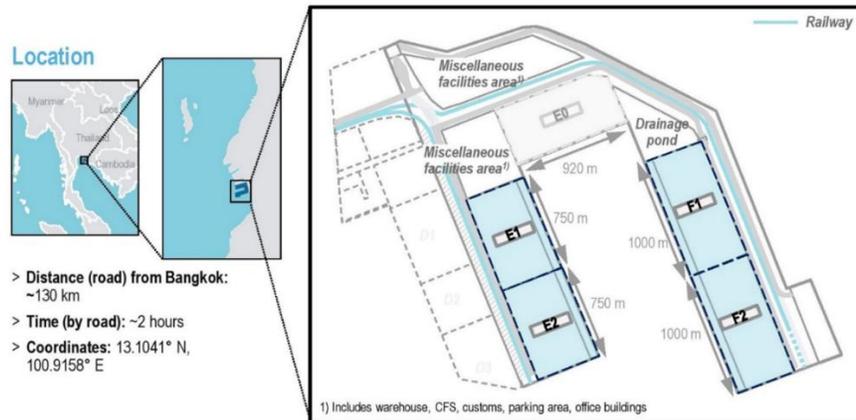
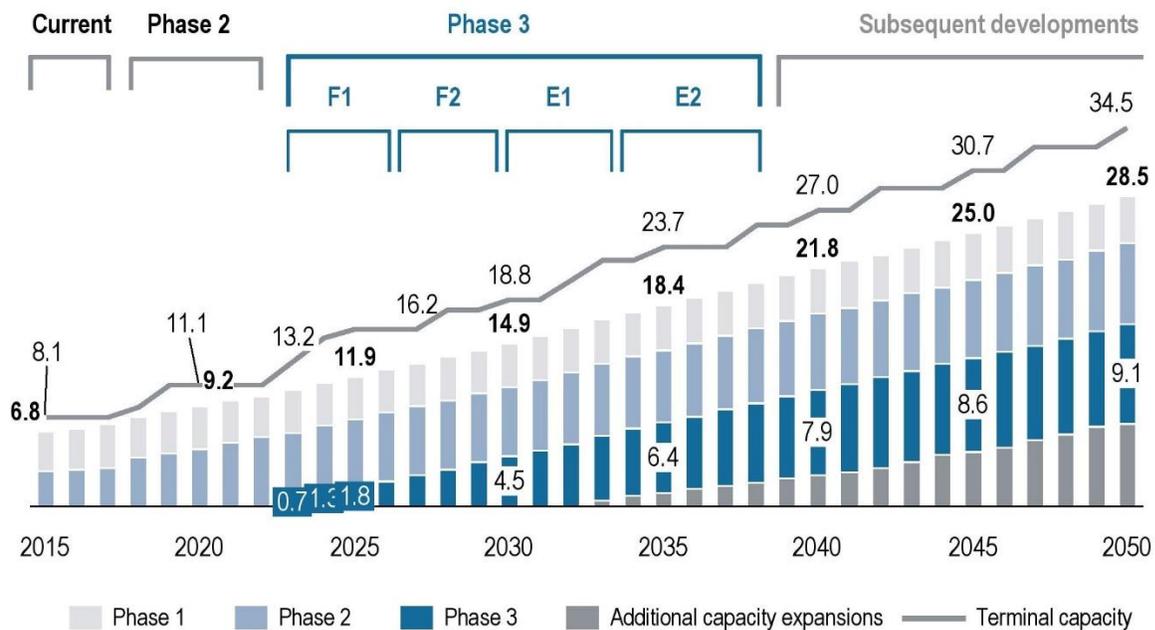


Figure 2: Laem Chabang Port Historical TEU Capacity and Phase III Projections⁹⁶



1) Productivity improvement from 2,130 TEU per berth meter in 2015 to 2,900 TEU per berth meter in 2050

The existing port infrastructure includes 11 container berths, one cruise ship/roll on-roll off (Ro-Ro) terminal, one dedicated Ro-Ro terminal, one container and general goods berth, one bulk goods berth, and one repair and maintenance shipyard. The Phase III expansion project (Figure 3) will add to this infrastructure with the following components:

⁹⁵ TEAM Group

⁹⁶ Ibid.

- Four international container terminals (E1, E2, F1, F2 in the map below) with a combined capacity of seven million TEU/year;
- One domestic coastal terminal (adjacent to F2 in the map below), with up to one million TEU/year;
- One multipurpose/Ro-Ro terminal (E0 in the map below) designed for up to one million vehicles/year; and
- Rail lines to connect the new terminals to the existing railway network.

Figure 3: Map of Laem Chabang Terminal III⁹⁷



The new infrastructure will add two kilometers to the wharf at Terminal F, with a width of 55 meters and more than 2.5 kilometers in Terminal E, with a channel depth of 18.5 meters. The size of the terminals and depth of the water will allow for Post Panamax vessels to dock. The further integration of rail infrastructure, combined with the ongoing rail network expansion being conducted by the State Railway of Thailand (SRT), will offer even greater connectivity and trade connections with regional neighbors Laos, Cambodia, and Myanmar. During Phase III of the Port expansion, Terminals F1 and F2 will be developed first, while the E Terminals and the domestic coastal terminal will be developed approximately two years later, once land reclamation is complete.

A key element of the Phase III expansion will be the integration of port automation technologies. The Port Authority aims to integrate intelligent solutions to improve the efficiency and safety of port operations. Possible technologies that can be incorporated include real-time forecasting of

⁹⁷ Port Authority of Thailand

ship arrival times, predictive maintenance, automated yard planning, and demand planning at the gate to plan for arrivals and departures.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

In March 2019, the Port Authority of Thailand received two bids from consortiums interested in operating the new F1 and F2 port facilities. The bids are still being reviewed, and a selection is planned for December 2019, with operations slated for 2025. The development of Terminal E, which includes two container terminals, the Ro-Ro terminal, and the coastal terminal, is approximately two years behind Terminals F1 and F2. The land reclamation for Terminal E is in process, and a developer is expected to be selected in 2022, followed by operations in 2027.

PROJECT COST AND FINANCING

The overall cost for the expansion of the port is estimated at \$3.8 billion. This will be a public-private partnership (PPP) development, with the government providing \$1.8 billion and the private sector partners contributing the remaining \$2 billion. The government will be responsible for reclaiming the land where the terminals will be positioned and for the construction of the utility systems. The PPP structure calls for the private sector partners to design, build, operate, and maintain the facility for a period of 35 years.

U.S. EXPORT OPPORTUNITIES

The expansion of the Laem Chabang port presents many opportunities for U.S. firms to become involved. Both equipment and services will be required to make the expansions a success. Currently, the U.S. firm PwC is serving as a port advisor to the Eastern Economic Corridor Office. There will be strong competition from Asian and European firms who have deep experience with port developments in Southeast Asia. Equipment and services from China, Korea, and Japan will be particularly competitive.

Specific opportunities for U.S. firms related to the Phase III expansion of Laem Chabang include the following:

- Construction supervision and management
- Engineering and design services
- Water and wastewater treatment facilities
- Waste treatment facilities
- Hazardous waste treatment technologies
- Automation solutions
- Intelligent transportation
- Access control
- Telecommunications solutions

- Cybersecurity technologies
- Dredging equipment
- Barges
- Terminal lighting
- Navigational aids
- Quay and yard cranes
- Vessel traffic management system
- Power supply equipment
- Terminal operating system
- Transtainers
- Container inspection/security equipment
- Rail signaling

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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State Railway of Thailand Upgrade		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Rail
	LOCATION	Nationwide, Thailand
	PROJECT VALUE	\$15 billion network-wide; > \$120 million in rolling stock

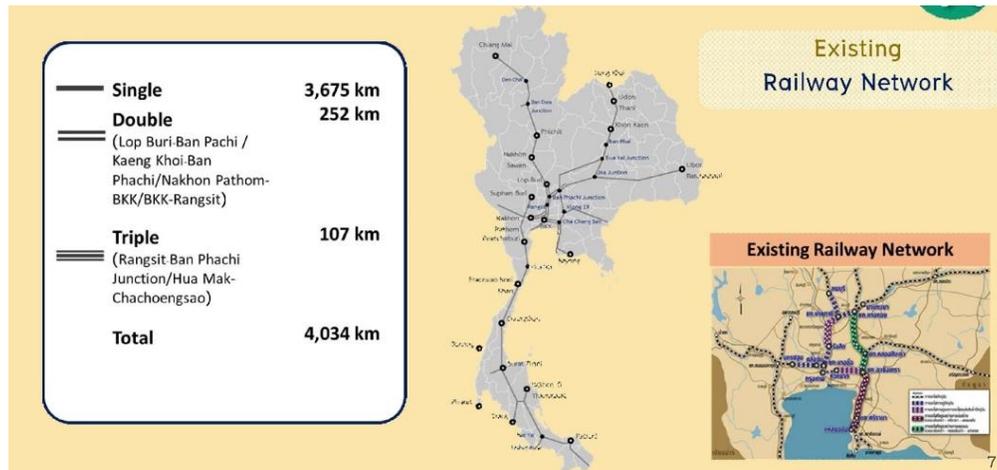
PROJECT SUMMARY

The State Railway of Thailand (SRT) is embarking on a massive infrastructure development plan across the country. Within the next 10 years, the country will have up to 80 percent of its intercity rail network double-tracked, including new investments in signaling and telecommunications. At the same time, the purchase and lease of new and refurbished locomotives and flat cars are being pursued to transport the goods and passengers throughout the expanded system.

PROJECT DESCRIPTION

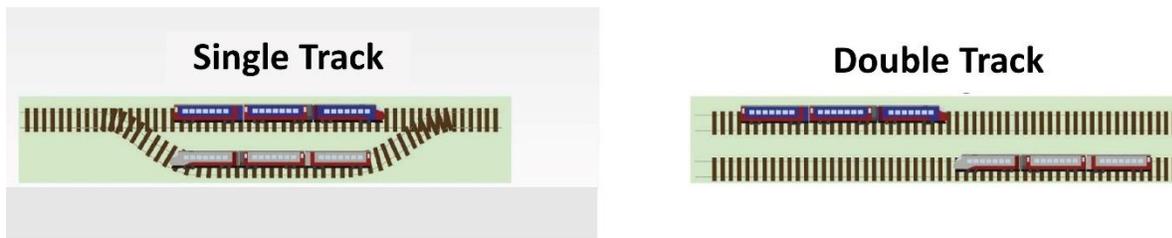
As part of the Thai Transport Infrastructure Development Plan 2015-2022, Thailand is aiming to expand its existing rail network (*Figure 1*) significantly by increasing the amount of their network that is double-tracked. At the beginning of this period, only 359 km of Thailand’s 4,034 km of track was double or triple-tracked. The remaining 3,675 km was single track, resulting in delays and inefficiencies in transporting passengers and cargo. As Thailand looks to reduce logistical costs and decrease congestion on roads by shifting cargo to rail, significant upgrades were necessary.

Figure 1: Existing Rail Transport Network in Thailand⁹⁸



By 2022, Thailand aims to add an additional 839 km of double-tracked rail, with a total of 2,992 km of new double-tracked rail by 2035 (Figures 2 and 3). This would represent approximately 81 percent of the entire network having double tracks.

Figure 2: Double Track and Single Track⁹⁹



In 2018, the SRT network carried approximately 35 million passengers. With the increase in network size and double-tracking of the railway, that number is expected to rise to 80 million when all of the upgrades have been completed. The reach of SRT’s network will also grow greatly, reaching 14 new provinces in that period, for a total of 61 (Figure 3).

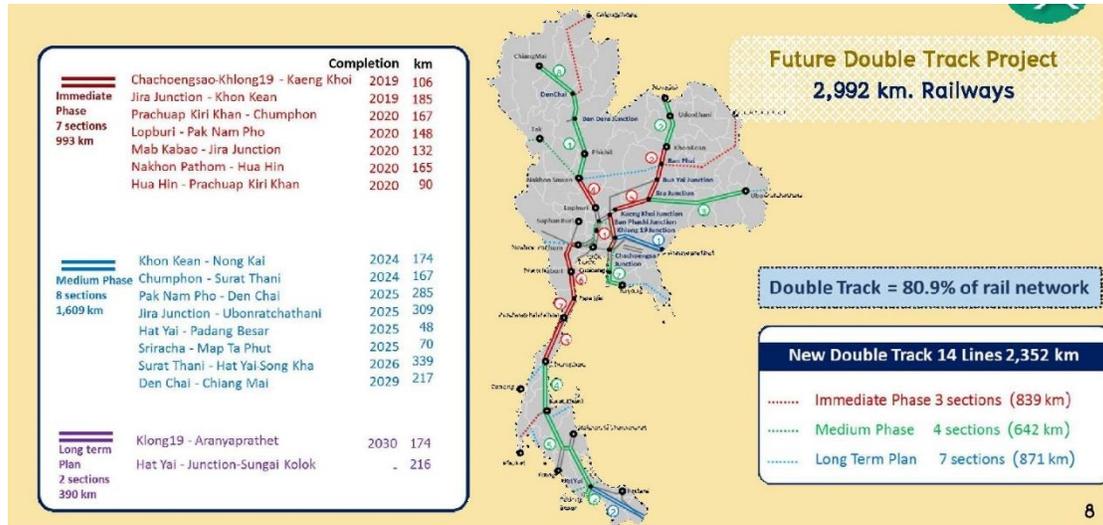
To properly utilize this greatly increased network size, SRT is also improving its fleet of locomotives, with plans for the purchase of 50 new diesel locomotives, refurbishment of 60 existing diesel locomotives, and the lease of an additional 50 locomotives, split 30/20 between diesel and electric locomotives, respectively. The 60 locomotives planned for refurbishment include 38 units manufactured by GE and in service with SRT for approximately 25 years already, and 22 units from Hitachi with a similar service record. Ultimately, SRT has plans to shift its locomotive fleet to become electrical, focusing first on transport within a 250 km radius around

⁹⁸ Ministry of Transportation

⁹⁹ Office of Transport and Traffic Policy and Planning

Bangkok. Accompanying the locomotives, SRT will procure 1,000 new flat cars and bogies (trucks in U.S. rail vernacular) for cargo transport.

Figure 3: Planned Rail Transport Network for Thailand¹⁰⁰



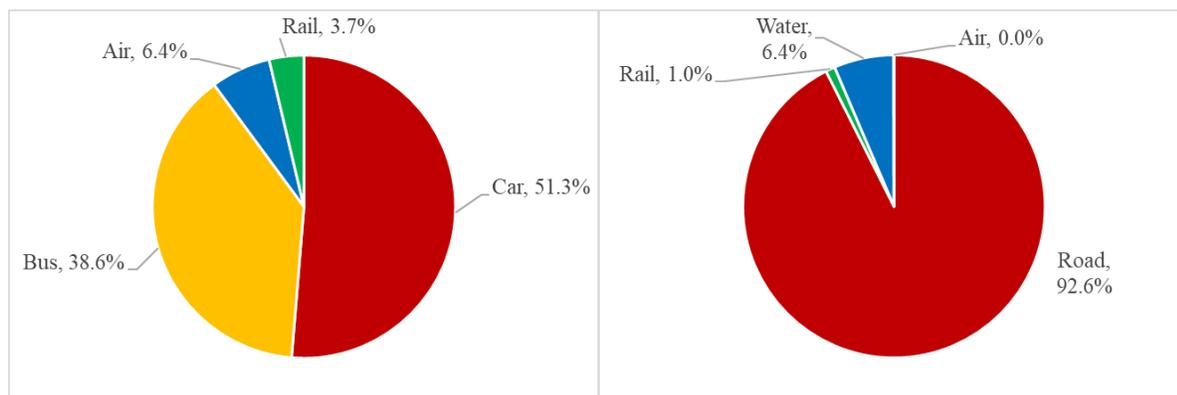
While the locomotives will be sourced from overseas suppliers, SRT is trying to establish and expand local capabilities to support the flat cars and bogies. The 1,000 flat cars will be sourced from Thailand within the next 10 years, but the bogies will originate from outside of the country. SRT is encouraging manufacturers to invest in Thailand as a means to service their bogies in the 5-10-year timeframe. Long-term maintenance contracts will be provided to bogie manufacturers if they are able to undertake maintenance on the equipment domestically.

These new locomotives and flat cars will support the government’s plan to shift transport away from road and air to safer and more economical means using the expanded rail network. In 2016, the share of rail transport was only one percent, with road transport making up an overwhelming 92.6 percent. For moving passengers, rail was only used 3.7 percent of the time, with cars and buses, using roads and highways, representing nearly 90 percent. New track, locomotives, and flat cars will provide SRT with the means to offer rail services and help decongest Thailand’s road network.

The final component of this network expansion involves signaling and telecommunications along the newly constructed rail lines. Earlier in 2019, three separate bidders were awarded contracts for three different rail lines. However, two additional lines will be offered in 2020, each involving 350 km of line for coverage.

¹⁰⁰ Ministry of Transportation

Figure 4: Passenger Travel (left) and Freight Transport Modes (right) (2016)¹⁰¹



PROJECT STATUS AND IMPLEMENTATION TIMELINE

SRT procured 20 locomotives from China approximately 5 years ago and is evaluating their durability now. Bids for the 50 new locomotives were submitted to SRT in mid-October 2019, and a winner will be declared soon. For the 60 refurbished locomotives, the terms of reference are being prepared as of October 2019 and will be issued in mid-2020. In addition, in 2020, SRT plans to issue tenders to lease 50 locomotives (30 diesel and 20 electric).

The tenders for 1,000 flat cars and bogies will be issued periodically over the next 10 years, while incentives will be put in place to encourage domestic maintenance and local content requirements for spare parts. Tenders for signaling and telecommunications for two new, double-tracked rail lines of 350-km each, will be issued in 2020.

PROJECT COST AND FINANCING

The overall cost of the network expansion is above \$15 billion, including the cost of double-tracking, signaling, and locomotives. Within that, the 60 refurbished locomotives are anticipated to be \$60 to 75 million, with the new diesel locomotives approximately \$2 million each.

The cost of the overall network expansion will be financed through a combination of methods, including public-private-partnerships, government-directed resources, and SRT funds. However, SRT has significant debts and is losing money each year. It is anticipated that as the SRT network expands in size and improves in quality that a significant amount of road cargo will be shifted to the rail, thereby improving the rail organization's finances.

¹⁰¹ Office of Transport and Traffic Policy and Planning

U.S. EXPORT OPPORTUNITIES

In the rail sector, U.S. firms are very well-positioned to secure diesel locomotive supply and refurbishment contracts, pending the overall terms of the contract. This is particularly true for the refurbishment work, as many of the locomotives planned for service were manufactured by GE. The U.S., however, does not manufacture electric locomotives and will not be competitive in future bids for these elements. On the signaling side, European and Asian firms have won the previous three tenders.

Opportunities for U.S. firms in the rail sector include:

- New locomotives
- Refurbishing locomotive contracts
- Long term maintenance contracts
- Bogies (trucks)
- Signaling systems
- Telecommunications systems
- Engineering services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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U-Tapao International Airport Development

	SECTOR	Transportation Infrastructure
	SUBSECTOR	Aviation
	LOCATION	Rayong, Thailand
	PROJECT VALUE	\$9.6 billion

PROJECT SUMMARY

As part of Thailand’s plan to develop the Eastern Economic Corridor (EEC), U-Tapao International Airport, located in Rayong, will be expanded to include a new passenger terminal, MRO facility, air cargo facility, and an aviation-training center. This \$9.6 billion project is designed to spur further investment in the EEC area and ease the burden of passenger congestion at Bangkok’s two other international airports.

PROJECT DESCRIPTION

To combat overcrowding in Bangkok’s two main international gateways, Suvarnabhumi (BKK) and Don Mueang (DMK) airports, and support the development of the Eastern Economic Corridor, the Thai government has approved the development and expansion of the U-Tapao International Airport, located in Rayong. This airport, currently operated by the Royal Thai Navy for civilian and military purposes, is located approximately 150 kilometers from Bangkok (*Figure 1*).

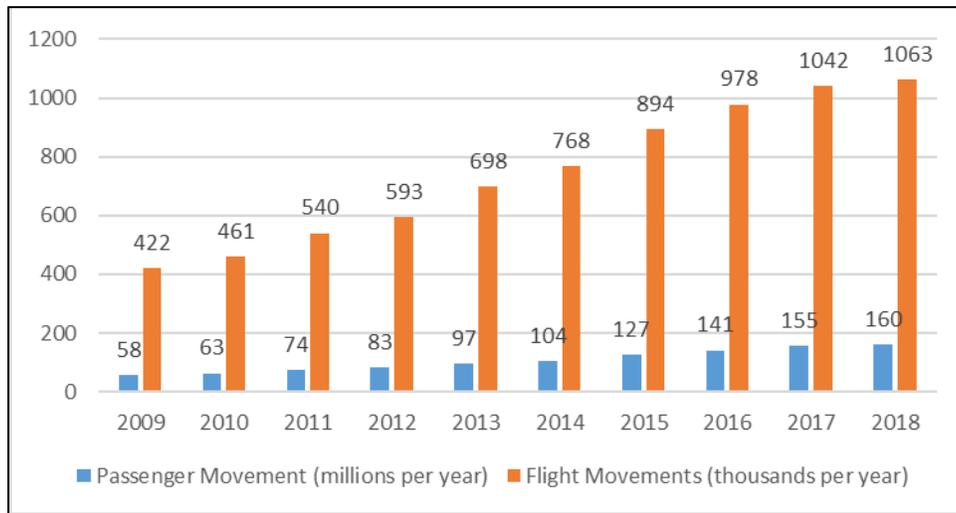
Figure 1: Thai map with EEC Airports¹⁰²



¹⁰² Thai Board of Investment; Civil Aviation Authority of Thailand

Both BKK and DMK have exceeded their capacity for passenger traffic and have expansions planned to meet future traffic projections. In 2018, those two airports saw a combined passenger volume of 104 million, out of 160 million passengers at all airports throughout the country (*Figure 2*). At BKK alone, the capacity is 45 million passengers, yet the airport saw 63.4 million in 2018. The new U-Tapao airport will be able to accommodate some of the overflow of passengers from both BKK and DMK.

Figure 2: Thailand Passenger and Flight Movements¹⁰³



The construction of a high-speed train is being planned and currently in the contract negotiations stage with the developer to link all three Bangkok airports. The U-Tapao airport expansion and the associated high-speed train will be two of the flagship projects developed within Thailand's Eastern Economic Corridor.

The U-Tapao airport currently has one runway of 3,500 meters, with 52 bays for aircraft parking and two terminals that combined can handle 3 million passengers. In 2015, there were 170,000 passengers at the airport, growing to 700,000 passengers in 2016, and 1.2 million in 2017. Passenger traffic in 2018 was approximately 2 million. A third terminal is planned as part of the airport expansion project to manage the expected 12-15 million passengers in 10 years. Ultimately, the airport is projected to receive 60 million passengers per year by 2032, rivaling the throughput of BKK. A second runway is planned to accommodate the anticipated increase in passengers and will be constructed by the Royal Thai Navy. The airport handles both scheduled and chartered flights, with the majority originating from and departing to China. Other destinations include Southeast Asia, and Eastern and Central Europe.

Passenger traffic at U-Tapao is largely targeted to tourists visiting the beaches of Thailand's eastern seaboard. As shown below, growth in the tourism industry has largely been steady since 2014, resulting in increasing numbers of visitor arrivals (*Figure 3*). The increase in seat availability for U-Tapao has shown remarkable growth since 2014, particularly in 2015 and 2016,

¹⁰³ Thai Board of Investment; Civil Aviation Authority of Thailand

with growth rates of 138 percent and 312 percent. The growth figures have lessened recently but remain strong (Figure 4).

Figure 3: Thailand Visitor Growth¹⁰⁴

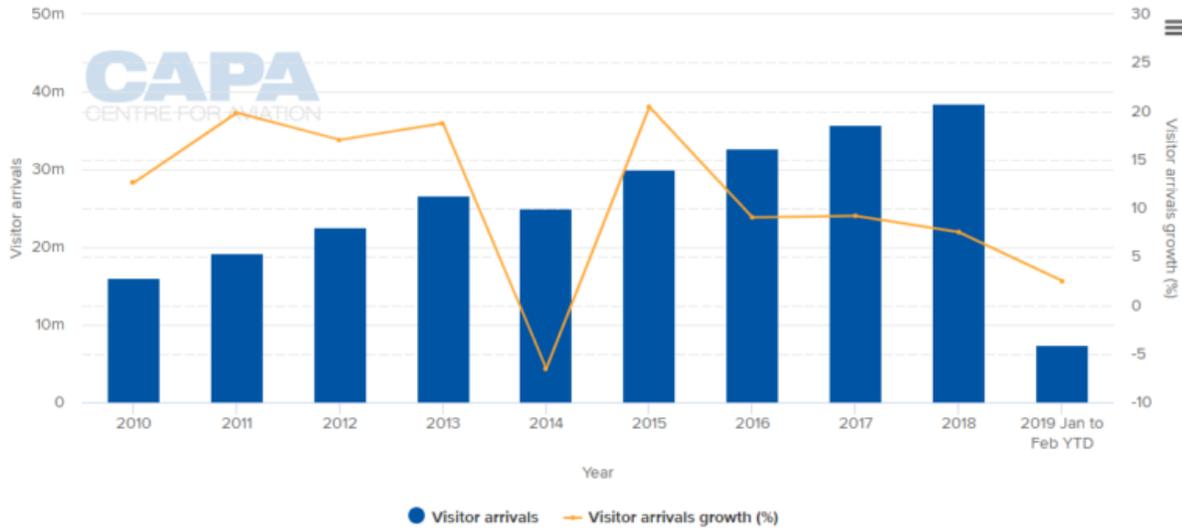
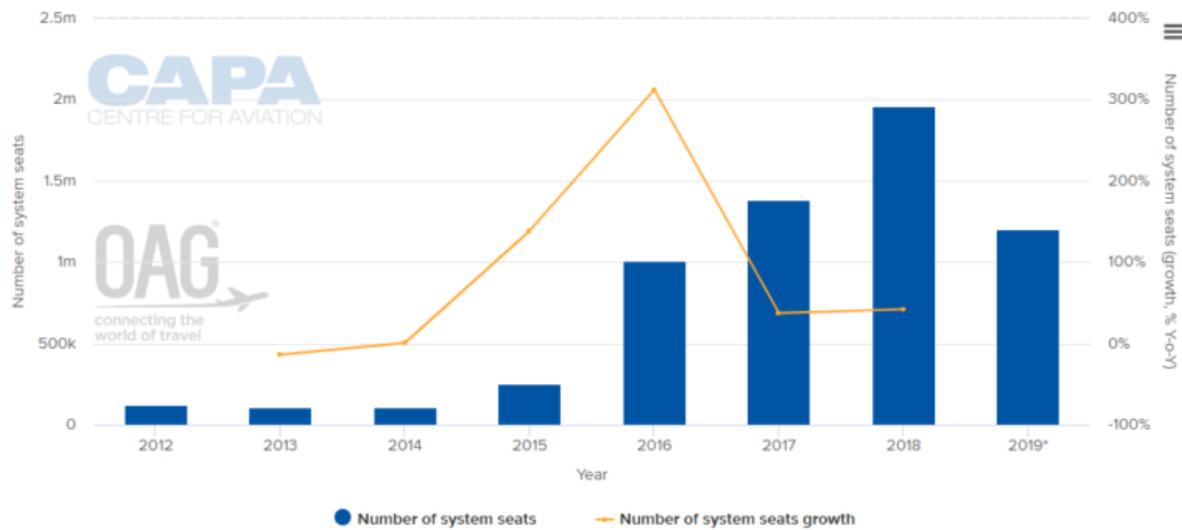


Figure 4: U-Tapao System Seat Growth¹⁰⁵



The U-Tapao airport development plan (Figure 5) will consist of the following components:

- Second runway
- Air cargo facilities

¹⁰⁴ CAPA - Centre for Aviation; Ministry of Tourism; via The Blue Swan

¹⁰⁵ Ibid. – Centre for Aviation; OAT; via the Blue Swan

- Maintenance, Repair, and Overhaul (MRO) facilities (developed under a separate PPP)
- Aviation training center
- Passenger terminal 3
- Free trade zone

Figure 5: Map of U-Tapao International Airport Expansion¹⁰⁶



With three major international airports in a relatively small area, it will be critical to take the approach and departure procedures from BKK and DMK into consideration when planning U-Tapao’s expansion. This metroplex, where airspace is shared across multiple airports, could become quite congested without proper planning, resulting in delays across all three airports. However, with planned expansions at each of these three airports, Bangkok and Thailand will be seen as an even more important aviation hub for ASEAN.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Following a tender earlier in 2019 for the development of the airport, submitted proposals are still under review. A selection will be made before the end of 2019, and the contract to move forward will be signed in January 2020. Once the private sector consortium has been selected, they will need to undertake an environmental impact assessment (EIA). The EIA for the second runway is currently being conducted by the Royal Thai Navy and is expected to be completed in mid-2020. Once construction on the airport expansion gets underway, it will last for five years.

¹⁰⁶ Eastern Economic Corridor Office

In June 2019, Airbus signed an agreement with Thai Airways International to establish a joint venture MRO facility at the airport. This MRO facility will be developed under a separate PPP and will involve the construction of a new hangar, as the second runway and third passenger terminal will be located on the site of the existing MRO facility.

PROJECT COST AND FINANCING

The airport will be developed using a public-private-partnership model, with the government assuming 6.1 percent (\$585 million) and the remainder being allocated to the private sector. For the government element, they will be tasked with the construction of the second runway, while the private sector partner will be responsible for the remaining investment. The Thai government projects that return on investment can be realized within 15 years. The overall cost for the expansion of the U-Tapao airport is \$9.6 billion.

U.S. EXPORT OPPORTUNITIES

Significant opportunities exist for U.S. firms to become involved with the further development of this airport. U.S. firms are currently teaming with local Thai companies to compete for upcoming design and engineering contracts. The U-Tapao expansion has drawn the attention of many international firms, including those from China, Japan, Europe, and Southeast Asia. Of particular note, the largest market for flights to and from U-Tapao is China, which could result in significant interest from Chinese firms.

Opportunities for providing technologies or services include the following:

- Design and engineering services
- Construction supervision
- Air traffic control and management technologies
- Cybersecurity solutions
- Access control solutions
- Baggage claim systems
- Ground handling equipment
- Runway lighting and signals
- Navigational aids
- Firefighting equipment
- Communications technologies
- Jet bridges
- Security screening technologies
- Water treatment
- Power plant/supply
- Airspace planning
-

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Ho Chi Minh City Airports		
	SECTOR	Transportation Infrastructure
	SUBSECTOR	Airports
	LOCATION	Vietnam, Ho Chi Minh City
	PROJECT VALUE	\$6 billion (Phase I)

PROJECT SUMMARY

The Ho Chi Minh City Airports Project bundle contains two distinct components:

1. Tan Son Nhat Airport Expansion; *and*
2. New Long Thanh International Airport

Both airports serve Ho Chi Minh City.

PROJECT DESCRIPTION

The two projects comprising the Ho Chi Minh City Airports project bundle are described individually below.

Project 1: Tan Son Nhat Airport Expansion Project

Tan Son Nhat International Airport (IATA airport code SGN) is the largest airport and the main international gateway to Vietnam. The airport currently handles 32 million passengers annually, well over its designed capacity of 25 million passengers per year. An aerial view of Tan Son Nhat’s Terminal 2 (international flights) is shown below (*Figure1*).

The state-owned Airports Corporation of Vietnam (ACV) has plans to upgrade the airport to a capacity of 50 million passengers annually.

The Tan Son Nhat airport expansion project includes the following components:

- Expand existing terminals (T1 for domestic flights and T2 for international flights) to 30 million passengers per year
- Construct a new T3 terminal with a capacity for an incremental 20 million passengers per year

- Create a combined capacity of 50 million passengers per year through the T1, T2, and T3 expansions
- Increase apron capacity by constructing new 56 new aprons and a new taxiway, yielding a total number of 106 stands

In 2017 the Ministry of Defense transferred 20 hectares of military land adjacent to the airport to facilitate this expansion project.

Figure 1: Aerial View of Tan Son Nhat Airport Terminal 2¹⁰⁷



Project 2: New Long Thanh International Airport

At a site located 40 km northeast of Ho Chi Minh City in Dong Nai Province, the New Long Thanh International Airport will be Vietnam's most significant new airport project. Approved in June 2015 by the National Assembly, it is destined to become one of the largest and the most advanced aviation transportation hubs of the Southeast Asian region. An artist's rendering of the new airport is provided in *Figure 2*.

The build-out plan for the New Long Thanh International Airport calls for the handling of up to 100 million passengers and five million tons of cargo per year. The project is divided into three construction phases:

First Phase: provides for a single 4km runway and one passenger terminal capable of accommodating 25 million passengers and 1.2 million tons of cargo per year.

Second Phase: adds a parallel 4km runway and a second passenger terminal to raise capacity to 50 million passengers and 1.5 million tons of cargo per year.

¹⁰⁷ Airports Corporation of Vietnam

Third Phase: adds another pair of parallel 4km runways and two additional terminal buildings, raising the capacity to 100 million passengers and five million tons of cargo annually.

Figure 2: Rendering of New Long Thanh International Airport¹⁰⁸



PROJECT STATUS AND IMPLEMENTATION TIMELINE

Tan Son Nhat

The Tan Son Nhat airport expansion project currently is under a feasibility study. The terminal expansions for T1 and T2 are scheduled to be completed by 2021. The construction of the T3 terminal is scheduled for 2030. The 56 new stands on the apron will be phased in through 2030. ACV has obtained approval of the Government of Vietnam to carry out this expansion project.

New Long Thanh

In July 2019, the Ministry of Transport (MOT) submitted the feasibility study of New Long Thanh Phase I to the National Assembly. Observers indicate that it is expected to get approval by the end of 2019. Construction of this First Phase would then commence in 2020 and could be operative by 2025.

Future phases of Long Thanh International Airport would require separate feasibility studies and subsequent approvals. Indicative planning suggests the construction of phase II during the 2025-2030 timeframe, with phase III being operational by 2050.

¹⁰⁸ Ibid.

PROJECT COST AND FINANCING

Tan Son Nhat

ACV estimates the cost of the Tan Son Nhat airport expansion project to be nearly \$500 million. ACV will finance the project through conventional means.

New Long Thanh

The total build-out of the New Long Thanh International Airport has an estimated price tag of \$16 billion. Phase I investment is estimated to reach \$5.45 billion. The National Assembly is evaluating different structures and associated financing mechanisms:

- **Option 1:** Official Development Assistance (ODA) funding - this method is not recommended by the MOT since it could lead to a rise in public debt, as well as a dependence on the lending country's contractors;
- **Option 2:** Private Placement Program (PPP) with an open bidding process - not recommended by MOT since the bidding process could increase project duration by 18 months; and
- **Option 3:** Appointing ACV as the main investor - ACV would use its own capital of \$1.5 billion and borrow the rest or coordinate with its partners to develop airport facilities. This format is proposed by MOT since ACV has enough experience and financing capability to build major airports.

U.S. EXPORT OPPORTUNITIES

A wide range of U.S. export opportunities exists for airport projects such as this bundle:

- Jet bridges
- Navigational aids and lighting systems
- Distance measuring equipment (DME)
- VHF omnidirectional radio range (VOR)
- Instrument landing systems (ILS)
- Visual aids, including precision approach path indicators (PAPIs)
- Runway lights
- Communications systems
- Terminal security systems
- Metal detectors / body scanners
- Baggage Screening (Scanners, X-Rays and Explosive Detection)
- Closed-circuit television(CCTV)/cameras
- Access control systems
- Ground-handling equipment
- Fire-fighting trucks and emergency vehicles

- Baggage and cargo handling equipment
- Engineering Services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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4 ENERGY

Electricity Background

The Energy Sector in the Indo-Pacific region is among the fastest-growing. This growing demand for power exceeds five percent per annum in many Indo-Pacific countries, requiring the addition of generation, transmission, and distribution infrastructure. The specific technology opportunities include solar generation, wind generation, natural gas import terminals, gas-fired generation, hydro generation, geothermal energy generation, coal-fired generation, waste to energy, energy recovery from biomass, transmission line upgrades, energy storage, and smart grid.

Many governments in the region have been focusing on meeting the requirement that all people have access to electricity. Some of the countries have met or are soon to meet this goal, while others still have some ways to go. Access to remote populations is the greatest challenge to deliver reliable grid power at reasonable rates. Table 2 shows the penetration rate and the population without access to electricity.

*Table 1: Electricity Penetration Rate*¹⁰⁹

Country	Energy Penetration Rate (Percent)	Population without Access to Electricity (millions)
India	82	239
Indonesia	91.2	23
Malaysia	98.6	< 1
The Philippines	89.6	11
Thailand	100	0
Vietnam	98.3	1.6

*Table 2: Electricity Capacity and Growth Rates*¹¹⁰

Country	Installed Generation Capacity (MW)	Growth Rate 2018/2017 (Percent)
India	308,800	6.2
Indonesia	54,580	5.0
Malaysia	33,340	3.8
The Philippines	22,730	5.7
Thailand	40,970	0.5
Vietnam	45,410	10.6

¹⁰⁹ CIA World Factbook

¹¹⁰ Ibid.

Power Generation

Each country faces challenges. Indonesia and the Philippines are challenged by the many distant islands, and small population centers make it difficult to bring reliable, affordable power. Vietnam has difficulty with high technical transmission losses due to the country's geography and imbalance of supply and demand by region with the Northern region a net exporter of power and the Southern region a net importer. India has difficulty due to the significant population that lives in rural areas without reliable grid access. There are considerable opportunities to assist in tackling these issues.

Overall demand growth is also a very important issue in the power sector. With these high demand growth rates, additional power is required. Many of these countries have enormous coal deposits, and coal-fired power plants are still being built due to the access to fuel and fuel security concerns. LNG projects are being developed in most of the Indo-Pacific countries. Vietnam has at least five large scale LNG import terminal projects in development. Indonesia and Malaysia are LNG exporters, but Indonesia is also an LNG importer. This is driven by the lack of new gas finds and the difficulty of moving stranded gas to markets because of the country's geography. The Philippines, India, and Thailand also have LNG import terminal projects, some that are profiled in this Resource Guide.

Along with all the LNG projects are many projects for natural gas-based power generation. There are well over 10 GW of combined cycle gas turbine power generation projects currently being developed in the region. Some of these projects are included in the project profiles that follow. These projects include turbines for new generation based on LNG. Other smaller gas projects include simple cycle gas turbine projects to capture the value of stranded gas assets and for the replacement of old oil-fired generation plants.

Large scale import terminals capable of handling large LNG carrier delivery as well as breakbulk projects where smaller volumes of LNG can be delivered into smaller markets. In the region, there is considerable interest in the importation of U.S. LNG to fuel power and industry. Additional export opportunities for U.S. firms include engineering, procurement and construction projects, sales of cryogenic equipment, compressors, electric and instrumentation equipment, unloading equipment, safety equipment, and power generation equipment. In addition, we expect that U.S. LNG exporters will participate in these markets, allowing for a considerable opportunity for U.S. exports.

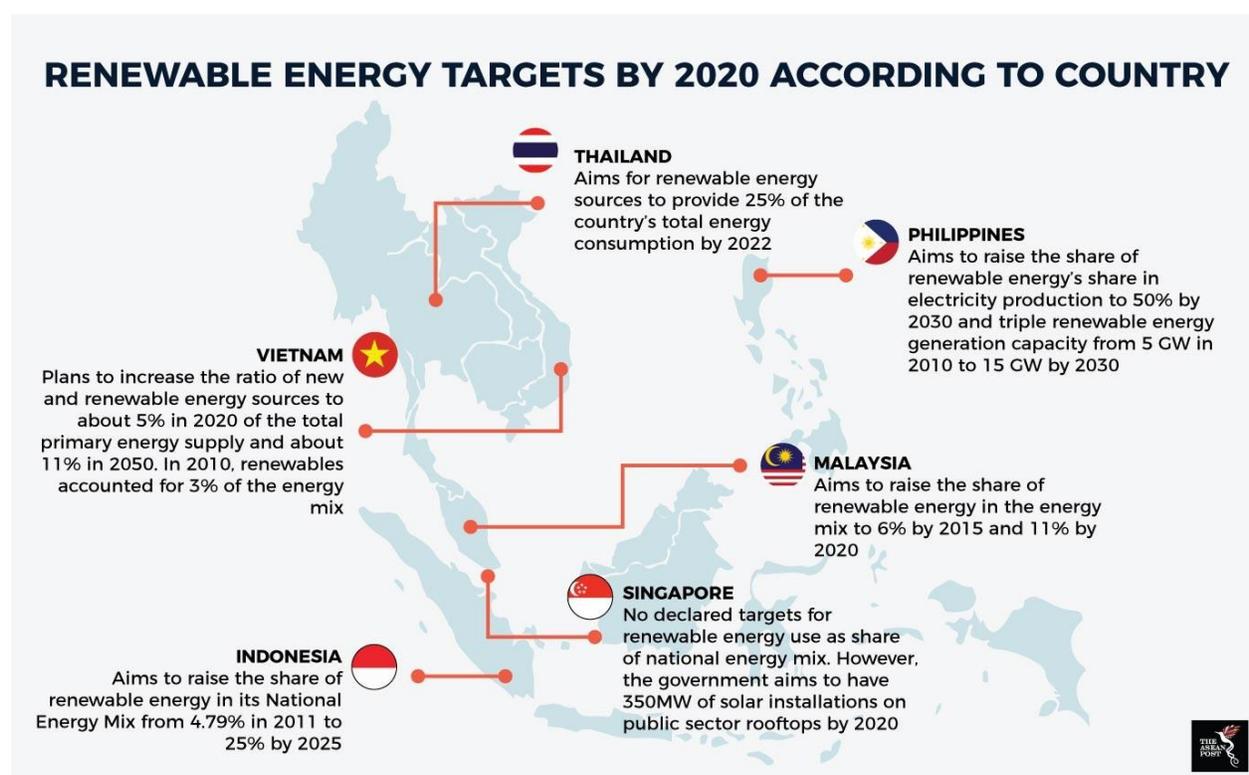
Renewable Energy

The primary renewable energy goals of the main economies in Southeast Asia are shown below (*Figure 1*). The countries of Southeast Asia have significant goals for renewable energy in the near term and longer-term. However, the abundance and low cost of coal in the region has kept the developments of renewables somewhat in check.

The Government of India is committed to increased use of clean energy sources and is already undertaking various large-scale sustainable power projects and promoting green energy heavily.

The Ministry of New and Renewable Energy (MNRE) has set an ambitious target to set up renewable energy capacities of 175 GW by 2022, of which about 100 GW is planned for solar, 60 for wind, and other for hydro, bio among others. As of June 2018, the Government of India is aiming to achieve 225 GW of renewable energy capacity by 2022, much ahead of its target of 175 GW as per the Paris Agreement. India’s renewable energy sector is expected to attract investments of up to US\$ 80 billion in the next four years.

Figure 1: Renewable Energy Targets by Country¹¹¹



Solar Generation

Many solar projects are being developed in the region. The Philippines and Vietnam are improving the tariffs and making it simpler to develop such projects. Indonesia seems to be lagging in this sector. Only microgrid projects based on solar are the bright spot in Indonesia. These microgrid projects are very small and have limited export potential. Large scale solar projects are difficult to source from the U.S. as the production of most of the equipment needed for them can be sourced at lower costs in the region. Many companies (including U.S. firms) have solar module and inverter plants in Southeast Asia. India is a leader in new solar capacity and has some of the lowest tariffs in the world. Abundant solar intensity, coupled with business models that favor the developer, has led to an explosion of projects.

¹¹¹ Rewind.es

Wind Generation

India is also a leader in the wind generation sector. Most of the remaining countries of the Indo-Pacific region are behind India in generation growth for wind energy. Wind potential is mixed in the region, and regulations are not fully developed to assist in the growth of this sector.

Geothermal Generation

There are many active geothermal opportunities in South East Asia, especially in Indonesia and the Philippines. U.S. systems engineering, geosciences consulting, steam generation, and electrical systems infrastructure could be exported for the projects. There is a geothermal development project in the Resource Guide.

Waste to Energy

The Philippines is beginning to address its waste management capabilities and is seeking alternatives to landfilling of wastes. Similar efforts are underway in Indonesia. India has a substantial waste to energy industry but has had difficulties because of limited access to high calorific wastes and the large portion of waste being food wastes having lower calorific values making them less productive. Higher U.S. exports of combustion/gasification systems, pollution control, feed systems, and electrical infrastructure are possible. One U.S. consortium has been awarded a large project in the Philippines. There is one profile in the Resource Guide defining several projects in the Philippines. Other projects waste to energy projects include a series of projects in Indonesia and one gasification co-firing projects in Thailand.

Coal

Even with the pressures to reduce carbon emissions and to adopt more carbon-neutral energy generation, coal will remain a major source of electricity in the region for decades to come. Coal-fired plants continue to be developed in the region since abundant, low-cost coal is available in most of the region. A large portion of the development of energy plants continues to be coal-fired. Vietnam, the Philippines, India, and Indonesia are still adding major coal projects, but are likely to start to accelerate the development of renewables and gas plants to replace older coal and oil-fired plants during the next decade. India has managed to accelerate its adoption of other generation sources and may make greater strides than some of its neighbors. There are two coal projects in the Resource Guide.

There are several developments seeking to recover gas from coal beds. One project is profiled in India. There are other opportunities near major coal deposits in some of the other countries.

Battery Storage

Battery storage, coupled with renewable energy generation, is beginning to be developed in the Indo-Pacific region. One solar plus storage project is included in the Resource Guide in Thailand.

Smart Grid

Grid integrity issues and load-shedding are issues in some of the areas in the Indo-Pacific region. With high power demand growth rates, there continues to be an opportunity within this sector. In addition, battery storage systems suitable for grid management, as well as to support the implementation of inconsistent renewable energy solutions are also being developed. Several

smart grid projects are included in the Resource Guide, including Advanced Metering Infrastructure, transmission line management systems, and smart meter rollouts.

Oil and Gas

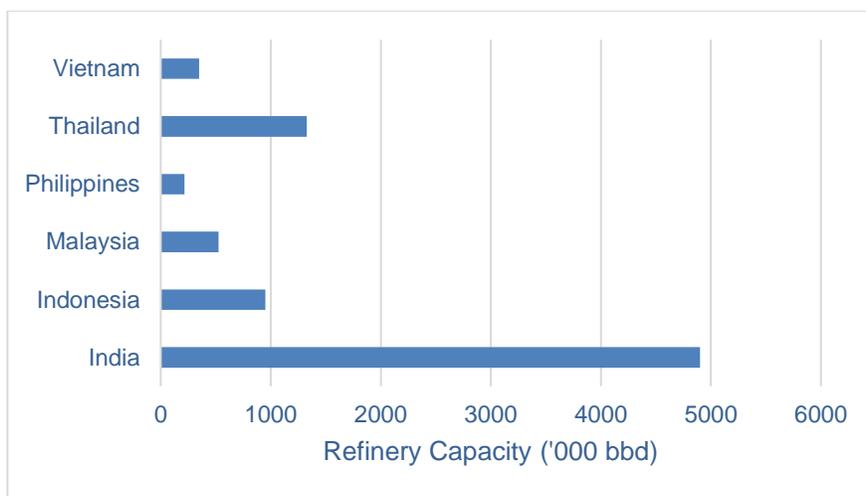
Oil and Gas Exploration

This report does not focus on exploration and production projects for oil and gas. However, one project profiled was a decommissioning project being executed by Petronas in Malaysia. Petronas is decommissioning wells at a rate of about 50 per year, and they are seeking international expertise to assist them.

Petroleum Refining

Every major country in the Indo-Pacific region operates oil refineries, India is by far the largest refiner in the region. India has many new refineries and has been upgrading many refineries. Many of those projects have been ongoing.

Figure 2: Refinery Capacity ('000 bpd)¹¹²



Pertamina, the state oil and gas company of Indonesia, is in the middle of a major upgrade of its refinery fleet. We identified several refinery upgrade projects as well as two greenfield projects under development in Indonesia, which are profiled in this Resource Guide. There are also some pipeline and refinery projects in India.

Natural gas

Natural gas is an extremely important aspect of the energy situation in the Indo-Pacific region. Much of the benefit of gas in the region in the next five years will be focused on the development

¹¹² Oil and Gas Journal

of natural gas-fired power projects and the massive developments in LNG importation in the region. This is already covered earlier in this overview section.

Chemicals

The trend in the region is to look for opportunities to monetize stranded assets to produce petrochemicals. This is a much more efficient way to capture the values of gas especially while advancing the development of the chemical industry in the region. Production of ammonia derived chemicals is consistently growing in the region and elsewhere. Several methanol projects are highlighted in this resource Guide as both Indonesia and Malaysia; traditionally gas exporters have determined to enhance their chemical industry by exploiting gas fields to produce chemicals. Malaysia has several projects in development in Salah and Sarawak to develop methanol projects. Indonesia is pursuing one in Eastern Indonesia.

Bina Panki Petroleum Product Pipeline		
	SECTOR	Energy
	SUBSECTOR	Oil and gas development
	LOCATION	Bina, Madhya Pradesh Panki, Uttar Pradesh
	PROJECT VALUE	\$227 million

PROJECT SUMMARY

This project, being implemented by Bharat Petroleum Corporation Limited (BPCL), involves laying a multiproduct, cross-country pipeline connecting Bina dispatch terminal (Madhya Pradesh) to the existing Panki (Kanpur) terminal (Uttar Pradesh) of BPCL with intermediate sectionalizing valve stations, an intermediate pigging station, and a receipt terminal at Panki. The pipeline length will be 360 km using 18-inch diameter pipe. The system capacity is defined at 3.45 million tons per annum (MMTA) for the first 13 years. Worley Parsons, India (WPIL), has been appointed as the engineering project management consultant (EPMC).

PROJECT DESCRIPTION

Bharat Petroleum Corporation Ltd. (BPCL) is a public sector enterprise in the oil and gas (O&G) sector. The company was established in 1976 after Burmah Shell was taken over by the Government of India. Headquartered in Mumbai, it was the first refinery to process indigenous crude oil – Bombay High. BPCL produces a broad range of petroleum and gas products at its refineries (*Figures 1 and 2*) and has a 2,300-kilometer pipeline network.

Figure 1: BPCL Refinery Throughput¹¹³

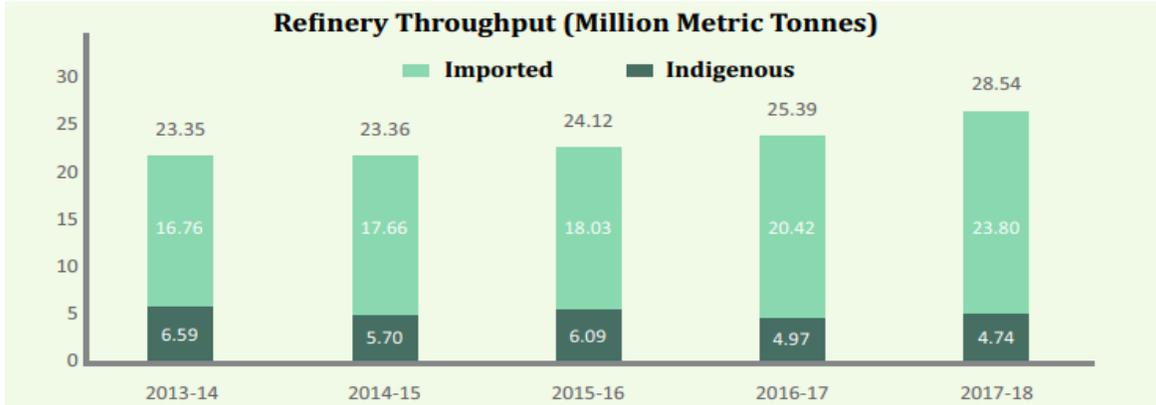
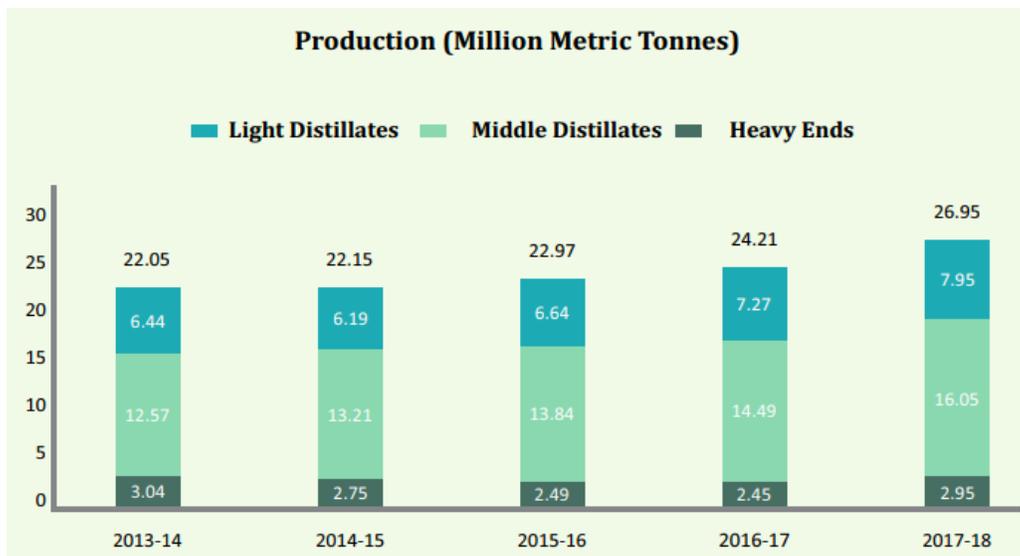


Figure 2: BPCL Production Trends¹¹⁴



The proposed new pipeline will optimize product movement from Bina refinery (*Figure 3*) to Panki depot (Kanpur) to feed the Uttar Pradesh and Bihar markets. It will replace existing rail transport and is envisaged to yield investment returns of more than 12 percent. The proposed 18-inch, multi-product pipeline will carry a range of petroleum products, including motor spirit (MS), high-speed diesel (HSD), superior kerosene oil (SKO), and aviation turbine fuel. The proposed pipeline is designed for an ultimate capacity of 6.0 MMTPA.

The pipeline will pass through the Sagar and Tikamgarh districts in Madhya Pradesh and Lalitpur, Jhansi, Jalaun, and Kanpur districts in Uttar Pradesh. The pipeline will not pass through any environmentally sensitive areas.

¹¹³ BPCL

¹¹⁴ Ibid

Figure 3: Bina Refinery¹¹⁵



The Project (pipeline) battery limits are defined as follows:

- a. Dispatch station at Bina including booster pumps (1 operational and 1 stand-by), mainline pumps (1 operational and 1 stand-by), basket filter, metering, corrosion inhibitor dosing, and scraper launcher, along with associated facilities.
- b. Intermediate pigging station (IPS) including scraper receiver/launcher, filter, metering, corrosion inhibitor dosing, and associated facilities.
- c. 355 kilometers (approximately) cross country pipeline from Bina to Panki.
- d. Receipt terminal at Panki, including scraper receiver, filter, metering, and associated facilities.
- e. Sectionalizing valve stations (SVS) as per code and profile requirements.
- f. SCADA (Supervisory Control & Data Acquisition), LDS (Leak Detection System), CP (Cathodic Protection) & ESD (Emergency Shut Down), telecommunications, and instrumentation systems.

The scope of work for the contractor installing the pipeline is divided into three parts:

Part A: Basic Engineering:

- a. Preparation of process package consisting of all Process & Engineering design basis, conducting optimization studies for the entire pipeline, review/update layout of facilities, process flow diagrams, piping and instrumentation diagrams, process/ equipment datasheets, and electrical/instrumentation datasheets.
- b. Pipeline system operation and control philosophy & manuals.
- c. Preparation of conceptual designs, telecommunication, Supervisory Control and Data Acquisition (SCADA), inclusive of leak detection systems and turnkey instrumentation.

¹¹⁵ Ibid

- d. Carry out pipeline optimization studies and modify pipeline design, per throughput specifications.
- e. Carry out analyses and provide detailed route survey/survey alignment sheets/cadastral survey/soil investigation/soil resistivity data (to be supplied by BPCL).

Part B: Detailed Engineering, Inspecting, Monitoring and Project Management

This element will include all activities subsequent to basic engineering, including: detailed engineering, finalization of specification for procurement of equipment/materials and works packages, preparation of RFQ, detailed estimates, floating of open and limited tenders for equipment's and works, tender evaluation, issuing letter of intent/purchase order, approval of approved for construction (AFC) drawings, all vendor documents, quality assurance plan, inspection, expediting, project management, project risk management, etc., until commissioning of the project.

Part C: Construction Supervision - Site construction supervision services through mechanical completion, pre commissioning and commissioning assistance stage

The Contractor will comply with the provisions under the Petroleum and Natural Gas Regulatory Board Regulations, the service obligations specified in Schedule J to the Petroleum and Natural Gas Regulatory Board (Authorizing Entities to Lay, Build, Operate or Expand Petroleum and Petroleum Products Pipelines) Regulations, 2010, and other relevant regulations for the technical standards and specifications, including safety standards and any other regulations that may be applicable, along with the provisions of the PNGRB Act, 2006.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Detailed Feasibility Report (DFR) and studies for environmental clearance for the project have been completed. In December 2018, the Petroleum and Natural Gas Regulatory Board (PNGRB) granted Bharat Petroleum Corporation Limited (BPCL) the authorization to lay, build, and operate the pipeline. In the third quarter of 2019, bids were invited to install 29 kilometers of 18-inch, API 5L grade X-70 pipeline through horizontal directional drilling (HDD) at various crossings for the project.

Bids were issued for the supply of coated submerged arc longitudinal welded/submerged arc helical welded/high frequency electric welded carbon steel line pipes for the project. The bids for various other parts of the pipeline are expected in the near future. The pipeline is expected to be commissioned by 2020 or 2021.

The concession authority for this project is the Petroleum and Natural Gas Regulatory Board (PNGRB). Several consultants are also involved with the development of the project:

Consultant	Contact Details	Scope of Work
N.K. Buildcon Private Limited	B-62, "UGANTA", University Marg, Bapu Nagar, Jaipur. Rajasthan, India Ph: S+91 141- 2710841 http://www.nkbuildcon.com/	Survey works
Worley Parsons India Private Limited	B Wing, 5th Floor, i-Think Lodha Techno Campus Off Pokhran Road No. 2, Thane (West), Mumbai Maharashtra, India Ph: +91 22 6781 8000 https://www.worleyparsons.com/	Project Consultant
Projects & Development India Limited (PDIL)	PDIL Bhawan, A-14, Sector 1, Noida, Uttar Pradesh India Ph: +91 120 2529842 www.pdilin.com	Pre-feasibility report
Engineers India Limited	Engineers India Bhawan, 1, Bhikaiji Cama Place, RK Puram Delhi, India Ph: +91 11 26762121 http://www.engineersindia.com/	DFR of 327 km pipeline

PROJECT COST AND FINANCING

The estimated cost of the project is \$227 million. This project will be funded by Bharat Petroleum Corporation Ltd (a public sector, State-owned undertaking controlled by the Government of India) through their internal resources, including reserve funding and debt financing.

U.S. EXPORT OPPORTUNITIES

U.S. firms will have opportunities in subcontracting to the EPMC. U.S. exporters will also have opportunities to provide equipment and services per the project description above. While BPCL will be required to adhere to local content (LC) regulations for upstream EPC projects, the import content for the off-shore specified pipeline will be approximately 65 percent in 2020 to 2021, as defined by the PNRGB. For tubulars, the import content will be 40 to 50 percent. For drilling services, pumping units, and wetheads, the import content is expected to be 70 to 80 percent. This

will include downhole tools, logging services, premium bits, machine and equipment, and associated components.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Bharat Petroleum Corporation Limited (BPCL) Bharat Bhavan, 4&6 Currinbhoy Road Ballard Estate, Mumbai Maharashtra, India Mr. Samir Banerjee, Senior GM, Procurement Amol.gosavi@worleyparsons.com visalpaliwal@bharatpetroleum.in www.bharatpetroleum.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudana tmadhusudanan@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Aileen Crowe Nandi office.newdelhi@trade.gov</p>

Intra-State Transmission Strengthening System		
	SECTOR	Electricity
	SUBSECTOR	Transmission & Distribution
	LOCATION	Arunachal Pradesh and Sikkim, India
	PROJECT VALUE	\$699 million

PROJECT SUMMARY

Power Grid Corporation of India Limited (PGCIL), a public sector undertaking of the government of India, plans to develop a Comprehensive Scheme for Strengthening of Transmission and Distribution Systems in Arunachal Pradesh and Sikkim (Intra-State Transmission Strengthening System). The project is intended to improve electric power access and reliability and will require an investment of \$699 million. The government has approved and expedited this project to accelerate the development of the North-Eastern (NE) region.

PROJECT DESCRIPTION

The Government of India has announced several energy initiatives aimed at building power generation capacity, promoting energy efficiency, and increasing clean energy sources in the country’s overall power mix. India is the fifth largest electric energy producer in the world, with a total installed power generation capacity of 356 gigawatts (GW). India’s energy demand grew by four percent in 2018, outpacing global demand growth of 2.3 percent¹¹⁶. While coal continues to dominate the energy mix, its share is declining as renewable energy sources become more widely adopted. The private sector now represents 45 percent of electric power production in India, whereas 10 years ago, the Indian Government’s share dominated overwhelmingly.

The roadmap for power sector development requires the strengthening of overall Transmission, Sub-transmission, and Distribution Systems, a challenge for the NE Region and the State of Sikkim. The magnitude of the challenge was articulated in the “Pasighat Proclamation on Power” released during the first Sectorial Summit of the North Eastern Council at Pasighat in Arunachal Pradesh in January 2007. Pursuant to recommendations of the Pasighat summit, a Sub-Group was established. Thereafter, a comprehensive scheme for strengthening of transmission, sub-transmission and distribution systems was developed by the Central Electricity Authority (CEA) in consultation with PGCIL and the States of the NE Region and Sikkim.

¹¹⁶ International Energy Agency

Presently, only five of 20 districts in the State of Arunachal Pradesh are connected to a transmission network at 132/220 kV. Today, a 33-kV system is the backbone of the power distribution system in the State. Due to low population density over a geographic area of 84,000 sq.km, power demand in Arunachal Pradesh is scattered over large distances. Hence it is necessary to provide 132 kV connectivity in the state for proper voltage management and lower distribution losses. Similarly, the distribution system in Sikkim mainly relies on a 66-kV network, which needs to be strengthened substantially. Representative infrastructure in the region is shown below (Figure 1).

Figure 1: Representative Electric Power Infrastructure – North-Eastern Region¹¹⁷



The project will benefit the people of the NE region and the State of Sikkim, who are not connected in a reliable and secure manner to the power grid. As well, when complete, the area will have a backbone for the transmission of regional hydropower. Further, as is common, the network is planned to have built-in optical fiber cable for the utility's supervisory control and data acquisition (SCADA) system, which can also support other high-speed communication capabilities locally.

Project components include the following:

Sikkim

- 4,240 km of 220 kV, 132 kV, 66 kV, and 33 kV transmission lines
- 1,304 mega-volt ampere (MVA) substation transformation capacity via 115 new substations
- 134 transmission lines covering 15 districts and four districts in Arunachal Pradesh and Sikkim, respectively
- Seven new 132/66 kV substations (590 MVA)
- 14 - 66/11 kV substations (170 MVA)

¹¹⁷ LiveMint

- Total Transformation Capacity (at 132& 66 kV level) of 590 MVA
- Eight 132 kV and 220 kV (initially charged at 132 kV) transmission lines spanning 118 km
- 281 km of 66 kV line
- One 66/33 kV substation, total 10 MVA
- 13 - 6/11 kV substations, total 160 MVA

Arunachal

- 24 new 132 kV substations with a total additional 529 MVA transformation capacity
- Augmentation of 15 MVA capacities at Daporijo
- 33 new transmission lines spanning 1917 km; seven 132 kV lines (initially operated at 33 kV)
- 70 - 33 kV substations with a total 33/11 kV transformation capacity of 465 MVA
- 70 - 33 kV line feeders over 1,923 km

Following construction, which is expected to be completed by 2021, the power systems will be transferred to the State governments for operation and maintenance.

EPC contractors have been or will be selected for different sections of the project. Their scope will include:

- Design, engineering
- Manufacture, testing, and supply to the site, including transportation and insurance
- Unloading, storage, erection
- Testing and commissioning

The EPC contractors will be responsible for procuring equipment and services from other national and international vendors for system components including:

- Design
- Transmission lines
- Tower packages
- Substation packages
- Distribution packages
- Optical Ground Wire (OPGW) packages

Of the original \$750 million project budget, EPC contracts worth approximately \$450 million have been awarded to different parties. Given a budget reduction, about \$250 million has yet to be awarded.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Cabinet Committee on Economic Affairs (CCEA) approved this project in 2014. The initial completion target was 2018, which has now been extended to 2021. EPC contracts for 60 percent

of the value of the project have been awarded, including contracts for 61 substations. Contract awards for the remaining 33 substations are available. Parties who have already secured primary contracts grid sections include (*Table 1*).

Table 1: EPC Contractor Awards to Date

Contractor	Award	Value (\$ Million)
Tata Projects Limited (TPL)	Tower, Substation, et al	79.9
KEC International Limited	Turnkey Tower packages	74.9
Larsen & Toubro Limited (L&T)	Turnkey Tower packages	67.4
EMC Limited	Substation	44.9
Technofab Engineering Limited	Distribution	31.9
Sterling and Wilson Limited	Substation	27.9
Shyama Power Private Limited	Substation	22.8
KEI Industries Limited	Substation	22.7
Angelique International Limited	Substation	21.4
KEI Industries Limited	Substation	17.4
PLR Projects	Tower	11.7
Mohan Energy Corporation	Transmission Line	10.1
Reliance Elektrik Works	Substation	7.9
Simplex Infrastructures Limited (SIL)	Pile Foundation package	5.4
Transglobal Power Limited	Tower	4
Vishal Infrastructure	N/A	N/A
JV - Aster Private/Kusuk Construction	N/A	N/A

In September 2017, Power Grid Corporation of India Limited (PGCIL) requested the Government of Arunachal Pradesh to expedite the process of land allotment. At present, some awarded project sections are under construction, while others await land clearances. Of the total 61 substations awarded, land for only 38 substations has so far been made available by the state government. Completion is planned by 2021.

PROJECT COST AND FINANCING

EPC contracts worth approximately \$450 million have been awarded to a variety of parties. Contracts valued at \$250 million have yet to be awarded.

The project is divided between direct project capital investments (88 percent) and consultancy fees (12 percent). By geographic area, the budgetary split is approximately two-thirds for Arunachal Pradesh and one-third for Sikkim.

Initially, a \$750 million project was proposed to be funded under the Non-Lapsable Central Pool of Resource (NLCPR - Central) of the Ministry of Development of North Eastern Region (DONER). DONER conveyed its inability to provide funding given budgetary constraints. Several further changes to budget and oversight were made.

Funding will be the responsibility of the Government of India through the PGCIL, who will hold 100 percent equity. Once the project is completed, it will be turned over to the state governments of Arunachal Pradesh and Sikkim for operations and maintenance.

U.S. EXPORT OPPORTUNITIES

U.S. firms have opportunities to bid for EPC contracts for the \$250 million remainder of this project. U.S. energy sector equipment and services companies may participate as subcontractors and suppliers to the primary EPC contractors. Opportunities include:

- Electric transmission lines
- Sub-stations
- Towers and allied electrical equipment including transformers
- Fixed capacitors
- Fuses for electrical apparatus
- Lightning arrestors
- Voltage limiters
- Electric conductors
- Microprocessors
- Amplifiers
- Electric/smart meters
- Other smart communication technology

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Power Grid Corporation of India Saudamini, Plot No 2 Sector 29, Near IFFCO Chowk Gurgaon , Haryana India +91 125 2571700 tcsarmah@powergridindia.com https://www.powergridindia.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan tmadhusudanan@ustda.gov</p> <p>USTDA U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Aileen Crowe Nandi office.newdelhi@trade.gov</p>

Kerala TransGrid 2.0		
	SECTOR	Energy
	SUBSECTOR	Electric Power
	LOCATION	Kerala
	PROJECT VALUE	\$1.4 billion

PROJECT SUMMARY

TransGrid 2.0, a project sponsored by the Kerala State Electricity Board (KSEB), is intended to upgrade the state’s electric power transmission system to facilitate intrastate power distribution. Facing rising electric power consumption, KSEB desires to create a transmission system capable of meeting demand in any part of the network without overloads or other constraints, in compliance with the “24 X 7 Power for All” mandate of the Indian Government. TransGrid 2.0 is a two-phase project with a total cost of \$1.4 billion. The project is underway, but bids on future works packages present opportunity.

PROJECT DESCRIPTION

Kerala imports approximately 70 percent of its electric power from outside the state, necessitating an intricate intrastate power transmission network. The state’s daily peak-hour demand is expected to rise substantially over the next 15 years (*Table 1*), stressing the already complex system. TransGrid 2.0 is the planned solution to manage both greater power delivery coming into the state from outside and its distribution across Kerala. The project will add five new 400kV substations, roughly twenty-five 220kV substations, and associated transmission lines.

Table 1: Kerala Electric Power Demand / Supply Shortfalls, 2017-2032 (MW)¹¹⁸

Period	Daily Peak Hour Demand	New Supply Required
2017-18	4,900	2,000
2022-23	6,398	4,000
2032	12,000	8,000

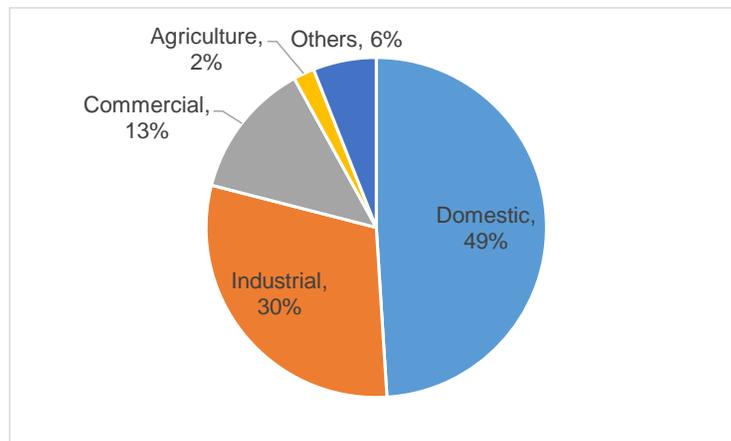
¹¹⁸ 18th Electric Power Survey of India

National policy, including the Electricity Act of 2003, has put emphasis on the development of an Indian electric power transmission sector supported by adequate and timely investments. According to the regulations, investments must be based on efficient and coordinated action plans to ensure a robust and integrated power system. Further, any transmission system is expected to be capable of meeting the demand in any part of its network without overloading or creating constraints elsewhere, even under contingency conditions. The intent is to provide secure, reliable, efficient, and economical electricity under all circumstances.

The Kerala state government, as a result, began planning and developing an upgraded transmission network that became TransGrid 2.0. The objective is to create an efficient pathway to meet the challenges posed by greater power evacuation from the proposed high capacity Inter-State Transmission System (ISTS) and its transfer into and throughout the State of Kerala.

Kerala is densely populated. The entire state can be considered an extended metropolitan area for the purposes of transmission planning. In fact, in Kerala, domestic power demand accounts for almost 50 percent of consumption (*Figure 1*).

*Figure 1: Kerala Electric Power Demand Segmentation*¹¹⁹



Kerala’s demographics pose significant right-of-way (ROW) issues. To minimize these, TransGrid 2.0 plans to embrace the latest technological innovations, including innovative business models and alternative construction methods. Newer technologies, such as monopoles, sleek towers, and digitization, offer the ability to enhance system reliability and security with minimum disturbance to the public and the environment. A green vision for better energy management through a reduction in system losses is expected.

TransGrid 2.0 has already begun (*Figure 2*). The project is being implemented in sections, having begun in 2016. TransGrid 2.0 aims to scale and improve the intrastate power transmission network with five new 400kV substations, approximately 25 220kV substations, and several new transmission lines across 26 locations.

¹¹⁹ Electrical India

TransGrid 2.0 is being implemented in two phases. Except where noted, the packages listed for each of the two will be forthcoming for bid:

Phase 1: 2016 - 2021

- ***Ernad Special Line (ESL) Package (Partially Executed)***
 - Upgrade existing 220/220 kV SC line to 400/220 kV multi-circuit multi-voltage (MCMV) line
 - Upgrade existing 110 kV DC line/220 kV SC line to 220/110 kV MCMV line to take 220 kV circuits to existing 220 kV substation
 - Install MCMV narrow-base tower to connect several substations in the city and suburbs
 - An award of \$54.35 million to L&T Construction Limited was made in 2018 to install advanced MCMV technology
- ***HTLS Northern Region Package (Recently completed)***
 - Upgrade existing 66 kV line to 110 kV DC line using special poles, insulated cross arms and high-temperature/low sag (HTLS) lines
- ***Kolathunadu Lines Strengthening (KLS) Package* (Bids Invited – see below)***
 - Upgrade of 110 kV line to 220/110 MCMV line.
- ***Kochi Lines Package (KTL)***
 - Upgrade of 66 kV S/C line to 220/110 kV MCMV.
- ***North Malabar Lines (NML) Package* (Bids Invited – see below)***
 - Upgrade 110 kV DC line to 220 kV MCMV and line in/line out (LILO) to 220 kV at Kakkayam HEP substation
- ***North-South Interlink (NSI) Package* (Bids Invited – see below)***
 - Upgrade 66 kV line to 220 kV MCMV line and construct 220 kV DC line
- ***Sabari Lines Package (STL)***
 - Upgrade 110 kV DC feeder to 220/110 kV using MCMV towers
- ***Thiru-Kochi 400 kV Lines (TKL400) (to be tendered)***
 - Construction of 400 kV line by upgrading 110 kV SC line to 400 kV using 400/110 kV MCMV towers
- ***Travancore Lines Package (TVL (1)) (to be tendered)***
 - Upgrade Kottiyam-Kollam, Kundara-Sathamkotta, Attingal-Palode lines

For packages identified above as “Bids Invited – see below” -- Larsen & Toubro Limited (L&T) and Sterlite Power Transmission Limited have been shortlisted as technically qualified for implementation of the Kolathunadu Lines Strengthening (KLS), North Malabar Lines (NML) and North-South Interlink (NSI) Packages. Bids for these packages were invited in August 2018.

Phase II: 2019- 2023

- ***Kochi Lines Package (KTL) (to be tendered)***
 - Double 220kV S/C line to 400/220 kV DC
 - Upgrade Vaikom-Thykattussery-Eramallur lines
 - Upgrade Aluva-Edayar-North Paravur lines
- ***Thrissivaperur Line Strengthening (TLS) Package (Previously Bid – yet to be awarded)***

- Upgrade 66 kV ROW C to 220/110 kV line in the existing LILO from meter data management repository (MDM/R) line
- **Substation Development for Travancore Lines (TVL (2)) (Package to be tendered)**
 - Construct S/C 110 kV feeder from 110 kV substation
 - Kottiyam substation upgrade to 110 kV global geographic information system (GIS)
 - Kollam substation upgrade to HTLS conductor using Monopoles/underground (UG) cable
 - Interlink both substations to provide backup failure support for Kundara substation
 - Upgrade Kundara-Sasthamkotta and Attingal-Palode substations
- **Valluvanad Special Lines (VSL) (Package to be tendered)**
 - Upgrade 110 kV SC line to 220/110 kV DC line and 220/110 kV line

Participants selected for the project will undertake the following, consistent with the needs of their awarded package(s):

- Design, engineering, manufacturing, construction, and erection of substations and multi-circuit lines
- Testing and commissioning, as well as any necessary dismantling of existing conductor earthwire, towers, and accessories
- Design, manufacture, erection, testing, and supply of towers and aluminum conductor steel reinforced (ACSR) conductor
- Conversion of 220 kV DC line to multi-circuit and double circuit up to the proposed substation
- Design, manufacture, testing, supply, and stringing of optical ground wire (OPGW) with all accessories
- Design, manufacture, testing, and supply of high temperature/low sag (HTLS)/composite core (CC) conductor
- Supply of spares per specification
- Other allied works per the tower schedule/design provided by KSEB
- Technical support and training for KSEB staff and officers for operations and maintenance (OM) of the line
- Emergency Restoration Service (ERS) as required

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Kerala TransGrid 2.0 project is already being implemented. All necessary government approvals and environmental clearances are in place.

Sections have been awarded for parts of Phase I and much of Phase II. The balance will be available for bid from 2019 forward.

The main works are expected to be completed by 2023. The completion period for each package ranges from 18-24 months.

Power Grid Corporation of India Limited (PGCIL) has been involved as a Project Management Agency for the implementation of TransGrid 2.0.

PROJECT COST AND FINANCING

TransGrid 2.0 total project cost is \$1.41 billion.

The Kerala Infrastructure Investment Fund Board (KIIFB) is funding \$764 million of the total. KIIFB has been structured to act as a Special Purpose Vehicle (SPV). It will mobilize and channel funds to the various subprojects, which will also use the SPV approach.

KSEB is in discussion with the Power System Development Fund (PSDF), the Ministry of New and Renewable Energy (MNRE), and the Ministry of Power and Rural Electrification Corporation Limited (REC) for debt financing for the remainder. A decision with regard to future funding is expected to be taken in the next few months.

U.S. EXPORT OPPORTUNITIES

To participate in TransGrid 2.0., U.S. companies will work under the direction of primary contractors. Opportunities exist to support design, equipment supply, testing, and operations and maintenance (O&M). Specific opportunities are expected to include the following:

- Design, manufacture, testing, and supply of:
 - Substation packages
 - HTLS/Composite Core-type conductors for 110kV or higher voltage level
- Supply and installation of:
 - Tele-protection and optical networking equipment for 400/220/110 kV substations
 - Stringing and tensioning equipment including re-stringing/stringing works
- Civil survey and measuring/testing equipment
- Operations and maintenance contracts
- Provision of componentry
 - Electric transmission lines
 - Towers and allied electrical equipment including transformers
 - Fixed capacitors
 - Fuses for electrical apparatus
 - Lightning arrestors
 - Voltage limiters
 - Electric conductors
 - Microprocessors
 - Amplifiers

- Electric/smart meters
- Other smart communication technology

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Kerala State Electricity Board (KSEB) Vidyuthi Bhavanam Pattom Thiruvananthapuram 695004 Kerala India +91 471 2446480 https://www.kseb.com	Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan tmadhusudanan@ustda.gov U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Brenda VanHorn office.mumbai@trade.gov

Mumbai Harbor FSRU LNG Terminal		
	SECTOR	Energy
	SUBSECTOR	Oil and Gas
	LOCATION	Mumbai
	PROJECT VALUE	\$395 million

PROJECT SUMMARY

Mumbai Port Trust (MbPT) is undertaking a five million metric ton per annum (MTPA) floating storage and regasification (FSRU) LNG terminal project in Mumbai Harbor (Maharashtra State). The project will be a public-private partnership (PPP) with a concession period of 30 years. The project value (\$395 million) excludes the vessel cost.

PROJECT DESCRIPTION

The Government of India has announced plans to raise the share of natural gas in India’s energy mix from 6 percent in 2016 to 15 percent by 2022. Currently, half of India’s supply of natural gas comes from domestic production, while the other half comes from LNG imports. Rising demand creates a desire to achieve a 30 percent domestic/70 percent imported LNG supply mix by 2025. Anticipating future demand, India has broadened its international supply base and negotiated long-term LNG supply contracts.

A challenge in meeting the 2025 supply goal is building sufficient gas infrastructure to receive LNG shipments, regasify, and then distribute the gas across a wide geographic area. Currently, India has four operating LNG terminals located on its western coast, with several more coming onstream. LNG terminals can be either land- or water-based, with the latter commonly known as floating LNG (FLNG).

The components of an FLNG project are:

- Gas production facilities
- Baseload liquefaction plant with storage and export facilities
- LNG tanker ships (transportation)
- Import terminal with storage regasification unit(s) (SRU)

The Indian Ministry of Shipping has issued guidelines for setting up floating storage regasification units (FSRU) for handling liquefied natural gas (LNG) cargo at major ports. The policy lays down

investment structure options for private investors to incentivize a shift in focus from land-based LNG storage terminals to offshore terminals, as the construction cost of the latter is roughly half and timing shorter. Land-based LNG terminals at major ports entail lease of waterfront, while offshore storage ships (*Figure 1*) with onboard regasification plants can be moored and linked directly to a gas pipeline network. This provides a faster, more cost-efficient way of increasing total LNG storage capacity.

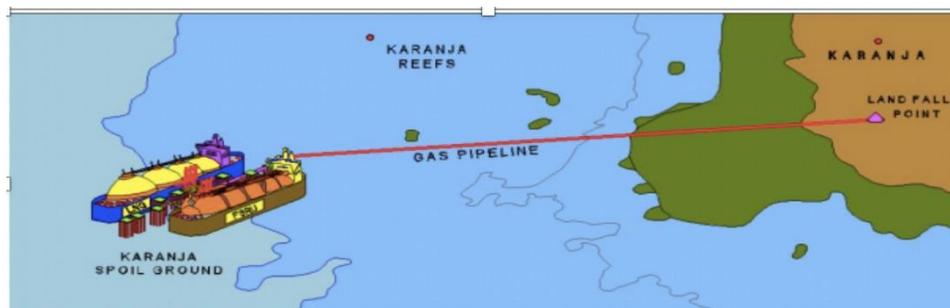
*Figure 1: Floating LNG Storage*¹²⁰



The speed at which LNG storage is built is critical if India is to meet its target of increasing natural gas use by two-and-a-half times by 2030. Then, natural gas is expected to make up 15 percent of the country's energy consumption. To meet this estimated volume, an LNG storage capacity of 47.5 million tons will be required, almost double that currently available.

There is a growing demand for natural gas along India's western coast. Mumbai Port Trust (MbPT) is implementing a Floating Storage and Regasification Unit (FSRU) with a capacity of 5 million tonnes per annum of LNG to be sited in the Mumbai Harbor area (*Figure 2*).

*Figure 2: FSRU Terminal with Submarine Pipeline to Landfall*¹²¹



¹²⁰ Vancouverobserver.com

¹²¹ Master Plan for Mumbai Port by AECOM

The project will be a public-private partnership (PPP) with a 30-year concession period. The terminal is to be connected to the national pipeline grid, so natural gas can be transported as far away as Panipat in Haryana.

The scope of the MbPT FSRU project includes discharge of LNG, re-gasification, storage for the required period, and supply/transportation as described below:

Berthing structure: overall length of 348 m and width of 69 m; shipside water depth of -15.0 meters and an approach channel depth of -13.5 meters with 6 nos. mooring dolphins, 8 nos. berthing dolphins, and one-service platform resting on cast-in-situ piles

Berth segments: each to be fixed with fenders, quick release mooring hooks, and other necessary fixtures required for berthing and mooring the LNG carrier and FSRU vessel

Superstructure: monolithic beam-slab framed structure with piles to support the berth

Advanced communication/security & surveillance/firefighting system: to ensure efficient operation and management, as well as safety

LNG carrier vessel: capacity of 216,000 m³ to be berthed at one side of the jetty

FSRU vessel: storage capacity of 176,000 m³ to be moored on the other side of the jetty; located approximately 7 km from landfall point

Dedicated marine loading arms: number of arms matched to unloading capacity; located on the unloading platform of the jetty to pump refrigerated LNG from carrier (shuttle tanker)

LNG storage: LNG received at the FSRU will be stored in the tanks within the FSRU

LNG transit: stored LNG will be passed through the regasification facility, then through the conditioning and metering section, and finally through the dedicated loading arm to the unloading platform; from there, a dedicated riser will take the gas through the submarine pipeline

Submarine pipeline: connected to existing concession (ONGC/Gail) at a landfall point

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Terms of Reference (ToR) for the project were developed in 2015 by MbPT. Coastal Regulation Zone (CRZ) and other environmental clearances were received in 2017. Requests for Proposal (RFPs) for project implementation are now in-process. The closing date for submissions is November 5, 2019 (extended from July 2019). Once the prime contractor is appointed, the development of subcontracting and equipment and services supply contracts will begin. The

project is likely to be fast-tracked once the bid closes, as all clearances are in place. The project is scheduled to be completed 36 months after contract award.

PROJECT COST AND FINANCING

The cost of the project is \$395 million, excluding the vessel's cost. The project is structured as a public-private partnership (PPP).

Mumbai Port Trust will enter into a 30-year concession arrangement with the private partner who will be responsible for setting up, operating, and maintaining the FSRU. The private partner will be the prime contractor for all subcontracts and vendor management.

According to Indian guidelines, a Land License model is to be followed with a single-stage e-tender for implementing FSRUs with private funds. Per the guidelines, projects will not be bound by any minimum guaranteed throughput (MGT) until five years after Commercial Operations Date (COD). Thereafter, 30 percent of the project capacity will be MGT.

U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. firms will exist during the detailed design, construction, and operation phases of the project. These include:

- Systems and detailed engineering design services
- Condensing equipment and feed
- Uploading and return arm design and equipment
- LNG regasification facilities (onshore and offshore)
- Tanks and floater vessels design and supply
- Containment systems and storage tanks architecture
- Vaporizers
- High precision metering and associated equipment
- Berthing and unloading design and equipment
- Facilities design
- Operation and Maintenance (O&M) services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Paradip-Somnathpur (Balasore)-Haldia Pipeline		
	SECTOR	Energy
	SUBSECTOR	Oil & Gas Development
	LOCATION	Paradip and Balasore (Odisha), Haldi (West Bengal)
	PROJECT VALUE	\$196 million

PROJECT SUMMARY

This Indian Oil Corporation (IOCL) pipeline project is located in eastern states of India and services a 15 million metric tons per annum (MMTA), INDMAX technology, high-sulfur, heavy crude oil refinery commissioned in 2016. IOCL will lay an 18 inch, 344-km pipeline from Paradip (Odisha) to Haldia (West Bengal) via Somnathpur (in Balasore, Orissa).

PROJECT DESCRIPTION

India’s petroleum products demand in 2018 to 2019 was 211.6 million metric tons, growing 2.7 percent over 2017-18. Gasoline, diesel, and LPG demand increased by 8.1 percent, 5 percent, and 6.8 percent, respectively, in the same period. India’s refining capacity stood at 249.4 million metric tons per annum (MMTA) at the end of 2018-19, which is the second-largest in Asia.

Indian Oil Corporation Limited (IOCL) is a Government of India public sector undertaking (PSU). IOCL is a global Fortune 500 company that engages in refining, transportation, and marketing of petroleum products across India. IOCL’s Pipelines Division owns and operates more than 14,500km of pipeline networks.

Paradip is IOCL’s eleventh and most-modern refinery with a complexity factor of 10.7, based on the Nelson Index. The refinery uses domestically-sourced INDMAX technology developed by IOCL’s R&D Center. INDMAX can produce 44.15 percent LPG, the highest yield achievable from the refinery type. Paradip is a milestone in Indian refining and positions IOCL as a global technology licensor.

The refinery has a design capacity of 4.17 MMTA. The Paradip refinery can process 100 percent high-sulfur and heavy crude oil to produce various petroleum products, including:

- Petrol and diesel of BS-IV quality
- Kerosene
- Aviation turbine fuel
- Propylene

- Sulfur
- Petroleum coke

Figure 1: Paradip Refinery and Pipeline Rendering¹²²



The Paradip refinery is also designed to produce Euro-V premium-quality motor spirit and other green auto fuel variants for export.

To service the Paradip refinery and as a part of a proposed pipeline system, IOCL intends to build new LPG and product cross-country pipelines from Paradip (pump station) to Haldia via the Somnathpur terminal, a run of 344Km. In addition, IOCL will build adjacent pipelines across rivers via horizontal drilling. The Paradip-Somnathpur-Haldia Pipeline (PSHPL) product pipeline is for the transport of HSD (high-speed diesel), motor spirits, and kerosene. The pipeline will incorporate various pumping and delivery stations, operating and control systems, cathodic protection, and other features typical of a pipeline system.

The PSHPL project will be segmented into three groups (*Table 1*). Each run will utilize 18” OD x 0.250” WT API 5L X-70 nominal mainline pipe. The project involves the installation of this 18” pipeline across major rivers employing horizontal directional drilling (HDD).

The Project Group specifications require pipeline installation civil, mechanical and electrical engineering services and equipment, telecommunications, and instrumentation to be present at existing Sectionalizing Valve (SV) PHDPL/PHCPL locations and at new SV stations. Bidders may choose to bid for one or all the Groups. Consortiums may also be formed for the project groups.

¹²² IOCL

Table 1: PSHPL Project Groups¹²³

Group	Mainline Stretch (From/To)	State	Associated Stations	Mainline Length, Km (approx.)
A	Paradip to Kansana Bansa River Crossing (~ Ch.123km)	Odisha	Paradip Pumping Existing SV Stations of PHDPL/PHCPL (2 No.) New SV Station (8 No.)	123
B	Kansana Bansa River Crossing (Ch. 123km) to Odisha, West Bengal Border (Ch. 248 km)	Odisha	Existing SV Stations of PHDPL/PHCPL (1 No.) New SV Station (3 No.) Somnathpur Delivery Station	125
C	Odisha, West Bengal Border (Ch. 248km) to Haldia (Ch.344 km)	West Bengal	Existing SV Stations of PHDPL/PHCPL (2 No.) New SV Stations (2 No.) Haldia Station	96

The summarized scope of work includes:

- **Basic Engineering**
 - Preparation of process package & optimization studies
 - Development of equipment and electrical/instrumentation data sheets
 - Pipeline system operation and control manuals
 - Preparation of conceptual designs for Supervisory Control and Data Acquisition (SCADA)
 - Conducting detailed route surveys
- **Detailed Engineering, Inspecting, Monitoring and Project Construction Supervision**
 - Site construction supervision services up to mechanical completion
 - Pre-commissioning and commissioning assistance

The project will comply with the provisions of the Petroleum and Natural Gas Regulatory Board (PNGRB) regulations, including Authorizing Entities to Lay, Build, Operate or Expand Petroleum and Petroleum Products Pipelines Regulations, 2010 and other relevant regulations for technical standards and specifications. As well, safety standards and additional regulations as applicable, including the provisions of the PNGRB Act, 2006, must be met.

¹²³ Ibid

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The project received approval in April 2018. Subsequently, financial studies, environmental impact assessments (EIA), and risk assessments (RA) were conducted. The IOCL board then approved a project investment of \$196 million.

The scope of work for laying API 5L grade X-70 pipelines is divided into three packages:

- **Group A** – total length 123km
 - Paradip to Kansana Bansa river crossing (approximate chainage 123 km)
- **Group B** – total length 125km
 - Kansana Bansa river crossing (chainage 123 km) to Odisha/West Bengal border (chainage 248 km)
- **Group C** – total length 96km
 - Odisha/West Bengal border (chainage 248 km) to Haldia (chainage 344 km)

Bids for the project were invited in September 2019, with likely bid closure in November 2019. Subsequent to the appointment of the prime contractors, IOCL will select/approve sub-contractors and vendors for equipment and services. The project is expected to be commissioned by the end of 2021.

PROJECT COST AND FINANCING

The expected project cost is \$196 million. IOCL is sponsoring the project and will retain 100 percent equity ownership.

The local content (LC) clause must be met by the contractor, ensuring adequate domestic sourcing/supply of material and supplies (see Annex). The balance may be acquired from foreign sources.

Rate schedules are also specified by IOCL for certain items and services, with which the contractor must comply.

U.S. EXPORT OPPORTUNITIES

For this project, IOCL will follow LC regulations (see Annex) for upstream EPC projects. Component-wise, the import content will be approximately:

- Tubulars and drilling services – 40-50 percent
- Machinery and equipment, premium bits, wetheads, logging services - 70-80 percent

This project is one of the many new planned pipelines by IOCL. Entry into this project and becoming a registered supplier to IOCL may create additional opportunities.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Raniganj (South) CBM Block Expansion		
	SECTOR	Energy
	SUBSECTOR	Oil & Gas
	LOCATION	Raniganj, West Bengal, India
	PROJECT VALUE	\$3.97 billion

PROJECT SUMMARY

The Raniganj South Block in West Bengal, India, has estimated in-place shale gas reserves of 6.13 trillion cubic feet (TCF), of which about 1.7 TCF can be recovered. This project involves the drilling of 400 shale and 150 coal bed methane (CBM) wells to depths of 3,000 meters and 1,500 meters, respectively. In addition, the project will require the construction of five gas-gathering stations (GGS) and five central gas stations (CGS) with associated infrastructure. The project is being undertaken by Great Eastern Energy Corporation Limited (GEECL).

PROJECT DESCRIPTION

CBM, an unconventional source of natural gas, is now considered an alternative source for augmenting India’s energy resources. India has the fifth-largest proven coal reserves in the world, holding significant prospects for exploration and production of CBM. The resources in India are estimated at 92 TCF, spread across twelve Indian states. To harness CBM potential, the Government of India formulated a policy in 1997, enabling exploitation of these resources under the provisions of several longstanding regulations administered by the Ministry of Petroleum & Natural Gas (MoP&NG).

New government policy initiatives have been undertaken to improve the viability and implementation of CBM projects. In 2016, a new Hydrocarbon Exploration and Licensing Policy (HELP) replaced the earlier New Exploration Policy (NELP). HELP provides for simpler rules, tax breaks, pricing, and marketing freedom, along with a revenue-sharing model that is part of a government strategy to double oil and gas output by 2022-2023. In the revenue sharing model, the government will receive a share of the gross revenue from the sale of oil and gas, but will not be concerned with the costs incurred. HELP will enable a faster coverage of targeted geographic areas. Under NELP, the exploration of hydrocarbons was limited only to blocks put to tender by the government. In 2017, a further policy framework for early monetization of CBM projects was issued to allow for pricing and marketing freedom for contractors through arms-length pricing in the domestic market.

To exploit the full potential of CBM in India, the Directorate General of Hydrocarbons (DGH), in close interaction with the Ministry of Coal (MoC) and the Central Mine Planning and Design Institute (CMPDI), carved out CBM blocks. Select CBM blocks have been awarded through Open Acreage Licensing Policy (OALP) bid rounds (*Figure 1*).

Figure 1: Indian CBM Blocks¹²⁴

Block Name	Consortium	Area (km ²)	Recoverable Reserves (TCF)
RG(E) -CBM-2001/1	EOL (100)	500	0.99
SPW(W) -CBM-2001/1	RIL (100)	500	0.67
Raniganj South	GEECL (100)	210	1.34
SP(E)-CBM-2001/1	RIL (100)	495	0.59
BK-CBM-2001/1	ONGC (80) - IOC(20)	95	0.13
Jharia	ONGC (90) - IL (10)	85	0.11
NK-CBM-2001/1	ONGC (55) - IOC (10) - PEPL(25)	340	0.05
Raniganj North	ONGC(74) - CIL(26)	350	0.07
	TOTAL	2575	3.95

Note: bold is operator

Commercial production of CBM at CBM Block Raniganj (South) began in July 2007 under the operations of GEECL. Currently, there are 3 producing CBM blocks:

- Raniganj (South) operated by Great Eastern Corporation Ltd (GEECL)
- Raniganj (East) operated by Essar Oil & Gas Exploration & Production Limited (EOGEPL)
- Sohagpur (West) operated by Reliance India Ltd.(RIL)

In addition, there is incidental CBM gas being produced in testing wells:

- Jharia block operated by the Oil and Natural Gas Company Limited (ONGC)
- Sohagpur (East) operated by RIL

London-listed Indian CBM producer, GEECL, proposed expanding its exploration and production activities at its flagship Raniganj (South) Coal Bed Methane (CBM) block in West Bengal with a project estimated to cost \$3.97 billion. This project will include both new CBM and shale gas production.

New investments planned under this project include:

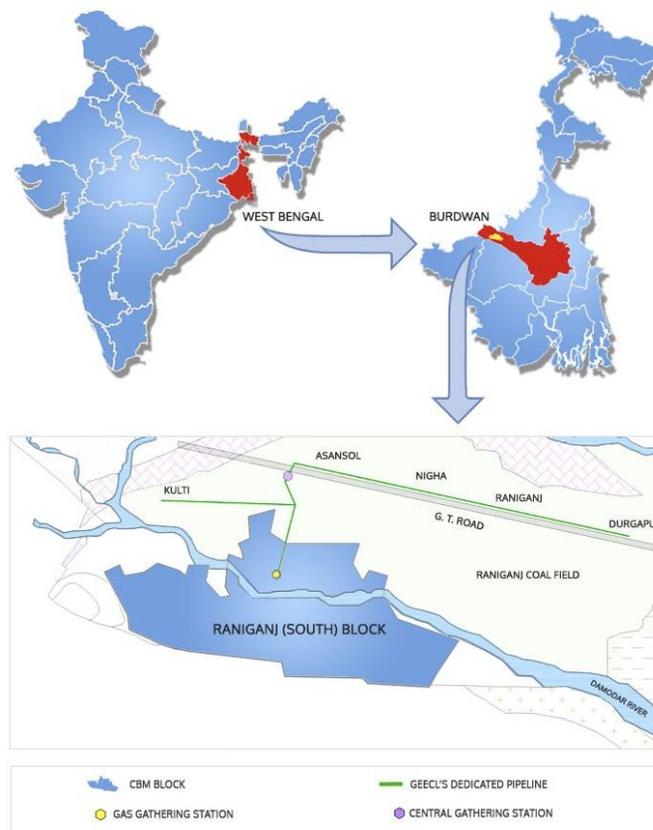
- Drilling 400 shale wells
- Drilling 150 CBM wells
- Constructing as many as five Gas Gathering Stations (GGS)

¹²⁴ Directorate General of Hydrocarbons

- Constructing as many as five Central Gas Stations (CGS)
- Development of allied infrastructure at its block in West Bengal

GEECL's Raniganj (South) block license covers 210 sq. km (52,500 acres) (*Figure 2*). A 5-well cluster pattern will be followed for drilling the wells. An internal MDPE pipeline network going into the Gas Gathering Station connects the wells and then feeds gas into the dedicated external steel pipeline network. GEECL intends to drill CBM wells to a depth of 1,500 meters and shale wells as deep as 3,000 meters. Typically drilling a CBM well requires 8-10 days, whereas drilling a shale gas well requires twice that time. GEECL expects to invest \$2 billion over 10 years in this block.

*Figure 2: Raniganj (South) Block*¹²⁵



Specific work for this project includes:

- Drilling vertical and inclined wells
- Casing and cementation
- Logging
- Sand jet perforation
- Hydro-fracturing

¹²⁵ GEECL website

- Well completion with appropriate lift pumps
- Creation of GCSs
- Installation of Early Production System (EPS)
- Laying of comingled CS/HDPE pipelines for gas and HDPE pipelines for water
- Bringing wells to production following Good International Petroleum Industry Practices (GIPIP) and sound health, safety, and environment (HSE) practices.

GEECL's Raniganj (South) block has similarities to the Black-Warrior basin in the United States, where multiple coal seams with significant gas content and favorable permeability account for high productivity. CBM wells are not significantly different from other gas wells, with the exception that conventional wells typically begin production with high gas/water ratios (GWR) that decrease with time, whereas CBM wells start with low GWRs that increase with time.

This project is an expansion of GEECL's already successfully drilled 156 wells. Upstream and midstream assets are located at the block site, while downstream activities are aided by proximity to West Bengal's large and growing industrial center, where GEECL enjoys multiple contracts with large and medium industrial customers.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

On May 22, 2019, a proposal for approval of the Terms of Reference (ToR) for the project was submitted to the Ministry of Environment, Forest and Climate Change (MoEFCC). This was consistent with policy frameworks already in place and is an expansion of GEECL's wells already operating in the area.

In June 2019, GEECL started its expansion planning, which includes drilling core wells during the first half of 2020, to be followed by the drilling of pilot production wells. The field development plan will then be detailed by the end of 2020. Overall project development is expected to extend through the next decade.

PROJECT COST AND FINANCING

The estimated project cost is \$3.97 billion. GEECL is the 100 percent equity stakeholder in the project. GEECL will be the prime contractor and will manage all sub-contracts, securing services and supplies for the project during the construction and operations phases. Investments in drilling, extraction, and transportation will be phased-in over a decade.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include:

- Design and engineering services

- Supply of equipment related to gas estimations
- Drilling
- Safety and maintenance services

Technology-specific export opportunities exist in:

- Coring system design
- Manifold and flowline design/definition
- Cleat system design
- Stimulation design and modeling

Equipment and material supply opportunities will exist for:

- Water-based drilling fluids
- Air/gas drilling chemical
- Variable-depth drilling rigs and associated equipment (e.g., rotary drilling rigs, mining rigs, coiled-tubing drilling units, modified completion rigs)
- Air compressors and boosters
- Blowout preventers
- Rotating heads
- Drill pipes
- Wireline-coring equipment
- High-end pressure coring equipment
- Hydraulics
- Componentry including pipe, bridge plugs, Frac baffles, sealers,
- Fluid entry survey equipment

With two allocated blocks, one in Raniganj at West Bengal and another at Mannargudi at Tamil Nadu, GEECL has played an important role in producing CBM gas in India. This project alone is large and long-term with numerous supply needs. GEECL also has plans for CBM exploration beyond this field in other regions. Thus, a reliable service or equipment supplier may have access to numerous additional opportunities both near and long term.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Western Region Strengthening Scheme WRSS XXI		
	SECTOR	Energy
	SUBSECTOR	Electricity Transmission and Distribution
	LOCATION	Gujarat and Maharashtra
	PROJECT VALUE	\$789 million

PROJECT SUMMARY

The Western Region Strengthening Scheme (WRSS) XXI project is an electric power transmission system for the 10.5 gigawatts (GW) of renewable energy being generated from new solar (7.5GW) and wind (3GW) energy zones in the states of Gujarat and Maharashtra:

- **Gujarat**
 - Wind: Bhuj II (2000 MW); Lakadia (2000 MW); Dwarka (1500 MW)
 - Solar: Lakadia (2000 MW)
- **Maharashtra**
 - Wind: Osmanabad (2000MW)
 - Solar: Solapur (1000 MW)

In addition to transmitting new renewable energy, the transmission lines will also help transmit power from the existing 6 GW of wind power projects in Gujarat (Bhuj/Bhachau), bringing the total transmission capacity to 16.5 GW.

The Ministry of Power (MoP) has appointed bid process coordinators (BPC) for the selection of transmission service providers (TSP).

PROJECT DESCRIPTION

The Government of India has announced several energy initiatives aimed at building power generation capacity, promoting energy efficiency, and increasing clean energy sources in the country’s overall power mix. India is the fifth largest electric energy producer in the world, and the country’s energy demand grew by four percent in 2018, outpacing global demand growth of 2.3 percent¹²⁶. The new generation capacity must be supported by transmission infrastructure to economically and safely deliver this power to consumers, as envisioned in this project.

¹²⁶ International Energy Agency

The Government of India (GoI) has set a target for developing 175 GW of Renewable Energy (RE) capacity by 2022. Of this target, 83 GW has already been commissioned, approximately 29 GW is under installation, and about 30GW is currently being tendered.

The Solar Energy Corporation of India (SECI), in association with the Ministry of Renewable Energy (MNRE) and renewable energy power developers, has identified Solar-Energy-Rich Zones (SEZs) and Wind-Energy-Rich Zones (WEZs). These zones exist in seven RE-rich states:

- Andhra Pradesh
- Gujarat
- Karnataka
- Maharashtra
- Madhya Pradesh
- Rajasthan
- Tamil Nadu

In an order dated June 8, 2018, MNRE established a sub-committee to identify Inter-State Transmission System (ISTS) connectivity of about 50 GW for renewable energy projects from the potential SEZs and WEZs identified above. In Gujarat and Maharashtra, this project serves as the implementation vehicle and will be executed in two phases:

- Phase I (through Dec 2020)
 - 20 GW solar energy
 - 9 GW wind energy
 - 10.5 GW new generation and 6 GW of existing generation included
- Phase II (through Dec 2021)
 - 30 GW solar energy
 - 7.5 GW wind energy

The WRSS XXI project is slated to install a power transmission system for new potential SEZs and WEZs in the Western Region, totaling 10.5 GW of RE plus 6.5 GW of existing generation (i.e., Phase 1 of the project). The estimated cost of the project is \$789 million. Resulting annual transmission charges are estimated at \$134 million. WRSS XXI is designed to help meet India's long-range energy security, sustainability, and climate goals at affordable prices.

Maps of the SEZ and WEZ transmission schemes for Gujarat and Maharashtra under WRSS XXI are provided below (*Figures 1 and 2, respectively*).

The National Committee on Transmission (NCT) has recommended the use of tariff-based competitive bidding (TBCB) on a build-own-operate-maintain (BOOM) platform for this project.

Figure 1: Gujarat SEZ and WEZ Transmission Scheme¹²⁷

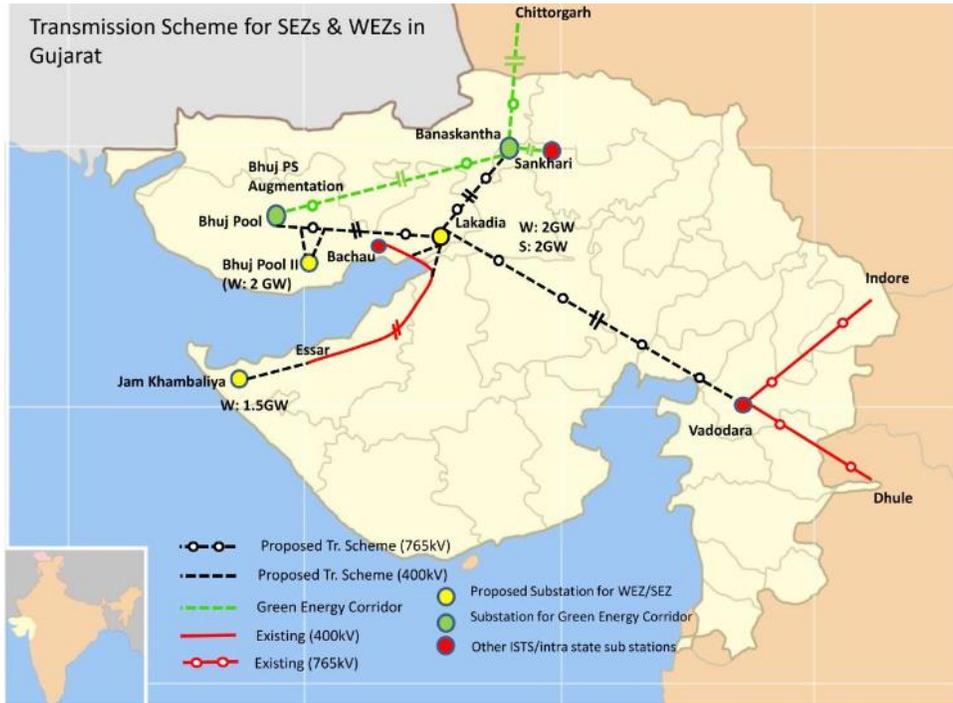
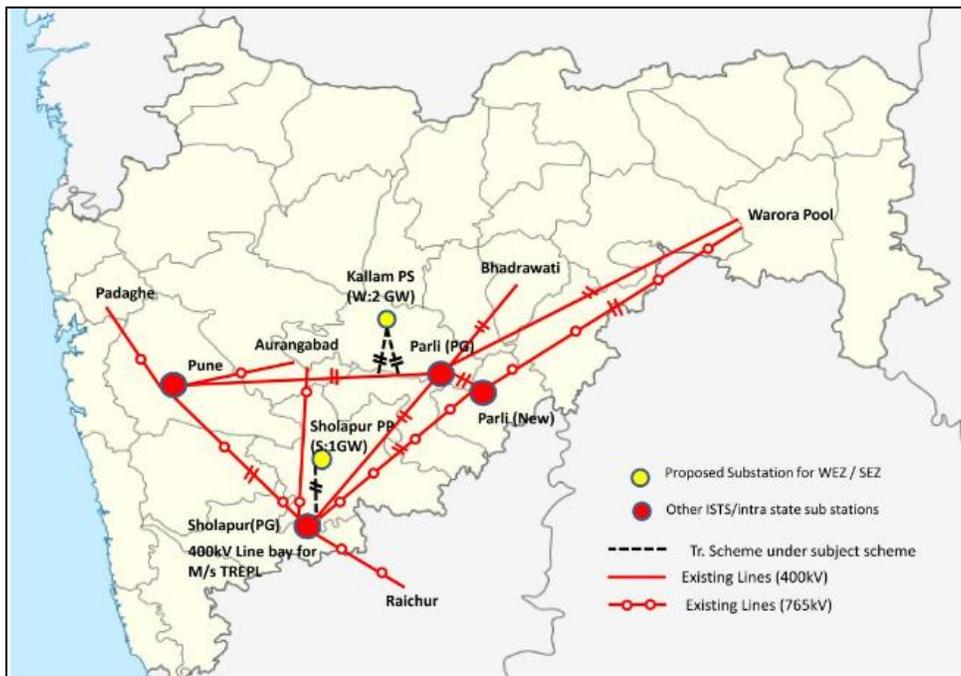


Figure 2: Maharashtra SEZ and WEZ Transmission Scheme¹²⁸



¹²⁷ Government of India Ministry of Power

¹²⁸ Ibid

The project has been divided into the following parts (*Table 1*):

Table 1: Electricity Transmission and Distribution Project Parts

Part	Purpose	Cost (\$ million)
A	Additional 1x500 MVA 400/220 kV (9th) ICT, for injection from any additional RE project (beyond 4000 MW) at Bhuj PS	78.4
B (WRSS-21) <i>Part A</i>	Transmission System strengthening for relieving over loads in the Gujarat Intrastate system due to RE injections in Bhuj PS	122.5
C (WRSS-21) <i>Part B</i>	Transmission System strengthening for relieving overloads in Gujarat Intrastate system due to RE injections in Bhuj PS	261.0
D	Transmission system associated with RE generations at Bhuj II, Dwarka and Lakadia	150.5
E	Transmission System for providing connectivity to RE projects at Bhuj II (2000 MW) in Gujarat	90.3
F	Jam Khambhaliya PS for providing connectivity to RE projects (1500 MW) in Dwarka (Gujarat), Interconnection of Jam Khambhaliya PS for providing connectivity to RE projects (1500 MW) in Dwarka (Gujarat)	56.0
G	400 kV line bay at Solapur PS for St-II connectivity to M/s Toramba Renewable Energy Pvt. Ltd	1.4
H	Transmission System for providing connectivity to RE projects in Gujarat [Lakadia (2000MW)]	27.4
I	Transmission system associated with RE generations from potential wind energy zones in Osmanabad area of Maharashtra	42.0
J	Transmission system associated with RE generations from potential Solar Energy Zone in Maharashtra (1000 MW under Ph-I)	30.8

The scope of work for the Transmission Service Provider (TSP) involves the following:

- Establish, operate and maintain the project and completion of all activities for the project, including survey and detailed project report (DPR) formulation;
- Arrange financing;
- Provide project management;
- Obtain necessary consents, clearances, and permits (e.g., wayleave, environment and forest, civil aviation, railway/road/river/canal/power crossing/PTCC);
- Manage design and engineering services;
- Procure equipment and material supplies; and
- Oversee construction, erection, testing, and commissioning.

Key components of the project include the development of the following:

- Pooling Stations
- Transmission Lines
- Sub Stations

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Western Region Standing Committee on Transmission (WRSCCT) approved the two-phase project in September 2018. Technical surveys and feasibility studies have been completed. Phase 1 includes Parts A-G; Phase 2 covers Parts H, I and J. Phase 1 is expected to be completed by June 2021 along the following timeline (*Table 2*):

Table 2: Phase 1 Implementation Timing

Part	Completion	Oversight
A	December 2020	RTM*
B	December 2020	TBCB**
C	December 2020	TBCB
D	June 2021	TBCB
E	December 2020	TBCB
F	June 2020	TBCB
G	December 2020	RTM

*RTM: regulated tariff management
 **TBCB: tariff-based competitive bidding

This is a greenfield project using requests for quotation (RFQs), with TSPs being selected. Successful bidders will incorporate special purpose vehicles (SPVs) for project implementation.

Bids for Parts A and B of the project were awarded in August 2019 to Adani Transmission and Sterlite Grid, for which SPVs already have been incorporated. RFQs for the remaining parts of Phase 1 is expected over the next three to 12 months.

PROJECT COST AND FINANCING

The total project cost is \$789 million. The project will be implemented through tariff-based competitive bidding (TBCB) or a regulated tariff management (RTM) process on a build-own-operate-maintain (BOOM) basis.

U.S. EXPORT OPPORTUNITIES

The project will be awarded to various TSPs/implementation parties based on bidding. U.S. companies will be required to work with primary contractors in supporting design, equipment supply, testing, and operations and management. Specific opportunities include:

- Technical knowhow
 - Design and application development for wind and solar integration systems
 - Frequency regulation systems
 - Peak management systems
 - Transmission and distribution deferral systems

- Supply of equipment and componentry
 - Electric transmission lines
 - Substations
 - Towers
 - Electrical equipment including:
 - Transformers
 - Fixed capacitors
 - Fuses for electrical apparatus
 - Lightning arrestors
 - Voltage limiters
 - Electric conductors
 - Microprocessors
 - Amplifiers
 - Electric/smart meters
 - Other smart communication technology

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Ministry of Power Central Electricity Authority Power system planning and Appraisal – 1 division Sewa Bhavan, RK Puram 1, New Delhi 110066 India Secretary cea-ppsa1@gov.in</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Tanvi Madhusudanan tmadhusudanan@ustda.gov</p> <p>USTDA U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Aileen Crowe Nandi office.newdelhi@trade.gov</p>

Bintuni Methanol Plant		
	SECTOR	Energy
	SUBSECTOR	Gas Processing; LNG
	LOCATION	Bintuni, West Papua, Indonesia
	PROJECT VALUE	\$890 million

PROJECT SUMMARY

Indonesia is planning for the construction of an 825,000 ton/year methanol production facility in the Bintuni Regency of West Papua. This plant will source piped gas from the Tangguh and Genting fields and ultimately provide Indonesia and other regional markets with the finished product. This methanol project supports the desire of the Government of Indonesia to spur investment and economic growth in markets outside of the capital area.

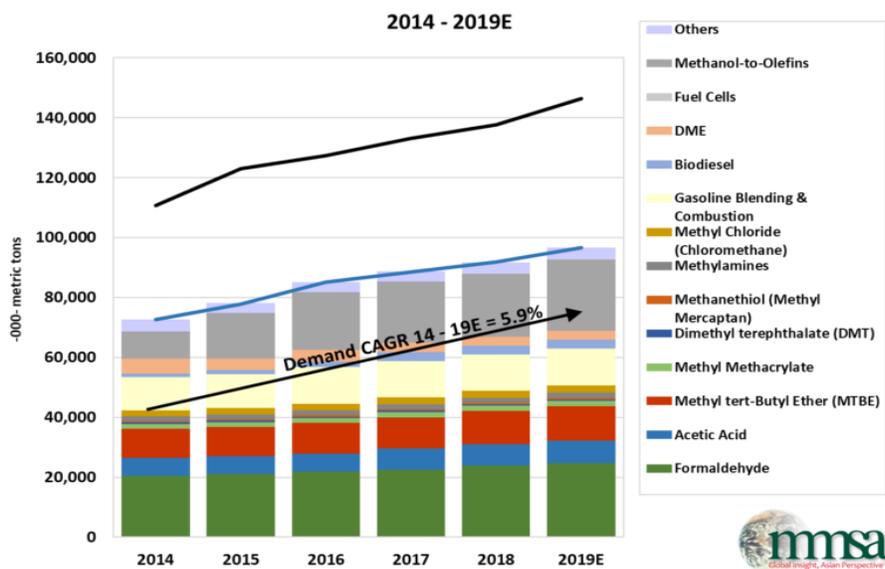
PROJECT DESCRIPTION

The global demand for methanol is rising, with a projected demand increase of five million tons in East Asia alone from 2016 to 2020 and have a global compound annual growth rate (CAGR) of 5.64 percent from 2019-2024. In the absence of new production facilities in Southeast Asia, there is a projected increase in methanol trade flow from Latin America and the Middle East into the fast-growing Indo-Pacific markets.

The Government of Indonesia determined that a methanol production facility be established to target this market, using an oversupply of domestic natural gas in West Papua. At the same time, the methanol plant will able to serve demand in the domestic market, which is not fully addressed by local production. This methanol can be used to facilitate increased production of biodiesel fuels to support the greater B30 (30 percent bio-content) and B100 (100 percent bio-content) programs underway in Indonesia, as well as serve as a feedstock for the production of other products such as polypropylene and ethylene.

The development of the Bintuni Bay Industrial Zone in West Papua, in the far eastern area of Indonesia, is being undertaken to develop infrastructure outside of Java, increase inclusive and equal economic development across the country, and take advantage of the locally available resources for advancement. The new methanol facility will serve as the anchor tenant for this Industrial Zone.

Figure 1: Global methanol supply and demand¹²⁹

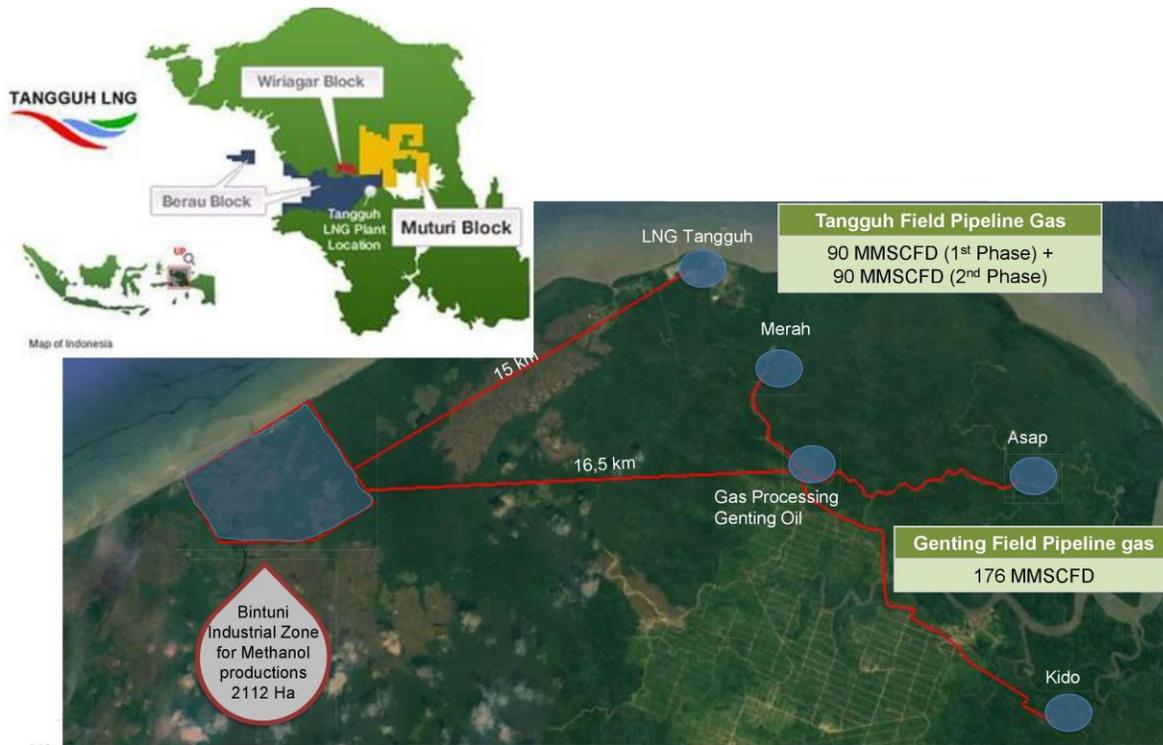


The Bintuni Methanol Plant will receive up to 180 million standard cubic feet per day (MMSCFD) of pipeline gas from the Tangguh LNG Train-3 Project, a National Strategic Project, which is nearing completion. The delivery of this gas from the field being developed by BP, in phases, with Phase 1 and Phase 2 each involving 90 MMSCFD. The LNG Train-3 Project will be operational in the last quarter of 2020, allowing the gas to be piped 15 kilometers to the site of the methanol plant once constructed. When completed, the capacity of the methanol facility is planned to be 825,000 tons per year. An additional Phase III expansion may include sourcing an additional 176 MMSCFD of pipeline gas via a 16.5-kilometer pipeline from the Genting Field, being developed by the Malaysian firm Genting Energy Ltd. (Figure 2).

The Ministry of Industry has completed a Master Plan for industrial development for the Bintuni Bay Industrial Zone. It is designed to limit environmental impacts, so that increases in industrial development will not have a detrimental effect on the environment. The gas reserves in the Bintuni Bay are estimated to be 23.8 trillion standard cubic feet, allowing for sustained growth in the petrochemical industry in this region and the feasibility of a methanol plant.

¹²⁹ Methanol Market Services, Asia

Figure 2: Bintuni Industrial Zone and Gas Sources¹³⁰



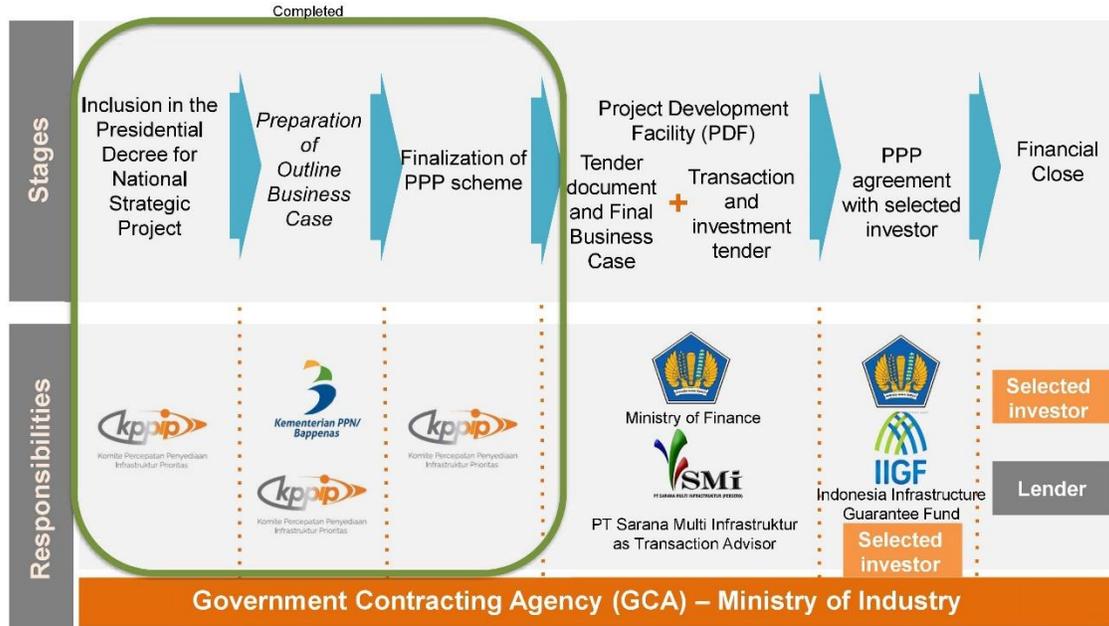
PROJECT STATUS AND IMPLEMENTATION TIMELINE

To date, the outline business case for the project has been completed, and the PPP model has been developed. Land acquisition has begun, with the Bintuni Regency providing the 50 hectares necessary for the core methanol facility. The remaining land to complete the industrial zone is being acquired by the regency. The Ministry of Finance and PT Sarana Multi Infrastruktur (PT SMI) are developing the tender documentation and the final business case to issue the transaction and investment documentation. The tender is anticipated to be issued in the last half of 2020, with an investor selected in 2021. Construction is planned for 2022, and operations slated for 2025.

The Tangguh LNG Train 3 project, where the methanol plant will obtain its gas for Phases 1 and 2, is nearing completion. Approximately 89 percent of the offshore facilities have been constructed, while 61 percent of the onshore facilities are in place. The target for operations is late 2020.

¹³⁰ KPIP

Figure 3: Flow Chart of Status of Bintuni Methanol Project¹³¹



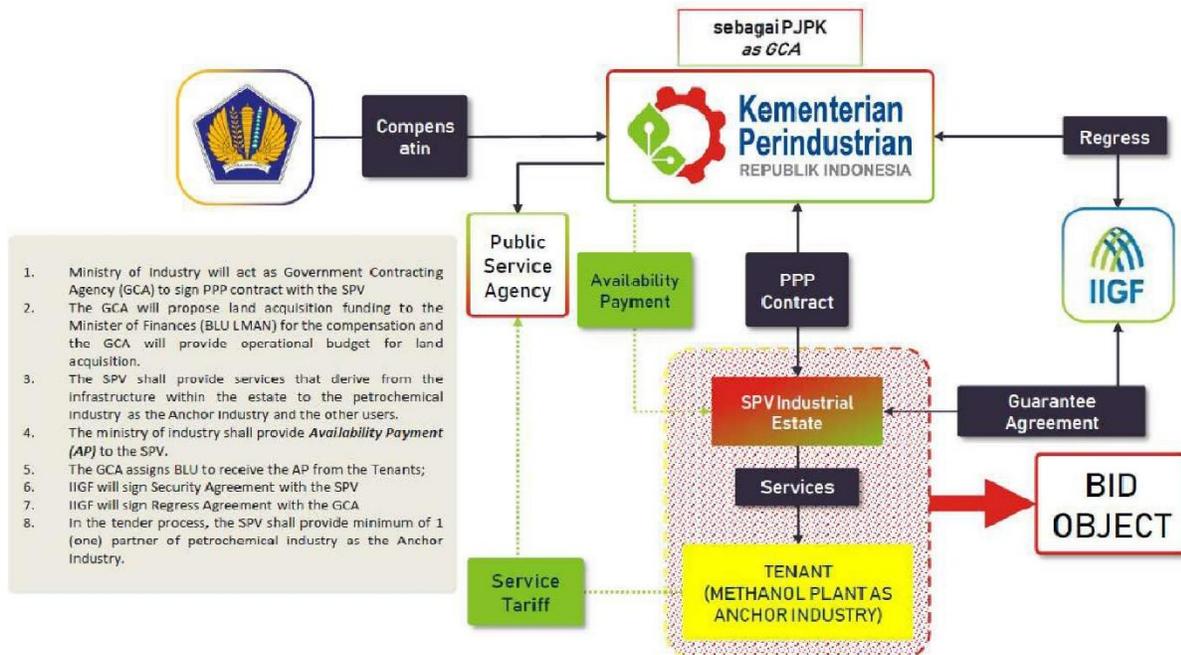
PROJECT COST AND FINANCING

The project cost is anticipated to be \$890 million and will be financed through a PPP model. This is the first time that the Government of Indonesia is pursuing this model and anticipates replicating it in other fields across the country, including Masela and IDD. The Ministry of Industry (Kementerian Perindustrian) will sign a PPP contract with the industrial estate, who will be responsible for all of the facilities that support the plant (i.e., jetties, utilities, housing) and provide availability payments. The tenant will only be responsible for the methanol plant itself.

Any methanol produced at the plant that cannot be utilized in the domestic market can be exported to other markets where demand continues to rise, particularly in China and India. In those markets, the rapidly expanding automotive industry and rising demand for automobiles will continue to drive the methanol consumption into 2024 and beyond.

¹³¹ KPIP

Figure 4: PPP structure¹³²



U.S. EXPORT OPPORTUNITIES

There are significant opportunities for U.S. companies to support the development of these methanol production facilities. Interest from other countries has also been significant, with German, Korean, Malaysian, and other firms exploring the development of this facility. The firms from Malaysia may have a competitive advantage in the development of this new methanol facility, given their involvement with the activities at the Genting Field.

Specific opportunities that may be available to U.S. firms include:

- EPC contracting
- Design services
- Financing
- Technology providers and licensing
- Catalysts
- Towers
- Compressors
- Pumps
- Valves
- Control systems
- Safety equipment

¹³² KPIP

- Security solutions
- Emissions controls
- Construction supervision and management

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Ministry of Industry Jl. Gatot Subroto Kav. 52-53 Jakarta Selatan 12950 INDONESIA Mr. Triharyo Soesilo Triharyo.soesilo@kppip.go.id https://kemenperin.go.id/</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov</p> <p>U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service Embassy of the USA Jl. Medan Merdeka Selatan 5 Jakarta, 10110 INDONESIA Mr. Mario Simanjuntak Mario.simanjuntak@trade.gov www.export.gov/indonesia</p>

Indonesia New Capital City – Green City		
	SECTOR	Energy/Transportation/ICT
	SUBSECTOR	Renewables; EVs
	LOCATION	East Kalimantan, Indonesia
	PROJECT VALUE	Up to \$33 billion (Phase 1)

PROJECT SUMMARY

Indonesia’s new capital city, whose name has not yet been announced, will be a greenfield construction project, using environmentally friendly technologies and products as a way to maintain the existing eco-system as much as possible. It is being designed to be smart, green, beautiful, and sustainable. The government plans to incorporate renewable energy (primarily large hydro and rooftop solar), waste-to-energy, electric vehicles, and Leadership in Energy and Environmental Design (LEED) certifications. The first phase of the capital’s relocation is scheduled for completion in 2024.

PROJECT DESCRIPTION

In August 2019, Indonesia’s President, Joko Widodo, announced that the country would move its capital from Jakarta, located on Java, to an as-yet-unnamed city in East Kalimantan, on the island of Borneo (*Figure 1*). The new city will be located on 180,000 hectares of government-owned land, between the cities of Balikpapan and Samarinda. The overall cost for Phase 1 of moving the capital is expected to be approximately \$33 billion. The city is planned to accommodate a population of 1.5 million people.

The core of the city will occupy 6,000 to 10,000 hectares and serve as the seat of government. It will also contain housing for many of the federal employees and their families. This core city center that will be developed under Phase 1 is planned to accommodate 150,000 to 200,000 inhabitants initially. After the completion of the core, the rest of the metropolitan area will be developed across a total of 40,000 hectares.

Figure 1: Location of the New Capital of Indonesia¹³³



Indonesia's national government is committed to making its new capital a green city, using environmentally friendly technologies and designs wherever possible. The tag line for the new city promotes it as smart, green, beautiful, and sustainable. The government has plans to use renewable energy (primarily large hydro and rooftop solar) to provide a significant portion of the energy required to power the city and use technologies such as waste-to-energy technologies to dispose of the city's waste. Other tools, such as low emissions or electric vehicles, will be used to limit pollutants. Many of the buildings will be constructed to meet Leadership in Energy and Environmental Design (LEED) certifications as a way to reduce energy consumption.

Figure 2: Renderings of New Capital¹³⁴



¹³³ The BBC

¹³⁴ Bappenas

One of the major challenges facing the city developers will be managing the environmental impacts. Currently, a portion of the land where the city is planned is occupied by forests. While the planners aim to make the new capital city a smart and forest city, clearing of trees and other natural habitats will need to occur. A strong, thorough environmental impact mitigation plan will be necessary to ensure the success of the city. Presently, a strategic environmental assessment is ongoing and will be completed before the end of 2019.

The national government has also expressed a desire to keep the city compact as a way to limit the environmental impacts associated with new development. It is planned that half of the city's area would be "green spaces" and that protected/conservation areas will stay untouched. Additionally, each individual project within the new capital will be required to undertake an environmental impact assessment.

Figure 3: Rendering of the New Capital¹³⁵



At present, the country's Ministry of National Development Planning (Bappenas) is the lead organization for the new capital's planning and development. They are working in coordination with all line ministries, particularly the Ministry of Public Works, to ensure that the city is effectively planned, functional, and environmentally focused. Once Indonesia's new Cabinet ministers are appointed, a new Agency or Board will be established at the national level that will be the primary decision-maker for advancements in the new capital.

¹³⁵ Bappenas

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Phase 1 of the project has begun, with a projected end date of 2024. Private sector firms interested in supporting this development have already undertaken site visits and reviewed topographical maps to develop ideas for incorporation into the green city design. All of the design and planning for the new city is scheduled to conclude by the end of 2020, with construction beginning in 2021. The first phase of construction will focus on the central core area of the capital, and be completed within 3 years. The government is scheduled to move and begin operations in 2024.

Final approval is needed from the new Parliament for this project, which is proceeding simultaneously with the planning process. Parliamentary approval is expected by the end of 2019, which will be followed by the revision of the national law that governs the location and operation of the capital. Should Parliament choose not to approve the capital's move, the government will be faced with three options: 1) continue to work with Parliament to seek approval; 2) continue to develop the city plan, but not relocate the capital at this time, or 3) abandon the project altogether.

PROJECT COST AND FINANCING

The cost of Phase 1 of the move is expected to be approximately \$33 billion. This will be financed through a variety of mechanisms, including government resources, private investment, and public-private-partnerships (PPP). Approximately 50 to 60 percent of the financing is expected to come through PPPs, while 20 percent will be provided by the government and the remaining 20 to 30 percent from the private sector.

U.S. EXPORT OPPORTUNITIES

Significant opportunities exist for U.S. firms offering green technology solutions as a way to drive the country's plan for a smart, green, beautiful, and sustainable city. To meet the government's desired goal of at least half of the city being composed of "green spaces," critical planning will need to be done at an early stage to successfully integrate green technologies to limit the city's footprint on the environment and reduce overall emissions. U.S. firms are well-placed to provide the necessary goods and services to aid the Indonesian government with this effort. In October 2019, the U.S. firm, McKinsey, was selected to develop the master plan concept and is currently in financial negotiations with Bappenas.

Possible opportunities for U.S. firms operating in this space include:

- Electric Vehicles and charging stations
- Waste to energy solutions
- Integrated battery storage solutions
- Water and wastewater technologies
- Public transportation
- Emissions control systems
- Air and water monitoring solutions

- Renewable energy technologies and supporting devices
- Energy-saving appliances
- Run of river hydropower solutions
- Biogas and biomass technologies
- LEED design services
- Green building materials
- Recycling technologies
- Control systems and ICT solutions
- Urban Planning services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Ministry of National Development Planning Maidun Building, 4/F Jl. Taman Suropati No. 2 Jakarta, 10310 INDONESIA Dr. Rudy Prawiradinata Rudysp@bappenas.go.id www.bappenas.go.id	U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Commercial Service Embassy of the USA Jl. Medan Merdeka Selatan 5 Jakarta, 10110 INDONESIA Ms. Yulie Tanuwidjaja Yulie.tanuwidjaja@trade.gov www.buyusa.gov/indonesia

Pertamina – Balikpapan Refinery Upgrade		
	SECTOR	Energy
	SUBSECTOR	Refining
	LOCATION	Balikpapan, East Kalimantan, Indonesia
	PROJECT VALUE	\$4 billion

PROJECT SUMMARY

Pertamina, an Indonesian state-owned oil and gas company, is in the process of upgrading four of its refineries as part of its Refinery Development Master Plan (RDMP) and constructing two new refineries. The upgrade of the Balikpapan refinery will result in an increase in crude processing capacity to 360,000 barrels per stream day. The EPC contract for this upgrade has been awarded to Hyundai Engineering Co, Ltd., SK Engineering & Construction Co. Ltd., and two domestic EPC firms. The upgrade process is expected to be completed in 2023.

PROJECT DESCRIPTION

In 2016, Pertamina formed the Department of Refinery and Petrochemicals Mega Projects to manage the revitalization of existing refineries and the construction of two new refineries. The end goal of this Refinery Development Master Plan (RDMP) is to increase the overall production capacity, produce cleaner fuels, and ultimately support an energy security policy that reduces dependence on energy imports. Without the RDMP, Indonesia would need to import approximately 62 percent of its fuel for domestic consumption by 2025. In 2017, imported fuel accounted for nearly one-third of domestic fuel consumption in the country. The goal of the RDMP is to double the domestic refining capacity to 2 million barrels of oil per day by 2025, up from the current level of 1 million barrels per day. The project will also increase the overall Nelson Complexity Index factor for Pertamina’s facilities (Figure 1) from 5.4 to 8.9. At the same time, Pertamina will have a more flexible production capability to meet the country’s growing need for fuel.

In 2018, the combined domestic refinery capacity of Indonesia was 1.15 million barrels per stream day, with crude oil refinery production reaching 364.1 million barrels of fuels, non-fuels, and lubricants (Table 1). This represents an upward trend beginning in 2010 when production was 321.6 million barrels. Imports of refined products have fluctuated up and down over that same period, with a high of 209 million barrels in 2014 and a low of 144 million barrels in 2016. Exports of refined products, however, have been trending downward, from 36.8 million barrels in 2010 to 11.8 million barrels in 2018. Net imports of refined products were 164 million barrels in 2018.

Figure 1: Pertamina's Refineries¹³⁶



Table 1: Indonesia Refined Products – Produced and Traded¹³⁷

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Crude Oil Refinery Production (Thousand Barrels)	321,578	341,384	352,263	324,795	342,578	329,581	340,289	352,182	364,135
Export of Refined Products (Thousand Barrels)	36,794	30,399	28,315	26,843	32,616	23,755	12,858	14,822	11,801
Import of Refined Products (Thousand Barrels)	163,642	195,858	201,160	205,645	209,287	175,473	143,628	177,498	175,825

Balikpapan is Pertamina's oldest refinery, commencing operations in 1922, and supplies up to 26 percent of fuel needs of Indonesia. The current refinery has a crude processing capacity of 260,000 barrels per stream day. The refinery has seven integrated components: crude distillation unit (CDU), high vacuum distillation unit (HVU), hydrocracker unit, platformer, naphtha treater, gasoil treater, and LPG recovery.

¹³⁶ Pertamina

¹³⁷ Adapted from Indonesia Directorate General of Oil and Gas reported data and <https://www.esdm.go.id/assets/media/content/content-handbook-of-energy-economic-statistics-of-indonesia-2017-.pdf>

The upgrade process will result in an increase to 360,000 barrels per stream day and an increase in diesel production of 30,000 barrels per day, further reducing the need for imported fuel. Ultimately, the Balikpapan refinery will produce fuel that meets the Euro-5 standard. After completion of the upgrade process, the refinery will produce 230,000 tons of polypropylene per year.

Figure 2: Balikpapan refinery¹³⁸



To meet these targets, the scope of work undertaken by the EPC contractors includes processing residues into high-quality fuel, reducing the sulfur content of diesel and gasoline to improve quality and reduce environmental impacts, and producing high-octane fuel. At the completion of Phase 1 of the upgrade, the Balikpapan refinery will be able to produce fuel that conforms to the quality specifications of Euro-2. Phase 2 of this project is planned to produce fuels to meet Euro-5 specifications. The output of Phase 2 at Balikpapan will ultimately supply the feedstock to the planned greenfield petrochemical facility in Balongan. At the conclusion of the RDMP process, the Nelson Compatibility Index for the Balikpapan facility will be 9.

Previous upgrades to the Balikpapan facility include work done by Honeywell UOP in 2017 to provide technology licensing and engineering design for a 33,000 barrels per day continuous catalyst regeneration unit and a 47,000 barrels per day hydrocracking unit.

¹³⁸ Pertamina, via Jakarta Post

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The EPC contract for the upgrade of the Balikpapan Refinery has been awarded to a joint venture of Hyundai Engineering Co, Ltd., SK Engineering & Construction Co. Ltd., and two local Indonesian EPCs: PT Rekayasa Industri and PT Pembangunan Perumahan. The operating company for the refinery, PT Kilang Pertamina Balikpapan, was officially formed on May 7, 2019.

Progress on the refinery upgrades has been subject to considerable delays throughout the planning process that was largely due to funding and policy considerations. Increasing oil prices globally and the decision by the government not to raise fuel prices have put a strain on Pertamina's resources, slowing the overall RDMP process. However, the Balikpapan refinery has cleared these hurdles, attracted outside financing, and is now moving forward. The FEED study has been completed, along with land acquisition. Construction has begun for the infrastructure to support improvements at Balikpapan, and completion and operation of the first phase is scheduled for 2023, with phase two operational in 2026. Initially, the entire RDMP, encompassing all refinery upgrades and new construction, was slated to finish in 2021. The current target for the overall completion of the RDMP is 2026.

PROJECT COST AND FINANCING

The project financing element for this upgrade at Balikpapan has been arranged by Pertamina through export credit financing with the Government of South Korea. Additional investments are also being sought to support the upgrade process and ease the financial cost that is being assumed by Pertamina. The overall cost of the Balikpapan refinery upgrade is projected at \$4 billion.

U.S. EXPORT OPPORTUNITIES

Throughout their history with refinery development, Pertamina has had a strong relationship with U.S. suppliers. Firms such as Honeywell UOP and Fluor are well-positioned to continue their relationship with Pertamina. However, significant competition exists from East Asian firms, particularly given the role of Korean firms in the JV Company. Additional competition will come from European firms active in this space. Specific opportunities for U.S. firms for this refinery upgrade process include:

- Engineering services
- Construction supervision
- Design services
- Process equipment
- Vessels
- Quenching towers
- Heat exchangers
- Compressors
- Condensers
- Distillation towers

- Pumps
- Safety and fire protection equipment
- Catalysts
- Instrumentation and controls
- Electrical equipment
- Turbines
- Water treatment systems
- Storage tanks
- Air pollution control systems

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Pertamina Jl. Medan Merdeka Timur 1A, Jakarta 10110 INDONESIA Mr. Ignatius Tallulembang lembang@pertamina.com www.pertamina.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov</p> <p>U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service Embassy of the USA Jl. Medan Merdeka Selatan 5 Jakarta, 10110 INDONESIA Mr. Mario Simanjuntak Mario.simanjuntak@trade.gov www.export.gov/indonesia</p>

Pertamina – Bontang Refinery		
	SECTOR	Energy
	SUBSECTOR	Refining
	LOCATION	Bontang, East Kalimantan, Indonesia
	PROJECT VALUE	\$15 billion

PROJECT SUMMARY

Pertamina, an Indonesian state-owned oil and gas company, is in the process of upgrading four of its refineries as part of its Refinery Development Master Plan (RDMP) and constructing two new refineries – Bontang and Tuban. The greenfield Bontang refinery is planned to have a crude processing capacity of 300,000 barrels/stream day. Construction of this refinery is expected to start in 2021, with operations beginning in 2026.

PROJECT DESCRIPTION

In 2016, Pertamina formed the Department of Refinery and Petrochemicals Mega Projects to manage the revitalization of existing refineries and the construction of two new refineries – Bontang in East Kalimantan and Tuban in East Java. The end goal of this Refinery Development Master Plan (RDMP) is to increase the overall production capacity, produce cleaner fuel, and ultimately support an energy security policy that reduces its dependence on energy imports. Without the RDMP, Indonesia would need to import approximately 62 percent of its fuel for domestic consumption by 2025. In 2017, imported fuel accounted for nearly one-third of domestic fuel consumption in the country. The goal of the RDMP is to double the domestic refining capacity to two million barrels of oil per day by 2025, up from the current level of one million barrels per day. It will increase the overall Nelson Complexity Index factor for Pertamina’s facilities (Figure 1) from 5.4 to 8.9. At the same time, Pertamina will have a more flexible production capability to meet the country’s growing need for fuel.

Figure 1: Pertamina's refineries¹³⁹



In 2018, the combined domestic refinery capacity of Indonesia was 1.15 million barrels per stream day, with crude oil refinery production reaching 364.1 million barrels of fuels, non-fuels, and lubricants (Table 1). This represents an upward trend beginning in 2010 when production was 321.6 million barrels. Imports of refined products have fluctuated up and down over that same period, with a high of 209 million barrels in 2014 and a low of 144 million barrels in 2016. Exports of refined products, however, have been trending downward, from 36.8 million barrels in 2010 to 11.8 million barrels in 2018. Net imports of refined products were 164 million barrels in 2018.

Table 1: Indonesia Refined Products Refined Products – Produced and Traded¹⁴⁰

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Crude Oil Refinery Production (Thousand Barrels)	321,578	341,384	352,263	324,795	342,578	329,581	340,289	352,182	364,135
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Import of Refined Products (Thousand Barrels)	163,642	195,858	201,160	205,645	209,287	175,473	143,628	177,498	175,825

In December 2018, Pertamina signed a Framework Agreement with Overseas Oil and Gas LLC (OOG) from Oman for the development of this new, greenfield refinery. OOG will work with two local companies, PT Meta Espy and PT Sanurhasta Mitra Tbk, to advance the refinery. Its 300,000 barrels/stream day will be used to help meet domestic demand, as well as sold to neighboring countries, including Australia and the Philippines. The output of this facility will raise Indonesia's domestic refinery capacity by nearly 30 percent when completed and include gasoline, aviation turbine fuel, and liquefied petroleum gas (LPG). These outputs will meet Euro-5 standards, resulting in a refinery that not only improves domestic energy security but also provides more environmentally friendly fuels.

The Ministry of Spatial Planning has approved the new location of the refinery in East Kalimantan. It will be located approximately 130 kilometers from the site of Indonesia's new capital city. Land acquisition has begun for the project, though final negotiations are ongoing for the remaining

¹³⁹ KPPIP

¹⁴⁰ Adapted from Indonesia Directorate General of Oil and Gas reported data and

<https://www.esdm.go.id/assets/media/content/content-handbook-of-energy-economic-statistics-of-indonesia-2017-.pdf>

necessary space. The Nelson Compatibility Index for the Bontang facility will be greater than 9. The Bontang refinery may also be integrated with an as-yet-undefined petrochemical facility at the same location that will receive feedstock from the refinery itself.

Unlike other Pertamina refineries, this construction of the Bontang facility will not require the development of surrounding infrastructure, including a port, airport, access roads, and residences, as much of that already exists. Ultimately, that will facilitate the construction of the refinery and reduce overall costs.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

After the Framework Agreement for the new refinery was signed, Técnicas Reunidas was commissioned for the bankable feasibility study, which is ongoing. At the completion of this feasibility study, the front-end engineering design (FEED) study will get underway, followed by the EPC tender that is planned to be issued in 2020. Construction is slated to begin in 2021, though this may be delayed, pending the completion of the FEED study, with an operational target of 2026. In the course of the evaluation of the project, additional sources of crude oil supply will be examined, as domestic sources may not be sufficient to meet the anticipated 300,000 barrels/stream day output target.

The Joint Venture Company that will run the refinery is in the final negotiation stage and is expected to be completed by Pertamina and OOG by the end of 2019. OOG has teamed with two local firms, PT Meta Epsi and PT Sanurhasta Mitra Tbk, for the construction of this new refinery.

Progress on all of Pertamina's refinery projects has been subject to considerable delays throughout the planning process, largely due to funding and policy considerations. Increasing oil prices globally and the decision by the government not to raise fuel prices put a strain on Pertamina's resources, slowing the overall RDMP process implementation. This financing constraint has limited Pertamina's equity stake in the Bontang project to only 10 percent at present.

Initially, the entire RDMP, encompassing all refinery upgrades and new construction, was planned to finish in 2021. The current target for the overall completion of the RDMP, as well as the commercial operation of the Bontang refinery, is 2026.

PROJECT COST AND FINANCING

The overall cost of this new refinery is expected to be \$15 billion. Currently, it is slated for project financing through a joint venture formed between Pertamina and OOG. At present, Oman has approximately 85 to 90 percent of the commitment in the JV, and both parties are open to additional outside investors, including those who had earlier expressed interest in taking part in the project, to reduce that stake to approximately 51 percent. Pertamina may also increase its contribution to the project from the current level of approximately 10 percent up to 30 percent. OOG has committed €90 million to start the FEED study.

U.S. EXPORT OPPORTUNITIES

There are numerous export opportunities for U.S. companies associated with this multi-billion-dollar refinery project, particularly given the historical relationship that Pertamina has had with U.S. suppliers for the construction and upgrade of their refining facilities. In particular, Fluor and Honeywell UOP have had a very strong track record of working with Pertamina. However, OOG has strong ties with European companies who will be strong competitors to U.S. firms operating in this area. In addition to Europe, OOG has also expressed interest in sourcing technology and services from Singapore, and Japan.

Opportunities for U.S. firms to support the construction and operation of the Bontang refinery include:

- Construction Supervision
- Design Services
- Engineering Services
- Power plant
- Piping
- Fabrication
- Licensing
- Process equipment
- Vessels
- Quenching towers
- Heat exchangers
- Compressors
- Condensers
- Distillation towers
- Pumps
- Safety equipment
- Catalysts
- Instrumentation and controls
- Electrical equipment
- Turbines
- Water treatment systems
- Storage tanks
- Air pollution control systems
- Fire Protection Equipment
- IT solutions
- Access control solutions
- Communications equipment
- Water treatment technologies
- Power systems

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Pertamina – Balongan Refinery Upgrade		
	SECTOR	Energy
	SUBSECTOR	Refining
	LOCATION	Balongan, West Java, Indonesia
	PROJECT VALUE	\$100 million (Phase 1); up to \$6.5 billion

PROJECT SUMMARY

Pertamina, an Indonesian state-owned oil and gas company, is in the process of upgrading four of its refineries as part of its Refinery Development Master Plan (RDMP) and constructing two new refineries. The upgrade of the Balongan refinery will result in an increase in naphtha production and a crude processing capacity of 240,000 barrels per stream day. Pertamina has decided to undertake this upgrade process alone, without a foreign partner. The estimated completion date for Phase 1 of the upgrade process is 2023.

PROJECT DESCRIPTION

In 2016, Pertamina formed the Department of Refinery and Petrochemicals Mega Projects to manage the revitalization of existing refineries and the construction of two new refineries. The end goal of this Refinery Development Master Plan (RDMP) is to increase the overall production capacity, produce cleaner fuel, and ultimately support an energy security policy that reduces dependence on energy imports. Without the RDMP, Indonesia would need to import approximately 62 percent of its fuel for domestic consumption by 2025. In 2017, imported fuel accounted for nearly one-third of domestic fuel consumption in the country. The goal of the RDMP is to double the domestic refining capacity to two million barrels of oil per day by 2025, up from the current level of one million barrels per day. While the Phase 1 expansion of the Balongan refinery is part of the RDMP, the petrochemical facility that will be constructed is not considered part of this plan, but rather a separate development that will be sited next to the existing refinery.

In 2018, the combined domestic refinery capacity of Indonesia was 1.15 million barrels per stream day, with crude oil refinery production reaching 364.1 million barrels of fuels, non-fuels, and lubricants (*Table 1*). This table represents an upward trend from 2010 when production was 321.6 million barrels. Imports of refined products have fluctuated up and down over that same period, with a high of 209 million barrels in 2014 and a low of 144 million barrels in 2016. Exports of refined products, however, have been trending downward, from 36.8 million barrels in 2010 to 11.8 million barrels in 2018. Net imports of refined products were 164 million barrels in 2018.

Figure 1: Pertamina's Refineries¹⁴¹



Table 1: Indonesia Refined Products – Produced and Traded¹⁴²

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Crude Oil Refinery Production (Thousand Barrels)	321,578	341,384	352,263	324,795	342,578	329,581	340,289	352,182	364,135
Export of Refined Products (Thousand Barrels)	36,794	30,399	28,315	26,843	32,616	23,755	12,858	14,822	11,801
Import of Refined Products (Thousand Barrels)	163,642	195,858	201,160	205,645	209,287	175,473	143,628	177,498	175,825

The existing Balongan refinery, commissioned in 1994 in West Java, has a current refining capacity of 125,000 barrels per stream day of crude throughput, about 11 percent of the country's total refining capacity, and will be upgraded in two phases. Currently, the Balongan refinery is composed of the following units: crude distillation unit (CDU); atmospheric hydrodemetallization Unit (ARHDM); residual catalytic cracking (RCC); catalytic condensation unit; penex; kero treater; naphtha treater; gasoil treater; olefins conversion unit (OCU); and propylene recovery unit (PRU).

¹⁴¹ Pertamina

¹⁴²Adapted from Indonesia Directorate General of Oil and Gas reported data and

<https://www.esdm.go.id/assets/media/content/content-handbook-of-energy-economic-statistics-of-indonesia-2017-.pdf>

As of 2017, Balongan is able to produce fuel that is compliant with Euro-4 standards. In late 2018, Pertamina issued a tender seeking to expand its sources of crude oil that could be utilized in the Balongan refinery (*Figure 2*). New grades were added to include more options for West Africa sourced crudes.

*Figure 2: Balongan refinery*¹⁴³



The first phase of the Balongan expansion will entail an investment of \$100 million for a comparatively modest upgrade to facilitate the production of naphtha by 2023. This would then be followed by a Phase 2 expansion on a much greater scale, increasing the refinery's capacity to 240,000 barrels per stream day of crude oil and result in the ability to process medium crude oil at the plant with a sulfur content of 0.4-0.5 percent. However, plans for this Phase 2 are still being developed and may be dropped, pending the availability of financing.

Regardless of whether Pertamina's Phase 2 moves forward, the Balongan refinery will be augmented by a much larger investment (est. \$6.5 billion) and involve the integration of a greenfield petrochemical complex. This complex will provide the ability to process sour crude, produce at least one million tons of ethylene per year in addition to other refinery derivative products, and become more competitive on costs. The petrochemical project is being developed by CPC Corporation, Taiwan.

There will not be any need to acquire new land for the Phase 1 upgrade of the refinery, though the greenfield petrochemical facility will require additional land/land reclamation. The output from

¹⁴³ Antara via Jakarta Post

Pertamina's Balikpapan refinery will also be used as feedstock in some of the processes for the Pertamina/CPC petrochemical facility. At the conclusion of the RDMP process, the Nelson Compatibility Index for the Balongan facility will be nine.

Earlier upgrades to the Balongan facility were conducted by Toyo Engineering Corporation in 2003 and 2008.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The bankable feasibility study for the Balongan refinery upgrade has been completed, and Pertamina is currently tendering a combined package for the front-end engineering design (FEED) study and the engineering, procurement, and construction (EPC) contract for Phase 1. These contracts are expected to be awarded in early 2020, with completion of construction and expected operation in 2023.

PROJECT COST AND FINANCING

Pertamina has decided to undertake the Phase 1 refinery upgrade without a foreign partner. Initially, the company had signed an agreement with Saudi Aramco to undertake this upgrade jointly, but that agreement expired in 2016. The \$100 million for Phase 1 will be financed through export credit financing that Pertamina is currently exploring. Should additional financing become available, Pertamina will move forward with Phase 2, in order to increase the capacity of the refinery to 240,000 barrels per day.

The petrochemical facility being developed in conjunction with CPC will be financed through an arrangement developed by CPC.

U.S. EXPORT OPPORTUNITIES

There are numerous export opportunities for U.S. companies associated with this refinery upgrade project and new petrochemical facility. The existing Balongan refinery already contains significant content from the U.S., including both equipment and services.

- Engineering services
- Construction supervision
- Design services
- Process equipment
- Vessels
- Quenching towers
- Heat exchangers
- Compressors
- Condensers
- Distillation towers

- Pumps
- Safety and fire protection equipment
- Catalysts
- Instrumentation and controls
- Electrical equipment
- Turbines
- Water treatment systems
- Storage tanks
- Air pollution control systems

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Pertamina – Tuban Refinery		
	SECTOR	Energy
	SUBSECTOR	Refining
	LOCATION	Tuban, East Java, Indonesia
	PROJECT VALUE	\$15.7 billion

PROJECT SUMMARY

Pertamina, an Indonesian state-owned oil and gas company, is in the process of upgrading four of its refineries as part of its Refinery Development Master Plan (RDMP) and constructing two new refineries – Bontang and Tuban. The greenfield Tuban refinery is planned to have a crude processing capacity of 300,000 barrels/stream day. Construction of this refinery is expected to start in 2020, with operations beginning in 2025.

PROJECT DESCRIPTION

In 2016, Pertamina formed the Department of Refinery and Petrochemicals Mega Projects to manage the revitalization of existing refineries and the construction of two new refineries – Bontang in East Kalimantan and Tuban in East Java. The end goal of this Refinery Development Master Plan (RDMP) is to increase the overall production capacity, produce cleaner fuel, and ultimately support an energy security policy that reduces its dependence on energy imports. Without the RDMP, Indonesia would need to import approximately 62 percent of its fuel for domestic consumption by 2025. In 2017, imported fuel accounted for nearly one-third of domestic fuel consumption in the country. The goal of the RDMP is to double the domestic refining capacity to two million barrels of oil per day by 2025, up from the current level of one million barrels per day. It will increase the overall Nelson Complexity Index factor for Pertamina’s facilities (Figure 1) from 5.4 to 8.9. At the same time, Pertamina will have a more flexible production capability to meet the country’s growing need for fuel.

Figure 1: Pertamina's refineries¹⁴⁴



In 2018, the combined domestic refinery capacity of Indonesia was 1.15 million barrels per stream day, with crude oil refinery production reaching 364.1 million barrels of fuels, non-fuels, and lubricants (Table 1). This represents an upward trend beginning in 2010 when production was 321.6 million barrels. Imports of refined products have fluctuated up and down over that same period, with a high of 209 million barrels in 2014 and a low of 144 million barrels in 2016. Exports of refined products, however, have been trending downward, from 36.8 million barrels in 2010 to 11.8 million barrels in 2018. Net imports of refined products were 164 million barrels in 2018.

Table 1: Indonesia Refined Products Refined Products – Produced and Traded¹⁴⁵

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Crude Oil Refinery Production (Thousand Barrels)	321,578	341,384	352,263	324,795	342,578	329,581	340,289	352,182	364,135
Export of Refined Products (Thousand Barrels)	36,794	30,399	28,315	26,843	32,616	23,755	12,858	14,822	11,801
Import of Refined Products (Thousand Barrels)	163,642	195,858	201,160	205,645	209,287	175,473	143,628	177,498	175,825

In late 2017, Pertamina and Rosneft established a joint venture, PT Pertamina Rosneft Pengolahan dan Petrokimia, to construct and operate an integrated greenfield refinery and petrochemical facility in Tuban, East Java. This facility will have the ability to produce 300,000 barrels/stream day, along with 1 million tons/year of ethylene and 1.3 million tons/year of aromatics. Like the other greenfield refinery Pertamina is constructing, Tuban's outputs will be used to help meet domestic demand for fuel and will raise Indonesia's domestic refining capacity by nearly 30 percent. The refinery will be configured in a way that will allow it to process Russian ESPO and Iraqi Basrah imports, along with other crudes that will act as a feedstock to the integrated petrochemical facility. These outputs will meet Euro-5 standards, resulting in a refinery that not only improves domestic energy security but also provides more environmentally friendly fuels.

The President of Indonesia and the Ministry of Finance have approved the use of land owned by the Ministry of Forestry for this new refinery. However, Pertamina is still in discussions with local

¹⁴⁴ KPPIP

¹⁴⁵ Adapted from Indonesia Directorate General of Oil and Gas reported data and

<https://www.esdm.go.id/assets/media/content/content-handbook-of-energy-economic-statistics-of-indonesia-2017-.pdf>

residents and landowners to finalize the usage rights to the remaining land. The government and Pertamina envision the land acquisition process to be finalized by early 2020, and land clearing has already begun on the government-owned property. When completed and operational, the Nelson Compatibility Index for the Tuban facility will be greater than 9.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The basic engineering design and environmental assessment for the new Tuban facility have been completed. After signing the joint venture agreement, Rosneft and Pertamina have begun the front-end engineering design (FEED) study and begun the process of license purchases. Both of these processes are anticipated to be completed in late 2019/early 2020. Subsequent to the completion of the FEED study, an EPC tender will be issued in early 2020, with the construction scheduled to commence later that year. The construction stage is expected to last approximately 5 years.

Progress on all of Pertamina's refinery projects has been subject to considerable delays throughout the planning process, largely due to funding and policy considerations. Increasing oil prices globally and the decision by the government not to raise fuel prices put a strain on Pertamina's resources, slowing the overall RDMP process implementation. In addition, the Tuban refinery has faced some challenges at a local level with regard to land acquisition, but work has already begun on the site, and negotiations are ongoing. The purchase of land from private owners has also already begun.

Initially, the entire RDMP, encompassing all refinery upgrades and new construction, was planned to finish in 2021. The current target for the completion of the Tuban Refinery and Petrochemical Complex is 2025, while the overall RDMP is scheduled for 2026.

PROJECT COST AND FINANCING

The overall cost of this new refinery is expected to be \$15.7 billion. The joint venture company that will operate the refinery is 55 percent owned by Pertamina, with Rosneft accounting for the remaining 45 percent.

U.S. EXPORT OPPORTUNITIES

There are numerous export opportunities for U.S. companies associated with this multi-billion dollar refinery project, particularly given the historical relationship that Pertamina has had with U.S. suppliers for the construction and upgrade of their refining facilities. In particular, Fluor and Honeywell UOP have had a very strong track record of working with Pertamina. However, firms based out of Europe and Asia, including Korea, Singapore, and Japan, will be strong competitors to U.S. firms operating in this area.

Opportunities for U.S. firms to support the construction and operation of the Tuban refinery include:

- Construction Supervision
- Design Services
- Engineering Services
- Power plant
- Piping
- Fabrication
- Licensing
- Process equipment
- Vessels
- Quenching towers
- Heat exchangers
- Compressors
- Condensers
- Distillation towers
- Pumps
- Safety equipment
- Catalysts
- Instrumentation and controls
- Electrical equipment
- Turbines
- Water treatment systems
- Storage tanks
- Air pollution control systems
- Fire Protection Equipment
- IT solutions
- Access control solutions
- Communications equipment
- Water treatment technologies
- Power systems

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Indonesia Waste to Energy		
	SECTOR	Energy/Environment
	SUBSECTOR	Waste to Energy
	LOCATION	Multiple locations; Indonesia
	PROJECT VALUE	\$1.185 billion +

PROJECT SUMMARY

Indonesia is in the process of accelerating the use of waste-to-energy (WTE) technologies to manage its growing waste challenges. Twelve cities or provinces have been targeted for new facilities, representing more than \$1 billion of investment. The plants are expected to be operational no later than 2022.

PROJECT DESCRIPTION

In 2018, Indonesia’s President, Joko Widodo, issued a Presidential Decree to promote waste-to-energy (WTE) technologies projects as a way to combat the growing amount of waste that was accumulating across the country. Made up of more than 17,000 islands and more than 260 million inhabitants, Indonesia has a growing waste problem, including plastics being released into the ocean. Landfills are increasing in size and can leak into rivers and the surrounding environment. WTE plants are being accelerated not only to limit this pollution, but also to reduce the footprint of waste across the country. This policy has the added benefit of generating electricity, expected to be approximately 234 MW from burning up to 16,000 tons of waste per day. President Widodo noted that the driving force for the project was to take care of the trash, rather than generate electricity.

These projects have been listed as Priority Projects within the National Strategic Project list as developed by the Coordinating Ministry of Economic Affairs, line Ministries, and the Committee for Acceleration of Priority Infrastructure Delivery (KPPIP). The Priority Projects are determined by their alignment with the National Medium-Term Development Plan and a Presidential or Ministerial Decree, their strategic role for economic development, and overall size of investment value. When selecting projects for this classification, the KPPIP put particular emphasis on projects with a high economic internal rate of return (EIRR).

As part of the Presidential Decree, 12 cities and provinces have been selected for the implementation of waste to energy facilities (*Figure 1*). The Decree specified the electricity tariff for these projects. The tariffs depend on the capacity of the project:

- For projects *less than 20 MW*, the tariff is: U.S. 13.35 cents/kWh
- For projects *greater than 20 MW*, the tariff is: U.S. 14.54 cents/kWh – [0.076 x capacity in MW]
- The *maximum value* of the tipping fee is Rp 500,000/ton (approximately \$36/ton)

Figure 1: Location of WTE Projects¹⁴⁶



Of the cities where WTE plants are targeted, seven plants will be developed using a public-private-partnership (PPP) model (*Table 1*). This structure involves the use of an outside transaction advisor by the cities to structure the project, before selecting the investor and receiving approval from MEMR to sign a power purchasing agreement (PPA with PLN). Once the PPA has been signed, the construction of the facility will begin.

For those projects not being developed under the PPP, the local investor will manage the process, including the preparation of documents for tender, rather than an outside transaction advisor. The non-PPP structure is being pursued in 6 locations. (A 1.5 MW portion of the Bekasi facility is being developed in under the non-PPP model, while an additional 20 MW is being developed in Bekasi as a PPP.)

¹⁴⁶ KPIP

Table 1: PPP Projects¹⁴⁷

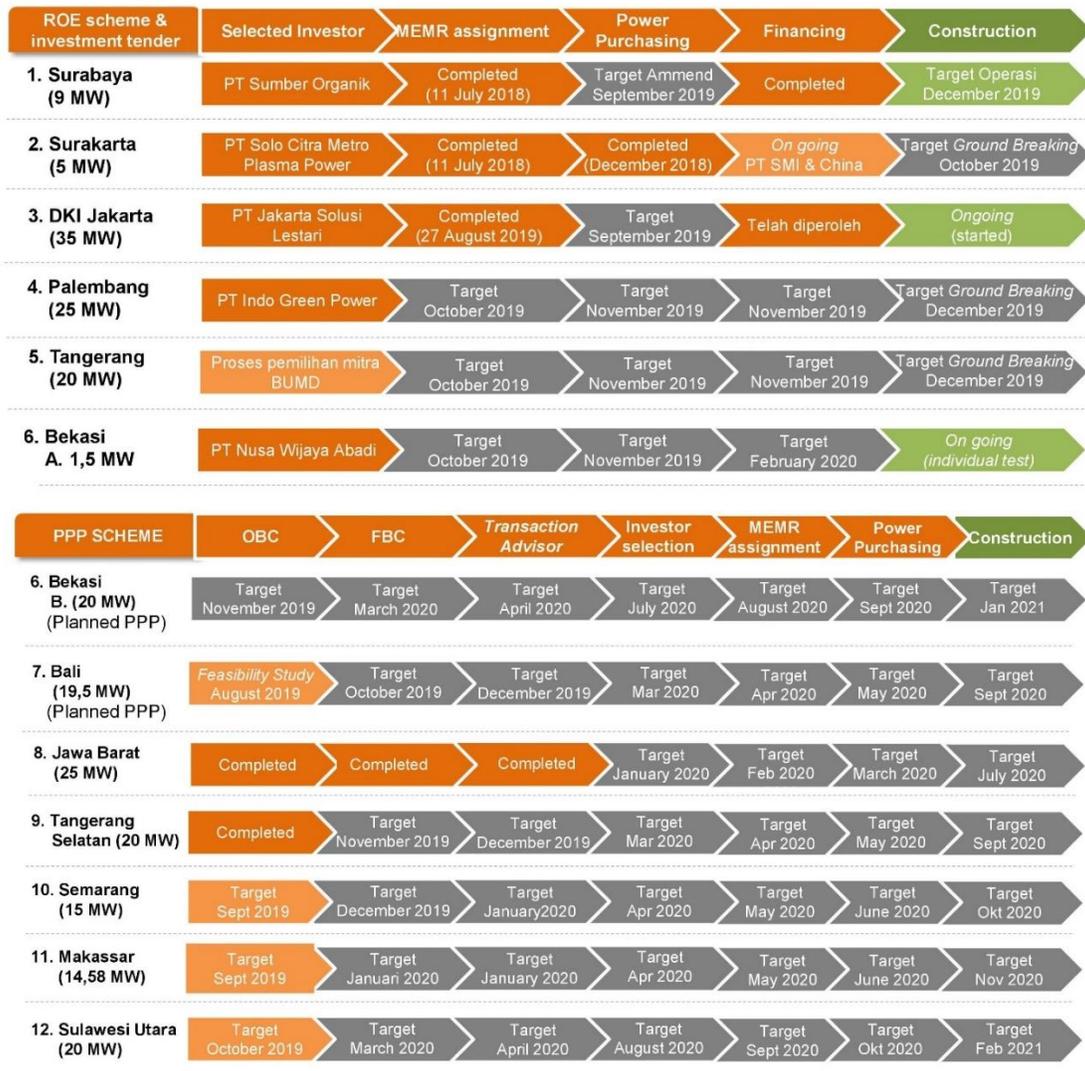
Location	Capacity (ton/day)	Estimated Investment Value (\$ million)	Estimated Start of Investment Tender
Legok Nangka, West Java (Jawa Barat)	1,845	\$265	September 2019
Sarbagita, Bali (Denpasar)	1,345	\$160	December 2019
Cipeucang, South Tangerang (Tangerang Selatan)	800	\$120	December 2019
Jatibarang, Semarang	1,000	\$130	January 2020
Tamangapa, Makassar	890	\$120	January 2020
Ilo-Ilo, North Sulawesi (Sulawesi Utara)	1,000	\$130	April 2020
Sumur Batu, Bekasi	1,800	\$260	April 2020

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The chart below demonstrates the progress of the seven projects that are being developed under the PPP scheme, using international organizations to prepare the associated documentation, including outside business case (OBC), final business case (FBC), and tender documents, along with serving as transaction advisors. These international organizations include the Millennium Challenge Account (USA/Indonesia), Japan International Cooperation Agency, Indonesia-Australia Partnership for Infrastructure, Korea Environmental & Technology Institute, the Asian Development Bank, and the Indonesia China Business Council. The status of these seven projects (*Figure 2*), all are projected for construction no later than 2021.

¹⁴⁷ KPPIP

Figure 2: Project Status¹⁴⁸



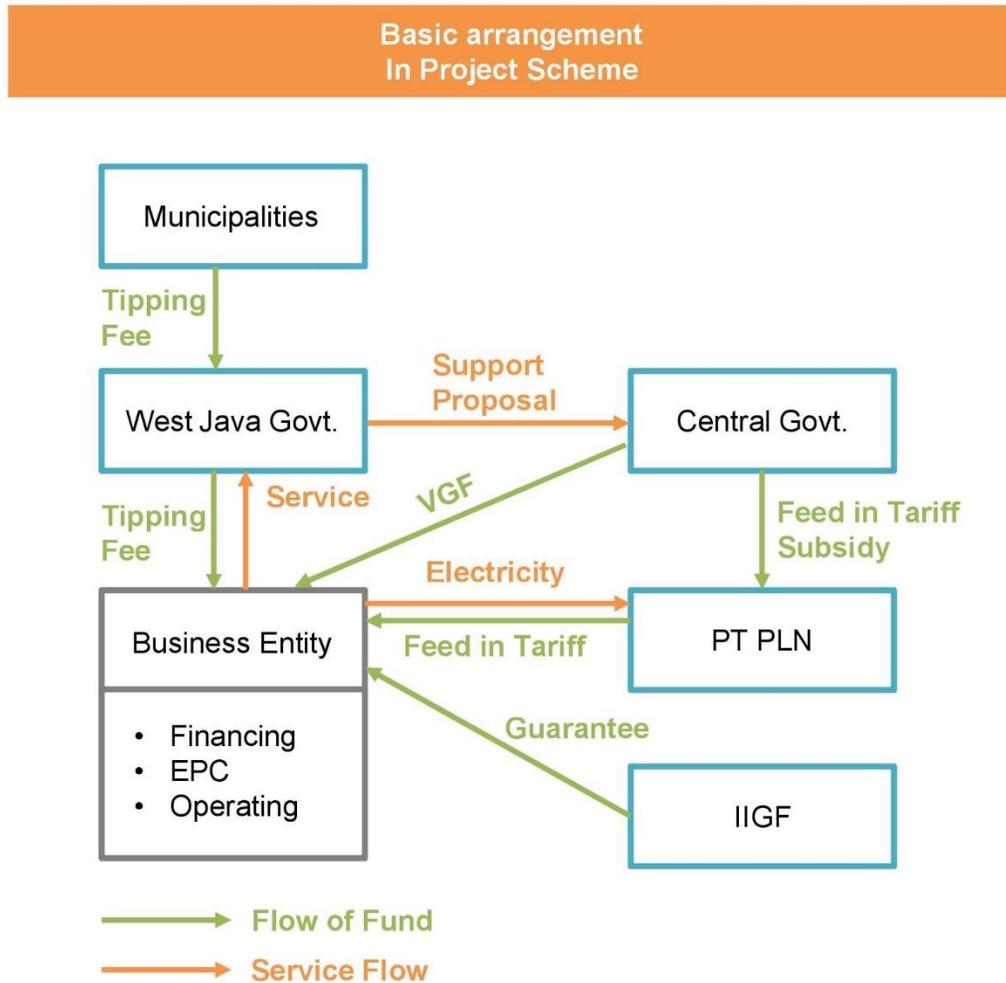
PROJECT COST AND FINANCING

The total estimated cost of the seven facilities that are being developed under the PPP scheme is \$1.185 billion.

For the PPP projects, which are encouraged by the government, the operator receives the tipping fee and tariff as detailed in the Presidential Decree. Additionally, the Indonesian government provides a viability gap fund (VPF), which is an equity portion of 30-40 percent and free use of the land. The Indonesia Infrastructure Guarantee Fund also provides a government guarantee for the project. The chart below (Figure 3) is the template for how the PPP structure will operate.

¹⁴⁸ KPIP

Figure 3: PPP Operating Structure¹⁴⁹



For those projects not developed under the PPP scheme, they will only receive the tipping fee and tariffs that have been included in the Presidential decree.

U.S. EXPORT OPPORTUNITIES

Numerous countries have already shown interest in supporting the development of these PPP projects and have been involved with their preparation. Organizations from the United States, China, Korea, Australia, and Japan have all been involved already.

- West Java: USA (OBC); Japan (FBC)
- South Tangerang: Korea (OBC, FBC); ADB (Transaction Advisor)
- Makassar: Korea (OBC, FBC)

¹⁴⁹ KPPIP

- North Sulawesi: China (OBC)
- Semarang: Australia (OBC, FBC, Transaction Advisor)

The construction of these sites provides ample opportunities for U.S. firms to become involved across the country. Specific examples of services and technologies include:

- Construction services and supervision
- Incinerators/Boilers
- Sorting technology
- Drying technology
- Emissions controls
- Turbines/Generators
- Recycling technologies
- Design services
- Hauling equipment
- Control systems

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Coordinator: Committee for Acceleration of Priority Infrastructure Delivery Gedung Pos Ibokota, Blok A, It. 6 Pasar Baru, Jakarta 10710 INDONESIA Mr. Triharyo Soesilo Triharyo.soesilo@kppip.go.id www.kppip.go.id	U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov IndoPacific@ustda.gov www.ustda.gov	U.S. Commercial Service Embassy of the USA Jl. Medan Merdeka Selatan 5 Jakarta, 10110 INDONESIA Mr. Mario Simanjuntak Mario.simanjuntak@trade.gov www.export.gov/indonesia

PETRONAS Well Management		
	SECTOR	Energy
	SUBSECTOR	Oil & Gas
	LOCATION	Malaysia
	PROJECT VALUE	\$500 million (est.)

PROJECT SUMMARY

A staged program of oil and gas well abandonment and upstream decommissioning by Petroliam Nasional Bhd (Petronas), the Malaysian Nasional Oil Company is in process in tranches over the period 2019-2021 and likely to extend beyond. Forty wells are scheduled for decommissioning in 2020, with an additional sixty in 2021. PETRONAS is proactively seeking offshore providers with specific technology and experience to support this group of projects. In addition to its own asset portfolio, PETRONAS sees decommissioning as a new, high-growth rate, business opportunity to service Indo-Pacific region oil and gas projects over the next many years. In addition, well completion projects are also available.

PROJECT DESCRIPTION

Petroliam Nasional Bhd (PETRONAS) is the integrated national oil company of Malaysia. The company’s operations span: oil and gas exploration and production (Figure 1); refining and marketing; and petrochemicals and specialty chemicals. The company was founded in 1974, in part due to the government’s concern during an oil crisis. The focus was to decrease the nation’s dependence on foreign energy. The founding also came after settling disputes over territorial waters with Indonesia. Oil was first discovered in Malaysia at the end of the 19th century, and in 1910, Royal Dutch Shell first drilled in Sarawak, then a British colony.

Last year the company posted revenues of over \$46 billion. Over the last few years, PETRONAS has been engaged in an assertive new procurement and vendor management program to clarify and extend supplier relationships in support of strategic projects in the company’s portfolio.

Figure 1: Representative PETRONAS Oil Rig/Well¹⁵⁰



Among those strategic projects is well-related asset management in the upstream side of the business. These projects include both well completion and decommissioning, as many of PETRONAS's own assets have been operating for more than 40 years. (Table 1).

Table 1: PETRONAS Upstream Asset Aging¹⁵¹

PETRONAS Upstream Assets	Percent Older Than 40 Years
>300 Platforms	11
>10,000 km of pipelines	8
>3900 well strings in >200 wells	11

For PETRONAS's own portfolio, asset decommissioning is necessary both for economic reasons and environmental stewardship. PETRONAS is decommissioning approximately 50 wells in 2019 and has identified 40 wells for decommissioning in 2020, and 60 wells in 2021.

PETRONAS does not release specific budget numbers for internal projects. While decommissioning costs vary widely depending on asset location and associated complexity, at a typical cost of between \$2 and 10+ million per well, PETRONAS's capital expenditure for the 2020 and 2021 project portfolios is estimated at \$200 and \$300 million respectively.

Beyond its own portfolio, PETRONAS sees decommissioning as a high-growth business opportunity in the region because the Indo-Pacific region is relatively early in its life cycle for this type of infrastructure management. Over the next decade, \$100 billion of decommissioning jobs are expected across the entire Asia-Pacific region¹⁵². These opportunities extend to nearly 2,600 platforms and 3,500 wells in more than 380 fields that are expected to cease production in that timeframe. The U.S. is well-positioned to take part in this growth because some of its hydrocarbon extraction assets have already faced depletion and decommissioning. Today, Europe and North America are the largest decommissioning markets.

¹⁵⁰ Source: Petronas

¹⁵¹ Ibid

¹⁵² Wood Mackenzie

PETRONAS is actively seeking to expand its foreign supply base to support its decommissioning program. This ongoing, internal-to-PETRONAS project includes management of:

- Well abandonment – permanent closure of wells when insufficient hydrocarbons are being extracted, or the reservoir has been drained
- Upstream facilities decommissioning – management of wellhead platforms, floating production storage and offloading (FPSO/FSO) and vent platforms at the ends of the oil and gas production lifecycle, including ensuring optimized cost management, full exploitation of asset re-use and repurposing, and environmental stewardship

PETRONAS seeks new business partners who offer technologies, services, and experience for innovative removal, value engineering, and stakeholder management in the following categories (Table 2):

Table 2: Required Business Partner/Supplier Experience¹⁵³

Well Abandonment	Upstream Facilities Decommissioning
Drilling rigs	Engineering services
Hydraulic workover units (HWUs)	Decommissioning yard/facility
Offshore support vessels (OSVs)	Transport and lifting services
Lifting Services	Decommissioning cutting services. (diamond wire cutting, abrasive water jet cutting, etc.)
Third-party drilling services (slickline, cementing, fishing, perforation-wash-cement, etc.)	Other services (underwater, decontamination, remediation, etc.)

Of particular interest are innovative suppliers who can offer costs effective and creative business models uniquely. Other requirements include:

- Own decommissioning yard and facility with:
 - Sea access
 - Area for dismantling and storage
 - Deep draft quay proximity to supply chain partners
 - Waste treatment
 - Smelting
- Availability of :
 - Lifting cranes
 - Cutting tools
 - Liquid pumps
 - Weighing station
 - Self-Propelled Modular Trailers (SPMT)

¹⁵³ Petronas

- Compliance with relevant Acts, Regulations, and Guidelines applicable to the nature of the work
- Technically suitable for decommissioning activities
- Company Health, Safety and Environment program and management systems including:
 - Occupational health
 - Environmental management
 - Management of contaminated steel and equipment
 - Pollution prevention
 - Wastewater management
 - Liabilities management
 - Cumulative impact of activities and risk assessment
 - Quality management

PROJECT STATUS AND IMPLEMENTATION TIMELINE

PETRONAS is in the process of decommissioning approximately 50 wells in 2019. The company has outlined specific future decommission projects for:

- 40 wells in 2020
- 60 wells in 2021

PETRONAS expects its decommissioning process in Malaysia to continue beyond 2021 and is exploring decommissioning as a business growth opportunity across Asia, as oil and gas assets mature in the region.

Supplier relations and contract awards are handled through the PETRONAS Procurement function.

PROJECT COST AND FINANCING

Overall project cost for 2020 and 2021 is estimated at \$200 and \$300 million, respectively. The costs for the management of individual assets vary widely. Decommissioning of a typical well costs approximately \$2 to \$10 million. Generally, decommissioning projects are covered out of the annual PETRONAS budget.

U.S. EXPORT OPPORTUNITIES

Established U.S. companies are well-positioned for this project because decommissioning is a well-developed industry in North America and Europe. In the Indo-Pacific region, the field is more nascent.

In addition to the well-decommissioning projects and associated capabilities offered in the Project Description section, PETRONAS has an ongoing program to attract suppliers for well completion

services, onshore and offshore maintenance, and for a variety of specific oilfield technologies and components for its upstream business, including:

- Distributed control systems
- Control valves
- Centrifugal pumps
- Electrical – switchgear, transformers, induction motors
- Wellhead control panels
- Directional drilling

One or more well completion contracts will also open in late 2020, for 2021 and 2022.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
PETRONAS Tower 1 Petronas Twin Towers Kuala Lumpur City Centre 50088 Kuala Lumpur Malaysia Mr. Samsudin Miskon VP – Global Procurement supplier.servicedesk@petronas.com.my	Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov IndoPacific@ustda.gov www.ustda.gov	Mr. Dennis Simmons Senior Commercial Officer U.S. Embassy Kuala Lumpur 376 Jalan Tun Razak 50400 Kuala Lumpur Phone: 60-3-2168-5000 dennis.simmons@trade.gov

Sarawak (and Sabah) Methanol and Derivatives		
	SECTOR	Energy
	SUBSECTOR	Petrochemicals
	LOCATION	Sarawak and Sabah, Malaysia
	PROJECT VALUE	\$2+ billion

PROJECT SUMMARY

The State of Sarawak is developing a methanol and derivatives complex in Bintulu, Malaysia. This is a two-phase project, the initial phase of which is a methanol plant with an announced capacity of approximately 1.7 million metric tons per year. The project aligns with other energy investments in the state of Sarawak, providing Sarawak’s first added-value oil-and-gas downstream value chain. The State of Sabah has completed a Master Plan for a similar complex.

PROJECT DESCRIPTION

The Malaysian States of Sarawak and Sabah, located on the island of Borneo, are each undertaking development of methanol and derivatives complexes at Tanjung Kidurong, Bintulu, and Sitipang, respectively. Both projects take advantage of their states’ natural gas resources on the upstream side and local agriculture markets, for at least a portion of plant output, downstream. The Sarawak plant, which is 100 percent owned by the State, is administered through Sarawak Petchem. The Sabah project is overseen as Sabah Oil and Gas Industrial Park (SOGIP) and will also be owned by its state. SOGIP is administered by Sabah Oil and Gas Development Corporation (SOGDC). A representative methanol ammonia plant is shown below (*Figure 1*):

Figure 1: Representative Methanol Ammonia Facility¹⁵⁴

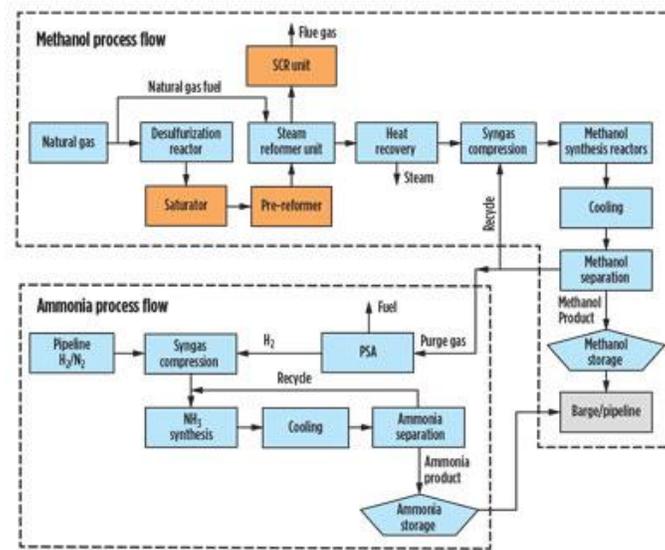


¹⁵⁴ Chemarc

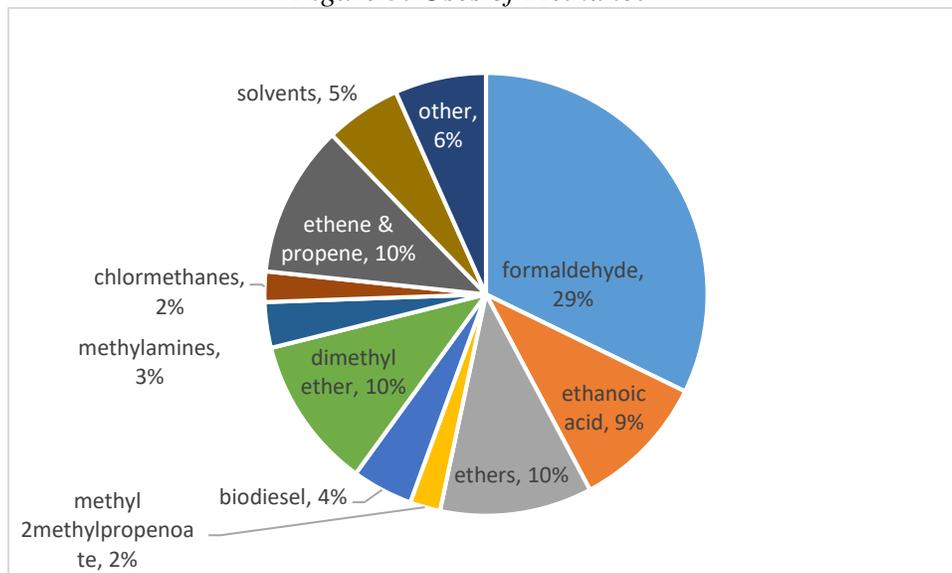
Methanol and ammonia are typically produced from natural gas using related processes, so it is common to co-site manufacturing (*Figure 2*). Technology for co-producing the two chemicals is being implemented currently in the U.S. and other countries. Typical large-scale derivatives from methanol-ammonia complexes are agricultural fertilizers. Methanol, particularly, is a precursor to a wide variety of other derivative industrial chemicals, resins, and polymers (*Figure 3*).

Both projects have access to regional ports. The Sarawak site is near the Port of Bintulu. The Sabah site is near the Port of Sabah and has a jetty with a conveyor installed.

*Figure 2: Relatedness of Methanol and Ammonia Processes*¹⁵⁵



*Figure 3: Uses of Methanol*¹⁵⁶



¹⁵⁵ Gas Processing News

¹⁵⁶ IHS Markit

Sarawak

The Sarawak complex will be 100 percent owned by the State of Sarawak via the Sarawak Economic Development Corporation (SEDC) using Sarawak Petchem, a special purpose vehicle-specific to the project, which was formed in 2017. The project's objectives are to:

- Add value to hydrocarbons produced in Sarawak
- Form the basis for creating an integrated petrochemical hub in the region
- Provide high quality/value employment to attract and return technical talent to the region

Sarawak holds the largest share (54 percent) of Malaysian natural gas reserves, the prime feedstock for the complex. The area is already home to three Malaysian liquefied natural gas (LNG) plants and nine LNG trains, as well as the world's first gas-to-liquids facility, Shell's MDS (middle distillate synthesis) plant, which produces gasoline, kerosene, distillate fuel oil, and lubricants, completed in 1993.

The plant will be located on an 80.9-hectare site and will be supplied with 160 million standard cubic feet per day (MMSCFD) of natural gas feedstock by PETRONAS. A 20-year purchase and sale agreement has been struck with PETRONAS for methanol sales and marketing. The plant is expected to employ 300 people when complete. PETRONAS operates the only other Malaysian methanol plant, a similar-scale facility at Labuan, an island off the coast of Sabah.

The methanol plant is one of two projects by the State of Sarawak to bring manufacturing and associated wealth and employment into the developing area. The second is the planned co-sited ammonia/derivatives complex.

The initial phase of the project is a 5,000 metric tons per day (circa 1.7 million metric tons per year) methanol plant. With a budget of \$2.0 billion, commercial production is expected in 2023. This methanol plant represents the first petrochemical investment in Sarawak.

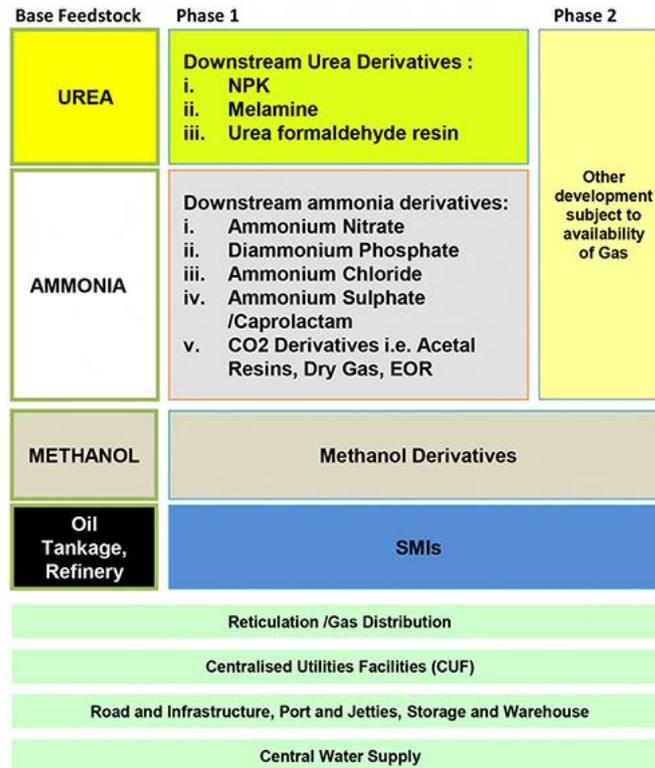
The second phase of the project is the construction of two additional plants: 1) ammonia and 2) methanol derivatives. As well, Sarawak is encouraging all feasible proposals to further extend the state's nascent petrochemical sector with the ultimate intent to turn the area into a petrochemical center.

Sabah

Sabah has dedicated a 4,000-acre site near the sea (and Labuan) for the Sabah Oil and Gas Industrial Park (SOGIP). Sabah Oil and Gas Development Corporation Sdn Bhd (SOGDC) is a wholly-owned company of the state of Sabah designated as the vehicle to own, manage and market SOGIP.

A Master Plan has been completed (*Figure 4*) with an expected first project phase to include methanol, ammonia, and urea. The goal is to house a world-scale (5,000 metric tons per day or larger), single train ammonia-urea plant, ideally the largest in South East Asia.

Figure 4: Sabah SOGIP Plan¹⁵⁷



SEDIA cites the advantages for the project:

1. Natural gas is available at the doorstep
2. Sabah state and PETRONAS have a partnership in the development
3. Sufficient development land is available : 4,065 acres
4. Location is strategic: near shipping lane – close proximity to Labuan, Brunei
5. Sheltered bay: sufficient water depth (16m – 25m) and availability of vessel anchorage
6. Customized tax incentives for SOGIP tenants
7. Minimal socioeconomic impact (relatively unpopulated/little population relocation)
8. Gas within the industrial park, tap from the Sabah Sarawak Gas Pipeline
9. Proximity to trunk road connecting Sabah to Sarawak and Brunei
10. PETRONAS SOGIP fertilizer hub -- opportunities to create downstream opportunities to produce a variety of fertilizer product
11. The agriculture industry in Sabah offers demand for fertilizer locally

Site features include:

- 4,065 acres total (1,820 acres developed and 351 acres occupied)
- Basic Infrastructure including worker quarters and office
- Fiber Optics 100 Mbps

¹⁵⁷ SOGIP <https://sogip.com.my>

- Receives 180 MMSCFD gas
- Land Sub-Lease only 30 years plus renewable for 30 years

PROJECT STATUS AND IMPLEMENTATION TIMELINE

A project feasibility study for the Sarawak methanol plant has been completed. A Phase 2 – Detailed Feasibility study is underway and is expected to be completed in early 2020, with a final investment decision during the first quarter of 2020. Project engineering and construction is expected to begin the second quarter of 2020, with final project delivery fourth quarter of 2022 and operations beginning in 2023. Samsung Engineering Co. Ltd. is expected to be the EPC (engineering, construction, and procurement) contractor.

A Master Plan for the Sabah site has been completed and envisions methanol, ammonia, and urea as the first phase. A second phase would consider additional petrochemicals, subject to natural gas availability. Timing is not firm, and the State is proactively seeking a foreign investor who can bring technology and experience to ensure the project's success.

PROJECT COST AND FINANCING

The Sarawak Phase 1 methanol plant has a budget of \$800 million. The entire project, Phase 1 Methanol, and Phase 2 Ammonia and Derivatives are estimated at \$2.0 billion. Financing is unannounced pending completion of the Phase 2 feasibility work.

The Sabah plant's estimated budget is \$2.5 to \$12 billion depending on plant scale and the products ultimately to be included. It is likely that a first phase methanol plant would be similar in scale and cost to the Sarawak world-scale facility. The project is not yet financed. Incentives, including a ten-year tax holiday, are available.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include:

- EPC contracting (Sabah)
- Design services
- Financing
- Technology providers and licensing
- Catalysts
- Towers
- Compressors
- Pumps
- Valves
- Control systems
- Safety equipment

- Security solutions
- Emissions controls
- Construction supervision and management

That State of Sabah is also desirous of parties with interests in financing/creative business models and/or development of other chemical production to participate.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Sarawak Petchem Sdn. Bhd. Jalan Tun Abdul Rahman 93100 Kuching Sarawak, Malaysia</p> <p>Sabah Economic and Development Investment Authority Lot 1, Wisma SEDIA Off Jalan Pintas Penampang P.O. Box 17251 88873 Kota Kinabalu Sabah, Malaysia Ms. Audrey Lin Mei Hwa audrey@sedia.com.my</p>	<p>Indo-Pacific Region 1101 Wilson Blvd. Suite 1100 Arlington, VA 22209 USA</p> <p>Ms. Shannon Roe sroe@ustda.gov</p> <p>U.S. Trade and Development Agency GPF Witthayu Tower A, Suite 302 93/1 Wireless Road Bangkok, 10330 Thailand</p> <p>Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>Mr. Dennis Simmons Senior Commercial Officer U.S. Embassy Kuala Lumpur 376 Jalan Tun Razak 50400 Kuala Lumpur Phone: 60-3-2168-5000 dennis.simmons@trade.gov</p>

Batangas Integrated LNG to Power		
	SECTOR	Energy
	SUBSECTOR	LNG & Power
	LOCATION	Batangas Province, Philippines
	PROJECT VALUE	\$1.6 billion

PROJECT SUMMARY

The Batangas Integrated LNG Terminal and Power Project is located in Batangas Province, Luzon Island, and the Philippines. The project will have an initial capacity of 3 million metric tons per year of LNG and an integrated combined-cycle power generation unit with approximately 1,100 MW capacity. Future phases will double the LNG regasification capacity. Gen-X Energy, a portfolio company of the Blackstone Group, and LCT Energy and Resources, Inc. (“LCT Energy & Resources”) are co-developing the project

PROJECT DESCRIPTION

The project site (*Figure 1*) is a 38.5-hectare industrial complex located on the east coast of Batangas Bay, at approximately 100 kilometers (by road) south of Metro Manila. The project site is located close to 3,200 MW of existing gas-fired power plants, existing gas distribution infrastructure, a grid interconnection point, oil refineries, and a petrochemical plant.

The project consists of a liquefied natural gas import and regasification terminal and a natural gas-fired, combined-cycle power plant at an existing industrial site located on Batangas Bay at Barangay Pinamucan, Batangas Province, in the Philippines, approximately 100 kilometers (by road) south of Metro Manila.

The LNG terminal will include the following components:

- a jetty with the capacity to unload LNG tankers
- one 180,000 cubic meter full containment LNG storage tank, and
- regasification facilities with a throughput of up to 3.0 million tons annually.

The combined cycle power plant will use the natural gas from the LNG terminal as fuel and will have a nominal gross installed capacity of approximately 1,100 MW and deliver the power to the 500 kV system of the National Grid Corporation of the Philippines.

Figure 1: Project Location



Gen-X Energy, a portfolio company of The Blackstone Group and LCT Energy and Resources, Inc. (“LCT Energy & Resources”), are the developers of the project.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Development Milestones Achieved to Date:

- Entered into commercial arrangements with LCT Energy & Resources, Inc. to jointly develop the project;
- Secured the use of the project site for the development, construction, and operation of the project;
- Commenced various project site activities, including field surveys, geotechnical investigations, and technical studies;
- Completed early-stage engineering and design work for the project; and
- Submitted project application for Notice to Proceed with the Philippine Department of Energy.

Project Schedule:

- Development: Q4 2019 to Q4 2020
- Financial Close and Construction Start: Q4 2020
- Commercial Operation Date: H2 2024

Current Development Activities:

- Undertaking field surveys, geotechnical investigations and conducting technical studies, including a system impact study for transmission interconnection;
- Preparing detailed engineering and design work for the project;
- Preparing an Environmental Impact Assessment for the project site; and
- Undertaking work to obtain various permits and approvals from municipal and national governmental authorities in the Philippines that are necessary for the development, construction and operation of the project, including, but not limited to, an Environmental Compliance Certificate from the Department of Environment and Natural Resources, validating the transmission interconnection with the National Grid Corporation and obtaining the permit to Construct, Expand, Rehabilitate, and Modify the project from the Department of Energy.

PROJECT COST AND FINANCING

The total estimated project cost is approximately USD \$1.6 billion.

The project will be financed with a combination of equity and non-recourse project debt. The invested capital will be mobilized from Gen X Energy and LCT Energy & Resources. Debt financing will be secured from local commercial banks, international lenders, development finance institutions such as the United States' Overseas Private Investment Corporation and other multilaterals and/or export credit agencies.

U.S. EXPORT OPPORTUNITIES

The project will require substantial quantities of LNG, providing significant export opportunities for U.S. LNG suppliers.

The management, planning, finance, project structuring, construction, and commissioning, as well as operations and maintenance services, will be provided by Gen X Energy. Additional U.S. export opportunities include:

- Large gas turbine generators
- Steam generators
- Cryogenic pipes and valve
- Specialized steel alloys for LNG service
- Engineering services
- Legal services
- Banking and financial services
- Inspection and quality control services
- Operations and maintenance services.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>GenX Energy Pte. Ltd. 9/F M1 Tower 141 HV Dela Costa St Salcedo Village, Makati Metro Manila 1227 Philippines Yari Miralo ymiralo@gen-x-energy.com www.gen-x-energy.com</p>	<p>US Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>Embassy of the United States of America 1201 Roxas Blvd., Manila, Philippines 0930 Mr. Greg O'Connor Senior Commercial Officer greg.oconnor@trade.gov</p> <p>Ms. Thess Sula Commercial Specialist thess.sula@trade.gov www.export.gov/philippines</p>

Excelerate Luzon LNG Terminal		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Batangas, Luzon Philippines
	PROJECT VALUE	\$200 million

PROJECT SUMMARY

Excelerate Energy L.P., a Texas-based LNG specialist with 9 regasification units, has received a Notice to Proceed from the Philippine Department of Energy for a Floating Storage Regasification Unit (FSRU) near Batangas. The 4 million metric ton per year LNG terminal is expected to be operational by the end of 2021.

PROJECT DESCRIPTION

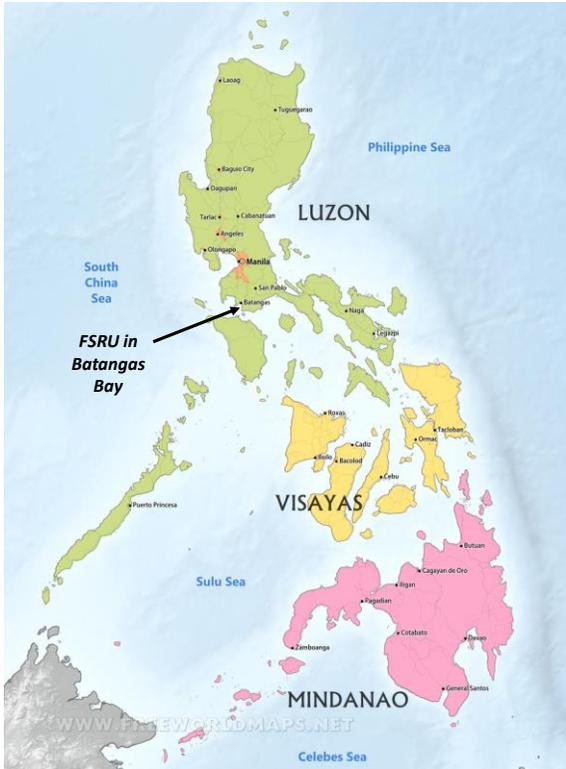
Excelerate’s FSRU LNG terminal received a Notice to Proceed from the Department of Energy on September 20, 2019. The project will be located 9.5 kilometers offshore in Batangas Bay, as shown in Figure 1.

The FSRU will have a capacity of 151,000 cubic meters and the ability to deliver 500 million standard cubic feet daily of regasified natural gas.

In addition to the FSRU, the offshore marine infrastructure includes submerged turret loading buoy mooring system, one pipeline end manifold, and subsea pipelines. Onshore project components include:

- Truck-loading facility
- Small-scale loading facility
- An onshore gas receiving facility

Figure 1: Project Location in Batangas Bay



The project will use a disconnectable submerged turret buoy for the mooring of the FSRU in a double-banked arrangement with LNG carriers (LNGCs). The Luzon LNG terminal will be able to handle LNGCs with nominal cargo capacities in the range of 138,000 to 216,000 cubic meters. The LNG carriers will be moored alongside the FSRU, with LNG transferred to the FSRU via flexible cryogenic hoses. Figure 2 shows an example of this proposed configuration.

Figure 2: LNG Carrier (left) Transfers LNG to the FSRU (right) Offshore



The terminal will use offshore technology specifically designed to perform in extreme weather conditions, like those of the Philippines. This technology has been proven on similar projects in the Gulf of Mexico, Massachusetts Bay, Mediterranean Sea, and, most recently, the Bay of Bengal. Excelerate has a fleet of nine FSRUs.

Many observers conclude that LNG is critical in the Philippines to replace Malampaya gas, which is expected to be depleted within the next decade. San Miguel Corporation Global Power Holdings Corp. (SMCGP), has submitted a letter of intent to purchase LNG from the project. SMCGP, via its subsidiary, South Premier Power Corp., operates the 1,200 Megawatt (MW) natural gas-fired power plant in Ilijan, Batangas.

Excelerate has signed an MOU with a local company called Topline Energy to jointly develop the project. The Topline group of companies has portfolio businesses in fuel, real estate, port development, energy, and technology.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Notice to Proceed (NTP) was issued by the Philippine's Department of Energy (DOE) on September 20, 2019. Excelerate is required to comply with permit requirements and submit proof of financial closing to the DOE within six months of the NTP issuance. If needed, this period could be extended for another six months, pending approval from DOE. Project construction is expected to begin by in the second half of 2020. Commercial operation is targeted for late 2021.

PROJECT COST AND FINANCING

The project submission to the DOE estimated a \$200 million investment for the project, implementation, excluding the cost of the FSRU vessel to be handled under a charter agreement. Excelerate will arrange financing for the project.

U.S. EXPORT OPPORTUNITIES

The project's demand for LNG could easily reach several million tons annually, providing substantial export opportunities for U.S. LNG suppliers. Excelerate Energy is part of a privately held US energy group with significant oil and gas production in North America as well as important midstream assets. Nevertheless, the sourcing of LNG for the project has not been announced.

Excelerate will develop, design, permit, construct, finance, and operate the terminal. Thus U.S. exports would include Excelerate services such as management, planning, finance, and project structuring, as well as operations and maintenance services. U.S. exports for associated project implementation services could include engineering, legal, banking, financial, inspection, and quality control.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Excelerate Energy L.P. 2445 Technology Forest Blvd Level 6, The Woodlands TX 77381 USA Karlman Tham karlman.tham@excelerateenergy.com www.excelerateenergy.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>Embassy of the United States of America 1201 Roxas Blvd., Manila, Philippines 0930 Mr. Greg O'Connor Senior Commercial Officer Greg.oconnor@trade.gov</p> <p>Ms. Thess Sula Commercial Specialist thess.sula@trade.gov</p> <p>www.export.gov/philippines</p>

FGEN Batangas LNG Terminal		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Batangas City, Philippines
	PROJECT VALUE	\$850 million

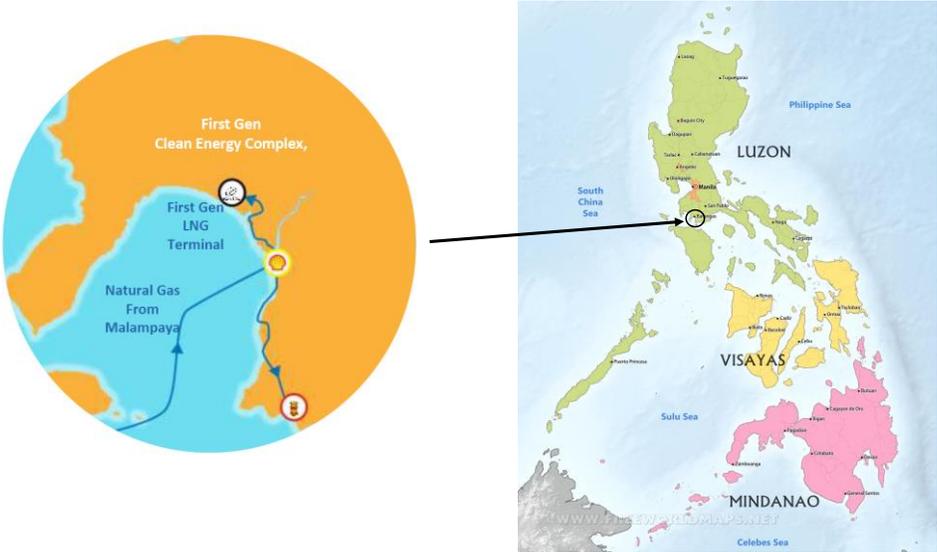
PROJECT SUMMARY

FGEN LNG Corporation, the LNG specialist of First Gen Corporation, the Philippines ' largest independent power producer, proposes to construct and operate an LNG Terminal Project within the First Gen Clean Energy Complex in Batangas City. The project comprises an LNG receiving terminal facility, with components and infrastructure for receiving, storing, and degasifying liquefied natural gas, as well as supplying natural gas through feeder lines to nearby users.

PROJECT DESCRIPTION

FGEN LNG Corporation proposes to construct and operate an LNG terminal project in the Province of Batangas. The project will occupy an area of approximately 21 hectares within the First Gen Clean Energy Complex in Batangas City. Figure 1 shows the project location.

Figure 1: Project Location with Expanded View of Batangas Bay



The project will be able to accommodate a Floating Storage Regasification Unit (FSRU) as early as 2021, after the modification of the existing jetty. The project design contemplates upgrading the terminal and its ancillary facilities in the future to become a hub for international trading and transshipment.

The project (*Figure 2*) will have the following components:

- New unloading facilities for LNG carriers of capacities ranging from 40,000 to 177,000 cubic meters;
- One FSRU of up to 170,000 cubic meter capacity with sendout capacity of 500 to 750 million cubic feet daily as an interim supply solution;
- One 200,000 cubic meter LNG storage tank with a maximum send-out capacity of 5.26 million metric tons per year, including two LNG truck loading bays and provision for a future LNG carrier reloading system for vessel capacities ranging from 5,000 to 40,000 cubic meters; and
- In the future, one additional 200,000 cubic meter LNG storage tank, and maximum send-out capacity increased to 7 million metric tons per year, additional LNG truck loading bays, and the LNG carrier reloading system.

Figure 2: LNG Terminal and the Entire First Gen Clean Energy Complex



The project is intended to serve gas requirements of various gas-fired power plants – affiliates of FGEN LNG as well as third party users – as required by the Philippine Department of Energy Circular 2018-11-0012 under the Philippine Downstream Natural Gas Regulation.

The project is located in districts of Barangays Sta. Clara, Sta. Rita Aplaya, and Bolbok, all within in Batangas City, adjacent to existing gas-fired power plants:

- 1000 MW Santa Rita Power Plant
- 500 MW San Lorenzo Power Plant
- 414 MW San Gabriel Power Plant
- 97 MW Avion Power Plant

PROJECT STATUS AND IMPLEMENTATION TIMELINE

On March 19, 2019, FGEN LNG Corp. received formal approval of its application for a “Notice to Proceed” from the Department of Energy for the construction of the LNG terminal in the First Gen Clean Energy Complex in Batangas City.

Key dates in the project development calendar include:

- Final Investment Decision (FID): Q1 2020
- Construction Period: 48-60 months from FID
- Commissioning Date: 2024

PROJECT COST AND FINANCING

The estimated total cost of the project is expected to be between \$700 million to \$1 billion.

FGEN LNG’s parent company, First Gen Corporation (FGEN), secured approval from the Philippine Securities and Exchange Commission in March 2019 to increase its authorized capital stock by 3 billion Philippine Pesos (\$60 million approximately) by issuing new preferred shares. Although the capital raised is not earmarked for any specific project, it provides the financial flexibility to manage the equity requirement for investment in this project. Aside from FGEN, Tokyo Gas Co. Ltd (Tokyo Gas) is the other sponsor of the project. Last December 5, 2018, Tokyo Gas signed a Joint Development Agreement (JDA) with FGEN in order to take a 20 percent participating interest in the project. Upon reaching FID under the JDA, the parties will enter into a definitive agreement to proceed with the construction of the project.

For debt financing, the sponsors are considering project finance debt from a combination of export credit agencies (ECA), multi-/bi-laterals, and commercial banks, with the objective of achieving the most cost-effective financing for the project. The sponsors may tap corporate finance debt if there is insufficient time to secure project finance debt to meet the target FID date of Q1 2020.

The project will also tap both local and foreign commercial banks. There has been interest from commercial banks, including local banks, as the project has been certified by the DOE as an Energy Project of National Significance. Nevertheless, the final funding plan will be based on the most optimal and competitive credit facilities, including their terms and conditions.

U.S. EXPORT OPPORTUNITIES

First Gen’s LNG terminal project is open to considering competitive and flexible LNG supply from various sources, including from the U.S.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>FGEN LNG Corporation 6/F Rockwell Business Center Tower 3 Ortigas Ave, Pasig City Metro Manila 1604 Philippines Fabian Mangahas famangahas@firstgen.com.ph</p> <p>www.firstgen.com.ph</p>	<p>US Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Shannon Roe sroe@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>Embassy of the United States of America 1201 Roxas Blvd., Manila, Philippines 0930 Mr. Greg O’Connor Senior Commercial Officer greg.oconnor@trade.gov</p> <p>Ms. Thess Sula Commercial Specialist thess.sula@trade.gov</p> <p>www.export.gov/philippines</p>

Meralco Smart Grid		
	SECTOR	Energy
	SUBSECTOR	Transmission and Distribution
	LOCATION	Metro Manila, Philippines
	PROJECT VALUE	Undisclosed

PROJECT SUMMARY

Meralco, the Philippines' largest power utility that distributes energy for the entire Metro Manila area, has announced the roll-out of 3.3 million smart meters by 2024. In addition to advanced metering infrastructure, Meralco’s smart grid program includes advanced network automation as well as supporting telecommunication infrastructure and platform solutions.

PROJECT DESCRIPTION

The objectives of Meralco’s smart grid program are to achieve benefits for the utility as well as its customers. Utility benefits from smart grid deployment include:

- Improved operational efficiency
- Greater intelligence and insights into customers
- Enhanced revenues
- Enhanced network reliability, efficiency, and power quality
- Improved crew and process efficiency
- Accommodation of renewables and other distributed energy resources

Benefits for power customers include:

- Increased energy management and efficiency
- Improved customer experience
- Improved customers’ productivity and quality of life through reduced service interruptions and improved power quality
- Potential savings due to energy conservation

Meralco’s smart grid program has two main pillars – advanced network automation (ANA) and advanced metering infrastructure (AMI). Implementation of both ANA and AMI is supported by a common smart grid platform solution that includes a back-end system, communications infrastructure, and field devices.

ANA: Advanced network automation comprises a number of elements:

- Advanced distribution management system – an integrated system combining both outage and distribution management, including:
 - Fault location, isolation, and service restoration – to decrease the duration of outages as well as the number of customers affected
 - Integrated volt-var optimization – to minimize technical losses and manage voltage variations within acceptable limits
- Advanced asset management – using asset condition sensors and advanced analytics to optimize asset utilization
- Mobility – using mobile devices to support business functions
- Substation automation – to achieve best practices levels
- Control center modernization – upgrading the system control center and operations dispatch centers
- Power Tech – rolling out high tech facility for innovation, research, and development as well as technical training

In a future phase, ANA will be upgraded with additional functions, including:

- Demand response – programs that achieve changes in customers’ consumption behavior to reduce peak demand
- Integration of distributed energy resources – to effectively manage variable renewable energy generators and other customer-sited energy resources
- Electric vehicle management – to enable the monitoring and control of electric vehicle charging stations for optimal grid operation.

AMI: Advanced metering infrastructure will enable the following basic distribution services:

- Remote meter reading
- Consumption monitoring and notification
- Remote connection, disconnection, and reconnection
- Outage detection and notification
- Meter irregularity detection

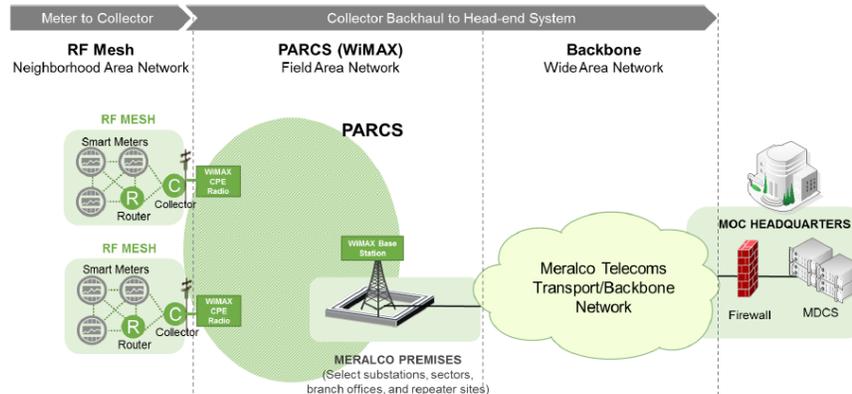
Figure 1 shows the infrastructure needed to implement AMI at Meralco, using radio frequency (RF) mesh to collectors in neighborhood area network, microwave frequency data transmission (WiMAX) in the field area network, and then Meralco’s own telecommunication backbone in the wide-area network.

Additional applications for AMI at Meralco include:

- Prepaid electricity
- Net metering
- Demand response
- Home area network

- Management of distributed energy resources
- Electric vehicle supply equipment management
- Advanced outage management
- Smart street lighting
- Distribution automation infrastructure support

Figure 1: Meralco's AMI Infrastructure



PROJECT STATUS AND IMPLEMENTATION TIMELINE

Meralco kicked off the smart grid program in 2017 with a goal to install 3.3 million smart meters by 2024.

Implementation of the smart grid program requires regulatory approval by the Philippines Department of Energy (DoE). To date, the regulator has approved the roll-out of 140,000 smart meters.

In 2017, the DoE established a smart grid working group to inform new regulations. Industry observers indicate that draft smart grid regulations are expected by the end of 2019. Once these regulations are in place, the pace of smart grid roll-out will increase.

PROJECT COST AND FINANCING

Meralco has not disclosed the total budget for implementing the smart grid program.

Since smart grid investments require regulatory approval, Meralco will finance the smart grid roll-out on its balance sheet.

U.S. EXPORT OPPORTUNITIES

With a goal of installing 3.3 million smart meters by 2024, the largest export opportunity lies in supplying AMI and its communication infrastructure.

Additional export opportunities can be found in:

- Field devices:
 - Smart substations
 - Smart sensors
 - Remote-controlled line devices
 - Mobile devices
 - Customer devices
- Utility Systems
 - Advanced distribution management system
 - Supervisory control and data acquisition systems
 - Intelligent asset management systems
 - Mobile work and outage management systems
 - Distributed energy resources management systems
 - Control center modernization
- Specialized equipment and systems for PowerTech, the innovation, research, and development center.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Red Core Geothermal		
	SECTOR	Energy
	SUBSECTOR	Geothermal Power Generation
	LOCATION	The Philippines (3 Locations)
	PROJECT VALUE	Up to \$200 million

PROJECT SUMMARY

Red Core is in the process of developing several geothermal projects-- the Tiaong-Dolores, the Tayabas-Lucban, and the San Juan -- under a Geothermal Renewable Energy Service Contract (GRESK) granted by the Department of Energy (DOE). Red Core estimates that the Tayabas property in Southern Luzon has the potential for at least 60 MW of geothermal-based power generation.

PROJECT DESCRIPTION

Tayabas Geothermal Power Inc. (TGPI), a special purpose vehicle (SPV), is the developer of the Tayabas geothermal project. TGPI has been granted a Geothermal Renewable Energy Service Contract (GRESK) by the Philippines Department of Energy for the project. TGPI is a wholly-owned subsidiary of Manila-based Red Core Investments Corp.

In addition to Tayabas, Red Core is developing three other geothermal projects on Luzon (*Figure 1*):

- Tiaong-Dolores, including two sub-prospects, one on the west flank of Mount San Cristobal and the other on the southwest flank of Mount Banahaw
- San Juan
- Talim Island

The focus of this discussion will be the Tayabas project. Here, Red Core will explore the geothermal prospect areas with the aim of identifying and proving commercially viable resources to develop into operating power plants.

The Tayabas-Lucban geothermal project occupies 75,006 hectares in the province of Quezon. The site straddles the municipalities of Liliw, Luisiana, Majayjay, and Nagcarlan in Laguna, as well as Lucban, Lucena, Mauban, Pagbilao, Sampaloc, Sariaya and Tayabas in Quezon.

The project area is east of the Tiaong-Dolores geothermal project, across the Mount Banahaw Volcanic complex. Like Tiaong-Dolores, the Tayabas-Lucban project is within the Manila Electric Company's (Meralco's) franchise area. A Meralco transmission line crosses the property.

A number of hot springs such as Bakia, Cagsiay, Mainit, Pablo-Tiaong, and Sampaloc are located within the Tayabas-Lucban area, which is a good indicator of geothermal potential. This potential is further validated by the magnetotelluric (or MT) surveys, resource assessment data, and 3D resource modeling studies completed in late 2015 by Red Core's geothermal consultants.

Figure 1: The Tayabas-Lucban and Other Red Core Projects¹⁵⁸



Geologic Setting

The resource is within a geologic setting strongly suggestive of a shallow magmatic heat source, which should be capable of supporting a significant geothermal system. Geothermal fluids from the Banahaw Volcanic Complex (composed of Mount Banahaw, Mount San Cristobal, and Mount Banahaw de Lucban) supply the area's geothermal reservoirs.

Proximity to the Luzon Grid

The network of the interconnected transmission towers and substations of the National Grid Corp. of the Philippines (NGCP) passes through the contract area. In addition, a major substation of NGCP's South Eastern Tagalog Grid, which services Laguna and Quezon, is located in the town of Tayabas. This connects the contract area to the NGCP's South Luzon grid, which has districts: Bicol, South Eastern Tagalog, and South Western Tagalog and to the North Luzon grid, which services an additional districts.

¹⁵⁸ Red Core

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Red Core is preparing to conduct thermal gradient testing of the Tabayas resource. After thermal gradient testing, resource definition and pre-production drilling will commence.

PROJECT COST AND FINANCING

Red Core has received initial funding from Altura and Associates and the Alberto Soriano Corporation. The company seeks further investment for resource definition. They are in negotiation with other investors and debt providers.

U.S. EXPORT OPPORTUNITIES

Projects like Red Core's require considerable equipment to extract the value of the geothermal resource. The equipment to support the development of the resource, capture, and direct the resource to the power plant and the power plant itself are quite complex.

U.S. export opportunities include:

- Drilling materials and equipment (e.g., muds, casings, valves, blow out preventer, safety equipment)
- Pipes and valves
- Drilling contract services
- Drill casings and gathering pipe
- An integrated geothermal power plant which includes:
 - Pumps, valves, and fittings
 - Steam and turbo generators
 - Heat exchangers
 - Power electronics and transformers
 - Instrumentation and controls
- Substation
- Transmission line

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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SURE Waste to Worth		
	SECTOR	Energy
	SUBSECTOR	Waste to Energy/Waste Management
	LOCATION	The Philippines (3 Locations)
	PROJECT VALUE	\$210 million

PROJECT SUMMARY

SURE Global Waste to Worth Innovations is developing a portfolio of waste-to-energy projects in the Philippines. Three projects are in their current project portfolio. SURE has completed front-end engineering design efforts for three projects at Angeles City, Cabuyao, and Dagupan. Dagupan, the smallest, is furthest along, but all three are progressing. Angeles City and Cabuyao involve source separation, anaerobic digestion, and gasification, producing 8MW and 22 MW of power, respectively. Dagupan involves pyrolysis and production of marine fuel. The fourth project at Bacolod is less developed.

PROJECT DESCRIPTION

SURE is developing these projects, which are part of their waste-to-energy portfolio (*Figure 1*). They are currently negotiating financing and will be entering detailed engineering in early 2020. U.S. engineering firm AECOM prepared feasibility studies for Angeles City and Cabuyao. Additional detailed engineering was done by Brightwave Energy, which worked closely with the combustion equipment suppliers ICM and Regen under a USTDA grant completed in 2019.

Waste-to-energy projects provide a more sustainable method of waste disposal and generate a stream of recycled materials and power. The Philippines still has many unregulated methods of waste disposal and litter. While waste-to-energy plants do not solve the problems, they do offer some incentive to manage the wastes more sustainably. In addition, the plants generate valuable energy.

Unregulated landfills, some adjacent to communities and waterways and the Pacific Ocean, have brought these issues to the attention of many communities and local officials. Besides the projects described here, there are major waste-to-energy projects being developed throughout the Philippines, including Quezon City, Davao City, and Puerto Princessa City.

Figure 1: Locations of the SURE Waste Two Worth Projects



Angeles City

Angeles City, which is a 230 ton-per-day municipal solid waste (MSW) facility, is being done as a joint venture with the local municipal government of Angeles City. Angeles City will supply the land and guarantee the minimum waste delivery to the joint venture. SURE will supply, develop, and operate the project under a 20-year contract.

The city is responsible for managing the hauling contracts (as they do today) and delivering a minimum of 230 tons/day of MSW on average. The project involves waste separation, preparation of refuse-derived fuel, anaerobic digestion of the liquid waste stream, and gasification of the solids waste stream producing gas for combustion and power generation. This project will generate approximately 8 MW of net power.

The ownership of the project is Sure Global Philippines W2Wi Inc. The project will be managed by a special project vehicle (SPV, named Angeles W2W), which has already been registered with the SEC. The city is not an equity partner.

Cabuyao

The second project is a private development with SB Hain in the City of Cabuyao. SB Hain is a major waste management firm operating in the Philippines and is the waste management contractor for the city of Cabuyao. Their contracts include waste collection for several cities, including Cabuyao and landfill operations. This is the largest of the projects at 650 tons per day. In this project, SURE will own and operate the facility. SB Hain will supply the waste for a fee under a guarantee arrangement. SB Hain will receive a percentage of SPV's revenues based on a formula tied to the amount of waste they deliver to the project.

The Angeles City and Cabuyao projects were supported by grants from Procter and Gamble and the Asian Development Bank. AECOM was hired to conduct the feasibility studies for those two sites.

Dagupan

The third project is with the City of Dagupan. Dagupan is a small coastal community with an unsecured waste dump that must be closed. They have agreed to work with SURE to implement the waste-to-energy facility that uses Regen technology. The project will convert 30 tons per day of MSW into marine diesel oil and biogas. The marine diesel oil will be blended with other diesel and sold to the local fishing industry for marine fuel. The municipality will serve as the waste supplier and landowner.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

All three of the projects have completed front-end engineering design. Concessions are in place for all three. Angeles City and Dagupan have received their environmental permits. Angeles City and Cabuyao projects are scheduled to enter a two-year procurement and construction phase within the next six months.

Dagupan has received approval from the municipality to begin construction. Dagupan is scheduled to begin construction before the end of 2019. The construction period is expected to be approximately one year.

A recent article in National Geographic features SURE Waste to Worth and the Dagupan project¹⁵⁹.

PROJECT COST AND FINANCING

Sure Waste 2 Worth estimates the CAPEX to be \$210 million for the four projects identified in the SURE portfolio. They are seeking equity investors for each of their projects.

The Angeles City project is estimated to have a capital expenditure of approximately \$38 million, with an all-in cost of approximately \$45 million.

The Cabuyao project is expected to require an investment of \$75 million.

Dagupan is estimated to cost \$15 million. The developer is seeking an additional \$2 million in equity. Dow Chemical has agreed to be an equity participant. The development bank of the Philippines will be providing project debt. The Development Bank of the Philippines will be providing project debt.

Procter and Gamble has been an early supporter of the projects and has provided funding for project development. USDA and the Asian Development Bank have provided grant funding for the projects.

¹⁵⁹ <https://www.nationalgeographic.com/science/2019/10/partner-content-others-see-waste-she-sees-worth/?fbclid=IwAR1QBKyftIO17UqV1uIW0p1OD3vXpn2nZu9-Bdo0a2HsZQ23rx9bXMEPYUk>

The feed-in tariff (FIT) for biomass and hydro in the Philippines was extended in January 2018 for three years or until the quota is filled. The waste-to-energy projects are included in the biomass category for FIT purposes. The current quota for biomass is not filled. The value of the FIT is Php 6.6 per kWh (approximately \$0.13/kWh).

U.S. EXPORT OPPORTUNITIES

The Grantee has selected the major equipment suppliers. Two principal U.S. suppliers of the thermal section of the plants are ICM Inc. and Regen Fuels and Energy. ICM will manufacture its process units in Kansas.

The U.S. export opportunities for the projects are shown.

- Engineering and Construction Management Services
- Waste Separation Press
- Anaerobic Digester
- Pumps
- Gas Cleaning System
- Conventional Incinerator
- Emissions control technologies
- Electrical Systems
- SCADA, Controls, Automation,
- Magnets and scales
- Turbines
- Air Handling and Combustion Systems
- Steam Generators/Boilers
- Loaders and Trucks

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Blue Solar 42 MW Solar Farm with Storage		
	SECTOR	Energy
	SUBSECTOR	Renewables (utility-scale solar plus storage)
	LOCATION	Suphan Buri, Thailand
	PROJECT VALUE	\$40 million

PROJECT SUMMARY

Blue Solar Co., Ltd. of Thailand, is seeking to develop an up-to 42 MW solar PV farm, with integrated 12 MW, 54 MWh battery energy storage system. This will be one of the first utility-scale battery energy storage projects, privately developed in Thailand. It is being developed under Thailand’s Small Power Producer (SPP) Hybrid Power Purchase Agreement (PPA) model.

PROJECT DESCRIPTION

Blue Solar Co., Ltd., a private sector Thai company, has been developing solar projects domestically since 2015. Their first project, which began operations in March 2016, installed solar rooftop solutions on 66 households, providing 450 kWh of power. Their next installation was also in 2016 and involved working with agricultural cooperatives to develop and operate 2 x 5 MW solar farms, selling the power to the Provincial Electricity Authority (PEA). The current project, Blue Solar’s first industrial-scale solar farm (*Figure 1*), is planned for an up to 42 MW capacity and an integrated 12 MW battery energy storage system.

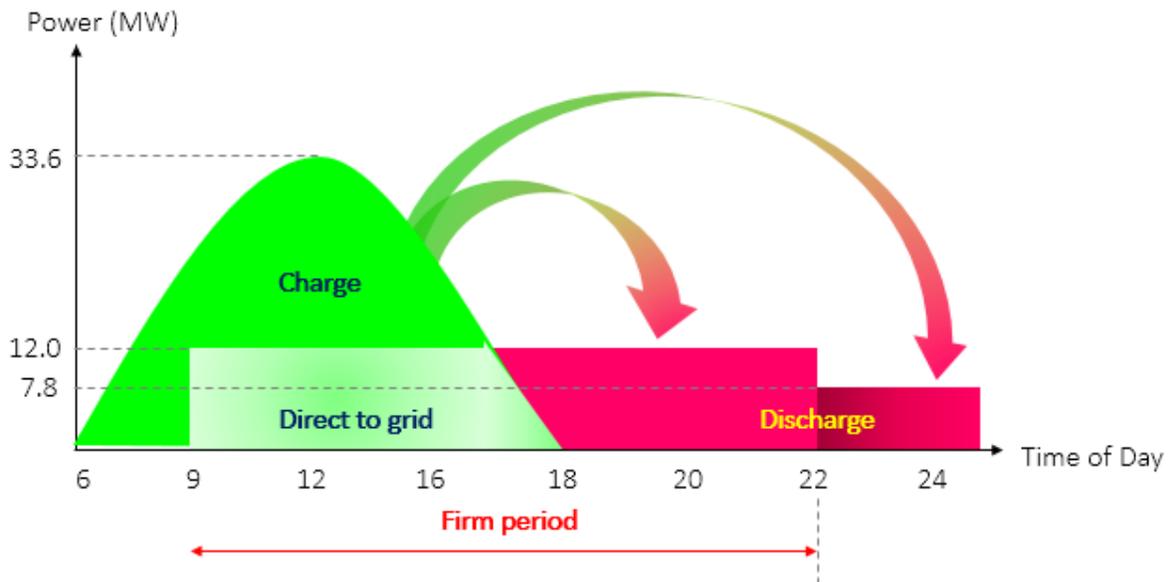
The project is located in Suphan Buri on land that is privately owned by the company and currently being used for rice farming. It is only 10 km from the main commercial and city center in Suphan Buri. This project is one of the first private sector deployments of a utility-scale solar form with integrated battery storage. It is also one of 17 renewable energy projects that were designated by Thailand’s Energy Regulatory Commission (ERC) to produce up to 300 MW of new, renewable energy under the SPP Hybrid PPA model.

Figure 1: Conceptual Design of Blue Solar farm¹⁶⁰



This hybrid PPA model, as detailed in (Figure 2) below, involves a contract of providing 12 MW to the grid. From 9am to 10pm, Blue Solar must supply this power (the firm period). The company has the ability to sell power outside of this time window as well, using the energy stored in the batteries. The proposed volume in the non-firm period (10pm to 9am) is 7.8 MW. The offtaker of the power will be the Energy Generating Authority of Thailand (EGAT), who will purchase electricity via the PEA grid.

Figure 2: Blue Solar hybrid structure¹⁶¹



¹⁶⁰ Blue Solar

¹⁶¹ Source: Blue Solar

The size and output of the solar farm will be determined over the course of the feasibility study and during its initial operating period, as the quality of energy supply is evaluated. When initially proposed, Blue Solar planned for a 42 MW facility, though Thailand's ERC announced the size of 35.6 MW. Over the life of the project, Blue Solar can request increases up to a total of 50 MW. In addition, it is possible to use tracker panels to increase energy yield by taking advantage of greater solar inputs.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

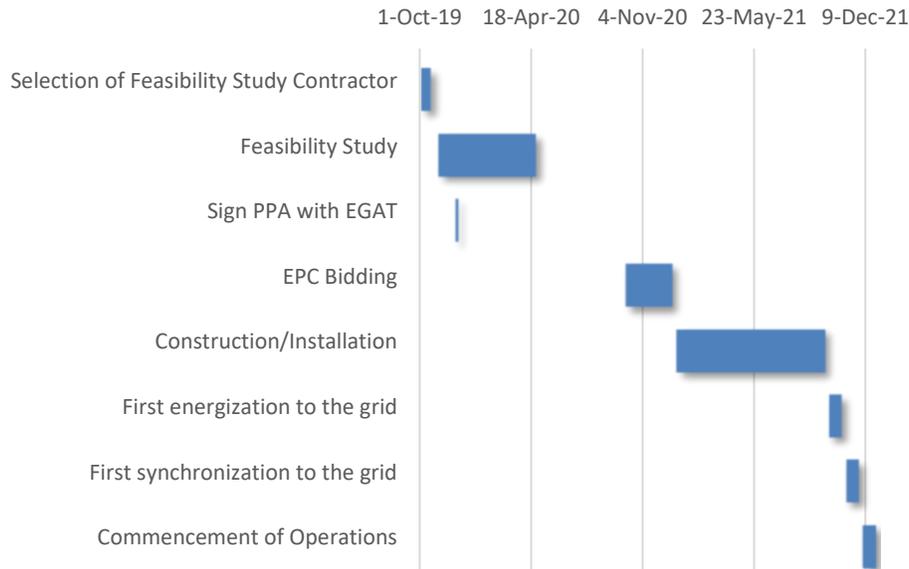
On August 14, 2019, the U.S. Trade and Development Agency (USTDA) signed a \$553,000 feasibility study grant with Blue Solar. The contractor that will conduct the feasibility study is currently being selected, and once underway, the study is expected to be completed within six months. The tasks of the feasibility study include:

- Determine the optimal project size of solar PV and storage to maximize IRR
- Determine optimal equipment selection and system design
- Analyze technical viability
- Review legal and regulatory issues
- Determine potential financing options
- Prepare documents for to advance Project's financing and tendering

Following the completion of the feasibility study, Blue Solar will move toward implementation, with the selection of equipment and an EPC contractor in 2020 and installation and kick-off planned for 2021. The supply to the grid is scheduled for the end of 2021 (*Figure 3*). For the firm to take advantage of the SPP Hybrid PPA, the plant will need to begin commercial operations before the end of 2021.

There is no need for an environmental impact assessment for this project, provided it is developed in line with the Code of Practice from the Energy Regulatory Committee of Thailand. From the environmental aspect, as the land is currently rice paddies, engineers will need to take into account the possibility of flooding when constructing the facility. Public consultations have occurred and have not raised any concerns that would prevent the project from moving forward.

Figure 3: Timeline for Blue Solar Farm development¹⁶²



PROJECT COST AND FINANCING

The cost of solar power with energy storage facility is estimated to be \$40 million. It will be financed through a combination of mechanisms. Approximately 75 percent of the project cost will come from a project finance loan, with a long tenor and low-interest rate. Conversations are already ongoing with local Thai lenders. The remaining 25 percent will be raised by publicly listing the company on the Stock Exchange of Thailand.

Given its position in the SPP hybrid PPA program, the feed-in tariff (FIT) is the same for the Firm and Non-Firm Periods. The FIT structure for this plant is:

$$FIT = THB\ 0.6878/kWh\ (fixed) + THB\ 1.85/kWh\ (to\ be\ annually\ adjusted\ with\ inflation)$$

U.S. EXPORT OPPORTUNITIES

Blue Solar has already begun speaking with firms regarding sources of supply for batteries, solar panels, and associated components. U.S. firms with technologies related to battery storage, racking, inverters, and tracking components will be competitive for opportunities associated with this solar project. The battery selection is seen by Blue Solar as the biggest challenge at this stage, as it attempts to achieve the best performance at the lowest cost.

Specific opportunities that may arise from the Blue Solar farm and integrated battery storage facility include:

¹⁶² Blue Solar

- Engineering and design
- Racking
- Inverters
- Solar panels
- Solar trackers
- Batteries
- Telecommunications
- Cabling
- Flood protection technology

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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EGAT Floating Storage and Regasification Unit		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Offshore; Gulf of Thailand
	PROJECT VALUE	Est. \$1.3 billion

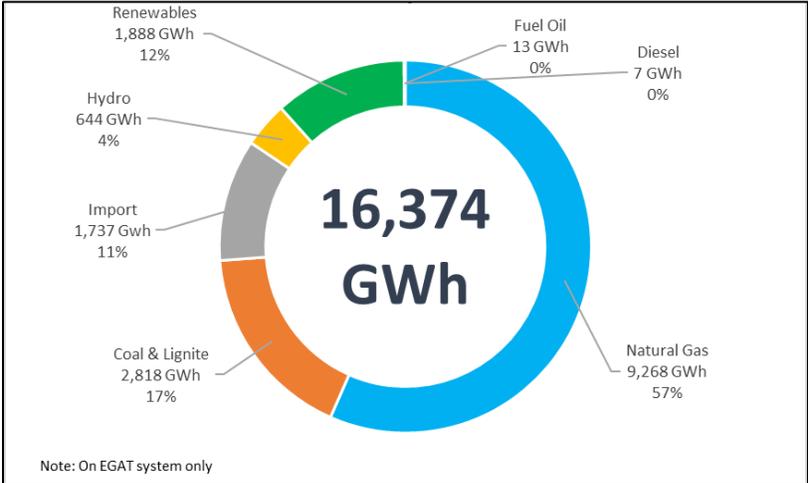
PROJECT SUMMARY

The Electricity Generating Authority of Thailand (EGAT) is in the final stages of approvals before beginning construction of a five million ton floating storage and regasification unit (FSRU). The FSRU will be located approximately 20 kilometers offshore in the Gulf of Thailand and will supply two of EGAT’s Bangkok-based power plants with natural gas. The EPC contracts are expected to be in place by the end of 2020.

PROJECT DESCRIPTION

In 2018, Thailand’s gas-fired generation capacity was nearly 29 GW, representing 61 percent of the overall generation in the country. Generation rates are similar to capacity rates, with natural gas remaining at nearly 60 percent of generated power (*Figure 1*).

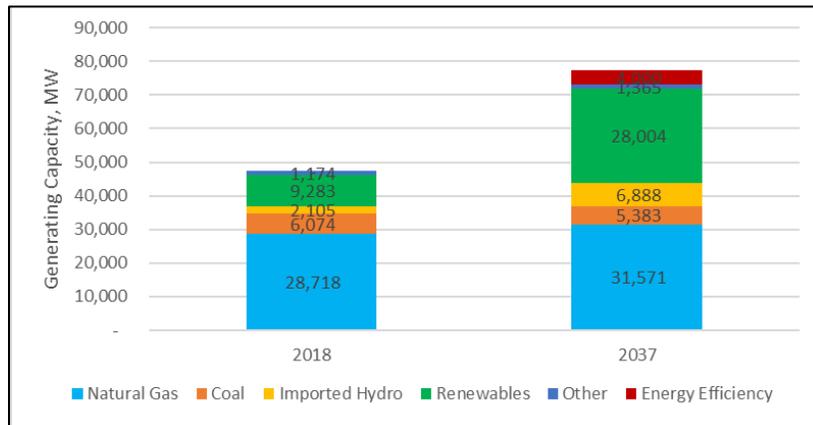
Figure 1: Thailand’s Total Electricity Generation by Fuel Type, January 2019¹⁶³



¹⁶³ EGAT

In the country’s updated Power Development Plan (PDP) that extends through 2037, gas generation capacity will increase by an additional 19.5 GW, resulting in an anticipated market share of 41 percent (*Figure 2*). While the overall capacity will increase, market share will decrease due to an increase in renewable energy generation and retirements of assets.

Figure 2: Thailand’s Current and Projected Generating Capacity¹⁶⁴



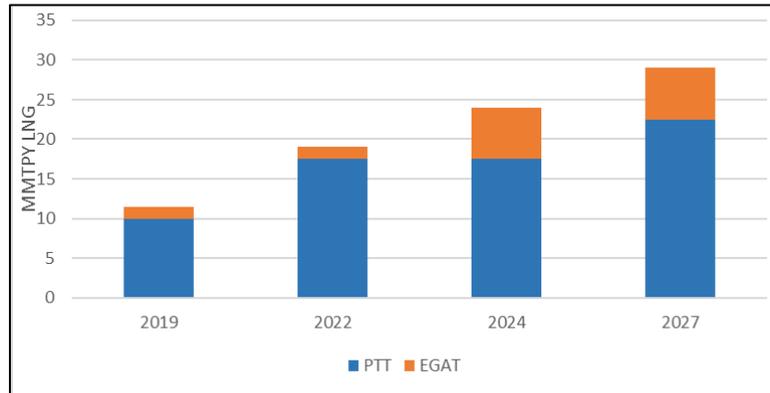
Thailand plans to expand its use of, and capacity for, liquefied natural gas (LNG) and become a regional hub. Presently, Thailand has one LNG receiving terminal with a capacity of 11.5 million metric tons per year (MMTPA), located in the Map Ta Phut terminal in Rayong, on the Gulf of Thailand. Of that total, 10 MMTPA is allocated to PTT, Thailand’s national oil and gas company, while the remaining 1.5 MMTPA is available for use by EGAT, who is currently in negotiations to import this quantity of gas.

This LNG terminal is being expanded through the addition of a new 7.5 MMTPA terminal, the Nong Fab Terminal, which is slated for operation in 2022. A third onshore expansion phase is planned to add an additional 5.0 MMTPA to the area and is expected to be operational by 2027.

Offshore, EGAT is currently in the final stages of studying the construction and implementation of a 5.0 MMTPA FSRU, to be located in the Gulf of Thailand. When completed, it will bring Thailand’s total LNG terminal capacity to 29 MMTPA (*Figure 3*).

¹⁶⁴ EGAT and EPPO

Figure 3: Thailand LNG Import Capability¹⁶⁵



EGAT's FSRU (Figure 4) will be located 20 kilometers offshore and will be linked by pipeline to two of their power plants that supply the municipality of Bangkok: Bangkok North Power Plant, a single fuel plant, and Bangkok South Power Plant, a dual-fuel power plant. The plants are located approximately 38 kilometers from the coast of the Gulf of Thailand. Together, these plants supply 3 GW to help supply the power needs for Bangkok.

Figure 4: FSRU¹⁶⁶



The FSRU is currently in the final stages of the front-end engineering design (FEED) study that is being conducted by the U.S. firm, Fluor Corporation. This study focused on the FSRU itself, along with the jetty, and onshore and offshore pipelines with facilities. The FEED study will be completed by the end of 2019.

¹⁶⁵ Petroleum Institute of Thailand

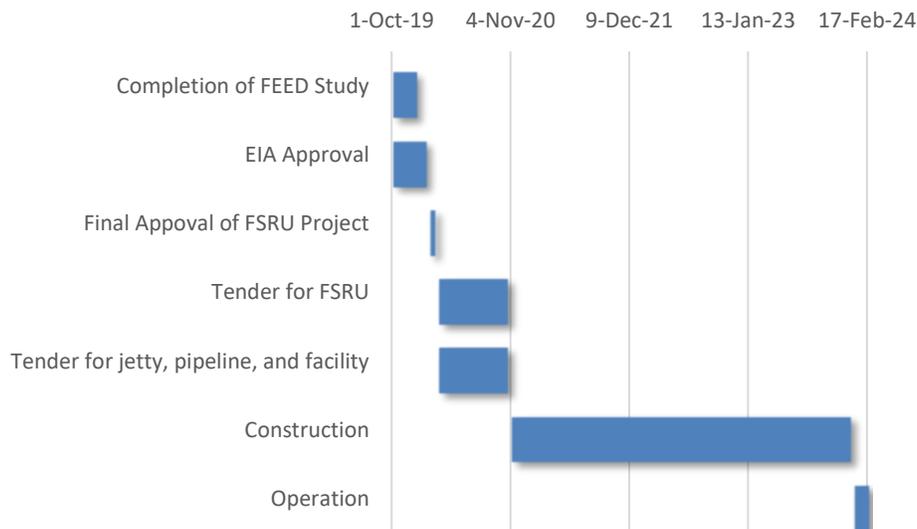
¹⁶⁶ <https://accelerateenergy.com>

In an effort to liberalize the gas market, EGAT was granted a license from the Energy Regulatory Commission (ERC) to import gas, making it only the second permitted importer for the country, in addition to PTT. EGAT is required to import LNG at a price less than the lowest contracted price of PTT. While EGAT has neared finalization of a contract with an international supplier for 0.8 to 1.2 million tons of LNG to be imported through the terminal at Map Ta Phut, the deal has been put on hold by the Thai government, citing the possibility of oversupply of LNG in the market. The current utilization of the Map Ta Phut terminal is approximately half of installed capacity, though LNG demand and usage will both increase significantly in the coming years as the domestic gas available in the Gulf of Thailand is depleted.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The FEED study for EGAT’s FSRU is scheduled for completion before the end of 2019 (*Figure 5*). The environmental impact assessments (EIA) for each of the three elements of the project (pipeline, jetty, FSRU) have been submitted to the government for approval, and EGAT is in the processing of responding to any questions posed by the review committee. It is expected that the EIA will receive final approval in Q1 2020. All of the public consultations have been completed. Following the approval of the EIA, EGAT will move to tender two EPC packages: one for the construction of the facility, jetty and pipeline, and the second for the construction of the FSRU itself. The tender will be an international competitive bid, with the procurement decisions made by EGAT and ratified by their Board of Directors. The EPC contracts are expected to be awarded before the end of 2020, with the terminal to be finished by 2023 and operational by 2024.

Figure 5: FSRU Project Schedule¹⁶⁷



¹⁶⁷ EGAT

PROJECT COST AND FINANCING

The estimated cost of the entire project, including jetty, FSRU, and pipeline, is approximately \$1.3 billion. The final cost of the project itself will be subject to change based on decisions regarding how it will be structured. For instance, should EGAT choose to procure and own the FSRU vessel, the overall cost will be greater. If a leasing option is chosen, the overall capital cost will likely decrease.

The project will be self-financed through the EGAT Fund.

U.S. EXPORT OPPORTUNITIES

The EPC contracts that will be tendered will be made through international competitive bidding. U.S. firms have shown interest in supporting the development of this project and will be welcome to participate, along with vendors from other countries. EGAT is open to sourcing the gas itself from the United States, though ultimately, the decision on the origin of the gas will depend on price, among other factors.

Specific opportunities for potential involvement in this \$1.3 billion project include:

- Construction and Engineering
- Project Management Contracts
- Civil Works
- Marine works and jetty
- Moorings
- Unloading arms
- FSRU provider
- IT systems, controls, and instrumentation
- Pipeline materials
- Safety systems
- LNG

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Siam Cement Group Pyrolysis		
	SECTOR	Energy
	SUBSECTOR	Waste to Energy
	LOCATION	Saraburi, Thailand
	PROJECT VALUE	\$3 million (Pilot Phase) \$30 million (Phase I) \$TBD million (Phase II)

PROJECT SUMMARY

Siam Cement Group (SCG), as one of the largest companies in Thailand, has begun developing a pyrolysis project as part of its focus on the circular economy and greenhouse gas emission reduction. The project supports the reduction of CO₂ in the cement business unit, with the objective of converting plastic waste and/or used tires to fuel oil and carbon black, which can then be used as an alternative fuel in the cement manufacturing process.

PROJECT DESCRIPTION

In SCG’s cement business line, significant amounts of energy for combustion are consumed to produce clinker. The primary fuel for this combustion process is coal. However, SCG is committed to reducing the amount of coal used in its facilities, pursuing a “zero coal” policy. Within 3-4 years, the company expects to reduce its coal inputs to cement kilns (*Figure 1*) by approximately 50 percent.

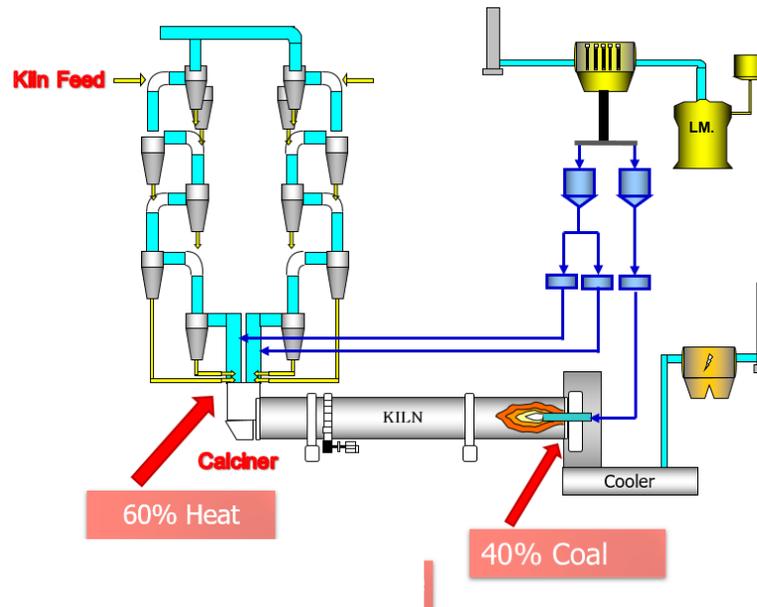
Figure 1: SCG cement kiln¹⁶⁸



¹⁶⁸ SCG

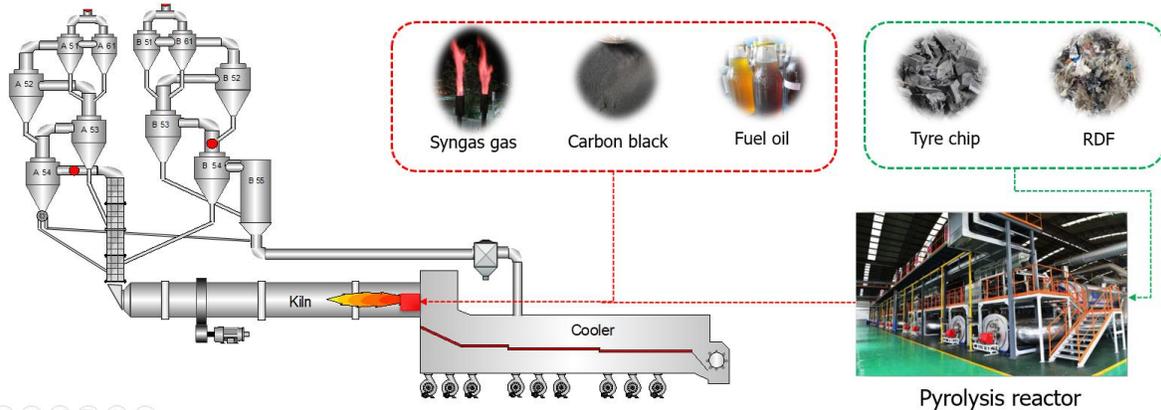
In line with this coal reduction policy and reducing CO₂ emissions, alternative fuels like biomass and plastic waste are used to replace coal consumption in the rotary kiln (*Figure 2*). However, due to the poor combustion quality and chloride content in plastic waste, coal replacement is limited to some percentage. Currently, these types of replacement fuel only make up approximately 10 to 20 percent.

Figure 2: Location and heat portion of fuel usage for clinker production in cement plant¹⁶⁹



To increase the replacement percentage of coal consumption by alternative fuel, SCG has been studying pyrolysis. Pyrolysis converts solid waste like plastic waste or waste tires, to liquid, solid, and gaseous fuels (called pyrolysis oil, carbon black, and syngas respectively) in a separate process. The resulting fuels have a higher energy content and lower chloride content than the original solid waste. Figure 3 shows how a pyrolysis reactor can be incorporated into a cement plant.

Figure 3: Pyrolysis feedstock and fuel output for cement plant¹⁷⁰



¹⁶⁹ SCG

¹⁷⁰ Ibid

SGG is planning to use plastic waste called RDF-2 (Figure 4, Table 1, and Table 2) or waste tires (Figure 5, Table 3) as feedstock for the pyrolysis plant. The RDF and waste tires would be sourced from Bangkok and combined with existing recycled material from one of SCG’s Saraburi cement production facilities. A supply of RDF-2 or waste tire fuel of up to 80,000 tons/year and more is available.

Figure 4: Plastic waste RDF-2

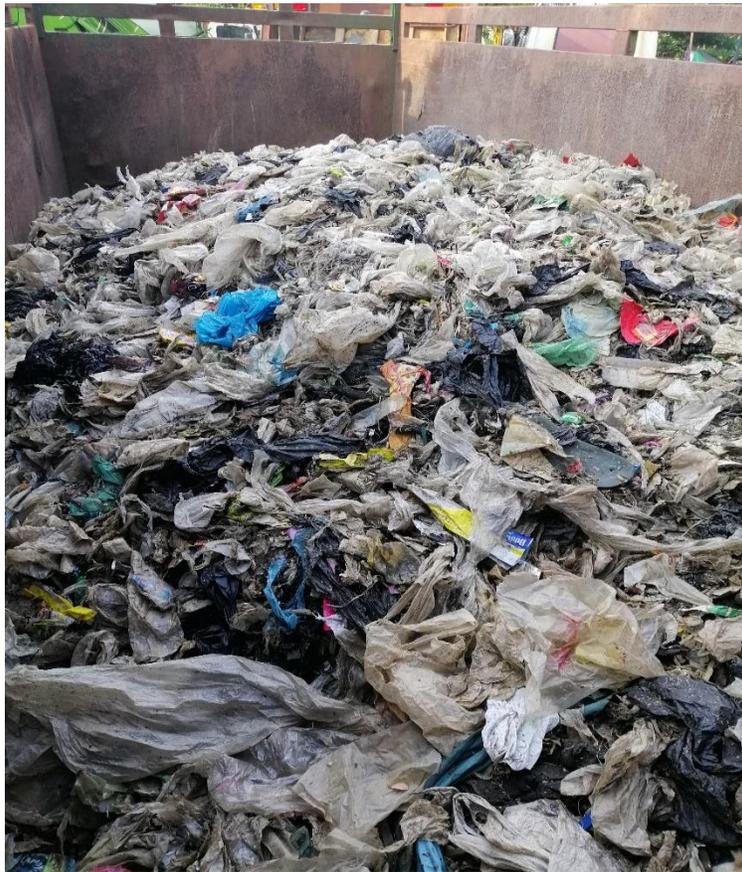


Table 1: Composition of plastic waste RDF-2¹⁷¹

Material composition	Percent
Plastic	84.8
Fabric	10.1
Wood	3.5
High strength plastic	1.4
Plastic foam	0.1
Rubber	0.1
Total	100

¹⁷¹ SCG

SCG is planning a pilot project to replace five percent of coal inputs on one production line at one of their cement plants in Saraburi, Thailand. The replacement fuel would be made from the pyrolysis of waste tires or RDF-2 and burned in the cement kilns. Should the pilot program be proven successful and economical, it can be replicated across all of SCG’s cement facilities in the region – 11 total production lines, at five locations in Thailand, two in Vietnam, and one each in Laos, Cambodia, and Myanmar – at a scale much greater than five percent replacement. By replacing the coal with RDF and waste tires, SCG is able to reduce overall emissions, including CO₂.

Table 2: Proximate/ultimate analysis of plastic waste RDF-2¹⁷²

Feedstock waste tire			AVG
Analysis result	LHV	kcal/kg	4,825
	Chloride	%	0.34
	Bulk density	Kg/L	0.075
Ultimate analysis	C	%	44.7
	H	%	10.9
	O	%	36.8
	N	%	0.4
	S	%	0.1
	Total		
Proximate analysis	Moisture	%	32.5
	Ash	%	6.6
	Volatile	%	60.4
	Fixed carbon	%	0
	Total		

Figure 5: Waste tires and rubber chips¹⁷³



¹⁷² SCG

¹⁷³ Ibid

Table 3: Proximate and Ultimate Analysis of Waste Tires¹⁷⁴

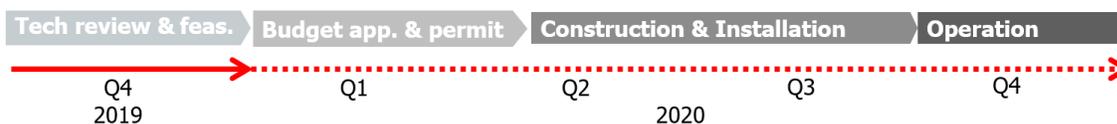
Approximate analysis (as received)	Percent
Fixed carbon	8
Volatile matter	74
Ash	17
Moisture content	1
Total	100

Ultimate analysis	Percent
C	56
H	7
O	17
N	0
S	1
Total	100
LHV (kcal/kg)	6,500

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Currently, SCG is studying various types of pyrolysis technologies and shall review and select the most appropriate option by the end of 2019 or Q1 of 2020 at the latest. Immediately following technology selection, SCG plans to build a pilot pyrolysis plant with capacity 20 to 40 tons/day and finish installation within 2020 (Figure 7). Ultimately, the company would like to use two million tons/year across its network.

Figure 7: Project Implementation Timeline of First Pilot Pyrolysis Plant, 2019-2020¹⁷⁵



If the performance of the first pyrolysis plant is good, SCG will increase the scale of the project and install more pyrolysis plants across additional cement plants in 2020-2022.

SCG has begun the application process for the correct permits and licenses to incorporate this new process at their facility in Saraburi. There is no need for an additional environmental impact assessment. All of the permits and approvals will be in place within the first quarter of 2020.

¹⁷⁴ SCG

¹⁷⁵ Ibid

PROJECT COST AND FINANCING

The investment cost of the total pyrolysis system for a pilot project (2020) is \$3 million, and investment for Phase I (2020-2022) is \$30 million. The overall investment will depend on the results of the feasibility study of the project. Pending the results of the feasibility study and Phase I, the solution may be rolled out to additional plants across SCG's network at a similar scale for each plant, resulting in even larger investments across all plants.

Additionally, SCG would be open to establishing a joint venture with a foreign partner/technology provider to build and operate a pyrolysis facility in Thailand. This facility would sell the pyrolysis oil, carbon black, and/or syngas directly to SCG cement production facilities, as well as other cement producers interested in reducing their coal use.

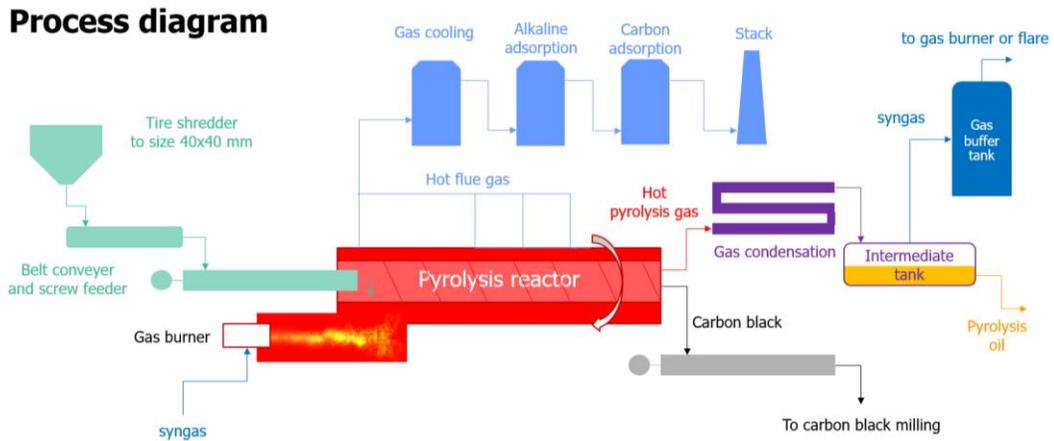
U.S. EXPORT OPPORTUNITIES

The pilot project will be undertaken using open, competitive international bidding. U.S. firms are encouraged to bid on each of the component parts listed below. European and Chinese firms have already expressed interest in these opportunities. As well, SCG is interested to learn of U.S. financiers interested in establishing a joint venture pyrolysis facility.

The pyrolysis system equipment being sought by SCG:

- Feedstock pre-treatment and feed conveyor (shredder and dryer (if needed), feed conveyor) (green portion of the diagram below)
- Pyrolysis reactor, (red portion of the diagram below but not limited to the rotary reactor)
- Gas condensing unit and oil storage tank, (the purple portion of the diagram below)
- Carbon black conveyor, (the grey portion of the diagram below)
- Gas treatment unit, (blue portion of the diagram below)
- Bas buffer tank or flare, (the navy portion of the diagram below)

Figure 8: Pyrolysis Equipment Diagram¹⁷⁶



CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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¹⁷⁶ SCG

Bac Lieu Clean Energy		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Bac Lieu Province, Vietnam
	PROJECT VALUE	\$3 billion

PROJECT SUMMARY

Delta Offshore Energy (DOE) is developing an integrated LNG terminal and combined-cycle gas turbine (CCGT) power plant in the Mekong Delta, Vietnam. DOE has signed a memorandum of understanding (MOU) with General Electric (GE) to provide technical and business development support for its CCGT technology. The build-out capacity of the CCGT plant is expected to be 3,200MW.

PROJECT DESCRIPTION

Delta Offshore Energy (DOE) has a binding MOU with the People’s Committee of Bac Lieu Province, Vietnam, to develop and invest in an integrated 3,200MW LNG-to-power project (Figure 1).

Figure 1: Bac Lieu Clean Energy Project Site in Bac Lieu Province



The project includes a floating LNG (FLNG) receiving, storage and regasification terminal, along with mooring and a pipeline to the power plant gate. The power station will require approximately three million metric tons per year LNG offtake, with the exact amount subject to negotiation of capacity hours with EVN.

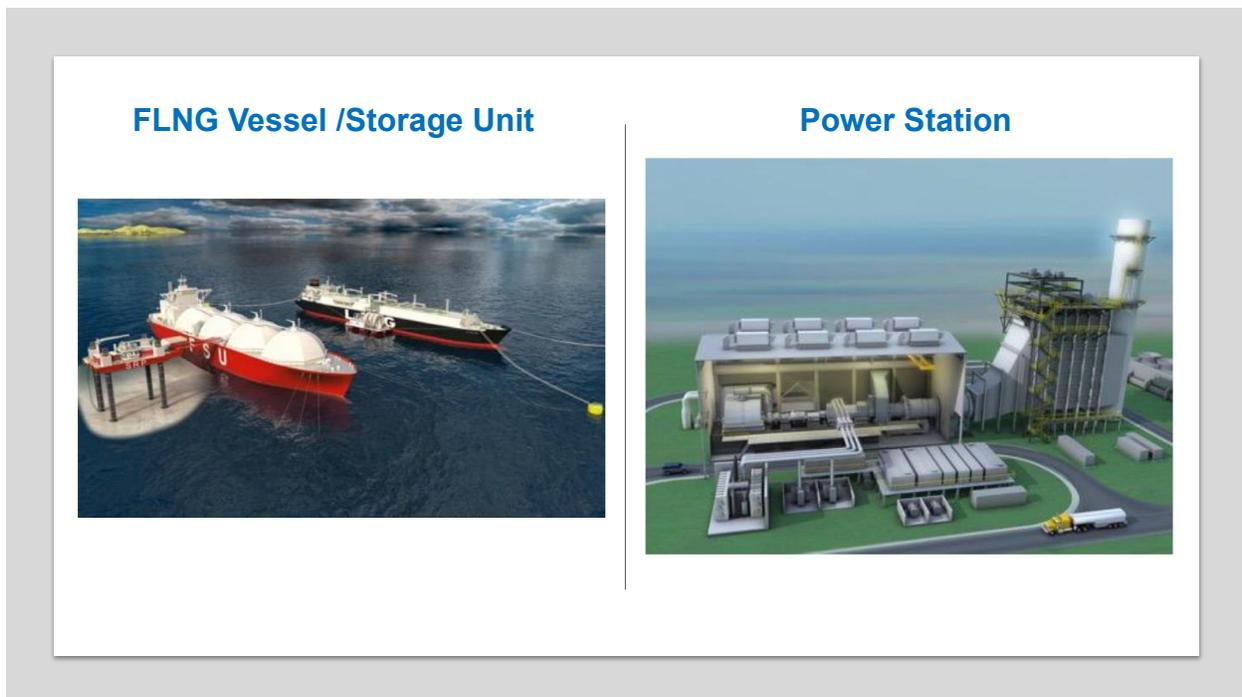
Excess capacity of the terminal can be used to toll gas subject to Gas Sales and Purchase Agreements (GSPAs) between LNG suppliers and other third parties (e.g., gas-fired power plants, fertilizer plants, industrial parks, downstream petrochemical distributors, et al.).

Key elements of the project's conceptual design include:

- Jetty-less floating terminal with an autonomous transfer system
- Self-installing regasification jack-up platform
- Floating storage unit
- GE 9HA high efficiency, air-cooled gas turbine

Key design aspects of the Bac Lieu Clean Energy Project are illustrated below (*Figure 2*).

Figure 2: Bac Lieu Clean Energy Project Design Features



The project has selected the GE 9HA high-efficiency, air-cooled gas turbine. The GE turbines have proven track records across locations matching the conditions for this project. Based on consultations with the engineering teams at GE, the project will utilize the 9HA.02 unit at 544 MW. In a combined cycle, this equates to 768MW per block, each of which will represent one phase in the rollout of the project. The 9HA.02 features a simplified air-cooled architecture,

advanced materials, and proven operability and reliability. The economies of scale created by this high-power-density gas turbine enable the cost-effective conversion of fuel to electricity at more than 63 percent combined cycle efficiency.

The coastal conditions around the Mekong Delta favor the use of a floating storage solution for LNG supply. The storage vessel will be situated offshore from Bac Lieu Province. The project has incorporated several solutions that will meaningfully improve the efficiency of the maritime elements of the project. An offshore bathymetric survey of one square kilometer for the LNG terminal has been completed.

Onshore, 100 hectares of land have been secured for storage, gasification, and power generation.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The target Commercial Operations Date for the first 750MW phase is 2023. Delivery of each of the subsequent 750MW phase is expected to take place at subsequent six-month intervals.

The project has been offered an accelerated timeline for approvals that should substantially reduce the time to final investment decisions in exchange for providing a fully private solution to Vietnam's strategic energy needs. Under the terms of the project's agreements, the Government of Vietnam has committed to delivering all of the agreements, licensing, permits, and other approvals required to facilitate financing within 12 months.

PROJECT COST AND FINANCING

CAPEX for project implementation is expected to exceed \$3 billion.

The investment implementation will be governed by the new Vietnam Law on Investment. Key features of this new law include:

- The project's special purpose vehicle will have the Enterprise Registration Certificate issued under the name Bac Lieu Clean Energy (BLCE). BLCE is a 100 percent private foreign direct investment company (i.e., there is no element of ownership by a state-owned enterprise). BLCE will have the development and investment rights to the Project.
- The power purchase agreement will be negotiated using an internationally bankable template.
- Government guarantees and undertakings are not subject to the constraints, conflicts, and sequences in the process typically applied to build-operate-transfer (BOT) projects.

The project sponsors believe this new structure will facilitate the equity raise for project implementation.

Debt financing for the project is expected to blend financing from multilateral and bilateral development financing institutions, as well as commercial entities.

U.S. EXPORT OPPORTUNITIES

The largest U.S. export opportunity for this project is LNG shipments:

Australia-listed Liquefied Natural Gas Ltd (LNG Ltd.) announced in September 2019 it signed a deal with a province in Vietnam to supply liquefied natural gas (LNG) from its Louisiana-based Magnolia project. Two million metric tons of LNG per year will be supplied from its Magnolia project, which locks in a buyer for 25 percent of the supply from the project.

Significant U.S. exports will also be generated as a result of the MOU between the project and GE for the series 9HA gas turbines. Additional U.S. exports will be generated by the project's strategic alliances with Baker Concrete Construction, Inc. and McDermott. Further U.S. export opportunities will exist for capital goods, as well as services, during all project phases – development, financing, construction, and operation.

Additional U.S. export opportunities during the implementation phase include:

Systems

- Unloading systems
- Moorings
- Fire protection
- Seawater in/out
- Port spill control
- SCADA systems

Equipment

- Gas turbines
- Gas compressors
- Balance of plant

Services

- Engineering, Procurement, Construction (EPC)
- Jetty construction

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Cap Mei Ha LNG-To-Power		
	SECTOR	Transportation/Energy
	SUBSECTOR	LNG
	LOCATION	Vung Tau Province, Vietnam
	PROJECT VALUE	\$3 billion

PROJECT SUMMARY

The Cai Mep Ha LNG-to-Power Project is located in Vung Tau Province in Vietnam. Initially, the project will have a capacity of three million metric tons per year LNG and 3,000MW power generation. Future phases will increase LNG capacity to 9 million metric tons per year and power generation to 6,000MW.

PROJECT DESCRIPTION

The Cai Mep Ha LNG-to-Power Project consists of an LNG import terminal with the capacity to process 3 MTPA of LNG, and a 3,000 MW gas-fired, combined-cycle gas turbine (CCGT) power plant. The proposed project also has the potential for LNG expansion in three incremental phases of three million metric tons per year each and in 1,500 MW expansions for power generation to 4,500 and 6,000 MW.

During the first phase of the project, composed of the first three million metric tons per year LNG import terminal and the 3,000 MW CCGT power plant, the project represents over \$3 billion of investment, with potential for future investment to support planned expansions. The project also provides an opportunity for U.S. LNG exporters to access a market with annual LNG purchases initially valued at over \$900 million, with obvious potential for this amount to grow.

The project is located in the Cai Mep Ha area, Phu My town, Ba Ria, in Vung Tau province (*Figure 1*). The aerial view (*Figure 2*) provides a closer detail of the project site.

The location of the Cap Mei Ha Project is ideally suited for an LNG-to-power project:

- Close proximity to an existing deep shipping channel
- In open water, so marine traffic congestion is not a concern
- Near existing transmission lines for the ability to transport power
- Near existing power plants (Phu My and Nhon Trach plants, representing 5,200 MW of installed capacity currently)
- Near existing gas pipelines (potential to tie into or use rights-of-way for expansion)

- Close proximity to major electricity demand center of Ho Chi Minh City

Gen-X Energy, a portfolio company of the Blackstone Group, is developing the Cap Mei Ha LNG-to-Power project.

Figure 1: Location of Project with Expanded View of Southern Provinces

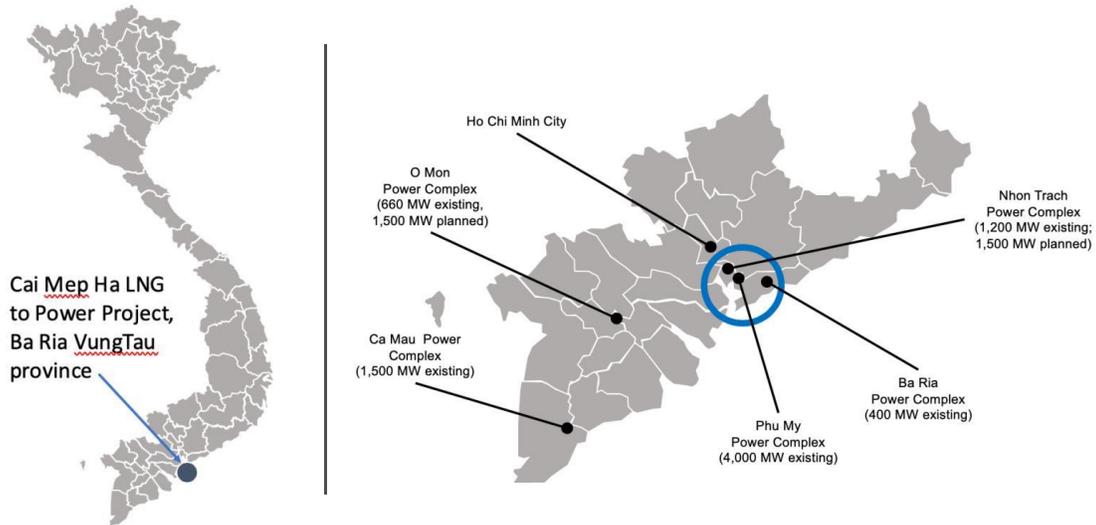


Figure 2: Aerial View of Cai Mep Ha LNG-to-Power Project Site



PROJECT STATUS AND IMPLEMENTATION TIMELINE

Present development milestones are:

- Approval and inclusion for the Project in the MOIT Power Master Plan (expected the first quarter of 2020)
- Execution of core Memoranda of Understanding (MOUs) for the Project (e.g., with EVN / MOIT, etc.) (expected first quarter 2020)

Phase I project planning includes:

- Financial Closing: first quarter 2022
- Construction start: first quarter 2022
- Commercial Operation Date (COD): first quarter 2025

The target dates for financial closing for Phases II and III are 2025 and 2028, respectively.

Gen X Energy has submitted an investment proposal and project proposal to the Ba Ria Vung Tau province and worked with their local staff/agencies to obtain formal permission to use 200 hectares of land for the project. Ba Ria – Vung Tau province has submitted a letter to the Prime Minister to request the approval of the project investment policy, and the Government Office has assigned MOIT to address this request.

Gen X Energy has also met with Deputy Prime Minister Vuong Dinh Hue and MOIT Minister Tran Tuan Anh to discuss the project. Both have offered initial positive feedback and support, as reported in the local press. The project is now awaiting approval to be included in the adjusted Master Plan VII.

PROJECT COST AND FINANCING

Total estimated investment capital for the entire project is \$6 billion, with Phase 1 being \$3 billion, Phases 2 and 3 estimated at \$1.5 billion each.

The project will be financed by a combination of equity and non-recourse project debt. The invested capital will be mobilized from Gen X Energy (backed by Blackstone) and other investors. Debt financing will be secured from international lenders such as the Overseas Private Investment Corporation (OPIC) and other multilateral and/or export credit agencies, as well as domestic, commercial banks, in line with the implementation schedule for the Project.

U.S. EXPORT OPPORTUNITIES

The project's first phase will require approximately 3 million metric tons per year of LNG, providing substantial export opportunities for U.S. LNG suppliers.

The management, planning, finance, and project structuring, as well as operations and maintenance services, will be provided by Gen X Energy. Additional US export opportunities include:

- Large gas turbine generators
- Steam generators
- Cryogenic pipes and valves
- Specialized steel alloys for LNG service
- Engineering services
- Legal services
- Banking and financial services
- Inspection and quality control services
- Operations and maintenance services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Gen X Energy 3 Temasek Avenue Level 18 Centennial. Tower Singapore 039190 Khanh Phan kphan@gen-xenergy.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Blvd. Arlington, Virginia USA Ms. Shannon Roe sroe@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>U.S. Embassy in Hanoi 170 Ngoc Khanh St Hanoi Vietnam Ms. Tuyet Trees Tuyet.Trees@trade.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service Diamond Plaza, 8F 34 Le Duan Street, District 1 Ho Chi Minh City Vietnam</p> <p>Mr. Nam Tran nam.tran@trade.gov</p>

EVN Generation Portfolio Expansion		
	SECTOR	Energy
	SUBSECTOR	Power Generation
	LOCATION	Throughout Vietnam
	PROJECT VALUE	\$7 billion

PROJECT SUMMARY

EVN, Vietnam’s state-held power company, is undertaking three significant expansion projects within its generation portfolio:

- Quang Trach I and II Thermal Power Plants (TPP) – Two supercritical and two ultra-supercritical coal-fired units totaling 2,400MW.
- O Mon III and IV CCGT – Four combined cycle gas turbine generation units totaling 2,100MW.
- Dung Quat I and III CCGT – Two combined cycle gas turbine generation units totaling 1,500MW.

PROJECT DESCRIPTION

Vietnam Electricity (EVN) is a state-owned company with the mission of ensuring sufficient electricity for national socio-economic growth. EVN is active in all aspects of the power business:

- **Generation:** EVN has a total installed capacity of 28,169MW, representing 58 percent of Vietnam’s power generation. EVN directly owns 10,540 MW of that generation capacity and controls the remaining through 100 percent ownership of GENCO1 (6,938MW), GENCO2 (4,496MW), and GENCO3 (6,195MW).
- **Transmission:** EVN owns the National Power Transmission Corporation (EVNNPT), which has 7,517km of 500 kilovolts (kV) lines and 17,360km of 220 kV lines.
- **Grid Operation:** EVN manages the operation of the national power system through the National Load Dispatch Center.
- **Distribution:** Five regional distribution companies serving the North Central, and South regions as well as Hanoi and Ho Chi Minh City

The growth in power demand in Vietnam over the past decade has ranged from 10 to 12 percent annually. This trend is forecasted to continue over the near- to mid-term period. New power generation capacity is required to meet this growing demand.

Figure 1 shows the location of these three projects within Vietnam. Further descriptions of each project follow.

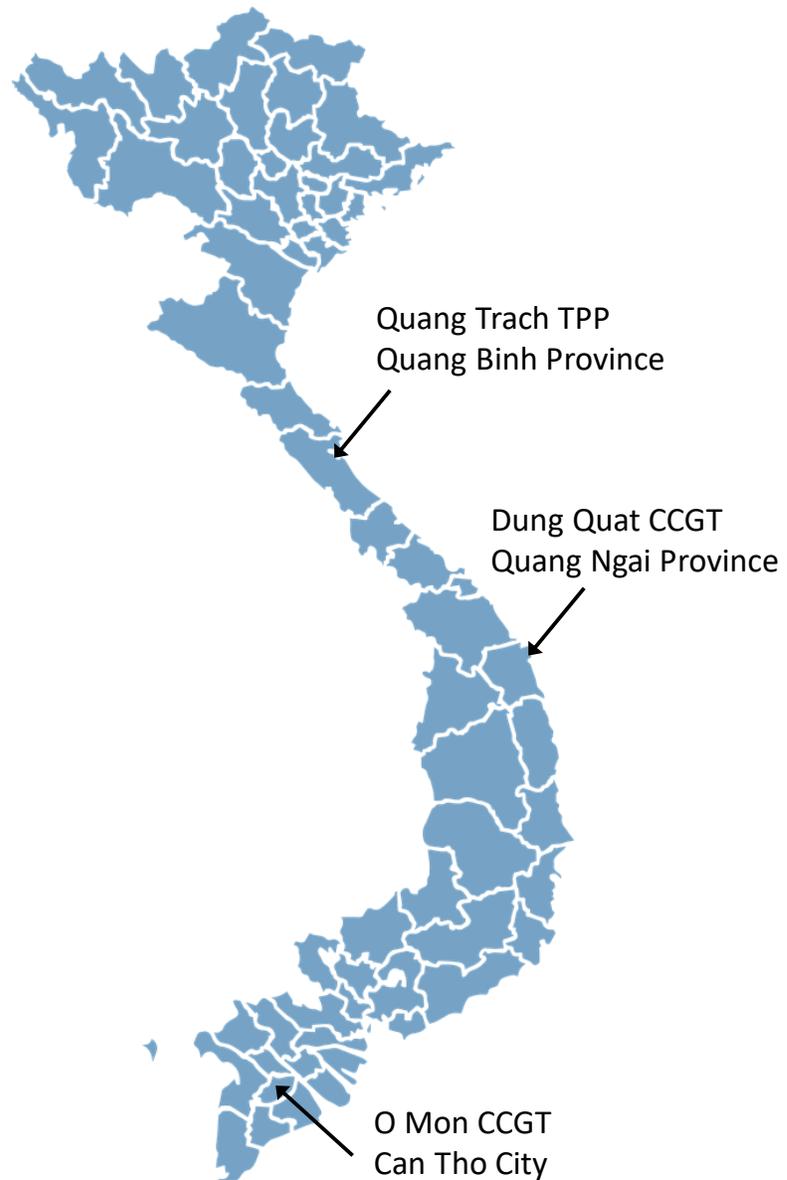
Quang Trach I and II Thermal Power Plants: The Quang Trach Power Complex consists of two 1,200 MW projects under development in Quang Binh province. Groundbreaking took place on the two-unit Quang Trach 1 project in July 2011. The power plant was originally scheduled to enter into service in 2015.

The project had been delayed due to the economic downturn. In October 2016, EVN took over the project, due to delays by the original developer, PetroVietnam. In November 2018, EVN completed land acquisition for the project and began upgrading the access road.

Quang Trach 1 will utilize supercritical combustion technology, whereas Quang Trach 2 will use ultra-supercritical coal combustion. Both plants will be equipped with seawater flue gas desulfurization and electrostatic precipitators.

O Mon III and IV CCGT: The O Mon Power complex, located in Can Tho City in the Mekong Delta region, has been operational since 2009. Unit 1 of the original power plant was commissioned in 2009 and unit 2 in 2015. O Mon II is planned but does not have a developer. EVN is developing O Mon III and IV.

Figure 1: Location of EVN Projects



Both O Mon III and IV are a single unit, combined cycle gas turbine (CCGT) power plants of 1,050MW each. O Mon I is a dual fuel-fired power plant (oil and gas). O Mon III and IV are designed to fire natural gas from a new pipeline connecting the power complex to the Block B field.

Dung Quat I and III CCGT: The Dung Quat Power Complex is planned for construction in Dung Quat Economic Zone, Binh Son District, Quang Ngai Province. The Dung Quat Power Complex will comprise of three CCGT power plants with a capacity of approximately 750 MW per each. The plant will use gas from the Blue Whale gas field, expectedly to be operational from 2024 to 2026.

The Dung Quat I and Dung Quat III power plants are being developed by EVN and are scheduled to be operational in 2023 and 2024, respectively. Dung Quat II, BOT power plant, has signed a power sales agreement with EVN. The plant is being developed by Sembcorp (Singapore) and is scheduled to be put into operation in 2024. The Dung Quat power complex could be expanded in the future.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

All six power plants at three power complexes listed in this profile are included in the Power Development Plan version 7 approved in 2011 and updated in 2016. They are all permitted.

Target operation dates for these six plants are:

Power Plant	Startup
Quang Trach I	2023
O Mon IV	2023
Dung Quat I	2023
Dung Quat III	2024
O Mon III	2025
Quang Trach II	2025

PROJECT COST AND FINANCING

Each of the six power generation projects in this portfolio has its own structure and financing sources. Nevertheless, the power complexes involve shared infrastructure. Reported financial magnitudes are:

- Total investment in Quang Trach I is VND 42 trillion (\$2 billion)
- Approved financing for O Mon IV is VND 13.9 trillion (\$650 million)
- The three combined cycle gas turbine power plants Dung Quat I, II, and III and the Shared Infrastructure project being planned at Dung Quat Power Complex site have a total investment cost of about \$2.5 billion.

The total investment amount of this portfolio of generation projects is estimated to be \$7 billion.

Regarding financing mechanisms for power generation projects, The Ministry of Industry and Trade recently observed:

Domestic corporations and project owners have struggled to finance projects since the Government put the loan guarantee policy on hold. There is only a limited source of ODA and concession loans invested in power projects. Sometimes though loan commitments of international banks and financial institutions had been obtained, state management authorities disapproved. It is very difficult to mobilize local sources of finance because most local banks have exceeded their credit limits to the project owners and relevant stakeholders.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities include:

- Large gas turbines
- Steam generators
- Flue gas cleanup systems
- SCADA systems
- Engineering services
- Legal services
- Banking and financial services
- Inspection and quality control services
- Operations and maintenance services

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>EVN 11 Cua Bac St Ba Dinh Dist. Ha Noi Viet Nam Contact to be named for each project activity www.evn.com.vn</p>	<p>U.S. Trade and Development Agency 1101 Wilson Blvd. Arlington, Virginia USA Ms. Shannon Roe sroe@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>U.S. Embassy in Hanoi 170 Ngoc Khanh St Hanoi Vietnam Ms. Tuyet Trees Tuyet.Trees@trade.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service Diamond Plaza, 8F 34 Le Duan Street, District 1 Ho Chi Minh City Vietnam</p> <p>Mr. Nam Tran nam.tran@trade.gov</p>

Mui Ke Ga LNG		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Binh Thuan Province, Vietnam
	PROJECT VALUE	\$5 billion approx.

PROJECT SUMMARY

The project is an integrated LNG terminal with a 3,600MW combined cycle, gas turbine power plant. The project location is in Mui Ke Ga, Binh Thuan province, about 100km north of Ho Chi Minh City. The project’s lead developer is Energy Capital Vietnam LLC.

PROJECT DESCRIPTION

The project will consist of a floating regasification and storage unit (FRSU) and an onshore power plant with associated facilities. Offshore project components will be located near the cape known as Mui Ke Ga. The onshore project elements will be located in Tan Thanh Commune, Ham Thuan Nam District, in Binh Thuan Province. Figure 1 shows the project location.

Figure 1: Mui Ke Ga LNG Project Location

The project site corresponds with one of the locations studied in a recent IFC report assessing twelve potential LNG terminal locations in the southern region of Vietnam. The twelve potential sites were narrowed down to five candidates that were studied in great detail, including Mui Ke Ga. Criteria for selecting and evaluating the five sites included:

- Proximity to power plants and natural gas pipeline connections
- Met-ocean exposure conditions and sheltering



- Bathymetry (water depth) for navigation and mooring of FSRU and LNG carrier

Metoccean conditions include both operational conditions (including effects from long-period waves (swells)) and extreme conditions (including effects from survival conditions such as typhoons). The IFC study concludes that all sites have technically viable solutions that could offer cost-effective electricity for Southern Vietnam. CAPEX at the five sites varies from \$102 to \$158 million for the assessed solutions. CAPEX at the Mui Ke Ga site was among the lowest estimated in the IFC report, \$112 million. Further site details are shown in Figure 2.

Figure 2: Further Details of Project Location¹⁷⁷

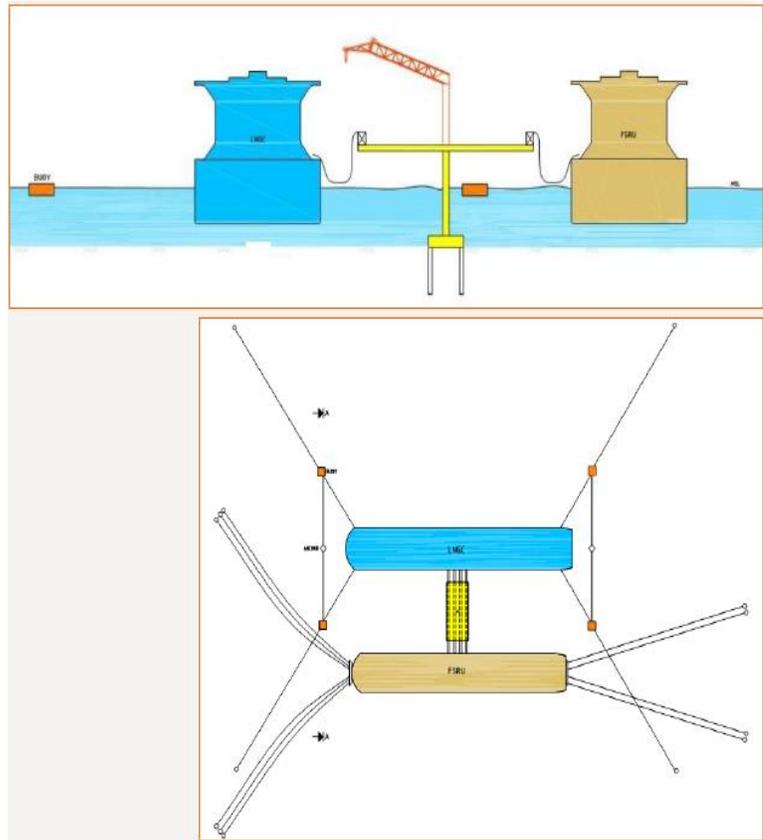


¹⁷⁷ IFC

Key observations from the initial site assessment include:

- Semi-permanent mooring is feasible for FSRU.
- Sea conditions are too rough for reliable ship-to-ship transfer.
- FSRU would need to depart under typhoon conditions (mooring must be disconnectable, but not necessarily quickly).
- FSRU must be Moss-type or membrane type with reinforced tanks (for sloshing).
- Motions of the FSRU and LNG carrier need to be decoupled, as shown in Figure 3.

Figure3: FSRU and LGNC Configuration



The proposed configuration and mooring solution is:

- Spread mooring (in-line tensioned) for the FRSU
- Multi-Buoy Mooring (MBM) for the LNGC
- Aerial transfer tower between the two vessels
- Transfer would be across a platform, with cryogenic hoses on each end

Additional features of the project include:

- Three phases of CCGT build-out, each consisting of two units of 600MW each phase, for a total capacity of 3,600MW.
- LNG to be sourced from a portfolio of suppliers to assure supply security.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Key milestones achieved to date include:

- A pre-feasibility study prepared by KBR
- A market study prepared by KPMG

- US Commercial Service Advocacy achieved in 2018
- MOU with the People’s Committee of Bin Thanh that supports project development and includes 113 hectares of land available for onshore facilities

Commercial operation is forecasted for the end of 2024. The front-end engineering design is underway. Other ongoing project development activities include permitting, licensing, and negotiating project agreements.

PROJECT COST AND FINANCING

The sponsors are using an order of magnitude estimate of capital expenditure on the order of \$5 billion. This figure will be revised as further information becomes known. Phase I has a total capital expenditure of about \$1.5 billion.

The target financing structure calls for two-third debt financing and one-third construction and equity hybrid financing. The overall project structure will be supported by sovereign credit enhancement and honed risk mitigation. Debt financing is expected from both commercial entities and international financial institutions.

U.S. EXPORT OPPORTUNITIES

U.S. export opportunities exist in various phases and aspects of the project:

- LNG (operational phase): Candidate terminals for exporting US LNG to the project include Sabine Pass, LA; Corpus Christi, TX; Quintana, TX; and Hackberry, LA. LNG exports to the project represent the largest single item of export opportunities.
- Gas turbines (construction phase).
- Specialized equipment items and systems (construction phase) for both the LNG terminal and the onshore facilities, including the CCGT.
- Additional services (implementation phase): including engineering, legal, banking, financial, inspection, and quality control.
- Operation and maintenance services once the project is operational.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Energy Capital Vietnam Highland Park Place 4514 Cola Ave. Suite 600 Dallas, TX 75205 USA Thanh Truong truong@ecvholdings.com www.ecvholdings.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Blvd. Arlington, Virginia USA Ms. Shannon Roe sroe@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>U.S. Embassy in Hanoi 170 Ngoc Khanh St Hanoi Vietnam Ms. Tuyet Trees Tuyet.Trees@trade.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service Diamond Plaza, 8F 34 Le Duan Street, District 1 Ho Chi Minh City Vietnam</p> <p>Mr. Nam Tran nam.tran@trade.gov</p>

Son My LNG Terminal And Son My 2 CCGT		
	SECTOR	Energy
	SUBSECTOR	LNG
	LOCATION	Vietnam, Binh Thuan Province
	PROJECT VALUE	\$3.1 billion (Phase I)

PROJECT SUMMARY

The Son My LNG Import Terminal is a greenfield project to be located in Binh Thuan Province of Vietnam. Phase I will have a capacity of six million metric tons per year to serve new and existing combined cycle power generators. PVGas (61 percent) and The AES Corporation (AES) (39 percent) are co-developing the project. Électricité de France (EDF) will be the operator.

Simultaneously, AES is also developing the Son My 2 Combined Cycle Gas Turbine (CCGT) power plant, rated at 2,250MW, and will be its operator.

PROJECT DESCRIPTION

The Son My LNG Terminal will be located on a 100-hectare plot in the Son My 1 Industrial Zone. The site is in Binh Thuan province in South Central Vietnam. The nearest city is Vung Tau, about 75km from the project site (*Figure 1*).

Figure 1: Son My LNG Terminal Location



The LNG project will include the following components:

Offshore Facilities

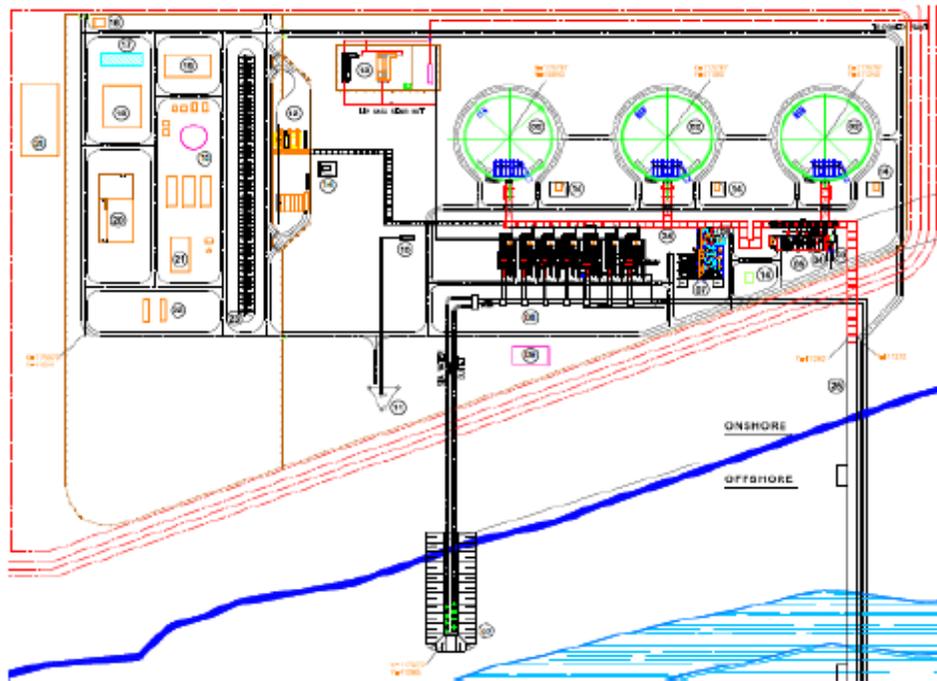
- LNG tanker jetty
- LNG transfer station
- Ship servicing station
- LNG transfer pipeline

Onshore Facilities

- LNG transfer pipeline
- LNG storage tanks
- Boil-off gas compression
- LNG pumping units
- Regasification units
- Cryogenic storage support units
- Compressed gas storage cylinders
- Compressed natural gas manifold

A schematic of the proposed onshore and offshore facilities is provided below (*Figure 2*).

Figure 2: Son My LNG Terminal Project Layout



The Son My LNG terminal is being developed by PVGas (61 percent) and AES (39 percent). The first phase of the Son My LNG Terminal will have a capacity of six million metric tons per year, of which 3.6 will be consumed by the new Son My Power Complex, including Son My 1 (operated by EDF) and Son My 2 (operated by AES). The remaining 2.4 million metric tons per year will

be consumed by the existing Phu My Power Complex in Vung Tau city, which has a generation capacity of about 4GW.

The second phase of the LNG terminal will increase capacity by 3.6 million metric tons per year. The LNG supplied by Phase 2 will be supplied to future industrial customers.

The Son My 2 CCGT project is located near the Son My LNG Terminal and is part of the overall Son My Power Complex. The Son My Power Complex includes Son My 1 CCGT and Son My 2 CCGT, each with a capacity of 2.25GW.

In accordance with the recent approval by the Government of Vietnam, AES was granted approval to develop Son My 2 CCGT using imported LNG and will involve the construction and operation of a high-efficiency and environmentally sustainable CCGT plant, for a 20-year period.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The projects have received initial approval. The present development effort includes environmental impact studies and permitting. Construction is forecast to commence in 2021, with commercial operation starting in 2024.

PROJECT COST AND FINANCING

The estimated capital expenditure for LNG Phase I (6 MTPY) is \$1.4 billion. This capital investment will be anchored by firm fixed gas purchase agreements with combined cycle power generators at the Son My and Vung Tau Power Complexes. The estimated cost for Son My 2 CCGT is \$1.7 billion.

The project sponsors will provide and arrange equity financing. Debt financing for the project is expected to blend financing from multilateral and bilateral development financing institutions, as well as commercial entities.

U.S. EXPORT OPPORTUNITIES

The largest U.S. export opportunity lies in the possibility of supplying LNG to the project under firm gas supply arrangements. At present-day market prices, this export opportunity is valued at over \$2 billion annually. Additional U.S. export opportunities during the implementation phase include:

Systems

- Unloading systems
- Cryogenic load arms
- LNG storage

- Vaporization units
- Boil-off gas recycle
- Fire protection
- Seawater in/out
- Port spill control
- SCADA systems

Equipment

- Gas turbines
- LNG transfer pumps
- Gas compressors
- ISO tanks

Services

- Long term maintenance contract with OEM
- Engineering

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Phu Cuong Nearshore Windfarm		
	SECTOR	Energy
	SUBSECTOR	Renewables
	LOCATION	Viet Nam, Sóc Trăng Province near the coastline of Vĩnh Châu
	PROJECT VALUE	\$300 million (approx.)

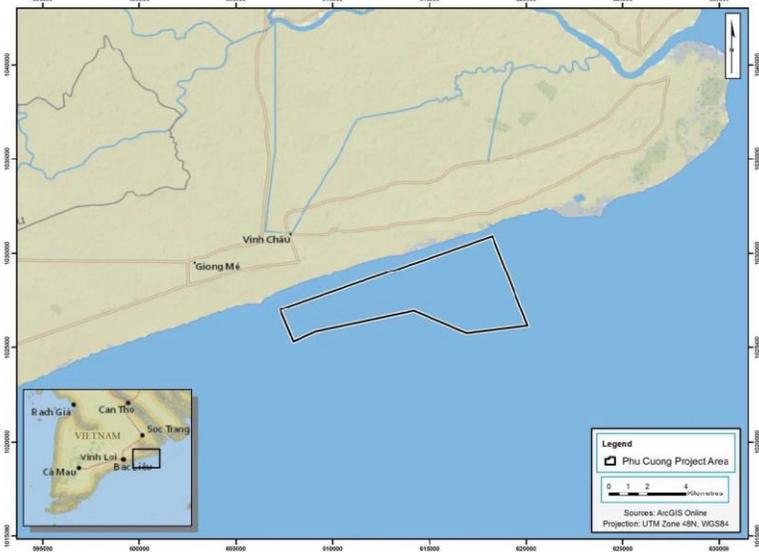
PROJECT SUMMARY

The Phu Cuong Nearshore Windfarm will be located in the province of Sóc Trăng, Vietnam. The site has a highly stable wind regime, parallel to the coastline. Installed capacity will be approximately 150MW, generating about 650GWh annually.

PROJECT DESCRIPTION

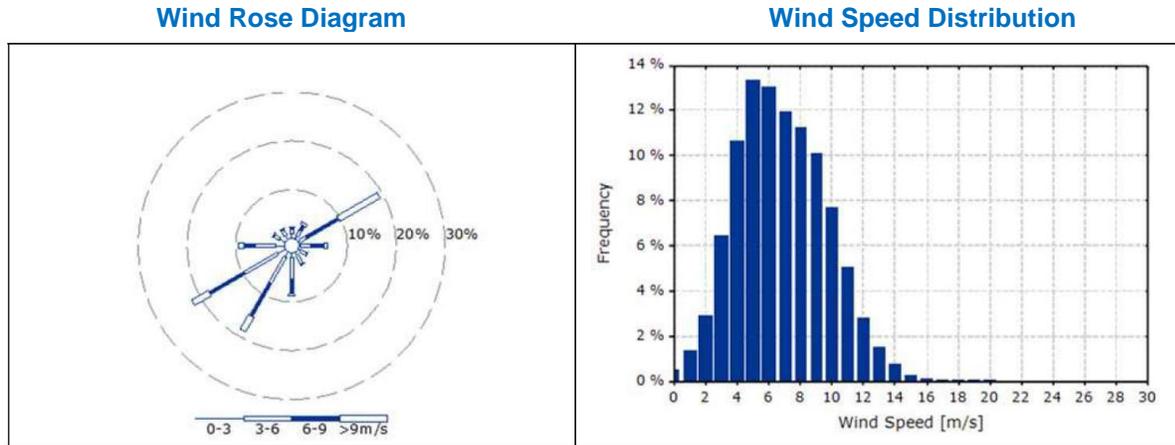
The Phu Cuong Nearshore Windfarm project will be located along the coastline of the Mekong River Delta with portions within the intertidal zone (*Figure 1*). The site is approximately 180km south-southwest of Ho Chi Minh City, in the province of Sóc Trăng, along the coastline nearest to the town of Vĩnh Châu. Because portions of the project site are within the intertidal zone, the majority of the development area under consideration by the project sponsor, the Phu Cuong Group Corporation (PCG), is underwater when the tide rises but exposed mudflat when the tide recedes.

Figure 1: Phu Cuong Nearshore Windfarm Project Area



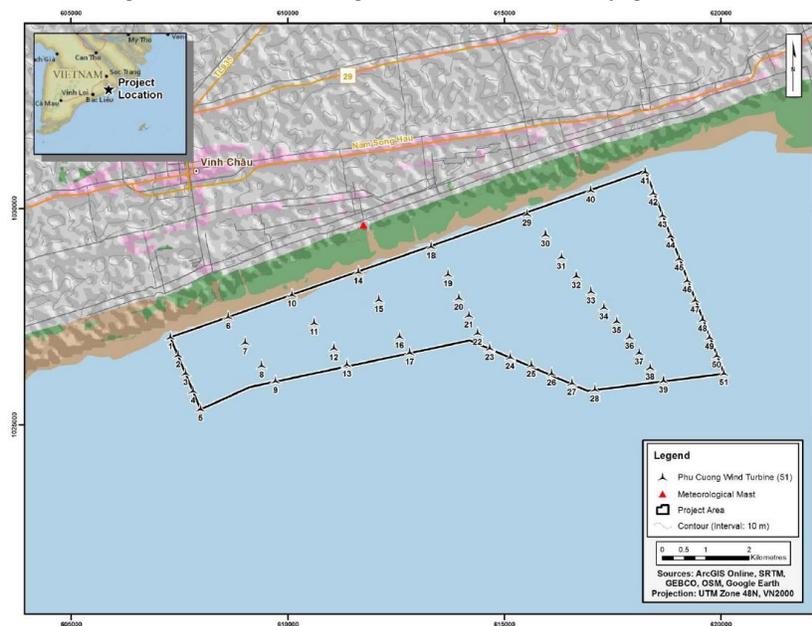
Onsite measurements, coupled with modeling and long-term data sets, demonstrate a valuable wind resource at the project site, consistent with published wind resource maps for Vietnam. Wind-turbine-hub-height annual average wind speed is about seven meters per second. Furthermore, the wind regime is parallel to the coastline, dominated by both west-southwest and its opposite east-northeast directions. The wind regime for the project is described by the wind rose diagram and a wind-speed distribution (*Figure 2*).

Figure 2: Phu Cuong Nearshore Windfarm Wind Regime



The sponsors have assessed various wind turbine manufacturers and models in specific configurations, designed to optimize performance. The potential wind turbine configurations for the project site are shown below (*Figure 3*). The rated power output for the different windfarm configurations ranges from 135 to 175MW. Estimated annual power production spans the range of 600 to 700 GWh.

Figure 3: Phu Cuong Wind Turbine Configuration



PROJECT STATUS AND IMPLEMENTATION TIMELINE

The feasibility study of the project is complete and includes:

- Wind resource assessment
- Permitting and land control review
- Logistics study
- Civil and electrical design
- Interconnection review
- Land and bathymetry surveys and geotechnical investigation
- Foundation design
- Preliminary environmental impact assessment
- Schedule and costs
- Operational review
- Financial model
- Financing plan

The next stages in project development include environmental and safety impact assessment, permitting, and contractual arrangements. Upon successful completion, the sponsors will seek implementation and construction finance.

PROJECT COST AND FINANCING

A firm estimate of the project cost will not be made until final contracts are negotiated with the turbine supplier and the construction subcontractors. At this time, the project sponsors are using the range of capital expenditure estimates prepared in the feasibility study, all of which fall under the target offshore wind benchmark of \$3,025/kW, published by Lazard,¹⁷⁸ demonstrating the benefits of nearshore project siting.

The sponsors of the project are considering the following debt financing sources, including:

- Global and regional development financing institutions
- Bilateral financing institutions
- Commercial banks
- Export credit agencies
- Credit enhancement institutions

Key considerations for the financing plan include specific details regarding power purchase agreement (PPA) terms, counterparty creditworthiness, and currency convertibility.

¹⁷⁸ Lazard's Levelized Cost of Energy Analysis, Version 12.0, November 2018

U.S. EXPORT OPPORTUNITIES

A wide range of U.S. export opportunities exists for offshore wind farms such as the Phu Cuong project:

Systems

- Turbines
- Medium voltage transformers
- Foundations
- Above ground electrical cabling
- Subsea electrical cabling
- Collector substation / main power transformers
- SCADA system

Equipment

- Cranes
- Barges
- Crane barges
- Purpose-built installation vessels
- Concrete batching
- Dredgers
- Heavy construction equipment such as excavators and bulldozers
- Cable burial equipment
- Piling equipment

Services

- Engineering and design
- Construction management
- Civil contractors
- Electrical contractors
- Geotechnical engineers
- Environmental and permitting services
- Subsea cable installers
- Project administration
- O&M providers

CONTACTS

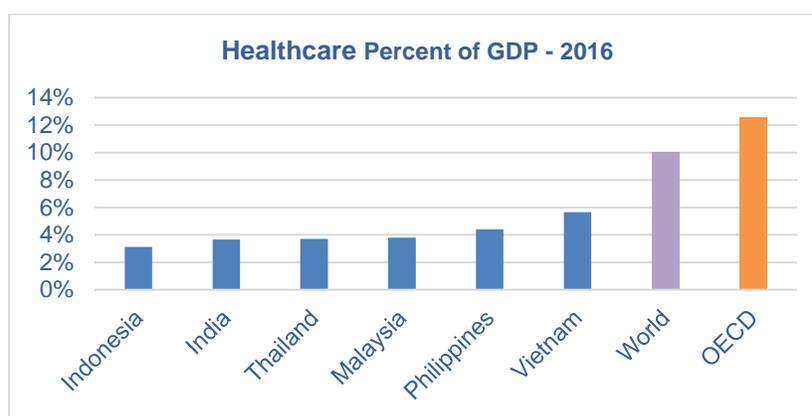
Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Phu Cuong Group Corp. 5 Nguyen Binh Khiem St District 1 Ho Chi Minh City Vietnam Mr. Pham Quoc Anh quocanh@phucuonggroup.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Blvd. Arlington, Virginia USA Ms. Shannon Roe sroe@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>U.S. Embassy in Hanoi 170 Ngoc Khanh St Hanoi Vietnam Ms. Tuyet Trees Tuyet.Trees@trade.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service Diamond Plaza, 8F 34 Le Duan Street, District 1 Ho Chi Minh City Vietnam</p> <p>Mr. Nam Tran nam.tran@trade.gov</p>

5 Healthcare and Public Health

Sector Overview: Healthcare

Healthcare expenditures vary widely, both globally and among the six countries evaluated for this resource guide: India, Indonesia, Malaysia, Philippines, Thailand, and Vietnam. The world average of healthcare expenditures as a share of GDP is approximately 10 percent, while the countries considered in this Resource Guide range from a low of 3.1 percent in Indonesia to a high of 5.7 percent in Vietnam. As a comparison, the OECD nations spend the greatest share of GDP on healthcare, at just over 12 percent (*Figure 1*).

*Figure 1: Healthcare Expenditures as a Percent of GDP, 2016*¹⁷⁹



On a per-capita basis, the countries considered in this Resource Guide are well under world averages for healthcare spending (*Figure 2*).

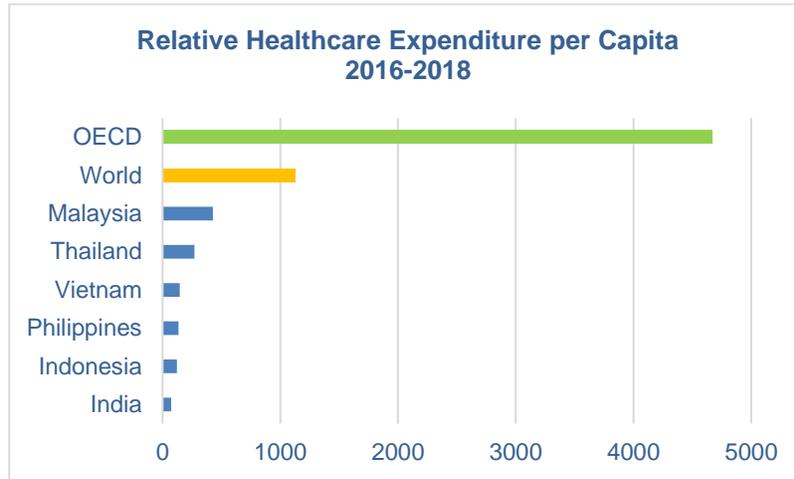
Factors influencing growth in healthcare expenditures¹⁸⁰ include:

- Population growth/number of births
- Aging of population/prevalence of end-of-life care
- Disease prevalence/incidence
- Frequency of service utilization
- Service price and intensity

¹⁷⁹ World Bank

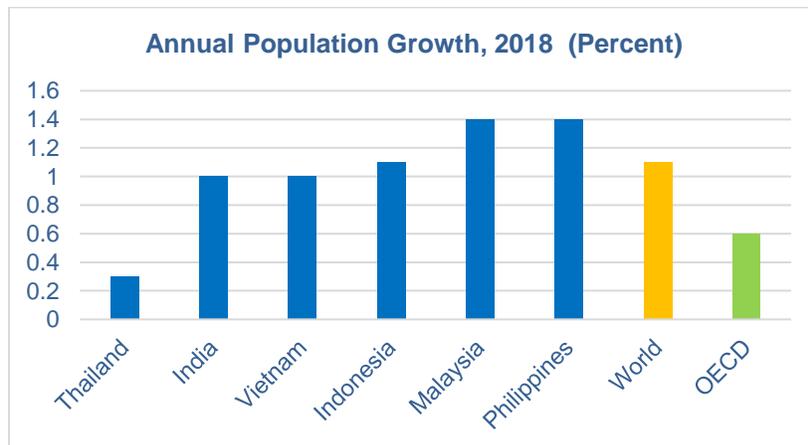
¹⁸⁰ Journal of the American Medical Association (JAMA)

Figure 2: Relative Healthcare Expenditure per Capita (\$), 2016-2018¹⁸¹



The countries considered for this Resource Guide, with the exception of Thailand, have population growth (i.e., number of births) at or above world average levels (Figure 3). At the other end of the spectrum, by 2021, the Asia Pacific Region is projected to host 55 percent of the world’s elderly (over 65 years of age) population¹⁸². With the exception of Thailand, the countries considered in the Resource Guide have a somewhat lower percentage of elderly than the global average (Figure 4). Half of the countries (India, Philippines, and Indonesia) have life expectancies under the world average (Figure 5), in part due to disease prevalence and lower levels of medical service access/utilization. The other half, however, have life expectancies at or above world averages (Vietnam, Malaysia, and Thailand).

Figure 3: Annual Population Growth (Percent), 2018¹⁸³



¹⁸¹ Ibid

¹⁸² Euromonitor

¹⁸³ World Bank

Figure 4: Aging Population, 2018¹⁸⁴

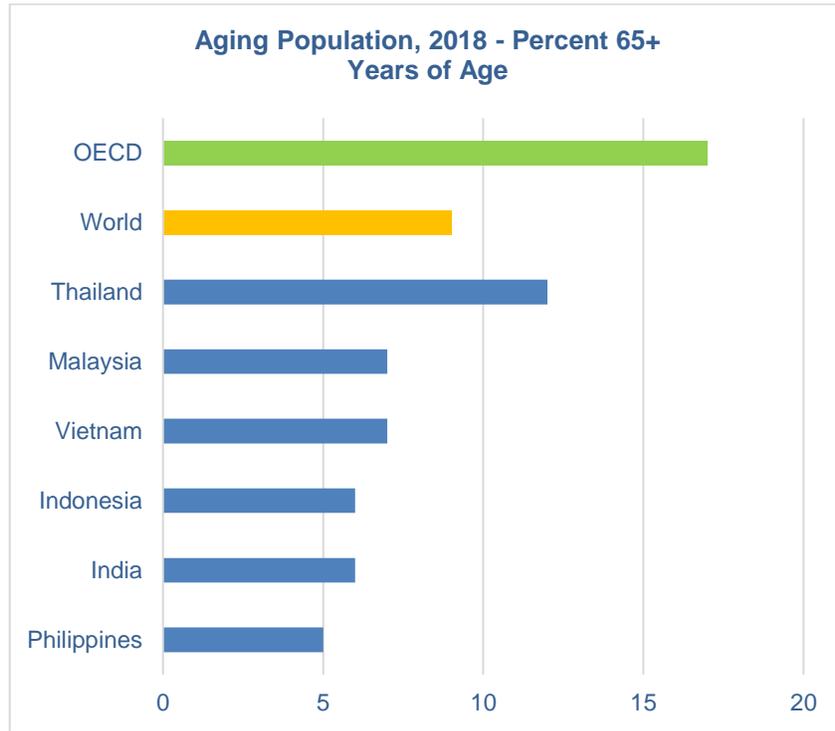
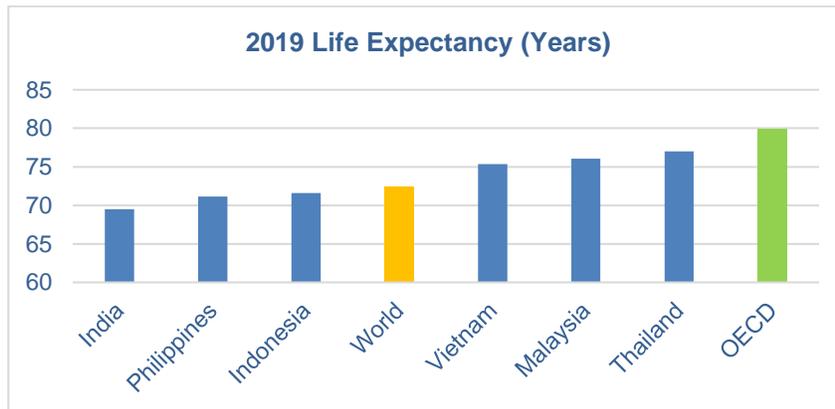


Figure 5: Life Expectancy (Years), 2019¹⁸⁵



Demographic data suggests the likelihood of substantial growth in investment in the Healthcare sector as the Resource Guide countries further industrialize, discretionary income levels rise, and healthcare is extended to remote and underserved regions. At least three Healthcare categories, hospitals, major healthcare equipment, and telemedicine, align regional needs with U.S. technological, manufacturing, and service capabilities.

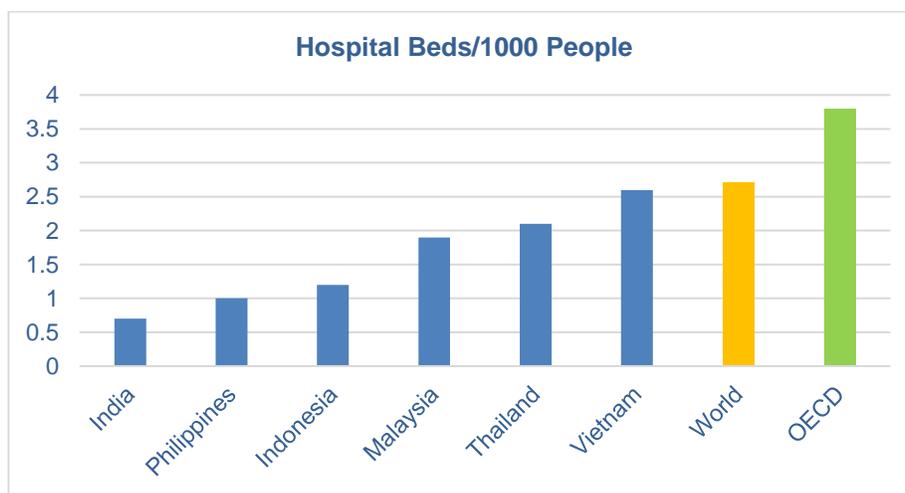
¹⁸⁴ Ibid

¹⁸⁵ Source: World Population Review

Hospitals

The countries covered in this Resource Guide are currently below world averages for available hospital beds per 1000 population (Figure 6). Most of these countries have undertaken significant build programs for new hospitals. For example, private healthcare provider, KJP, of Malaysia, is building numerous new facilities in their home country, including aged care facilities which are generally less available in the region than, for example, in the United States. As well, the company operates hospitals in Indonesia, Thailand and Bangladesh. The region features a mix of public and private healthcare, with private facilities typically offering superior care and a wider array of treatment options, albeit at a higher price.

Figure 6: Hospital Beds per 1000 People¹⁸⁶



As patients seek to arbitrage care costs and quality, medical tourism is a growing industry in the six countries covered in this Resource Guide, with India, Malaysia, and Thailand routinely mentioned among preferred destinations globally. This presents an opportunity for additional construction and outfitting of larger, specialist hospitals with state-of-the-art diagnostic, treatment, recovery, and digital records keeping capabilities.

Major Healthcare Equipment (Durable Medical and Medical Capital Equipment)

This subsector comprises the diverse array of capital equipment required to outfit hospitals, outpatient clinics, surgical centers, and sophisticated medical offices. Given the diversity of this subsector, it is difficult to get a precise market size, but various estimates suggest a value of at least \$150B globally, with roughly \$10B in the Indo-Pacific Region. Local segments generally have compound annual growth rates (CAGR) of 6-14percent, depending on the category.

Segments comprising this subcategory include:

¹⁸⁶ World Bank

- Medical imaging/radiology equipment (x-ray, MRI, CT, ultrasound, PET, endoscope, nuclear, workstations)
- Patient monitoring and digital record keeping
- Hospital beds/stretchers
- Intensive care/neonatal intensive care
- Surgical suite/operating room/medical robotics
- Cardiovascular, cardiology and defibrillation
- Intravenous therapy systems/dialysis
- Medical gas equipment
- Compressors, pumps, autoclaves, suction devices
- Refrigeration

Telemedicine

Doctor shortages are an issue in much of Asia, with India, Indonesia, and rapidly growing portions of Malaysia (e.g., Sarawak) experiencing acute shortages. Vietnam faces some shortage in remote areas, while the Philippines and Thailand have largely overcome shortages existing in the recent past. The rapidly growing (approximately 15 percent per annum) telemedicine industry offers a means to ameliorate these challenges by allowing patients and less skilled professionals to consult with and receive treatment and follow-up direction from more skilled practitioners who are located at a distance, using telecommunications and information technology (*Figure 1*).

*Figure 1: Telemedicine in Action*¹⁸⁷



The global telemedicine market is approximately \$ 21.5B¹⁸⁸, according to Mordor Intelligence. Of that, the countries covered in this Resource Guide accounting for roughly 10 percent. Telemedicine

¹⁸⁷ Diagnostic and Interventional Cardiology

¹⁸⁸ Mordor Intelligence

segments include real-time telemedicine and remote patient monitoring. Used most widely today for cancer, radiology, pathology, neurology, psychology, and dermatology, more advanced telemedicine systems can even be used to facilitate or perform surgeries. These applications represent roughly 75 percent of current telemedicine uses, with use in other medical subspecialties comprising the remainder.

Summary

The Healthcare sector in the Indo-Pacific region is an attractive opportunity for U.S. interests. The demographics favor continued strong growth in healthcare consumption. The region is already a heavy importer of the latest medical technology, much of which originates in the United States. Further, several countries have lesser restrictions on direct foreign investment in hospitals than in other economic sectors. U.S. capabilities fit well to support Indo-Pacific growth in Healthcare.

Public Health and Sanitation

While this Resource Guide did not focus on Public Health, included are several projects for tackling the waste management sector, especially as it relates to reducing the land disposal of municipal wastes. These projects are included in the energy section since the outcome generates electricity or manufactured gas. Two water network projects are included since access to freshwater is still a challenge in some areas of the Indo-Pacific region. India, for example, is experiencing significant pressures to maintain adequate water quality and quantities in some areas due to drought and population growth.

Aster KLE Hospital		
	SECTOR	Healthcare
	SUBSECTOR	Hospitals
	LOCATION	Bangalore
	PROJECT VALUE	\$57 million

PROJECT SUMMARY

Aster DM Healthcare has signed a 25-year lease agreement with Karnataka Lingayat Education (KLE) Society to set up a 600-bed hospital in Bengaluru. The hospital is expected to be operational by April 2024. Aster Healthcare is a diversified healthcare group with operations in the Middle East, India, and the Philippines. Its global network comprises 24 hospitals, 116 clinics, and 219 pharmacies. In India, it operates 13 hospitals and four clinics.

PROJECT DESCRIPTION

Healthcare has become one of India's largest sectors, both in terms of revenue and employment. India's healthcare market is projected to reach \$372 billion by 2022. Already, India has the world's largest government-funded healthcare system, with the launch of Ayushman Bharat in 2018. The country is expected to be among the top three for healthcare consumption rate of growth. Key components of the healthcare market in India include:

- Hospitals (government and private)
- Pharmaceuticals
- Diagnostics (imaging and pathology)
- Medical equipment and supplies
- Medical insurance
- Telemedicine

All sectors are expected to grow at double-digit rates. Pertinent to this project, by 2020-2022:

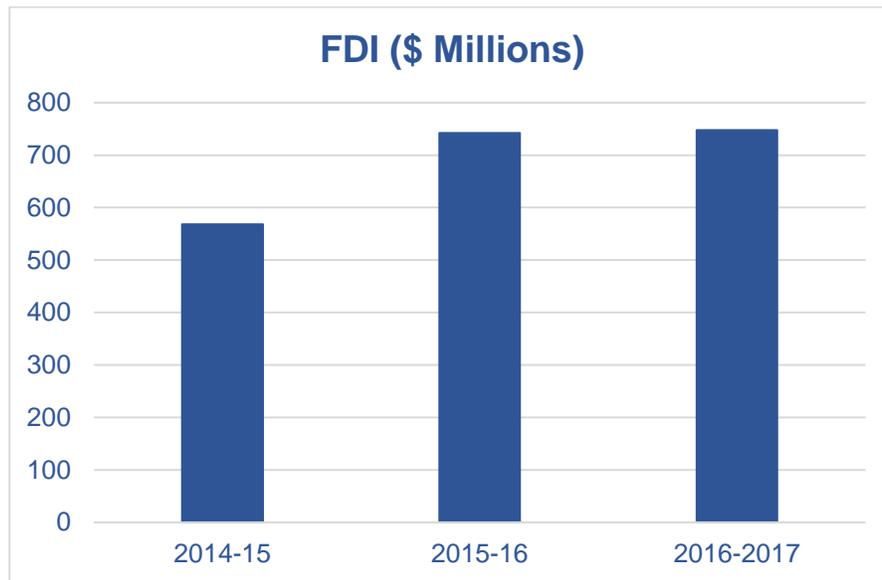
- Healthcare information technology is expected to reach \$1.5 billion
- Diagnostics will reach \$32 billion
- Medical device consumption is projected to reach \$280 billion

The hospital industry in India today accounts for 80 percent of the total healthcare market. This segment is witnessing investor demand from both domestic and foreign investors. The hospital

industry, in total, is expected to reach \$132 billion by 2023, from \$ 61.8 billion in 2017, a CAGR of 16 percent.

From a general investment standpoint, 100 percent Foreign Direct Investment (FDI) is allowed under the Automatic Route for any Greenfield or Brownfield Project. International investors may set up new hospitals with 100 percent foreign ownership, without government pre-approval. U.S. investors have taken advantage of this, with U.S. FDI standing at almost \$750 million in 2017 (*Figure 1*). The Indian healthcare sector provides good opportunities for both U.S. investors and suppliers of equipment, medical supplies, and services.

Figure 1: U.S. Foreign Direct Investment in Indian Hospitals¹⁸⁹



For the project in development, Aster KLE Hospital will be structured as an operating lease between Aster DM Healthcare and the KLE Society, a recognized and trusted Indian education and healthcare provider. Aster DM Healthcare is a large international healthcare player with a presence in India and 16 other countries. Aster is proactively growing its presence in the Karnataka region of India with the introduction of two new hospitals. KLE Society runs over 270 institutions across Karnataka, Maharashtra, and Delhi. The operating lease is structured to reduce CAPEX and real estate and rental risks for foreign service providers. This 600-bed, the quaternary-care hospital will be adjacent to KLE Dental College and will be Aster’s 15th hospital in India. The site is near Yeshwantpur on Tumkur NH Highway Road.

Aster KLE hospital will cover the following medical specialties under its Centers of Excellence, including:

- Cancer Care
- Cardiac Sciences
- Neurosciences

¹⁸⁹ Department of Industrial Policy & Information, GO

- Liver Care
- Organ transplant
- Orthopedics
- Urology
- Nephrology

Each unit will include the latest state-of-the-art medical technologies and equipment.

In India, Aster already operates six hospitals in six cities plus four clinics in Bangalore. With the addition of this project, Aster will service 2 million patients annually and operate 4,643 beds in India.

Aster KLE Hospital will be the company's third in Bangalore, with two of its hospitals operational and well established. Aster CMI Hospital (*Figure 2*) is highly regarded for its quality of care in several medical specialties. Beyond Aster KLE, the company is in the early stages of considering the fourth hospital in Bangalore, as well, in the planning stages for one in Chennai. Aster's strategic plan is to have investments of approximately \$220 million in new hospitals in India with a combined capacity of 2,000 beds. Further, the company is planning to launch a large clinical lab chain in Bengaluru as a new vertical. The Bombay Stock Exchange (BSE) listed Aster DM Healthcare earnings last year from India at \$140 million.

*Figure 2: Aster CMI Hospital - Bangalore*¹⁹⁰



¹⁹⁰ Medifree

KLE Society is associated with several universities and institutions in the U.S., including the Universities of Michigan and Illinois, as well as the Bill & Melinda Gates Foundation. KLE Society entered healthcare in 1986, with the establishment of a Hospital at Belagavi, Karnataka in South India. Today, across its healthcare portfolio, the Society has more than 4,000 beds, making it one of the largest private-sector organizations providing healthcare in Karnataka.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The Memorandum of Understanding and lease agreement between Aster and KLE was signed in Bangalore on 24th September 2019. The project is expected to be completed by April 2024. Further details on the project are expected to be released shortly.

PROJECT COST AND FINANCING

The total project cost for the greenfield hospital is estimated at \$57 million. The land for the project is provided by KLE through a 25-year lease agreement. The project will be funded, executed, and managed by Aster DM Healthcare.

U.S. EXPORT OPPORTUNITIES

The Aster KLE hospital is a greenfield project. Both Aster Group and KLE have been in the hospital business for many years and, as noted above, have announced several new projects. This offers U.S. companies the prospect of long-term business relationships, as 75 percent of medical equipment, including diagnostics, is currently imported into India.

This project offers opportunities for U.S. companies in the supply, operational training, and maintenance of equipment including:

- High-technology equipment (e.g., for cancer diagnostics, medical imaging including ultrasound, and polymerase chain analysis)
- Orthopedic surgical systems and prosthetic appliances
- Orthodontic and dental implant equipment
- Ophthalmic instruments and appliances
- Operating theatre equipment and systems
- Medical laboratory instrumentation
- Laboratory/diagnostics facility design and equipment
- Planning, design, engineering, and other services
 - Simulation laboratory training
 - Telemedicine architecture and training
 - Information and communications technology backbone
 - Patient monitoring and record-keeping systems

- Effluent and medical waste treatment and disposal
- Long-term maintenance and service contracts
- Hardware and software training
- Safety training including fire
- Maintenance

Several American companies are already using India as a manufacturing base by either setting up facilities of their own or by acquiring domestic manufacturers. These include 3M, Becton Dickinson, and Hollister.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Aster DM Healthcare Ltd 33rd floor , Tower D, Aspect Tower, Business Bay, PO Box 8703 Dubai United Arab Emirates Dr. Azad Moopen – Promoter, MD, ED chq@asterdmhealthcare.com</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Alissa Lee alee@ustda.gov</p> <p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Ms. Mehnaz Ansari mansari@ustda.gov</p> <p>IndoPacific@ustda.gov www.ustda.gov</p>	<p>U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Ms. Ruma Chatterjee ruma.chatterjee@trade.gov</p>

Patna Medical College & Hospital Redevelopment		
	SECTOR	Healthcare
	SUBSECTOR	Hospitals
	LOCATION	Patna, Bihar, India
	PROJECT VALUE	\$790 million

PROJECT SUMMARY

The 1700-bed Patna Medical College and Hospital (PMCH) will be upgraded to create a 5,462-bed, state-of-the-art hospital with ultra-modern medical facilities. As part of the project, the medical college will also be expanded to seating capacity for 250 Bachelor of Medicine, Bachelor of Surgery (MBBS) candidates. The project spans three phases to be implemented over the next 5-7 years. The renovation in total will cost \$790 million, with the first, second, and third phases requiring \$300 million, \$260 million, and \$230 million, respectively. Once redeveloped, PMCH will be the world’s second and India’s largest hospital with respect to bed capacity.

PROJECT DESCRIPTION

Healthcare has become one of India's largest sectors, both in terms of revenue and employment. India's healthcare market is projected to reach \$372 billion by 2022. Already, India has the world’s largest government-funded healthcare system with the launch of Ayushman Bharat in 2018. The country is expected to be among the top three globally for healthcare consumption rates of growth. Key components of the healthcare market in India include:

- Hospitals (government and private)
- Pharmaceuticals
- Diagnostics (imaging and pathology)
- Medical equipment and supplies
- Medical insurance
- Telemedicine

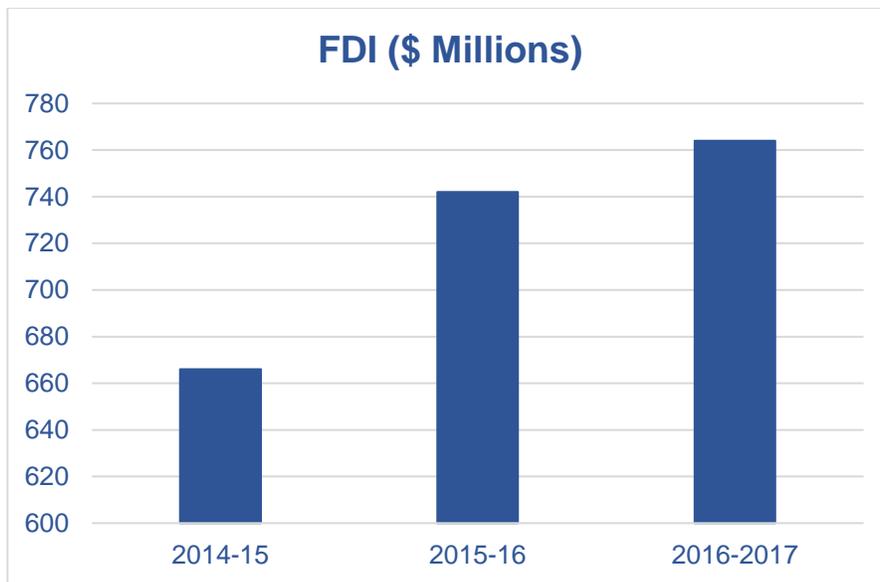
All sectors are expected to grow at double-digit rates. Pertinent to this project, by 2020-2022:

- Healthcare information technology is expected to reach \$1.5B
- Diagnostics will reach \$32 billion
- Medical device consumption is projected to reach \$280 billion

The hospital industry in India today accounts for 80 percent of the total healthcare market. This segment is witnessing investor demand, both domestic and foreign. The hospital industry, in total, is expected to reach \$132 billion by 2023, from \$61.8 billion in 2017, or a CAGR of 16 percent over the period.

From a general investment standpoint, 100 percent Foreign Direct Investment (FDI) is allowed under the Automatic Route for any Greenfield or Brownfield Project. International investors may set up new hospitals with 100 percent foreign ownership, without government pre-approval. U.S. investors have taken advantage of this, with U.S. FDI standing at almost \$800 million in 2017 (*Figure 1*). The Indian healthcare sector provides good opportunities for both U.S. investors and suppliers of medical equipment, supplies, and services.

Figure 1: U.S. Foreign Direct Investment in Indian Hospitals¹⁹¹



For this project specifically, a large scale redevelopment is planned to create a total of 5,462 beds versus PCMH’s current capacity of 1,700 beds. When completed, PCMH will be second only to Chang Gung Memorial Hospital in Taiwan, whose capacity of 10,000 beds is the largest in the world. Bachelor of Medicine/Bachelor of Surgery (MBBS) graduate student seating will be expanded from 150 to 250 seats during the redevelopment, with post-graduate seating expanding from 146 to 150 in the PCMH medical school.

Patna Medical College and Hospital was established in 1925 on 48 acres of land. Originally known as Prince of Wales Medical College, it is located in Patna, the state capital of Bihar, India. It is the oldest medical college and hospital in the state.

When complete, the hospital will host 29 wards, including the medical specialties described below (*Table 1*).

¹⁹¹ Department of Industrial Policy & Information, Government of India

Table 1: PMCH Expansion – Planned Beds by Medical Specialty¹⁹²

Medical Specialty	Planned Beds
Orthopedics	702
Pediatrics	610
General and Pediatric Surgery	522
General Medicine	478
Obstetrics and Gynecology	462
Ophthalmology	240
Intensive Care Unit	217
Endocrinology	85
Nephrology	75
Neurology	75
Psychiatry	75
Urology	75
Cardiology	72
Gastroenterology	72
Neurosurgery	72
Organ Transplant	55
Plastic Surgery	50
Burn Unit	30

The first phase will create 300 million square feet of the project’s planned total of 720 million square feet or just over 40 percent. Phase 1 includes:

- Two hospital blocks
- Hostels for nurses and support staff
- Doctor residences
- Central utility including laundry
- Blood bank
- Patient-stay facilities
- Multi-level parking

Additional facilities will be developed in the subsequent two phases. The facility will eventually have a 450-bed, low-income boarding facility, a separate power substation, and its own water treatment plant. Separate multi-story buildings will be constructed on the campus for doctors and

¹⁹² PCMH

medical staff residences. Planning includes “green buildings” with “foolproof” fire safety and medical gas pipelines.

Bihar Medical Services & Infrastructure Corporation (BMSIC) has invited bids for the redevelopment of PMCH. The primary EPC contractor will be selected during the 3-Phase bidding process. Subsequent sub-contracting will be determined by the primary contractor.

The scope of the initial tender includes Engineering, Procurement, and Construction (EPC) of the following:

- Demolition of existing structures
- Buildings for staff and faculty residence
- Building hostels and auditoriums
- Internal and external plumbing and sanitary works
- Electrical works
- Site development and boundary wall plus landscaping
- Sewage treatment plant
- Fire detection and suppression
- CCTV
- Medical and non-medical furniture
- Computers and servers
- Electrical and. mechanical services
- Management information systems (MIS)
- Supply of medical equipment and medical devices

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The detailed project report (DPR) for the PMCH revamp was prepared by Delhi-based architecture consultants Suresh Goyal and Associates under the guidance of Bihar Medical Services and Infrastructure Corporation Limited. The project will be executed in engineering, procurement, and construction (EPC) mode.

The project was announced in May 2018, and the tender for the \$790 million project was floated in September 2019. November 19, 2019, is the last date for tender submission. The three-phase project implementation timeframe is 7 years.

PROJECT COST AND FINANCING

The renovation in total will cost \$790 million, with the first, second, and third phases, each requiring \$300 million, \$260 million, and \$230 million, respectively. The medical equipment at PMCH will cost approximately \$126 million. The project will be funded by the Government of Bihar, as the PMCH is owned by the State.

U.S. EXPORT OPPORTUNITIES

Opportunities for U.S. firms in this project will be to supply equipment, know-how, and services for:

- Modular operating theaters
- Medical laboratory instruments
- Diagnostics facility design and equipment
- Nurse call systems
- Medical gas pipeline systems
- Pneumatic tube systems for medication delivery
- Central sterile services
- Pneumatic waste systems
- Laundry collection systems

The budget for capital medical equipment, including cancer diagnostics, medical imaging, et al., is approximately \$130 million. In addition, U.S. export opportunities exist for high technology consumables and associated specialized equipment such as orthopedic and prosthetic appliances, orthodontic and dental implants, and ophthalmic products.

Additional opportunities, related to hospital operations, will also exist. These include:

- Hardware and software training including simulation laboratory training
- Telemedicine architecture and training
- Information and communications backbone
- Patient monitoring and record-keeping systems
- Effluent and medical waste treatment and disposal
- Long-term maintenance and service contracts
- Safety training including fire

Several American medical device and equipment companies are already using India as a manufacturing base by either setting up facilities of their own or by acquiring domestic manufacturers. These include 3M, Becton Dickinson, and Hollister.

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Private Hospitals: Sabah & Sarawak		
	SECTOR	Healthcare
	SUBSECTOR	Hospitals
	LOCATION	Sabah and Sarawak, Malaysia
	PROJECT VALUE	\$50-90 million per project

PROJECT SUMMARY

The States of Sabah and Sarawak are simultaneously medically underserved and seeking to expand their medical tourism industries. Both states desire to attract new private hospitals to serve the local population with specialty medical care and to create a desired medical tourism destination.

PROJECT DESCRIPTION

The Malaysian government recently announced allocations of \$385 million for the construction of new hospitals and upgrading of hospitals in Klang, Kampar, Labuan (Sarawak) and Kota Kinabalu (Sabah). While these funds are targeted primarily at public hospitals, the states of Sabah and Sarawak are proactively seeking to attract new private hospitals, as well.

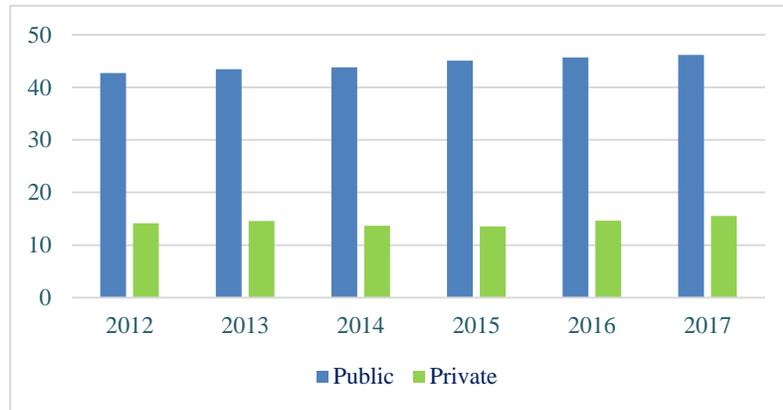
Sabah and Sarawak are simultaneously medically underserved and involved in developing industries in medical tourism. That creates different needs for medical facilities. New specialist hospitals capable of providing disease, trauma, reconstructive medical, and surgical services are sought for treatment of local residents. Typically, more luxurious facilities and a different slate of services are preferred for medical tourists. For example, Sabah seeks to emulate South Korea by offering medical aesthetics and plastic surgery services to its existing tourist base, which includes Korean and Chinese visitors. Today, Sarawak serves approximately 45,000 medical tourists annually, with most from Indonesia and a smaller number from China.

In 2017, Malaysia had 200 private hospitals with roughly 15,000 beds (*Figure 1*), as well as 16 maternity homes (50 beds), 22 nursing homes (700 beds), 2 residential hospice centers (17 beds), 100 ambulatory care centers (186 beds), 4 blood banks (25 banks/tanks), 450 hemodialysis centers (4,843 dialysis chairs), one community mental health center, and one combined ambulatory care and hemodialysis center (14 beds/21 dialysis chairs). There are also 7,571 registered private medical clinics, and 2,137 private dental clinics in the country.

In 2016, while private hospital outpatient attendance was only 6.3 percent of overall outpatient care provided in-country, private hospitals accounted for 42 percent of total hospital admissions. Approximately 27 percent of doctors are in private practice. Private specialist services are widely

available in peninsular Malaysia but limited in Sabah and Sarawak.

Figure 1: Hospital Beds (Thousands) Malaysia, 2017¹⁹³



The upper-middle-class and affluent segments of the population tend to use private healthcare services in Malaysia. As discretionary incomes rise, demand for private healthcare services typically increases as well. As Sabah and Sarawak both focus on the combination of industrialization and attracting greater tourism, demand for quality specialist healthcare is expected to be strong. Similarly, medical tourism typically attracts affluent patients. Medical aesthetics and executive health screening have proven popular services for the affluent in Malaysia generally and specifically for medical tourism.

In Sarawak, 11 private hospitals are currently operating with another six under development. The state hosted roughly 45,000 medical tourists in 2018, primarily from Indonesia and secondarily from China. Sabah, while known for eco-tourism, has had more difficulty attracting medical tourists due to transportation challenges, but the area is building a new airport and runway.

KPJ Healthcare Berhad (KPJ) is the largest builder and operator of private hospitals in Malaysia, with 25 private hospitals in the country as well as sites in Indonesia, Thailand, and Bangladesh and aged care facilities in both Malaysia and Australia. KPJ operates a specialist hospital in Kota Kinabalu (Sabah) and three in Sarawak. The Kota Kinabalu facility (*Figure 2*) has been proactively marketing to the medical tourism market.

Figure 2: Medical Tourism: Sabah¹⁹⁴

¹⁹³ Statista

¹⁹⁴ KPJ and Sabah Economic Development Authority



Project opportunities exist for foreign development of private hospitals, as there are no restrictions on foreign ownership. Alternatively, a joint venture or other working relationship with a Malaysian developer or owner/operator is possible.

For capital medical equipment, the growth of current facilities and outfitting new hospitals both offer opportunities. Surgical robotics are specifically desirable.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

Private hospital development in Malaysia typically follows a build-operate-transfer (BOT) model with a two-to-four-year timeline for the build, including site selection, site preparation, construction of the building, and outfitting of medical and surgical suites, patient rooms and hospital administration/patient record keeping infrastructure. Once the hospital is commissioned, the builder typically operates the facility until positive cash flow is reached and then sells the hospital to a real estate investment trust (REIT). Typically, the builder retains an interest in the REIT and a facility management contract.

PROJECT COST AND FINANCING

For those interested in participating in the development of new private hospital properties, project cost and financing will vary depending on the medical specialization and scale (measured by the number of beds) of the project. Typical private hospital construction costs in Malaysia range from about \$25 to 90 million, with the upper end of the range representing highly specialized facilities appropriate for medical tourism. A typical specialist hospital requires an investment of at least \$50 million. Financing is typically 30 percent equity with 70 percent debt from local banks, though financing from other sources is possible.

KPJ, for example, manages the land acquisition and builds a portion of its projects directly and ultimately sells to a REIT under a build-operate-transfer (BOT) model once the project is cash-flow positive. Upon sale, KPJ reportedly takes the deal valuation as 50 percent cash and 50 percent investment in the unit trust, as well as retaining facility management.

The KPJ business model is quite similar to hotel and resort development models. Like private hospitals, hotel and resort development is also open to foreign investors in Malaysia. This creates

an opportunity to expand medical tourism hospital projects to include luxury accommodations for patient recovery and rehabilitation and temporary housing of patient families either in a single complex or in paired facilities.

For suppliers of capital medical equipment, options exist to supply current specialist hospitals as they expand their scale and portfolio of services and to participate in the outfitting of new private hospitals.

U.S. EXPORT OPPORTUNITIES

Two groups of U.S. export opportunities are available for new private hospital construction in Sabah and Sarawak:

Facility Development and Management

- Architectural and design services
- Engineering, procurement and construction services
- Facility management
- Marketing and branding services

Capital Medical Equipment

- Medical imaging/radiology equipment (x-ray, MRI, CT, ultrasound, PET, endoscope, nuclear, workstations)
- Patient monitoring and digital record keeping
- Hospital beds/stretchers
- Intensive care/neonatal intensive care equipment
- Surgical suite/operating room equipment
- Medical and surgical robotics systems
- Cardiovascular, cardiology and defibrillation equipment
- Intravenous therapy systems/dialysis
- Medical gas equipment
- Compressors, pumps, autoclaves, suction devices
- Refrigeration

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
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Metro Pacific Hospitals Expansion		
	SECTOR	Healthcare
	SUBSECTOR	Hospitals & Clinics
	LOCATION	Throughout the Philippines
	PROJECT VALUE	\$600 million

PROJECT SUMMARY

Metro Pacific Hospital Holdings Inc. has a portfolio of 14 hospitals and over 3,200 hospital beds throughout the Philippines. The Group has a target to grow to 30 hospitals and over 5,000 beds by 2030 through organic growth and acquisitions. In October 2019, the Group inked a deal to finance this ambitious expansion plan.

PROJECT DESCRIPTION

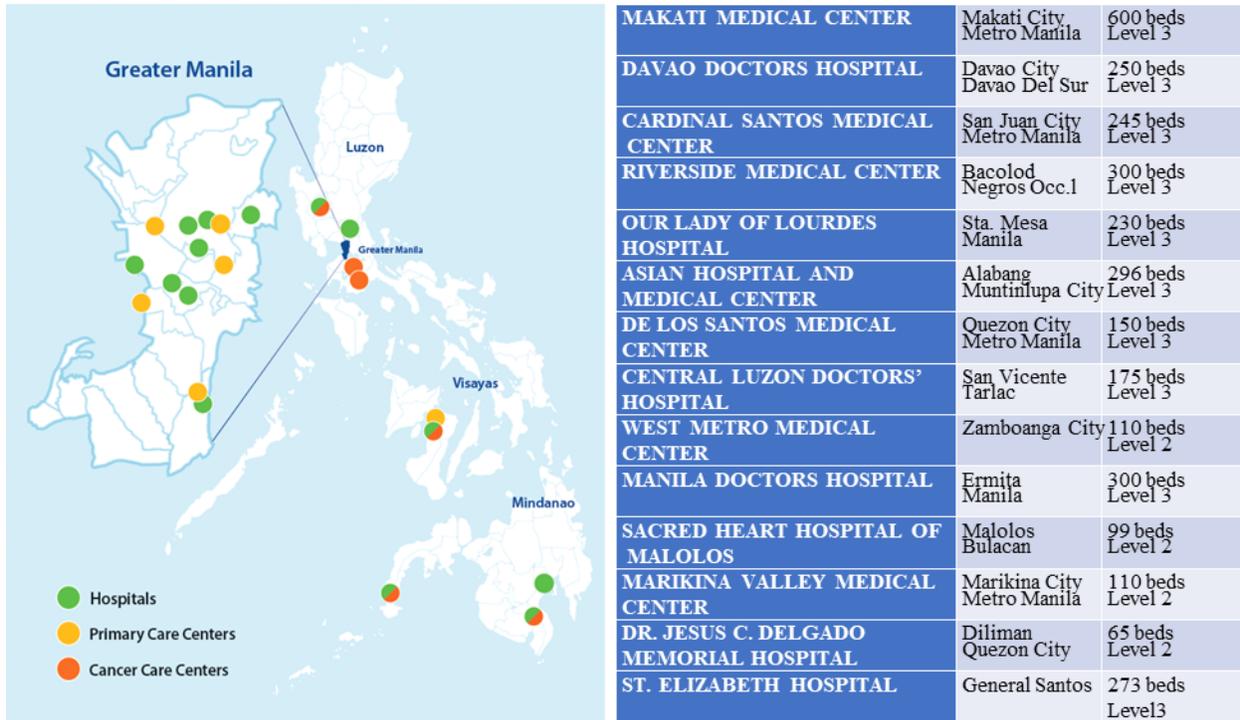
The Philippines currently has a relatively low penetration of healthcare infrastructure and healthcare professionals, with approximately 1.0 beds for every 1,000 people, which is well below the Organization for Economic Cooperation and Development (“OECD”) average of 4.6 beds per 1,000 people and below the average in selected Southeast Asian countries of 1.9 beds per 1,000 people. This signifies a substantial gap in supply to meet the growing demand for healthcare, suggesting that a significant amount of potential exists for future growth in the local Philippine healthcare market. In addition, the Philippine private healthcare service market is highly fragmented.

Metro Pacific Hospital Holdings Inc. (MPHHI or the Group) has grown to be the largest private hospital group in the Philippines. It has a portfolio of 14 hospitals in Luzon, Visayas, and Mindanao, with a combined authorized bed capacity of 3,200 beds. In addition, it is invested in allied health colleges, a growing network of primary care centers and cancer care centers, and a central clinical laboratory.

In 2018, MPHHI served approximately four million patients across the country, including 3.8 million outpatients and 194,000 inpatients. As of June 30, 2019, the Group’s portfolio of hospitals includes ten-level three hospitals and four-level two hospitals across the Philippines, with a total of 3,200 authorized beds, approximately 8,000 accredited doctors and 13,550 employees. The Group also operates eight clinics, eight cancer centers, and two healthcare colleges, across the country, as well as a centralized clinical laboratory.

Figure 1 shows the locations of MPHHI’s main healthcare facilities and a listing of its 14 hospitals.

Figure 8: MPHHI Locations and Hospitals



MPHHI has announced an expansion plan to 30 hospitals and 5,000 beds by 2030. An active pipeline of potential investments supports the Group's expansion model. The assessment of its potential investments considers, among other factors:

- Location of the target
- Local population density and its growth rate
- Targets scale of operations and variety of service offerings
- Competitive dynamics of the local market
- Targets potential for growth and efficiency improvement

In September 2019, Metro Pacific Hospitals announced an initial public offering (IPO) to raise 5.95 billion Philippine Pesos (equivalent to approximately \$114.4 million), about 67 percent of which will be spent on additional hospitals, cancer centers, clinics, and new health care businesses. Around 24 percent is expected to be used for additional investments in MPHHI's existing hospitals, while the remaining 8 percent is expected to be used for general corporate purposes.

The Group intends to strategically continue expanding its network of hospitals and healthcare facilities in the Philippines in order to meet the increasing demand for private healthcare services across the nation. The Group's current pipeline includes five potential hospital acquisitions or investments in various stages of discussion, with an aggregate bed capacity of approximately 650 beds. MPHHI indicates that these discussions are ongoing and are subject to commercial confidentiality until binding agreements are signed.

MPHHI aims to support the organic growth of its existing and new hospitals and healthcare facilities through the expansion of facilities, as well as the development of advanced higher value service offerings across its hospitals and healthcare facilities:

- Several of Group's hospitals are currently in the process of being renovated or having additional rooms installed in order to increase bed capacity.
- MPHHI expects to add at least 150 beds over the next two years from ongoing construction work at three of its hospitals (including Riverside Medical Center, Marikina Valley Medical Center, and St. Elizabeth Hospital).
- Additional fit-outs of its existing capacity and planned expansion projects will add at least 250 to 350 new beds within the existing hospitals over the next three to five years.
- The Group expects to continue investing in the development of specialist treatment facilities at its existing hospitals to increase and improve the treatment options available to patients.

As the Group's healthcare portfolio expands, the Group also intends to take greater advantage of the potential benefits of geographic clustering through the growth of its existing hospitals and facilities in the surrounding areas.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The expansion of MPHHI's holdings is ongoing. The prospectus for the IPO, available only to Philippine investors, indicates a five-year time frame for planned organic growth opportunities. The Group's expansion target is for 30 hospitals and 5,000 beds by 2030.

PROJECT COST AND FINANCING

The draft registration statement for the IPO stated that:

- MPHHI intends to offer up to 417.09 million common shares, consisting of up to 35.82 million new common shares as part of the primary offer, priced at a maximum of 182 Philippine Pesos (equivalent to approximately US\$3.5) each.
- The remaining 381.27 million existing common shares are expected to be sold by MPIC.
- Up to 40.77 million shares will be available for the over-allotment option.

On October 15, 2019, Metro Pacific Investments Corporation announced it would postpone the planned IPO of MPHHI indefinitely and would instead sign an investment deal with private equity firm KKR & Co. and Singapore sovereign wealth fund GIC Pte. In a statement, Metro Pacific said it would raise 35.3 billion Philippine Pesos (\$680 million) in fresh capital through the sale of shares to KKR and GIC, which will restructure its current investment in Metro Pacific Hospitals and will re-invest alongside KKR.

Under the agreement, KKR and GIC will pay 5.2 billion Pesos (\$100 million) worth of shares in Metro Pacific's hospital venture. The KKR-led consortium will also buy 30.1 billion Pesos (\$580

million) of exchangeable bonds, which can be converted to 239,932,962 common shares in Metro Pacific Hospitals in the next 10 years. Metro Pacific expects to complete the transaction by the end of 2019.

U.S. EXPORT OPPORTUNITIES

Considerable U.S. export opportunities exist for upgrading health care in new and existing hospitals and clinics, including:

Facility Development and Management

- Architectural and design services
- Engineering, procurement and construction services
- Facility management
- Marketing and branding services

Capital Medical Equipment

- Medical imaging/radiology equipment (x-ray, MRI, CT, ultrasound, PET, endoscope, nuclear, workstations)
- Patient monitoring and digital record keeping
- Hospital beds/stretchers
- Intensive care/neonatal intensive care equipment
- Surgical suite/operating room equipment
- Medical and surgical robotics systems
- Cardiovascular, cardiology and defibrillation equipment
- Intravenous therapy systems/dialysis
- Medical gas equipment
- Compressors, pumps, autoclaves, suction devices
- Refrigeration
- Diagnostic imaging equipment and systems
- Advanced cancer detection and treatment
- Specialized solutions and systems for teaching hospitals

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
<p>Metro Pacific Hospital Holdings Inc. 10th Floor, Makati General Office Building Legazpi corner Dela Rosa Street, Legazpi Village 0721 Makati City Philippines Contact to be determined for each procurement / acquisition https://www.mpic.com.ph/investor-relations/investments/healthcare</p>	<p>U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Ms. Alissa Lee alee@ustda.gov</p> <p>GPF Witthayu, Tower A, Suite 302 93/1 Wireless Road, Pathumwan, Bangkok 10330 Thailand Mr. Brandon Megorden bmegorden@ustda.gov</p> <p>IndoPacific@USTDA.gov www.ustda.gov</p>	<p>Embassy of the United States of America 1201 Roxas Blvd., Manila, Philippines 0930 Mr. Greg O'Connor Senior Commercial Officer Greg.oconnor@trade.gov</p> <p>www.export.gov/philippines</p>

Jalandhar Bulk Water Supply		
	SECTOR	Water Supply And Sanitation
	SECTOR	Public Health
	SUBSECTOR	Domestic Water Supply
	LOCATION	Jalandhar, Punjab
	PROJECT VALUE	\$180.44 Million

SUMMARY

Due to the significant depletion of groundwater in Jalandhar and adjacent towns in Punjab, this project has been initiated to meet drinking water needs by treating surface water and connecting it to the existing drinking water supply system. This will be an estimated \$180 Million project funded via a public-private-partnership (PPP), employing a hybrid annuity model (HAM) and will have World Bank (WB) and Asian Development Bank (ADB) financing. The project will be completed in 24 months, including a three-month trial run.

PROJECT DESCRIPTION

Rapid improvements are being made to augment drinking water supply and sanitation in India. National Urban Drinking Water and Sanitation Programs, the Swachh Bharat Mission (SBM), and National Rural Drinking Water Programs (NRDWP) have been launched to provide safe drinking water and continuously available water in open defecation free (ODF) districts.

Punjab has an extensive urban water supply, sewage, and sewage treatment network in place. Currently, about 85 percent of the urban population receives a basic service level of 135 liters per capita per day (LPCD) of water through public water supply schemes, which will be increased to 97 percent, following the completion of ongoing projects. Similarly, 76 percent of the population of the state has access to a sewage system, which will increase to 90 percent after the completion of ongoing projects.

Jalandhar is the third-largest city in the state of Punjab State. At present, Jalandhar relies on 100 percent groundwater extraction through tube wells being operated by Municipal Corporation of Jalandhar (MCJ) and other organizations, including private owners. The rate of depletion of groundwater is increasing every year, and the situation will continue to worsen as the city grows and develops. According to a report by the Central Ground Water Board, the water table has gone down 25 meters in the last 25 years, with an average depletion rate of one meter per year. In

addition, operation and maintenance (O&M) expenditures to run the 520 tube wells used to provide water are excessively high.

The quality of water obtained from the tube wells is deteriorating due to high percentages of fluoride, heavy metals, and uranium, all of which are health hazards. It has therefore been decided to use treated surface water from available surface water sources (i.e., river basins) and connect it to the existing drinking water supply system of regional towns, thereby reducing the use of groundwater. The Punjab Water Supply & Sewerage Board (PWSSB), in association with the Punjab Municipal Infrastructure Development Company (PMIDC), has decided to undertake the development of this project, with a water treatment plant capacity of 275 million liters/day (MLD), to be constructed in Jalandhar. It will be structured as a PPP project, employing a hybrid annuity model. While the Punjab Water Supply & Sewerage Board will be the principal executing agency and bidding authority for the Project, PMIDC will be responsible for making payments to the concessionaire.

Figure 1: Map of Jalandhar¹⁹⁵



The objectives of PMIDC and the PWSSB through the Project are to:

- Supply potable water to the citizens by shifting the source of water from groundwater to surface water;
- Treat raw water at the water treatment plant (WTP) and provide quality water that meets Indian Standard (IS) 10500, along with the latest amendments;
- Reduce dependence on the groundwater;
- Implement viable technologies and international best practices for the development operation and maintenance of the WTP and other facilities; and

¹⁹⁵ Punjab Water Supply & Sewerage Board

- Invite large scale private sector participation.

The main features of the Project are the following:

- The PWSSB will provide the required site to the Concessionaire to develop the facilities and implement the Project.
- The Concessionaire will be required to design, finance, construct, and complete the facilities.
- The PWSSB will facilitate the allocation of the raw water from the Jalandhar Irrigation Canal to the concessionaire.
- The Concessionaire will be required to operate and maintain the facilities beginning from the commercial operation date to the expiration of the O&M period.

The scope of work involves the construction of a 275 MLD WTP, raw water intake, raw water pump house and rising main, storage and sedimentation tank, and a clear water reservoir (CWR). It will also include the design, construction, testing and commissioning, operation and maintenance for a period of 10 years, with a PPP structure using a Hybrid Annuity Model.

Figure 2: Jalandhar irrigation canal¹⁹⁶



In addition to the above, the scope of work and services includes the following:

- Carrying out detailed topographic surveys and geotechnical investigations of the project sites and providing all of the information in electronic format (GIS) to PWSSB and mapping all assets.
- Identifying and applying for all necessary permissions and permits for the design, construction, and operation of the project.

¹⁹⁶ Punjab Water Supply & Sewerage Board

- Collecting raw water quality data and conducting water quality tests at intake locations before the design of the system.
- Designing the water treatment plant and associated works including process, hydraulic, structural, electrical, instrumentation, mechanical, piping.
- SCADA system design.
- Preparing and submittal of detailed project reports, all civil, mechanical, electrical, structural, architectural elements, and submission of design manuals, operation manuals, health, and individual system components.
- Conducting environmental impact assessment and preparation and implementation of an environmental management plan during construction and operation.
- Constructing the water supply system and associated works, which encompass intake works, storage reservoirs, water treatment works, raw water mains, underground clear water reservoirs, SCADA system, electric sub-station, control panels, electrical cabling, water quality testing laboratory, disinfection system, pumps, valves, and bulk meters. This includes all site development works (leveling/grading/landscaping), all-weather access approach roads, compound walls, and security arrangements.
- Testing and commissioning of individual components and overall water treatment facility system to meet the design requirements.
- Operating and maintaining all assets constructed under the contract for 10 years after successful testing and commissioning and recruiting and training personnel.
- Preparing and putting a Disaster Management Plan in place, including an emergency response plan for unforeseen events, e.g., the presence of pollution at any intake location.
- Establish an operational Project Office adequately staffed to manage all phases of the Project (design, construction, and operation).

Project specifications for this bulk water project include:

- Withdrawal of water - Design and construction of intake point, including gates at Jagrawan village to transfer raw water from Jalandhar Irrigation Canal to WTP site with 275 MLD capacity.
- Storage & sedimentation tank - Design and construction of four reinforced cement concrete (RCC) storage and sedimentation tanks (206.250 m³ each) capable of holding of three days of water demand during maintenance/closure of Jalandhar Irrigation Canal.
- Raw water pumping machinery and other accessories - Design and provide raw water pumping machinery, including all necessary electrical and other installation works, design and construction of raw water pumping main, valves and specials, valve chambers, supporting structures, and anchor / thrust blocks.
- WTP - Design and construction of complete WTP, with an output capacity of 275 MLD and the provisions for aeration and rapid mixing for coagulation. The facility should also include provisions for plate/tube settlers, all necessary mechanical and electrical installation works suitable for automated operation of the plant, along with provision for backwashing, laboratory facility, sludge system, recycling of backwash water, internal connection and bypass piping system, internal and external electrification work for compound lighting, and electrical switch gears of various drive motors of the Treatment Plant units.

- Clear water underground service reservoir - Construction of RCC underground clear water reservoirs (2 x 34,500 m³) in Jagrawan village, with suitable foundation, including all necessary inlet/outlet/overflow/draining capabilities, piping arrangement with control valves, with a solar-powered system with a battery backup for the electrical installation, security wall and gate, signboard, landscaping, and compound illumination.
- SCADA system - Installation, synchronizing, testing, and commissioning of a SCADA system for flow control and monitoring between raw water intake arrangements. It includes the main control unit for flow and pressure measurement and controls at the WTP and ultrasonic level sensor and transmitter, pressure sensor and transmitter, pressure regulating valve, turbine flow meter or electromagnetic flowmeter with signal generation, valve actuator motor, valve actuator drive and a programmable logic controller/remote terminal unit.
- Construction of overhead service reservoir.
- Land development and security wall of 1.8 m height gate.
- O&M of all components – for ten years from the date of commissioning.

Estimated quantities of major components include:

- Construction of storage & sedimentation tank – four tanks, with a capacity of 206,250 m³ each.
- Construction of WTP of capacity 275 MLD in Jagrawan village.
- Two clear water tanks in Jagrawan village with a capacity of 34,500 m³ each.
- Installation of the SCADA system at the water works site.
- Operation and Maintenance of all the components proposed under this project for a period of ten years.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The PWSSB will implement this project through a concessionaire arrangement. The last date for bid submission to manage the concession has been extended to October 31, 2019. The RFP was issued in July; hence, it can be expected that the project will start implementation in 2020. It is expected that there may be a further delay of two to three months in the project tendering process, and the bid is likely to stay open for primary contractor appointment until early 2020. The period of completion of the work is 24 months including a three-month trial run and O&M for ten years.

While the main PPP partner for the project implementation will be selected through the current bidding process, the sub-contracts for various components of design, equipment supply, construction and engineering services, technology partners, and O&M contracts will be entered into with relevant domestic and international vendors by the PPP partner over the 24 months following the contract award .

PROJECT COST AND FINANCING

The total project cost is \$180.44 million. The project is expected to obtain financing from the World Bank (WB) and Asian Development Bank (ADB). Currently, the project is at the bidding

stage. It is expected that the project will be completed by 2022. The greenfield project is to be carried out on PPP - Hybrid/DBOT (Annuity) basis.

Financial terms noted in the RFQ are:

- 70 percent of the Bid Project Cost will be reimbursed to the Concessionaire during the construction period, which will be linked to completion and certification of the works corresponding to specified payment milestones per the concession agreement.
- From COD, the CAPEX Annuity (along with interest) and the O&M charges will be paid on a quarterly basis to the Concessionaire; PWSSB/MCJ will pay the actual power charges directly to the Punjab State Power Corporation, Ltd.
- The PMIDC will establish a revolving escrow account for the Project and all payment milestones. O&M charges will be paid to the Concessionaire through this escrow account. From the effective date and until the construction completion date, PMIDC/Urban Local Body (ULB) will ensure that the escrow account is funded with an amount equivalent to the construction payments due to the Concessionaire for the next two Payment Milestones.

U.S. EXPORT OPPORTUNITIES

The project is a greenfield project, with opportunities for U.S. companies to collaborate with the PPP partner selected in the design and execution of this project. Specific opportunities exist in the design of the entire water supply system, construction contracts including sedimentation tanks, underground storage tanks, supply of primary pipelines to carry water from the irrigation canal, supply of secondary pipelines for treated water, system design, equipment and technology for the SCADA system, water treatment plants turnkey design and supply (see equipment and services outlined in the phases above).

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Punjab Water Supply and Sewerage Board (PWSSB) Plot No 1 B, Sector 27A Madhya Marg Chandigarh 160019 India +91 172 265 1176 ceopwssb@punjab.gov.in www.pwssb.gov.in	U.S. Trade and Development Agency 1101 Wilson Boulevard Suite 1100 Arlington, VA 22209 USA Tanvi Madhusudanan tmadhusudana@ustda.gov	U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Arup Mitra Arup.mitra@trade.gov

	<p>U.S. Trade and Development Agency U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi Delhi 110021 India Mehnaz Ansari mansari@ustda.gov IndoPacific@ustda.gov www.ustda.gov</p>	
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Marathwada Water Grid		
	SECTOR	Public Health
	SUBSECTOR	Water Systems
	LOCATION	Marathwada Region Maharashtra, India
	PROJECT VALUE	\$2.3 billion

SUMMARY

The Marathwada water grid project aims to create an integrated, piped network to supply water for drinking, industrial, and agricultural purposes. The project proposes to connect 11 major dams in Marathwada, in Western India, through a large secondary grid of pipelines, to transfer water to the region. The project is being structured as Design-Build-Finance-Operate-and-Transfer (DBFOT), using a hybrid-annuity-based, public-private partnership (PPP) model. The total project investment is estimated to be \$ 2.3 billion.

PROJECT DESCRIPTION

The Marathwada water grid project is the first of the National Jal Jeevan Mission, a \$50B national effort to provide piped drinking water to all rural homes in India by 2024. The Marathwada region in Maharashtra consists of the eight districts in the heart of Maharashtra, with a population of about 18.7 million. It covers a geographical area of 64.5 thousand square kilometers. Marathwada traditionally receives little rainfall due to its geographic location and environmental conditions (*Figure 1*).

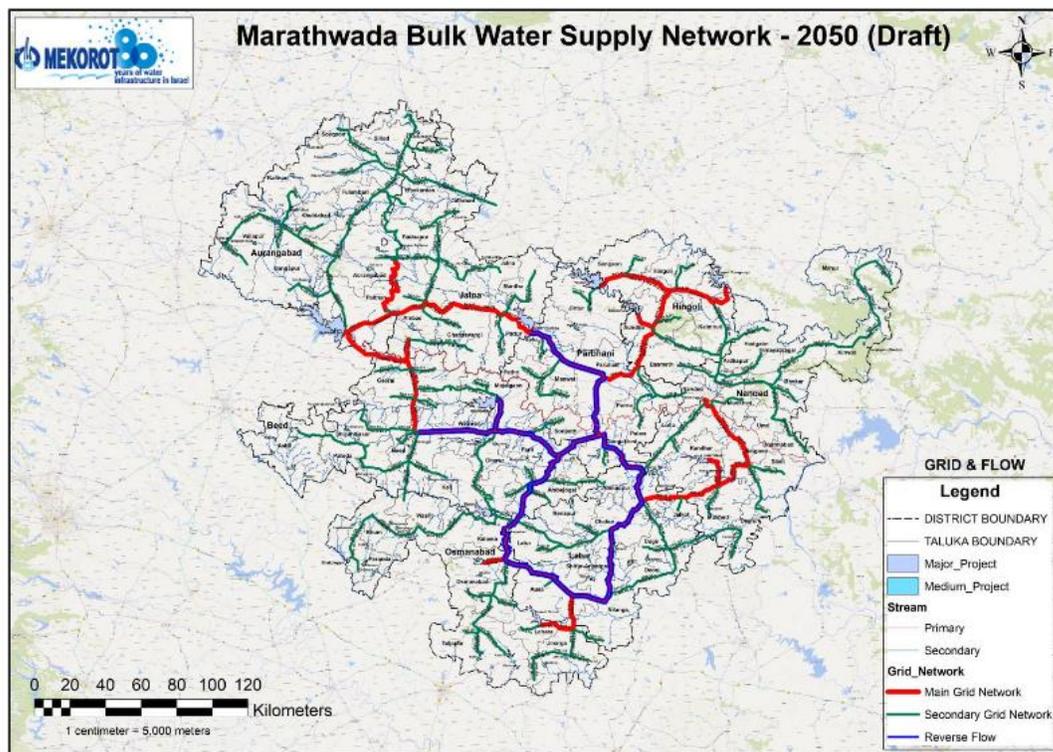
Figure 1: Marathwada Drought Conditions¹⁹⁷

¹⁹⁷ India Today



The project proposes to connect 11 major dams in Marathwada through large pipelines, including a primary loop connecting the reservoirs, to enable water to be pumped from dams with surplus water to areas serviced by reservoirs with low storage levels. It further includes a secondary grid of pipelines to transfer water to the region's 76 sub-districts (taluka) on a DBFOT basis, using a hybrid-annuity-based, public-private partnership (PPP) model. The project is expected to be implemented over a 5-year period. A future view of the water grid is provided (*Figure 2*) below.

Figure 2: Water Infrastructure in Marathwada¹⁹⁸



The Water Supply and Sanitation Department of Maharashtra (Maharashtra Jeevan Pradhikaran – MJP), in Aurangabad, is the nodal agency for this project.

¹⁹⁸ Mekorot - RFQ Tender Notice No. 7 of 2019-20, Maharashtra Jeevan Pradhikaran

The total project will be in four packages, based on a study prepared by the Israeli national water company, Mekorot Development & Enterprises Limited. The study scope included: planning; designing and cost estimations; assessment of demand; identification of water supply sources (i.e. dams and reservoirs); evaluation of linking the various reservoirs through a piped network to enable the transfer of water from surplus to deficit reservoirs; water release plans; identification of tapping points and tapping arrangements; detailed design; and digital maps.

The Mekorot report and its four recommended Packages for project completion have received approvals by the State Cabinet. Concessionaires for each package are expected to lay the primary pipelines for bulk water from the reservoirs, the secondary grid of pipelines for treated water, and develop water treatment plants (WTPs).

The project is to be implemented in the following geographic packages:

Package One – Aurangabad & Jalna: this is the first phase to be implemented. with a project cost of \$613 million. The initial tendering process for prime contractors has begun, with the final submission date postponed from October 15 to November 8, 2019. Global firms with experience in large water supply or similar projects (e.g., oil or irrigation pipelines) are expected to apply.

Aurangabad

- Lay 208 kilometers of raw-water rising main and 529 kilometers of pure-water rising main
- Construct 261 million liters per day (MLD) WTP capability at four locations

Jalna

- Lay 143 kilometers of raw-water rising main and 315 kilometers of pure-water rising main
- Construct 114 MLD WTP capability at three locations

Tenders were invited based on a Hybrid Annuity Model for Design, Build, Finance, Operate, and Transfer (DBFOT). With this model, following prequalification and vetting of designs, the bidder quoting the lowest Net Present Value (NPV) for construction and 15-year operations will be selected. It is anticipated that the concessionaire will tender and contract for equipment and services supply subsequent to the primary contract awards.

Package Two – Beed (Central Maharashtra): The Maharashtra cabinet has approved this phase for \$685 million with the following scope of work:

- Lay 373 kilometers of raw-water rising main, 705 kilometers of pure-water rising main and 1,078 kilometers of water pipelines
- Construct five WTPs with a total capacity of 255 MLD
- Construct raw-water pumping stations, pure-water pumping stations, and inline booster pumping stations

Package Two is expected to be completed over a period of 30 months from the date of award and includes Operation and Maintenance (O&M) for a period of 15 years. The RFQ was issued in September 2019, with an initial submission date of October 19, though likely it will likely be extended by a month or longer.

Package Three – Osmanabad & Latur: in August, the State Government approved \$446 million to create an integrated, piped network for the supply of drinking water, as well as water for industrial and agricultural uses for the cities of Osmanabad and Latur:

Latur:

- Lay 607 kilometers of pipeline
- Construct pumping stations and inline booster pumping stations as required
- Lay 149 kilometers of raw-water rising main and 458 kilometers of pure-water rising main

Osmanabad:

- Lay 717 kilometers of pipeline
- Construct three WTPs of total capacity 181 MLD (Osmanabad – 64 MLD, Washi – 59 MLD and Terna – 58 MLD)
- Construct pumping stations and inline booster pumping stations as required
- Lay 204 kilometers of raw-water rising main and 513 kilometers of pure-water rising main.

MJP invited bids on September 27, 2019, with a final submission date of November 22, 2019. Package Three is expected to be completed in 30 months from the date of award and is to include Operation and Maintenance (O&M) for a period of 15 years.

Package Four (Final) – Nanded-Parbhani-Hingoli: this package has yet to be presented, reviewed, and cleared.

PROJECT STATUS AND IMPLEMENTATION TIMELINE

The budgets for three of four phases have been approved based on technical and financial feasibility assessments. RFQs were issued during September for Phases I, II & III. With State Government Assembly elections scheduled at the end of October 2019, further progress on quotes is likely toward the end of 2019. Sub-contracts for design, works, equipment, and services will be issued after the primary contractor has been selected. Over the next 12-18 months, each phase of the project will be tendered, creating opportunities for both prime and subcontractors.

PROJECT COST AND FINANCING

The Government of Maharashtra and private partners will fund the Water Grid project. The full-project cost estimate is \$2.3 billion. Tranches will be announced and awarded for each of the four Phases as a Hybrid Annuity Model. The state government will fund 60 percent of project cost, with the developer raising the remaining capital through a mix of equity and debt financing. Although the assets of the project will remain with the state, a long-term model will be created to ensure the repayment of funds to the developer.

U.S. EXPORT OPPORTUNITIES

The project size and expected duration (a minimum of 5 years) create a range of possible participation options. For large U.S. companies with expertise in water management, participation either via technical and management support to the various phase developers or through partial financial participation in the Hybrid Annuity Model is feasible.

Other U.S. export opportunities include:

- Supply of primary and secondary pipelines
- Design of water treatment plants
- Water treatment equipment
- Design of mechanical and electrical works
- Water hammer control devices
- SCADA instrumentation and automation works
- Supply of componentry (pumps, valves, other piping accessories, storage tanks)
- Systems design and equipment
- Monitoring software and training
- Water-saving and conservation systems

CONTACTS

Project Sponsor	U.S. Trade and Development Agency	U.S. Commercial Service
Maharashtra Jeevan Pradhikaran Express Towers 4 th Floor Nariman Point Mumbai 400021 India Mr. P. Velrasu, Member Secretary ms@mip.gov.in	Indo-Pacific Region 1101 Wilson Blvd., Suite 1100 Arlington, VA 22209 USA Mr. Jeff Phillips jphillips@ustda.gov U.S. Embassy in Delhi Shantipath Chanakyapuri, New Delhi	U.S. Commercial Service The American Center 24 Kasturba Gandhi Marg New Delhi 100 001 91-11-2347-2000 India Mr. Arup Mitra arup.mitra@trade.gov

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Annex 1 List of Acronyms

List of Acronyms

AAI	Airports Authority of India
AC	Alternating Current
ACI	Airports Council International
ACP	Aviation Cooperation Program
ACSR	Aluminum Conductor Steel-Reinforced Cable
ADB	Asian Development Bank
ADIF	Administrador de Infraestructuras Ferroviarias
AFC	Approved For Construction
AFCS	Automatic Fare Collection System
AFTC	Audio Frequency Track Circuit
AI	Artificial Intelligence
AIF	Alternative Investment Funds
AIIB	Asian Infrastructure Investment Bank
AMI	Advanced Metering Infrastructure
ANA	Advanced Network Automation
ANS	Air Navigation Services
AOT	Airports of Thailand
API	Application Programming Interface
APSEZ	Adani Ports and Special Economic Zone Limited
ARHDM	Atmospheric Hydrodemetallization Unit
A-RMG	Automated Rail-Mounted Gantry
ASCN	ASEAN Smart Cities Network
ASEAN	Association of Southeast Asian Nations
ATC	Air Traffic Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automatic Train Supervision
BCDA	Bases Conversion and Development Authority
BIFZA	Batam Indonesia Free Zone Authority
BKC	Bandra Kurla Complex
BKK	Suvarnabhumi Airport
BMSIC	Bihar Medical Services & Infrastructure Corporation
BOOM	Build-Own-Operate-Maintain
BOT	Build-Operate-Transfer
BPaaS	Business Process as a Service
BPC	Bid Process Coordinators
BPCL	Bharat Petroleum Corporation Limited
BSE	Bombay Stock Exchange
BTH	Hang Nadim International Airport

BTP	Bataan Technology Park
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CATC	Continuous Automatic Train Control
CBM	Coalbed Methane
CBU	Completely Built Unit
CCEA	Cabinet Committee on Economic Affairs
CCGT	Combined Cycle Gas Turbine
CCOE	Cloud Computing Center of Excellence
CCTV	Closed Circuit Television
CDM	Collaborative Decision Making
CDU	Crude Distillation Unit
CEA	Central Electricity Authority
CEZ	Coastal Economic Zones
CGS	Central Gas Stations
ChPT	Chennai Port Trust
CMPDI	Central Mine Planning and Design Institute
CMRL	Chennai Metro Rail Limited
CO ₂	Carbon Dioxide
COD	Commercial Operations Date
CP	Cathodic Protection
CRK	Clark International Airport
Crs	Crores
CRZ	Coastal Regulation Zone
CSD	Cutter Suction Dredger
CT	Computerized Tomography
CTTMO	City Transport and Traffic Management Office
CWR	Clear Water Reservoir
DBFOT	Design-Build-Finance-Operate-and-Transfer
DC	Direct Current
DDC	Detailed Design Consultancy
DEA	Department of Economic Affairs
DFW	Dallas/Fort Worth International Airport
DGH	Directorate General of Hydrocarbons
DGPS	Differential Global Positioning System
DGRA	Delhi-Gurgaon-Rewari-Alwar
DICT	Department of Information and Communications Technology
DLP	Defect Liability Period
DMK	Don Mueang Airport
DMRC	Delhi Metro Rail Corporation
DOE	Department of Energy

DONER	Ministry of Development of North Eastern Region
DPR	Detailed Project Report
DVOR	Doppler Very High-Frequency Omni Range
DWT	Deadweight Tonnage
E&M	Evaluation and Management
E&M	Electrical and Mechanical
EC	Environmental Clearance
ECA	Export Credit agency
EDSA	Epifanio de los Santos Avenue
EEC	Eastern Economic Corridor
EGAT	Electricity Generating Authority of Thailand
EI	Electronic Interlocking
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
EMU	Electric Multiple Unit
EOGEPL	Essar Oil & Gas Exploration & Production Limited
EOI	Expression of Interest
EPC	Engineering, Procurement, Construction
EPL	Essar Ports Limited
EPMC	Engineering Project Management Consultant
EPPO	Energy Policy and Planning Office
EPS	Early Production System
ERC	Energy Regulatory Commission
ERS	Emergency Restoration Service
ESB	Enterprise Service Bus
ESD	Emergency Shut Down
ESL	Ernad Special Line
ESR	Environmental Study Report
EV	Electric Vehicle
EVCI	Electric Vehicle Charging Infrastructure
EVN	Vietnam Electricity
EVNNPT	National Power Transmission Corporation
FAA	Federal Aviation Administration
FBC	Final Business Case
FDI	Foreign Direct Investment
FEED	Front-End Engineering Design
FID	Final Investment Decision
FIDS	Flight Information Display System
FIT	Feed-In Tariff
FSRU	Floating Storage Regasification Unit

FY	Fiscal Year
GAD	General Arrangement Drawings
GAGAN	GPS Aided GEO Augmented Navigation
GCA	Government Contracting Agency
GDP	Gross Domestic Product
GEECL	Great Eastern Energy Corporation Limited
GGS	Gas-Gathering Stations
GHz	Gigahertz
GIPI	Good International Petroleum Industry Practices
GIS	Geographic Information System
GIS	Gas-Insulated Substations
GNIDA	Greater Noida Industrial Development Authority
GoI	Government of India
GoTN	Government of Tamil Nadu
GoUP	Government of Uttar Pradesh
GR	Government Resolution
GRESC	Geothermal Renewable Energy Service Contract
GSI	Geological Survey of India
GW	Gigawatt
GWh	Gigawatt hour
GWR	Gas/Water Ratios
HAM	Hybrid Annuity Model
HDD	Horizontal Directional Drilling
HELP	Hydrocarbon Exploration and Licensing Policy
HCM	Ho Chi Minh
HCMC	Ho Chi Minh City
HSD	High-Speed Diesel
HSE	Health, Safety and Environment
HTLS	High Temperature Low Sag
HUDCO	Haryana Urban Development Corporation
HVAC	Heating, Ventilation, and Air Conditioning
HVDC	High Voltage Direct Current
HVU	High Vacuum Distillation Unit
IaaS	Infrastructure as a Service
ICT	Information and Communications Technology
ICTT	Integrated Container Transshipment Terminal
IFC	International Finance Corporation
IGIA	Indira Gandhi International Airport
IIAC	Incheon International Airport Corporation
IIGF	Indonesia Infrastructure Guarantee Fund
IIT	Indian Institutes of Technology

ILS	Instrument Landing Systems
InVIT	Infrastructure Investment Trust
IOCL	Indian Oil Corporation Limited
IoT	Internet of Things
IPO	Initial Public Offering
IPS	Intermediate Piggling Station
IR	Indian Railways
IRR	Internal Rate of Return
IS	Indian Standard
ISTS	Inter-State Transmission System
IT	Information Technology
ITS	Intelligent Transportation System
JICA	Japan International Cooperation Agency
JV	Joint Venture
kcal	Kilocalorie
Kg	Kilogram
KIIFB	Kerala Infrastructure Investment Fund Board
KLE	Karnataka Lingayat Education
KLS	Kolathunadu Lines Strengthening
km	Kilometer
KPJ	KPJ Healthcare, Berhad
KPL	Kamarajar Port Limited
KPPIP	Committee for Acceleration of Priority Infrastructure Delivery
KRCL	Konkan Railway Corporation
KSEB	Kerala State Electricity Board
KTL	Kochi Lines Package
kV	Kilovolt
kWh	Kilowatt Hour
L	Liter
L&T	Larsen & Toubro Limited
LC	Local Content
LCC	Low-Cost Carrier
LDS	Leak Detection System
LEED	Leadership in Energy and Environmental Design
LGU	Local Government Unit
LHV	Lower Heating Value
LNG	Liquefied Natural Gas
LNGC	Liquefied Natural Gas Carrier
LOA	Length Overall
LPCD	Liters Per Capita Per Day
LPG	Liquefied Petroleum Gas

m ³	Cubic Meter
MAN	Metropolitan Area Network
MANO	Management and Network Orchestration
MBBS	Bachelor of Medicine, Bachelor of Surgery
MBM	Multi-Buoy Mooring
MbPT	Mumbai Port Trust
MC	Motor Car
MCJ	Municipal Corporation of Jalandhar
MCMC	Malaysian Communications and Multimedia Commission
MCMV	Multi-Circuit Multi-Voltage
MDPE	Medium-Density Polyethylene
MEMR	Ministry of Energy and Mineral Resources
MEP	Mechanical Electrical and Plumbing
MESTECC	Ministry of Energy, Science, Technology, Environment, and Climate Change
MGT	Minimum Guaranteed Throughput
MICE	Meetings, Incentives, Conferences and Exhibition
MIDA	Malaysian Investment Development Authority
MIS	Management Information System(s)
MJP	Water Supply and Sanitation Department of Maharashtra
MLD	Million Liters per Day
MM	Million
MMSCFD	Million Standard Cubic Feet per Day
MMTPA	Million Metric Tons Per Annum
MNRE	Ministry of Renewable Energy
MoC	Ministry of Coal
MoCA	Ministry of Civil Aviation
MoD	Ministry of Defence
MoDNER	Ministry of Development of North Eastern Region
MoEFCC	Ministry of Environment, Forest and Climate Change
MoF	Ministry of Finance
MoHA	Ministry of Home Affairs
MoP	Ministry of Power
MoP&NG	Ministry of Petroleum & Natural Gas
MoR	Ministry of Railways
MoRTH	Ministry of Roads, Transport and Highways
MoS	Ministry of Shipping
MOU	Memorandum of Understanding
MoUD	Ministry of Urban Development
MPHHI	Metro Pacific Hospital Holdings Inc.
MPPA	Million Passengers per Annum

MRI	Magnetic Resonance Imaging
MRO	Maintenance, Repair, and Overhaul
MS	Motor Spirit
MSW	Municipal Solid Waste
MT	Million Tons
MT	Magnetotelluric
MTPA	Metric Tonnes Per Annum
MTPY	Metric Tons Per Year
MVA	Mega Volt Amp
MW	Megawatt
MWh	Megawatt hour
NABH Nirman	NextGen Airports for Bharat
NAIA	Ninoy Aquino International Airport
NCR	National Capital Region
NCRPB	National Capital Region Planning Board
NCRTC	National Capital Region Transport Corporation
NDB	Nondirectional Beacon
NDB	New Development Bank
NE	Northeastern
NEC	North Eastern Council
NEDA	National Economic and Development Authority
NEERI	National Environmental Engineering Institute
NELP	New Exploration Licensing Policy
NFCP	National Fiberisation and Connectivity Plan
NGCP	National Grid Corporation of the Philippines
NH	National Highway
NIAL	Noida International Airport Limited
NLCPR	Non-Lapsable Central Pool of Resource
NLEX	North Luzon Expressway
NMIA	Navi Mumbai International Airport
NML	North Malabar Lines
NOIDA	Noida International Airport Limited
NPV	Net Present Value
NR	Northern Railways
NRDWP	National Rural Drinking Water Programs
NSI	North-South Interlink
NTP	Notice to Proceed
O&G	Oil and Gas
O&M	Operation and Maintenance
OALP	Open Acreage Licensing Policy
OBC	Outside Business Case

OCC	Operational Control Centre
OCU	Olefins Conversion Unit
ODA	Official Development Assistance
ODF	Open Defecation Free
OECD	Organization for Economic Cooperation and Development
OFC	Optical Fiber Cables
ONAF	Oil Natural Air Forced
ONAN	Oil Natural Air Natural
ONGC	Oil and Natural Gas Company Limited
OOG	Overseas Oil and Gas LLC
OPGW	Optical Ground Wire
OPIC	Overseas Private Investment Corporation
OPP	Original Project Proponent
ORD	O'Hare International Airport
PaaS	Platform as a Service
PAPI	Precision Approach Path Indicators
PDH	Plesiochronous Digital Hierarchy
PDI	Port Dependent Industry
PDIL	Projects & Development India Limited
PDP	Power Development Plan
PEA	Provincial Electricity Authority
PET	Positron-Emission Tomography
PGCIL	Power Grid Corporation of India Limited
PHP	Philippines Peso
PLEM	Pipeline End Manifold
PLN	Perusahaan Listrik Negara
PMC	Project Management Consultancy
PMCH	Patna Medical College and Hospital
PMIDC	Punjab Municipal Infrastructure Development Company
PMRDA	Pune Metropolitan Regional Development Authority
PNGRB	Petroleum and Natural Gas Regulatory Board Regulations
PPA	Power Purchase Agreement
PPI	Private Participation in Infrastructure
PPP	Public-Private-Partnership
PPT	Paradip Port Trust
PRU	Propylene Recovery Unit
PSDF	Power System Development Fund
PSHPL	Paradip-Somnathpur-Haldia Pipeline
PSSCC	Public Safety and Security Command Center
PT SMI	PT Sarana Multi Infrastruktur
PV	Photovoltaic

PwC	PricewaterhouseCoopers
PWSSB	Punjab Water Supply & Sewerage Board
RA	Risk Assessment
RCC	Residual Catalytic Cracking
RCC	Reinforced Cement Concrete
RCS-UDAN	Regional Connectivity Scheme – ‘Ude Desh ka Aam Naagrik’
RDF	Refuse-Derived Fuel
RDMP	Refinery Development Master Plan
RE	Renewable Energy
RE	Reinforced Earth
REC	Ministry of Power and Rural Electrification Corporation Limited
REIT	Real Estate Investment Trust
RF	Radio Frequency
RFP	Request for Proposals
RFQ	Request for Qualifications
RIL	Reliance India, Limited
RM	Malaysian Ringgit
RMG	Rail-Mounted Gantry
RoB	Roads Over Bridges
Ro-Ro	Roll On/Roll Off
ROW	Right of Way
RP	Regulated Period
RRTS	Regional Rapid Transit System
Rs	Indian Rupees
RS	Reach Stacker
RTM	Regulated Tariff Management
RuB	Roads Under Bridges
RVNL	Rail Vikas Nigam Limited
S&T	Signaling & Telecommunications
SaaS	Software as a Service
SBM	Swachh Bharat Mission
SCADA	Supervisory Control and Data Acquisition
SCCTV	Surveillance Closed-Circuit Television
SCG	Siam Cement Group
SDH	Synchronous Digital Hierarchy
SEC	Securities and Exchange Commission
SECI	Solar Energy Corporation of India
SEZ	Special Economic Zone
SEZ	Solar-Energy-Rich Zones
SHA	Security Hold Area
SITC	Supply, Installation, Testing and Commissioning

SKO	Super Kerosene Oil
SMC	San Miguel Corporation
SMCGP	San Miguel Corporation Global Power Holdings Corporation
SNB	Shahjahanpur-Neemrana-Behror
SPP	Small Power Producer
SPV	Special Purpose Vehicle
SRT	State Railway of Thailand
SRU	Storage Regasification Unit
STL	Sabari Lines Package
STS	Ship-to-Shore
SV	Sectionalizing Valve
SVS	Sectionalizing Valve Stations
TC	Trailer Car
TCBC	Tariff-Based Competitive Bidding
TCF	Trillion Cubic Feet
TEFR	Techno-Economic Feasibility Report
Telcos	Telecommunications Companies
TEU	Twenty-foot Equivalent Unit
TGPI	Tayabas Geothermal Power, Incorporated
THB	Thai Baht
TLS	Thrissivaperur Line Strengthening
TNB	Tenaga Nasional Berhad
TOR	Terms of Reference
TPL	Tata Projects Limited
TPP	Thermal Power Plants
TSL	Tata Steel Limited
TSP	Transmission Service Providers
TV	Television
TVL	Travancore Lines Package
TVS	Tunnel Ventilation Systems
UAS	Unmanned Aircraft System
UK	United Kingdom
ULB	Urban Local Body
US	United States
USBRL	Udhampur to Baramulla Rail Line
USD	United States Dollar
USTDA	United States Trade and Development Agency
VAC	Ventilation Air Conditioning
VGf	Viability Gap Fund
VHF	Very High Frequency
VHO	Virgin Hyperloop One

VND	Vietnamese Dong
VOCPT	V.O. Chidambaranar Port Trust
VoIP	Voice Over Internet Protocol
VOR	VHF Omnidirectional Radio Range
vRAN	Virtual Radio Access Networks
VSL	Valluvanad Special Lines
W2W	Waste to Worth
WB	World Bank
WDC	Western Dock Captive
WEZ	Wind-Energy-Rich Zones
WII	Wildlife Institute of India
WiMAX	Microwave Frequency Data Transmission
WPIL	Worley Parsons, India
WR SCT	Western Region Standing Committee on Transmission
WRSS	Western Region Strengthening Scheme
WTE	Waste to Energy
WTP	Water Treatment Plant
YEIDA	Yamuna Expressway Industrial Development Authority

Annex 2 U.S. Government Infrastructure Tools