ADB

Asian Development Bank

Memorandum

5 June 2019

To: Hun Kim, Director General, SARD 6 June 2019

Through: Priyantha Wijayatunga, Director, SAEN

From: Jaimes Kolantharaj, Energy Specialist, SAEN

Subject: **Democratic Socialist Republic of Sri Lanka: Supporting Feasibility Study and Survey to Adopt Liquefied Natural Gas (LNG) Power Generation to Diversify Energy Mix**
—Approval of Small-Scale Knowledge and Support Technical Assistance

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A. Request for Approval

1. We request approval of the subject small-scale knowledge and support technical assistance (TA) amounting to $225,000 to be financed on a grant basis by ADB's Technical Assistance Special Fund (TASF 6). This TA will become effective upon approval; such approval will be reported to the Board in the Quarterly Summary Report on Small-Scale and Supplementary Technical Assistance Projects not exceeding $225,000.

B. Rationale and Justification

2. **Power Generation Scenario in Sri Lanka.** By August 2017, Sri Lanka had a total installed power generating capacity of 4,043 megawatts (MW) including 516 MW of private sector owned plants. Of this, 2,115 MW (52.3%) was from thermal generation based on coal and oil while the remainder was renewable energy based including large hydro.[1] However in energy terms, in dry years like 2017 when approximately 78% of the total generated power provided to the grid was from thermal generation (40% from coal and 38% from oil), the share of oil fired power generation significantly increases. This leaves a heavy financial burden on the utility and poses a serious threat to the country's energy security and the environment. At the same time, development of new large hydro power plants is becoming increasingly difficult owing to social and environmental concerns. Hence there is an urgent need to develop other cleaner energy sources for power generation such as LNG in addition to other renewable energy sources, including potential future conversion of the oil-fired plants to LNG-fired plants. This is particularly important considering that the alternative to LNG is coal which will have more adverse environmental impacts including impacts on climate change.

3. **South Asia Subregional Economic Cooperation (SASEC) flagship initiative**. One of the SASEC flagship initiatives is development of a liquified petroleum gas and an LNG hub in Sri Lanka. Any LNG import and distribution facilities developed in Sri Lanka as part of its efforts on LNG based power generation can also form part of a regional LNG hub particularly addressing possible future LNG needs of Maldives.

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[1] Government of Sri Lanka, Ministry of Power and Renewable Energy. 2018. *Performance 2017 and Programmes for 2018 – handbook.* Colombo.

4. **Government request.** The Government of Sri Lanka, through the External Resources Department (ERD), has requested ADB via letter dated 11 March 2019 to support Ceylon Electricity Board (CEB) urgently in exploring LNG as a fuel for power generation. The Ministry of Power and Renewable Energy (MPRE) also sees a greater role for LNG in its goal of reducing the use of oil and coal in the country, particularly for power generation. This is also in line with the government's key development priority to diversify the existing generation mix to include cleaner energy resources and climate change mitigation actions.[2] A small-scale TA was preferred to initiate the necessary activities for LNG study quickly as requested by the government.

5. **The feasibility study**. The proposed feasibility study is to identify the optimal LNG facility for Sri Lanka (i.e., land-based LNG terminal or floating storage and regasification unit) and the most suitable location for the development of new LNG-fired power plants and its associated facilities. This will include detailed study by considering the demand for natural gas in Sri Lanka, global LNG market, LNG pricing and contracts, possibility of supplying LNG to regional markets, and other social and environmental aspects. Maldives is considering importing LNG for power generation and other uses. LNG terminal in Sri Lanka with sufficient storage and adequate supply will benefit from lowering the energy cost of both countries. The site selection requires offshore survey and hydrodynamic studies to ascertain technical parameters required for LNG power generation infrastructure and its associated facilities, therefore it is recommended to engage a firm with expertise, equipment, and experience working in Sri Lankan ocean waters to carry out this marine survey assignment.

6. The TA will help provide necessary support for the feasibility study including marine survey for developing LNG based power generation and its value chain. CEB, a state-owned electricity utility, has already carried out a preliminary feasibility study with support from ADB[3] exploring the possibility of LNG for Colombo-based power plants. The findings of the pre-feasibility study recommend the necessity to set-up an LNG terminal and other infrastructure on an expeditious basis for supplying LNG for power generation.

7. CEB currently does not have in-house capacity to undertake these tasks since LNG is entirely new to Sri Lanka. The TA will provide external consultants to assist in preparing the feasibility and survey report for LNG import, LNG terminal and sea side facilities, infrastructure and other allied facilities for LNG transmission to the prospective power plants. TA at a glance is in Attachment 1.

C. Impact and Outcome

8. The TA is aligned with the following impact: inclusion of cleaner energy resources and climate change mitigation actions in Sri Lanka government's priority to diversify the power generation mix achieved. The TA will have the following outcome: increased viable options to diversify primary energy sources in power generation of Sri Lanka. The design and monitoring framework is in Attachment 2.

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[2] Government of Sri Lanka. 2015. *Sri Lanka Energy Sector Development Plan for a Knowledge Based Economy 2015-2025.* Colombo.

[3] The preliminary feasibility study for LNG was supported by individual consultants using SAEN's staff consultancy budget.

D. Outputs and Activities

9. **Output 1: Feasibility study to identify optimal LNG facility and site completed.** Activities include detailed feasibility study to identify the type of LNG facility and suitable site for LNG infrastructure development with support from various experts. The potential of supplying LNG to regional markets such as Maldives will also be studied. Based on the feasibility study undertaken, technical report for type and capacity of LNG facility, engineering estimates, and other relevant details for potential LNG infrastructure will be prepared.

10. **Output 2: Site survey and hydrodynamic studies to confirm feasibility study for LNG infrastructure completed.** This will include topographic and bathymetric survey including hydrodynamic studies, analysis of weather conditions, modelling, geophysical and geotechnical analysis and development of layouts for the identified sites to ascertain the technical parameters for the LNG infrastructure prepared by feasibility study report.

11. **Output 3: Assessment of CEB's technical and procurement capacity for implementing LNG infrastructure and its associated facilities conducted.** Based on the complexity of feasibility study and survey, CEB's technical and procurement capacity to implement the LNG infrastructure and its associated facilities will be assessed and will propose necessary capacity building programs to support CEB in adopting this new technology. Basic trainings and workshops to understand LNG technology and its merits will be provided.

E. Cost and Financing

12. The small-scale TA is estimated to cost $225,000 which will be financed on a grant basis by ADB's Technical Assistance Special Fund (TASF 6). The government and its agencies will provide experienced counterpart staff and other in-kind contributions. The cost estimates and financing plan is in Attachment 3.

F. Implementation Arrangements

13. ADB will administer the TA and will be responsible for the selection, supervision and evaluation of consultants under the TA. CEB will be the executing and implementing agency. The TA will be implemented over 12–month period from June 2019 to May 2020. The TA resources will be disbursed following ADB's Technical Assistance Disbursement Handbook (2017, as amended from time to time). The TA does not require logistical support and undertaking from CEB.

G. Consulting Services

14. The feasibility study requires survey in Sri Lanka ocean waters and hence a consulting firm will be recruited to undertake topographic and bathymetric survey, modelling, geophysical and geotechnical investigations including hydrodynamic study to ascertain technical parameters to confirm the site feasibility of LNG infrastructure and its associated facilities. The firm will need access to Sri Lanka ocean waters. The coastal zone along Colombo is very sensitive due to the proximity to many important power plants, port and other sensitive areas. Lanka Hydraulic Institute Ltd. (LHI) is the only hydraulic survey firm authorized by Sri Lanka Coast Guard and Sri Lanka Port Authority to access Colombo coastal region to carry out physical survey which

requires deep water access due to security reasons.[4] In addition, LHI is the only firm in Sri Lanka which has vast experience in carrying out survey along this sensitive coastal region, and basic coastal information to initiate the survey is already with them. It is therefore recommended to recruit LHI through single source selection (SSS).

15. Individual consultants (3 person-months of key international experts) will be recruited through framework agreements wherein shortlisted candidates may be hired as needed for the duration of the agreement to provide their expertise in the fields of (i) LNG infrastructure design; (ii) marine engineering; (iii) LNG pipeline planning and design; and (iv) LNG finance and commercial management. ADB will engage the consultants following the ADB Procurement Policy (2017, as amended from time to time) and its associated staff instructions. The terms of reference for consultants are in Attachment 4. Additional person-months of individual consultancy support for detailed feasibility studies for LNG infrastructure, marine engineering, pipeline design, LNG commercial, LNG financial, environmental and social aspects will be supported by small-scale TA–South Asia Subregional Economic Cooperation Regional Energy Cooperation.[5]

Attachments:
1. Knowledge and Support Technical Assistance at a Glance
2. Design and Monitoring Framework
3. Cost Estimates and Financing Plan
4. Terms of Reference for Consultants

cc: S. Widowati, Country Director, SLRM

[4] Considering the recent security threats in the country especially in the Colombo region, it may take several months for any other firm to go through the process of receiving clearances and approvals to carry out work in the sensitive waters. Considering the urgency to develop the feasibility study by Ceylon Electricity Board (CEB) and the cost estimate ($150,000), single source selection (SSS) with Lanka Hydraulic Institute Ltd. (LHI) can be justified.

[5] The regional knowledge and support technical assistance (TA) is aimed at developing master plans, optimizing energy resources for power generation and enhance capacity development for the energy sector's regional cooperation and integration (RCI) under the South Asia Subregional Economic Cooperation (SASEC) program. It will cover Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, and Sri Lanka.

Project Classification Information Status: Complete

KNOWLEDGE AND SUPPORT TECHNICAL ASSISTANCE AT A GLANCE

1. Basic Data — **Project Number:** 53193-001

Project Name	Supporting Feasibility Study and Survey to Adopt Liquefied Natural Gas (LNG) Power Generation to Diversify Energy Mix	**Department/Division**	SARD/SAEN
Nature of Activity	Research and Development	**Executing Agency**	Ceylon Electricity Board
Modality	Small-Scale		
Country	Sri Lanka		

2. Sector	**Subsector(s)**	**ADB Financing ($ million)**
✓ Energy	Energy sector development and institutional reform	0.23
	Total	**0.23**

3. Strategic Agenda	**Subcomponents**	**Climate Change Information**	
Inclusive economic growth (IEG)	Pillar 2: Access to economic opportunities, including jobs, made more inclusive	Climate Change impact on the Project	Low
Environmentally sustainable growth (ESG)	Global and regional transboundary environmental concerns Natural resources conservation	**ADB Financing** Mitigation ($ million)	0.15
Regional integration (RCI)	Pillar 4: Other regional public goods		

4. Drivers of Change	**Components**	**Gender Equity and Mainstreaming**	
Governance and capacity development (GCD)	Organizational development	No gender elements (NGE)	✓

5. Poverty and SDG Targeting		**Location Impact**	
Geographic Targeting	No	Rural	Medium
Household Targeting	No	Urban	High
General Intervention on Poverty	Yes		
SDG Targeting	Yes		
SDG Goals	SDG7, SDG13		

6. Risk Categorization Risk Categorization does not apply

7. Safeguard Categorization Safeguard Policy Statement does not apply

8. Financing

Modality and Sources	**Amount ($ million)**
ADB	**0.23**
Knowledge and Support technical assistance: Technical Assistance Special Fund	0.23
Cofinancing	**0.00**
None	0.00
Counterpart	**0.00**
None	0.00
Total	**0.23**

Currency of ADB Financing: USD

DESIGN AND MONITORING FRAMEWORK

The TA is aligned with following impact:

Inclusion of cleaner energy resources and climate change mitigation actions in Sri Lanka government's priority to diversify the power generation mix achieved [a]

Results Chain	Performance Indicators with Targets and Baselines	Data Sources and Reporting	Risks
Outcome Increased viable options to diversify primary energy sources in power generation of Sri Lanka.	By 2020: a. Technical and financial viability of LNG-based power generation in Sri Lanka confirmed. (2019 baseline: NA) b. Potential locations for future LNG terminals identified. (2019 baseline: NA)	a. Feasibility reports and government policies and databases b. Consultant reports, TA report and knowledge products	Lack of interest and incentive to understand LNG market and its price dynamics among relevant stakeholders.
Outputs 1. Feasibility study to identify optimal LNG facility and site completed. 2. Site survey and hydrodynamic studies to confirm feasibility study for LNG infrastructure completed. 3. Assessment of CEB's technical and procurement capacity for implementing LNG infrastructure and its associated facilities conducted.	1. Feasibility report with type of LNG facility and location identified by Q4 2019. (2019 baseline: NA) 2. Technical report with site specific technical parameters for development of LNG infrastructure prepared by Q1 2020. (2019 baseline: NA) 3. Technical and procurement capability of implementing agency assessed and propose necessary capacity building program to strengthen their capacity if required by Q2 2020. (2019 baseline: NA)	1-3 consultant reports, TA report and final report	Lack of support from Government agencies to participate in and contribute to TA activities.

Key Activities with Milestones

1. Feasibility study to identify optimal LNG facility and site completed.

1.1 Preliminary feasibility report completed by Q3 2019.
1.2 Final feasibility report completed by Q4 2019.

2. Site survey and hydrodynamic studies to confirm feasibility study for LNG infrastructure completed.

2.1 Preliminary survey to ascertain technical parameters completed by Q1 2020.
2.2 Final report with survey and technical parameters submitted by Q2 2020.

Key Activities with Milestones

3. **Assessment of CEB's Technical and procurement capacity for implementing LNG infrastructure and its associated facilities conducted.**
   3.1 Assessment of CEB's technical and procurement capability completed by Q1 2020.
   3.2 Basic training / workshops for CEB on LNG technology provided by Q1 2020.
   3.3 Capacity building program recommendation for CEB to implement LNG infrastructure completed by Q2 2020.

TA Management activities

Recruitment of individual consultants for feasibility study and CEB's capacity assessment completed by Q2 2019.
Tendering for survey firm commence by Q3 2019.
Contract of survey firm awarded by Q4 2019.

Inputs

ADB: $225,000

Assumptions for Partner Financing

Not applicable

ADB = Asian Development Bank, CEB = Ceylon Electricity Board, LNG = Liquefied Natural Gas, RFP = Request for Proposal.

[a] Government of Sri Lanka, Ministry of Power and Renewable Energy. 2018. *Performance 2017 and Programmes for 2018 – handbook.* Colombo.

Sources: Asian Development Bank staff estimates based on discussions with CEB and Government of Sri Lanka in April 2019.

COST ESTIMATES AND FINANCING PLAN

($'000)

Item	Amount
Asian Development Bank[a]	
1. Consultants	
a. Remuneration and per diem	
i. National consulting for the hydrodynamic study and survey	150.00
ii. International consultants	45.00
b. Out-of-pocket expenditures	
i. International and local travel	7.00
ii. Reports and communications	1.00
2. Trainings/workshops	20.00
3. Contingencies	2.00
Total	**225.00**

[a] Financed by the Asian Development Bank's Technical Assistance Special Fund (TASF 6).

Note: Counterpart contributions will be provided by the Government in the form of staff time and office space for consultants which do not need budgetary allocations from the executing agencies.

Source: Asian Development Bank staff estimates.

TERMS OF REFERENCE FOR CONSULTANTS

1. The outline terms of reference for the small-scale knowledge and support technical assistance (TA) facility consultants are described in paras 2 to 5. Table 1 reflects the required services for the TA.

Table 1: Summary of Consulting Services Requirement

Positions	Person-months required
International Consultants	
LNG Design Expert	1.0
Marine Engineer	1.0
LNG Transmission Design Expert	0.5
LNG Finance and Commercial Expert	0.5
Total	**3.0**
National Consultancy Firm	
National consultancy firm for field survey and hydrodynamic study	Output-based

LNG = Liquefied Natural Gas.
Source: Asian Development Bank staff estimates.

2. **LNG Design Expert (international; 1 person-month).** The liquefied natural gas (LNG) expert shall have a master's degree in engineering/energy or related fields, and an overall minimum experience of 10 years in the LNG sector. The Consultant shall be an expert on LNG receiving terminal design, floating storage and regasification unit (FSRU) deployment, associated infrastructure deployment, costing and project management, preferably in projects with multilateral lending agencies in developing countries. Working experience in the South Asian region would be preferable. The tasks of the consultant and team leader will include, but not be limited to, the following:

(i) Work closely with the technical team of Ceylon Electricity Board (CEB) and coordinate with all other experts to prepare the feasibility study for supplying LNG for power generation and prepare pre-feasibility study for regional LNG hub;

(ii) Prepare request for proposal (RFP) for competitive procurement of:
   a. LNG;
   b. FSRU and sea side facilities for mooring on Build Own and Operate (BOO) basis; and
   c. Infrastructure and other allied facilities for gas pipeline from FSRU to the power generation plants on Build Own Operate and Transfer (BOOT) basis.

(iii) Determine the capacity of FSRU, pipeline, and the upper limit of LNG carrier;

(iv) Location study/site selection for FSRU in north of Colombo (Kerawalapitiya). Coordinate with the firm recruited for undertaking metocean/hydraulic studies and monitor the data collection and site selection study. Recommend the suitable site for FSRU considering the parameters such as proximity to coastline, bathymetry and water depth, safety, topography, proximity to the shipping route, sheltered area etc.;

(v) Mooring selection and downtime analysis. Coordinate with the firm recruited for determining mooring configuration and marine supporting facilities needed for safe ship to ship LNG transfer and delivery. Analyze sea and weather conditions to assess the impact and operational risks. Analyze survival conditions. Propose suitable mooring system and recommend limiting sea states to safely connect an LNG carrier.

Conduct hydrodynamic analyses and develop layouts and designs for mooring facilities;

(vi) Conduct marine operations study and provide recommendations on marine support services and operation requirements. The work includes sizing of tugs, assessment of navigational aids, and general commentary on berthing, unberthing, emergency departure and general ship traffic considerations;

(vii) Determine the feasibility of transporting LNG from the FSRU to identified power plants and recommend routes for subsea/onshore gas pipelines. Recommend onshore grid tie-in point and undertake topographic route survey. Propose gas pipeline configuration, capacity, diameter, thickness, pressure and temperature ratings, and major equipment;

(viii) Conduct preliminary environment impact study;

(ix) Determine overall project estimates including the capital investment and operational costs (considering BOO for FSRU and BOOT for infrastructure and pipeline) and the resulting impact on electricity generation cost;

(x) Coordinate with all the experts and determine the overall feasibility of the project;

(xi) Assess the possibility of developing Colombo as a regional LNG hub and prepare a pre-feasibility report; and

(xii) Assist ADB project team in document preparation and provide inputs further analysis and document preparation.

3. **Marine Engineer (international; 1 person-month).** The Marine expert shall have a master's degree in naval/marine engineering or related fields, and an overall experience of minimum 10 years in the marine/LNG sectors. The Consultant shall be an expert on marine studies (specifically relating to LNG and FSRUs) and marine environment impacts related to infrastructure development. Working experience in the South Asian region would be preferable. The tasks of the consultant will include, but not be limited to, the following:

(i) Work closely with the Team Leader, other experts and the technical team of CEB and coordinate with all other experts to prepare the feasibility study for supplying LNG for power generation and prepare pre-feasibility study for regional LNG hub;

(ii) Provide inputs to the team leader to prepare RFPs for competitive procurement of:
   a. LNG;
   b. FSRU and sea side facilities for mooring on Build Own and Operate (BOO) basis; and
   c. Infrastructure and other allied facilities for gas pipeline from FSRU to the power generation plants on Build Own Operate and Transfer (BOOT) basis.

(iii) Location study/site selection for FSRU in north of Colombo (Kerawalapitiya). Coordinate with the firm recruited for undertaking metocean/hydraulic studies and monitor the data collection and site selection study. Recommend the suitable site for FSRU considering the parameters such as proximity to coastline, bathymetry and water depth, safety, topography, proximity to the shipping route, sheltered area etc.;

(iv) Mooring selection and downtime analysis. Coordinate with the firm recruited for determining mooring configuration and marine supporting facilities needed for safe ship to ship LNG transfer and delivery. Analyze sea and weather conditions to assess the impact and operational risks. Analyze survival conditions. Propose suitable mooring system and recommend limiting sea states to safely connect an LNG carrier. Conduct hydrodynamic analyses and develop layouts and designs for mooring facilities;

(v) Conduct marine operations study and provide recommendations on marine support services and operation requirements. The work includes sizing of tugs, assessment of navigational aids, and general commentary on berthing, unberthing, emergency departure and general ship traffic considerations;
(vi) Determine the feasibility of transporting LNG from the FSRU to identified power plants and recommend routes for subsea gas pipelines. Recommend onshore grid tie-in point;
(vii) Assist the Natural Gas expert to determine the capacity of FSRU, pipeline, and the upper limit of LNG carrier;
(viii) Assist the Environment expert to conduct preliminary environment impact study;
(ix) Assist the Finance and Commercial expert to determine overall project estimates; and
(x) Assist ADB project team in document preparation and provide inputs further analysis and document preparation.

4. **LNG Transmission Design Expert (international; 0.5 person-month).** The gas transmission design expert shall have a degree in civil/mechanical/chemical engineering or related fields, and an overall experience of minimum 8 years in the gas sectors. The Consultant shall be an expert on pipeline design and maintenance related to gas infrastructure development, experience in working with development agencies like ADB, particularly in the power sector would be an advantage. Working experience in the South Asian region would be preferable. The tasks of the consultant will include, but not be limited to the following:

(i) Work closely with the Team Leader, other experts and the technical team of CEB and coordinate with all other experts to prepare the feasibility study for supplying LNG for power generation and prepare pre-feasibility study for regional LNG hub;
(ii) Provide inputs to the team leader to prepare RFPs for competitive procurement of:
  a. LNG;
  b. FSRU and sea side facilities for mooring on Build Own and Operate (BOO) basis; and
  c. Infrastructure and other allied facilities for gas pipeline from FSRU to the power generation plants on Build Own Operate and Transfer (BOOT) basis.
(iii) Determine the feasibility of transporting LNG from the FSRU to identified power plants and recommend routes for subsea/onshore gas pipelines. Recommend onshore grid tie-in point and undertake topographic route survey;
(iv) Propose gas pipeline configuration, capacity, diameter, thickness, pressure and temperature ratings, and major equipment;
(v) Assist the Environment expert to conduct preliminary environment impact study;
(vi) Assist the Finance and Commercial expert to determine overall project estimates; and
(vii) Assist ADB project team in document preparation and provide inputs further analysis and document preparation.

5. **LNG Finance and Commercial Expert (international; 0.5 person-month).** The Finance and Commercial expert shall have a master's degree in finance/economics or related fields, and an overall experience of minimum 10 years in project financing and infrastructure development (preferably in LNG sectors). The Consultant shall be an expert on financial and economic analysis of infrastructure development with extensive experience in oil and gas sectors. Working experience in the South Asian region would be preferable. The tasks of the consultant will include, but not be limited to, the following:

(i) Work closely with the Team Leader, other experts and the technical team of CEB and coordinate with all other experts to prepare the feasibility study for supplying LNG for power generation and prepare pre-feasibility study for regional LNG hub;

(ii) Provide inputs to the team leader to prepare RFPs for competitive procurement of:
   a. LNG;
   b. FSRU and sea side facilities for mooring on Build Own and Operate (BOO) basis; and
   c. Infrastructure and other allied facilities for gas pipeline from FSRU to the power generation plants on Build Own Operate and Transfer (BOOT) basis.

(iii) Propose appropriate business models for the sourcing of LNG and operation of FSRU and pipelines;

(iv) Determine overall project estimates including the capital investment and operational costs (considering BOO for FSRU and BOOT for infrastructure and pipeline) and the resulting impact on electricity generation cost;

(v) Provide financial and economic analysis to determine the viability of the project considering the long-term demand forecasts. Coordinate with the team leader and other experts to determine the overall feasibility of the project;

(vi) Provide the commercial analysis to assess the possibility of developing Colombo as a regional LNG hub; and

(vii) Assist ADB project team in document preparation and provide inputs further analysis and document preparation.