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A Playbook for ASEAN Power Grid Interconnector Feasibility Studies

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ACRONYMS

Acronym	Description
ACE	ASEAN Centre for Energy
ADB	Asian Development Bank
AERN	ASEAN Energy Regulators Network
AFD	French Development Agency
AIIB	Asian Infrastructure Investment Bank
AIMS	ASEAN Interconnector Master Plan Study
AMEM	ASEAN Ministers on Energy Meeting
AMS	ASEAN Member States
APAEC	ASEAN Plan of Action for Energy Cooperation
APG	ASEAN Power Grid
APGCC	ASEAN Power Grid Consultative Committee
ASEAN	Association of Southeast Asian Nations
DB	Development Bank
DFAT	Department of Foreign Affairs and Trade, Australia
DFC	U.S. International Development Finance Corporation
EE	Energy Efficiency
EMF	Electromagnetic Fields
EMS	Energy Management System
EPC	Engineering, Procurement, and Construction
ESMP	Environment and Social Management Plan
ESIA	Environmental and Social Impact Assessment
EXIM	Export-Import Bank of the United States
FS	Feasibility Study
GIS	Geographic Information System
HAPUA	Heads of ASEAN Power Utilities/Authorities
HVAC	High-Voltage Alternating Current
HVDC	High-Voltage Direct Current
HWG	HAPUA Working Group
IFC	International Finance Corporation
IFI	International Financial Institution
JICA	Japan International Cooperation Agency
kV	Kilovolts
LOI	Letter of Intent
LTC	Levelized Transmission Cost
MOU	Memorandum of Understanding

Acronym	Description
MOUs	Memoranda of Understanding
MPT	Multilateral Power Trade
MW	Megawatt
NDA	Non-Disclosure Agreement
OH	Overhead
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
PDP	Power Development Plan
PESIA	Preliminary Environmental Social Impact Assessment
PLN	PT Perusahaan Listrik Negara
PPA	Power Purchase Agreement
PMI	Project Management Institute
RE	Renewable Energy
ROI	Return on Investment
SCADA	Supervisory Control and Data Acquisition
SEB	Specialized Energy Bodies
SPP	USAID Southeast Asia Smart Power Program
SS	Subsea
TBC	To be constructed
TNB	Tenaga Nasional Berhad
ToR	Terms of Reference
TSA	Transmission Service Agreement
USTDA	U.S. Trade and Development Agency
UXO	Unexploded Ordnance
VRE	Variable Renewable Energy

NOTE ON TERMS

Throughout the report, various terms are used to describe stakeholders in the feasibility study (FS) process. The authors have attempted to standardize these terms, and they are defined below:

- "FS consultants" refers to the companies contracted to perform an FS and may refer to the prime contractor or specialized subcontractors depending on the context.
- "Beneficiaries" or "trading partners" refers to the Association of Southeast Asian Nations (ASEAN) governments (or utilities) that will eventually engage in the multilateral power trade (MPT) described by the FS.
- "Donor partners" refers to any organization paying for an interconnector FS (e.g., international financial institutions [IFIs], and development banks [DBs]).

ACKNOWLEDGEMENT

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EXECUTIVE SUMMARY

This Feasibility Study (FS) Playbook presents leading practices for scoping and implementing FS, proven frameworks for data sharing and analysis, and key content and analyses recommended for all FS. The audience for the Playbook includes energy ministries and utilities seeking guidance to navigate the FS scoping, funding, and delivery process; development partners responsible for procuring FS consultancies and providers; FS providers interested in leading practices and tips from ongoing efforts; and ASEAN Power Grid (APG) stakeholders interested in supporting progression of the APG.

The FS Playbook emphasizes the need for potential power trading partners and their stakeholders to collaborate effectively. Project-specific Memoranda of Understanding (MOUs) are key collaboration tools, signaling commitment to potential donors, creating frameworks for data sharing, aligning projects with ASEAN energy goals, and clarifying roles and responsibilities of trading partners. Effective data sharing is crucial for impactful FS. Proper data sharing ensures accurate representation of electricity systems, helps deliver the FS on time and on budget, and reduces risks in later project stages. ASEAN Member States (AMS) have a history of collaboration through data sharing agreements, but sensitive data must be handled with robust confidentiality agreements. The Playbook shows how ASEAN regional entities, such as ACE, can help align the priorities of utilities, energy ministries, and donor organizations and enhance the prospects for successful interconnector project development. The benefits of and challenges to effective interconnector FS are illustrated through the case study of the PLN (PT Perusahaan Listrik Negara)-TNB (Tenaga Nasional Berhad) interconnectors [funded by the U.S. Trade and Development Agency (USTDA)].

The Playbook also outlines successful FS delivery practices. Kickoff meetings and site visits are critical for aligning objectives, clarifying roles and responsibilities, identifying data needs, and setting project scope and timelines. Identifying and resolving data gaps early on is essential to avoid impacts on FS schedule, quality, and cost. Site visits area a good value for money if they help ensure input and buy-in from all partners and stakeholders. Effective delivery frameworks, adherence to internationally recognized standards, and alignment with global best practices helps ensure consistency and reliable results throughout the FS life cycle. Subsea cabling projects require special attention to early site selection and development of robust operation and maintenance (O&M) strategies. The Playbook also cautions that high-voltage direct current (HVDC) cable supply chain constraints in Southeast Asia may be a barrier to achieving desired interconnector commissioning dates.

The growing cooperation among AMS in developing the APG is attracting Donor Partner investment in interconnector FS. To continue this momentum, AMS should adopt the best practices outlined in the Playbook, improve data sharing frameworks, align FS projects with available funding, and facilitate selection of qualified FS consultants. Leveraging results from the ASEAN Interconnector Master Plan Study (AIMS) III and engaging with convening organizations will catalyze further investment and increase the likelihood of realizing the APG vision of regional interconnection by 2045.

INTRODUCTION

The FS Playbook provides comprehensive guidance for APG stakeholders—including energy ministries, regulators, and international organizations—on planning and conducting FS for greenfield transmission interconnectors. The Playbook describes the process and studies needed to determine a project's technical, market, commercial, and regulatory feasibility to a level sufficient to attract financing.

Collaboration among donor partners, beneficiary countries, and FS consultants is critical for project success. Previous work, notably AIMS III, has identified ten priority greenfield interconnectors needed to improve regional connectivity and connect renewable energy (RE) development areas with load centers. The first step in developing these projects—and the most difficult to finance—is the FS. ACE, in collaboration with the Heads of ASEAN Power Utilities/Authorities (HAPUA) and with the support of the USAID Southeast Asia Smart Power Program (SPP), has demonstrated that grant financing of transmission interconnector FS by development partners can be a crucial tool in kick-starting transmission interconnector early development efforts.[1]

Building on the ongoing USTDA-funded FS of two Indonesia-Malaysia priority interconnectors, ACE and HAPUA have engaged with additional development partners expressing interest in advancing the APG through grant-financed FS. Development partners expressing interest include Japan International Cooperation Agency (JICA), the Agence Française de Développement (AFD), the Asian Development Bank (ADB), and The World Bank. This FS Playbook will be used by ACE and HAPUA to guide development partners in sponsoring additional FS for ASEAN Priority Interconnectors.

FS results help determine the technical and financial feasibility of a project, legal and regulatory compliance needs and concerns, major risks and potential mitigation strategies, and an evaluation of technical and design alternatives. An FS report should inform decision-makers whether they should pursue the implementation of the interconnector project, and if so, what technical, market, and regulatory barriers must be overcome.

This Playbook provides guidance to APG stakeholders (e.g., ASEAN energy ministries, HAPUA, regulators, international consultancies, and international organizations/donor partners) on how to plan and conduct a comprehensive FS for greenfield transmission interconnectors. This Playbook will help them to better understand and prepare for developing terms of reference (ToR) and proposals seeking international funding/support in the future and will provide best practices for engaging with different stakeholders.

The FS Playbook includes guidance on planning and conducting the transmission interconnector project FS process, including: (i) establishing a cooperative framework between potential trading partners; (ii) developing the FS ToR; (iii) studying financing; (iv) mobilizing qualified experts; and (v) delivering/implementing suggestions.

Content for the FS Playbook was drawn from: (i) a desk review of FS guidelines and examples from the open literature; (ii) discussions with relevant bodies supporting the APG, including the United

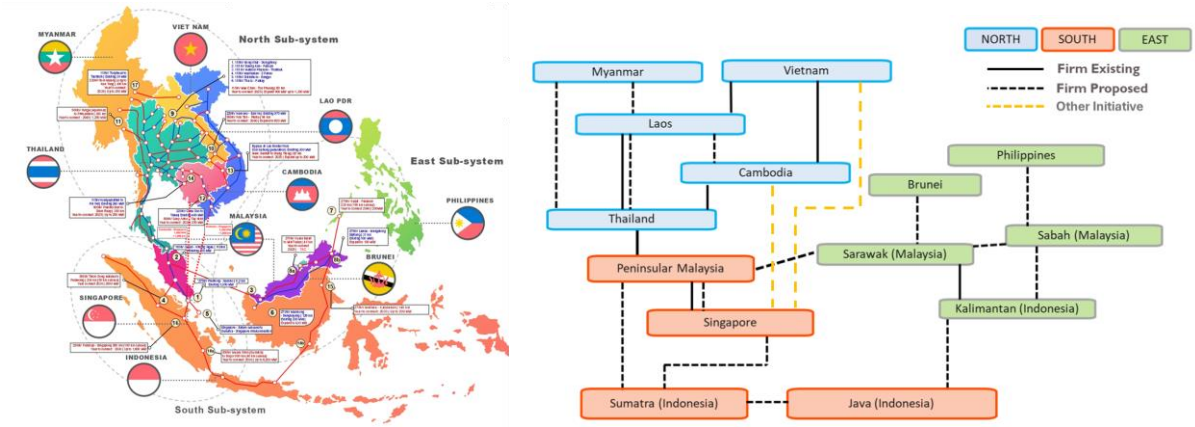
[1] On March 5. 2024 a $2 million grant agreement was signed by PLN and USTDA. This grant agreement will finance FS for two interconnectors between Indonesia and Malaysia identified in the AIMS III study.

Nations Economic and Social Commission for Asia and the Pacific, Green Grid Initiative, ACE, ADB, and Energy Transition Project; and (iii) interviews with leading consultancies providing FS.

PRIORITY INTERCONNECTORS AS IDENTIFIED BY AIMS III

The APG is comprised of multiple cross-border transmission projects grouped into northern, southern, and eastern sub-regions (Figure 1). Eight of ten AMS currently engage in interconnected power trade, mostly concentrated in the northern sub-region. The ASEAN Interconnector Master Plan Study (AIMS) calls for the APG to expand rapidly over the next 15 years, with the goal of a fully interconnected region by 2045. Once complete, the APG will enable resource-sharing and utilization among the ten countries that: (i) mobilizes sufficient RE to meet regional and national targets; (ii) efficiently accommodates increasing demand; and (iii) enables cost-saving and reliability-improving benefits.

Figure 1: Map of APG (left); Schematic Diagram of Sub-Regions (right)



Source: Updated Power Development Plan scenario under AIMS III, 2022.

The AIMS is a regional initiative to enhance energy connectivity within ASEAN. The AIMS series focuses on developing and improving the infrastructure needed to interconnect the electrical grids of ASEAN member countries. The study embodies the ASEAN Ministers on Energy Meeting (AMEM) directive to enable multilateral electricity trading across the ASEAN region.

AIMS III identified eighteen priority transmission interconnection projects under APG, ten of them greenfield transmission interconnections, informed by both regional and individual energy models (capacity-expansion model and production cost simulation) to evaluate the optimum additions of generation and interconnection and assess the operating performance of the APG resulting from capacity expansion planning. Table 1 provides details on all 18 interconnectors, both in operation and planned.

Table 1: Priority Interconnectors Identified by AIMS III

No	Connection	Interconnection Capacity (in Megawatt [MW])					
		Existing**	Ongoing (Up to 2024) **	Future**	Total**	AIMS III Projection (2040) *	Technology
1	Peninsular Malaysia – Singapore	525	525	TBC	1,050	1,050	HVAC
2	Thailand – Peninsular Malaysia	380	-	TBC	380	1,043	OH HVDC
3	Sarawak –Peninsular Malaysia (Greenfield)	-	-	1,600	1,600	695	SS HVDC
4	Peninsular Malaysia – Sumatera (Greenfield)	-	-	600/ TBC	600	2,130	SS HVDC
5	Batam – Singapore*** (Greenfield)	-	-	3,400	3,400		TBC
6	Sarawak – West Kalimantan	230	-	-	230	777	OH HVAC
7	Philippines – Sabah (Greenfield)	-	-	500	500	196	TBC
8	Sarawak – Brunei –Sabah						
	• Sarawak – Brunei (Greenfield)	-	TBC	TBC	TBC	TBC	TBC
	• Sarawak – Sabah	-	30 – 50	-	30 – 50	177	OH HVAC
9	Thailand – Lao PDR	955	-	TBC	955	700	OH HVAC
10	Lao PDR – Vietnam (Greenfield)	-	-	TBC	TBC	625	OH HVAC
11	Thailand – Myanmar (Greenfield)	-	-	365	365	1,262	OH HVAC
12	Vietnam – Cambodia	200	-	TBC	200	1,353	OH HVAC
13	Lao PDR – Cambodia	300	-	TBC	300	625	OH HVAC
14	Thailand – Cambodia	250	-	650	900	1,315	OH HVAC
15	East Sabah – North Kalimantan (Greenfield)	-	-	TBC	TBC	174	OH HVAC
16	Singapore – Sumatera (Greenfield)	-	-	TBC	TBC	1,133	SS HVDC
17	Lao PDR – Myanmar	30	-	100 – 600	130 – 630	624	OH HVAC
18	Internal Indonesia						
	• Kalimantan – Java	-	-	TBC	TBC	435	SS HVDC
	• Sumatera – Java	-	-	2,600	2,600	10,000	SS HVDC
TOTAL (MW)		**2,870**	**555 – 575**	**9,815-10,335**	**13,240-13,780**	**24,585**	

Source: AIMS III Report, Phase 1 and 2.

**The AIMS III Projection data refers to the ASEAN RE Target Scenario projection of AIMS III Phase 1 and 2 (2020).*

***The data is based on the latest updates from HAPUA Working Group 2 (per 16 September 2024), which only includes grid-to-grid interconnection projects.*

****Batam – Singapore was merged into Sumatera – Singapore Interconnection, based on AMS inputs.*

APG PROJECT PROFILES

To facilitate APG infrastructure development in the future, the AMS have agreed to expand multilateral power trading efforts. Following the directive of the 41st AMEM, ACE in collaboration with HAPUA Working Group (HWG) 2 have prepared the APG Project Profiles documents.[2]

The APG Project Profiles provide an in-depth analysis of each of these interconnectors. Each profile contains:

- A visual representation of the interconnection route.
- A general overview of the project.
- Key technical details and specifications.
- An assessment of potential RE locations that could be leveraged for international power trading through these interconnections.

The public release of the APG Project Profiles gives all interested parties a clear understanding of each proposed interconnection project and its potential impact on regional power exchange. These profiles may be periodically updated if there are updates to AIMS or additional project nominations from the AMS. This will allow ASEAN stakeholders to track the progress of each interconnector, thereby enhancing transparency in the development of the APG. This document also offers an overview of the APG's development priorities intended to inform financial institutions, development partners, researchers and academic institutions, and NGOs interested in supporting the APG's advancement.

MOBILIZING GRANT FINANCING OF FEASIBILITY STUDIES

Key Takeaways

- Collaboration between development partners and beneficiary countries is crucial.
- Developing a shared or standardized ToR and Study Contents can accelerate the funding process.

There are multiple pathways for funding an interconnector FS. The potential trading partners could pool their public resources to pay for the study, or one of the trading partners could fund the study. AMS could also benefit from the substantial interest and resources that are available through IFIs and donor partners. There is ample precedent for the application of grants from IFIs or donor partners to support FS of a wide range of projects, including transmission interconnectors. Grants are a form of equity (vs. debt) finance which are particularly appropriate for the early phases of project development, when projects face the most risks and banks are the least willing to invest.

Potential sources of grant-financed FS include governments, multilateral DBs, international organizations, and private foundations. These organizations fund projects in RE generation, grid upgrades and modernization, energy efficiency programs, and off-grid systems. A list of grant providers specifically focused on energy infrastructure is shown below:

[2] ASEAN Power Grid Interconnections Project Profiles - ASEAN Centre for Energy

NATIONAL GOVERNMENTS AND AGENCIES

Several government agencies provide grants for energy infrastructure projects through their national governments or energy-specific agencies. Examples:

- **USTDA** helps fund the export of U.S. goods and services for priority infrastructure projects in emerging economies.
- **The U.S. Department of Energy (DOE)** offers grants for RE projects, grid modernization, and energy efficiency programs.
- **The Department of Foreign Affairs and Trade (DFAT), Australia** funds FS as a critical step in larger projects, particularly in developing countries in the Indo-Pacific region.
- **JICA** provides grant aid and technical cooperation for FS in developing countries, often focusing on sectors like RE, transportation, water, and urban infrastructure.
- **The European Union (EU),** through EU-ASEAN Sustainable Connectivity Package Investment Facility, invests in connectivity infrastructure projects in the region, in line with the core principles of the Global Gateway.
- **Agence Française de Développement (AFD)** provides different forms of financial support for energy infrastructure projects, particularly those related to sustainable development and RE such as grants, loans, and partnerships.
- **UK Department for Energy Security and Net Zero** provides grants for clean energy infrastructure, including RE and energy efficiency projects.
- Germany's **KfW Development Bank** supports energy infrastructure projects in developing countries, particularly RE and energy efficiency initiatives.

DEVELOPMENT BANKS AND INTERNATIONAL FINANCE INSTITUTIONS

Development banks (DBs) and international finance institutions (IFIs) also provide significant funding—including grants—for energy infrastructure:

- **World Bank** provides grants and loans for energy infrastructure, including RE, grid expansion, and energy access projects, often through initiatives.
- **The U.S. International Development Finance Corporation** provides grant funding for feasibility studies, environmental and social impact assessments, and other project preparation activities.
- **ADB** supports energy projects in Asia, focusing on RE, grid expansion, and energy efficiency through its Clean Energy Program.

Each FS funding organization listed above has their own specific grant application requirements, different application processes, and different protocols of required supporting documents from government agencies. AMS are encouraged to utilize the expertise of intergovernmental bodies such as ACE to connect with donor organizations and understand their specific program requirements, which may or may not align with the objectives of an AMS.

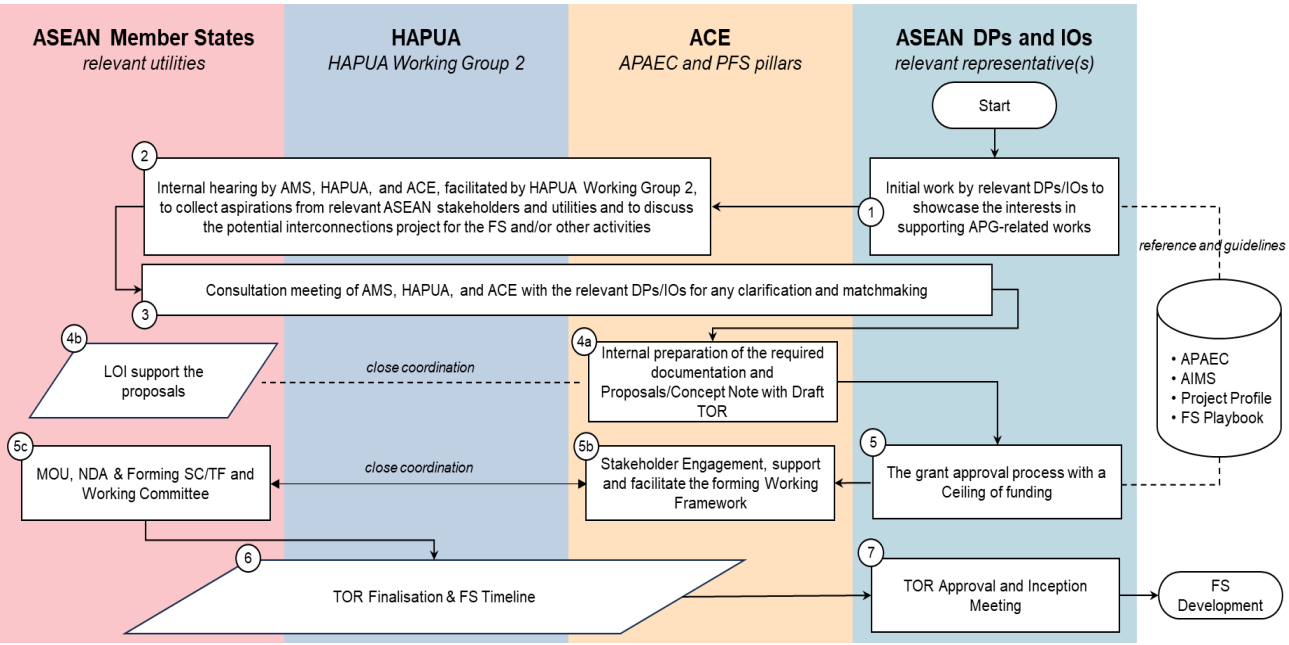
PARTNERSHIPS & COLLABORATION PATHWAYS

In large-scale projects like subsea cable interconnections, collaboration between beneficiaries and FS donor partners is critical to ensuring success. The complexity of these studies requires a coordinated approach that goes beyond mere financial involvement. Strategic partnerships foster a mutual understanding of goals, resource-sharing, and decision-making processes.

Potential donors and partners can evaluate the APG project list and related information through the published APG Project Profiles described earlier in this report. A framework or mechanism in selecting

the interconnections from the list must be established, as the eligible funding, priority and readiness from this project list are varied. Thus, following the guidance of HWG 2 as the in-charged group under HAPUA regarding ASEAN Power Grid, it is proposed that ACE will work together with HWG 2 to articulate the objectives of potential donors and partners as well as consult with the respective countries on the potential candidate interconnections for FS. HWG 2 will play a role in inviting countries and utilities, along with ACE and potential donors or partners, to participate in a matchmaking meeting. During this meeting, all involved parties can interact and express their preference, intentions, and purposes. Ultimately, this robust consultation and coordination process, shown in detail in Figure 3 below, will ensure alignment between donors, grantees, and other ASEAN stakeholders, and maximize the impact of development funding.

Figure 3 A robust consultation and coordination process is proposed to select the interconnection point(s) for FS and other relevant APG activities.



Source: ACE consultative meeting with HWG 2 results that reported to HAPUA Council Meeting.

AMS power trading partners could also collaborate directly with their preferred intergovernmental agencies/organizations to develop the grant proposal, and apply for the grant application through the grant provider's established process. Potential power trading partners/grantees would be able to report out the progress/update of their FS at the regular APG leadership meetings (HAPUA and AMEM).

BUILDING QUALIFIED FS DELIVERY TEAMS

Key Takeaways

- Delivery teams with local expertise or partnerships can help bridge the cultural gap that can be left by remotely based international consultancies.
- Strong experience with similar interconnector projects will allow the team to identify any gaps left by a lack of available data during the FS execution.

A qualified FS team requires a mix of skill sets, from power engineering to market research and financial analysis. The key to establishing a qualified FS team is ensuring the group collectively possesses the broad set of skills necessary for the project under study. The required skill sets should match the diverse demands of the scope of work, including technical, commercial, regulatory, and legal considerations. For example, a subsea transmission project will require consultant skills and experience not necessary for an overhead project. It is unlikely that a single firm possesses all the required expertise, so the FS consultant serving as the prime contractor should have demonstrated experience building cross-functional teams that satisfy the requirements below. It is also valuable when teams are built on previous successful partnerships. A strong track record of working together helps to reduce the risks of misalignment or communication breakdowns, while local presence and knowledge can prove invaluable in navigating AMS-specific challenges, from regulations to geographical considerations. These factors together provide a more robust and contextually relevant study, minimizing potential oversights or delays during execution.

DEMONSTRATED TECHNICAL EXPERTISE FROM SIMILAR PROJECTS

Delivery teams should demonstrate prior experience with projects of a similar nature or scale, such as subsea interconnectors, high-voltage levels, or regulatory frameworks. This includes the ability to assess the technical feasibility of cable routes, equipment sizing, system performance, and failure modes. Expertise in environmental impact assessments, offshore construction, and technical site studies—such as geotechnical and geophysical surveys—are also essential. An appropriate skills mix on the FS team ensures the technical knowledge and practical insights exist to adapt to project challenges and risks. Deep technical understanding relevant to the project, whether it is subsea interconnections, High-Voltage Alternating Current (HVAC)/High-Voltage Direct Current (HVDC) technologies, or AC-DC converter stations, is essential.

LOCAL KNOWLEDGE AND REGULATORY FAMILIARITY

Delivery teams that include organizations with experience in the specific country or region will have a deeper understanding of the local regulations, grid codes, and siting/permitting processes crucial for project compliance. This includes navigating the bureaucratic landscape, understanding environmental and legal constraints, and managing stakeholder relationships effectively.

ESTABLISHED RELATIONSHIPS WITH LOCAL STAKEHOLDERS

A firm with prior regional experience will often have established networks with local authorities, utilities, and other key stakeholders. These relationships can streamline project coordination, enhance communication, and expedite permitting and approval processes.

COMMERCIAL/FINANCIAL EXPERTISE

FS delivery teams must be able to conduct a robust financial analysis, including project cost estimations, capital expenditure and operational expenditure projections, and potential financing models. This ensures the credibility of project financial and economic analysis.

UNDERSTANDING OF REGIONAL MARKET DYNAMICS

Teams with regional experience will have a better grasp of market dynamics, including supply chain considerations, labor availability, and cost factors specific to the region. This can lead to more accurate FS cost estimates and timelines.

FAMILIARITY WITH GLOBAL MARKET DYNAMICS AND SUPPLY CHAINS

Teams should be able to access global experience in transmission technology leading practices, even those with limited application in the region. Familiarity with international Original Equipment Manufacturers (OEMs) and services suppliers — including overhead and subsea HVAC and HVDC cabling, HVAC-HVDC converter stations, and subsea cable laying technology and providers — enables the FS to process to bring insights on the latest technologies, new installation vessels, supply chain dynamics including lead times, and shortcomings experienced by other recent global projects. This can also lead to more accurate FS cost estimates and timelines. Understanding these global supply chains and their implications for project constructability, cost, and engineering-procurement-construction (EPC) timelines is vital to produce reliable and accurate FS results. A table of representative (but not exhaustive) global high-voltage cable OEM manufacturers and projects is included in the Playbook Appendix as a practical aid.

PROVEN TRACK RECORD OF SUCCESS

FS consultants who serve as the prime contractor should provide a portfolio or examples of similar projects successfully completed in the region and/or globally. This will provide FS sponsors and beneficiaries with practical evidence of their ability to deliver quality results based on comparable projects within the country or region and reflecting exposure or experience with international leading practices and technologies. Multiple consultants collaborating on the FS add more value if they bring complementary exposure, capabilities or project experience.

PROJECT MANAGEMENT AND STAKEHOLDER ENGAGEMENT

The ability to manage multiple stakeholders—from government bodies to utilities and subcontractors—is crucial. All team members must have strong project management skills, ensuring timely delivery of milestones, effective communication, and risk management. Expertise in handling cross-border projects and aligning different country regulations and standards is particularly critical for projects involving multiple jurisdictions.

The team should also demonstrate experience in managing communication and negotiation with key stakeholders, such as local communities, environmental agencies, investors, and government bodies. Clear and effective reporting, as well as the ability to present findings to both technical and non-technical audiences, is important for maintaining project transparency.

RISK ASSESSMENT AND MITIGATION

The FS consultant should have a structured approach to risk management, identifying both technical and commercial risks early in the project and proposing mitigation strategies.

Table 2 draws from the qualifications outlined above to provide an example matrix of key competency categories and their weightings, which donor partners and beneficiaries might consider when evaluating FS consultant candidates. Grantees and donor partners are encouraged to adapt the example rubric to fit their priorities.

Table 2. An Example of an Evaluation Rubric for Potential FS Delivery Teams

KEY COMPETENCY	WEIGHTING (%)
Company profiles related to the power sector	10
Experience in transmission interconnection, both HVAC and HVDC, as well as overhead and subsea cabling	30
Experience working with the donor partner	20
Experience in economic, financial, social, and environmental safeguard FS for interconnection transmission/power plant projects; as well as financial and commercial arrangements with related projects	20
Reference projects in Southeast Asia or in this region	10
Interview results on presenting their capabilities and qualifications	10

COLLABORATION FRAMEWORK AND FS SCOPING

FRAMEWORKS FOR POTENTIAL POWER TRADING PARTNER COOPERATION

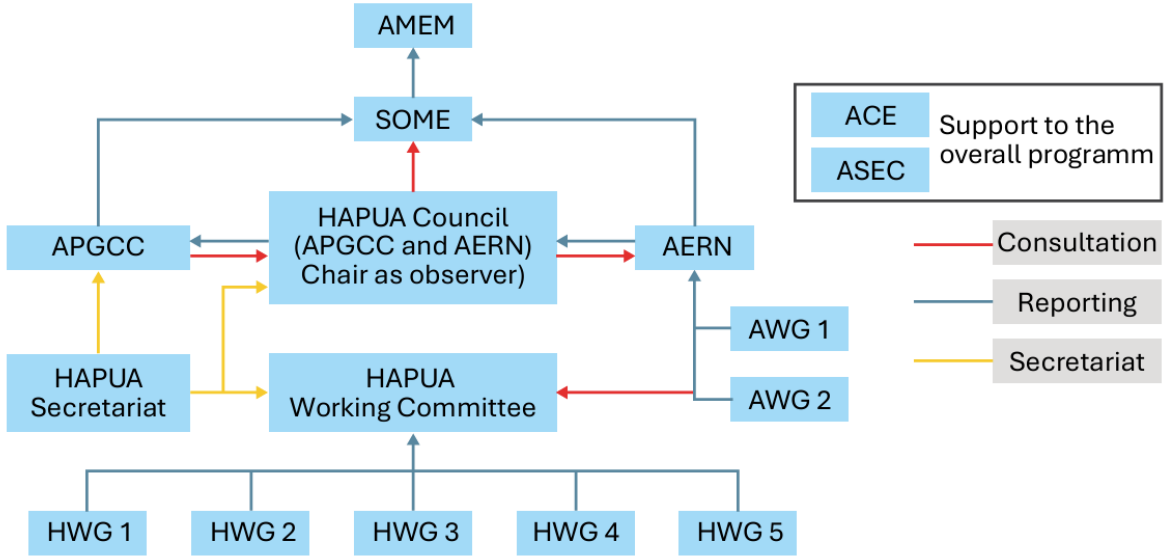
EXISTING FRAMEWORKS

The APG is the first program area of the ASEAN Plan of Action for Energy Cooperation (APAEC) designed to achieve energy security, accessibility, and sustainability within the region. The Heads of ASEAN Power Utilities/Authorities (HAPUA) is the primary implementing body for the APG activities under APAEC, playing a crucial role in planning and promoting interconnector development, enhancing private sector participation, and ensuring the reliability of electricity systems. HAPUA reports to the Senior Officials Meeting on Energy (SOME) and is supported by the ASEAN Power Grid Consultative Committee (APGCC) and the ASEAN Energy Regulators Network (AERN). A graphical representation of the APG governance structure is given below in Figure 2.

Key Takeaways

- The primary body mandated for the implementation of the APG activity is the HAPUA, which plays a crucial role as the SEB in ASEAN.
- HWG 2 will play a role in inviting countries and utilities, along with ACE and potential donors or partners, to participate in a matchmaking meeting.
- Project-specific MOUs signal commitment to potential donors, create frameworks for data sharing and transparency, align projects with ASEAN energy goals, and clarify roles and responsibilities of trading partners.

Figure 2. APG Governance Structure



Source: 8th ASEAN Energy Outlook 2023 - 2050

The AIMS III study identified the list of high-priority interconnector projects to be developed under the APG, and this list is endorsed by AMEM. Conducted in collaboration with HAPUA members, the AIMS study as the coordinated regional interconnection planning in ASEAN, benefited from the participation of existing and potential power trading partners. APGCC, HAPUA, AERN, and ACE are all established ASEAN platforms that can be utilized for discussing APG cooperation, including on priority interconnector FS.

LETTERS OF INTENT

A letter of intent (LOI) is a non-binding document declaring one party's intention to do business with another. In some cases, donors will require LOIs from the energy ministries or utilities that will be involved in an FS before committing to assist the project financially; however, this is not the case for all IFIs/prospective donor organizations, whose funding program requirements vary significantly. LOIs can serve as a signal for potential donors that specific ASEAN governments or HAPUA members are interested in participating in MPT with one another. An example of how an LOI catalyzed international investment in an ASEAN interconnector FS is the USTDA-Funded Indonesia-Malaysia Interconnector FS Project, described below.

MEMORANDA OF UNDERSTANDING

A Memorandum of Understanding (MOU) is a crucial step in a successful interconnector FS. Memoranda of Understanding (MOUs) outline shared vision and goals between utilities, ministers, and technical solution providers; define roles and responsibilities for various stakeholders; broadly define anticipated challenges to achieving the goals outlined in the MOU and suggest frameworks for overcoming those challenges.

An interconnector-specific project MOU between the utilities or governments or both is a key first step in establishing the basis for cooperation on an interconnector FS. Project-specific MOUs accomplish the following goals:

- **Provide a commitment signal to potential donors.** IFIs and other donor organizations want to know that a funded FS is important to the grantee, as well as all other potential beneficiaries. This is why all parties involved in the MPT power trade must sign the MOU.

- **Create a framework for data sharing and transparency.** A high-quality FS depends on high-quality data. Furthermore, interconnector FS requires data acquisition from multiple utilities and regulators. Accessing this data can be a challenge for consultants executing the FS, but a well-crafted MOU anticipates this challenge and provides a framework for cooperation. Data sharing is covered in more detail in a later section.
    - Note: confidentiality agreements will be required as part of the MOU to facilitate this data sharing. Although the APG MOU includes a confidentiality agreement, a more robust version should be crafted for a specific interconnector project that mentions specific technical, commercial, and other data categories that would be required to successfully execute the study.
- **Clarify the connection between the FS and ASEAN energy goals**. By connecting the interconnector project with country-specific and regional energy goals (such as improved energy reliability, affordability, and reduced carbon intensity), the MOU can increase momentum for the project and prevent scope changes that do not align with stated energy goals.
- **Outline roles and responsibilities of potential trading partners**. In addition to sharing data, all trading partners should commit to assisting with surveys and site visits as required. Regulators should commit to supporting the development of the policy and regulatory section of the study through interviews and other methods of timely feedback, as requested by the study execution team.

Developing these MOUs for interconnector FS is not easy. It requires engagement with multiple stakeholders whose requirements may be different. For example, some donor entities are willing to fund FS for multiple grantees; others require a single grantee. Some donors may require the utility/utilities to serve as the grantee(s), while others may require the governments themselves to act as grantee(s). More details on specific donor agencies that fund MPT in Southeast Asia are provided in a later section, but it is important that donor requirements be understood and addressed in the MOU to receive external funding.

In addition to meeting donor requirements in the MOU, the requirements of the energy ministries and utilities from each of the potential trading partners must be considered. ACE plays a critical role in aligning the demands of utilities, energy ministries, and donor organizations with the capabilities and recommendations from technical consultancies. ACE has acted in a facilitation/convening role for at least one interconnector FS (detailed in a later section), due to their responsibility in carrying out the action plans and milestones of the ASEAN Plan of Action for Energy. ACE has forged relationships with both HAPUA and AMS and brings a deep understanding of each country's potential to participate in the APG through their leadership of the AIMS. For these reasons, including ACE as a part of the MOU development process is crucial for aligning the priorities of AMS and HAPUA with donor organizations, which ultimately increases the chance of conducting a successful and impactful FS.

DATA SHARING ARRANGEMENTS

Key Takeaways

- AMS have a strong history of collaboration through data sharing agreements.
- Some data is too sensitive to be shared in a regional context but is crucial to share in the process of developing an interconnector FS.
- Data sharing agreements for each interconnector project should be customized based on the ToR.

A data sharing framework is essential in establishing effective cooperation between potential trading partners. It is also often the most difficult to establish. Almost every expert stakeholder interviewed identified data sharing as the biggest barrier to impactful FS. A proper data sharing agreement at the beginning of the project that is adhered to by all parties benefits the FS across its full life cycle. First, proper data sharing ensures an accurate representation of the electricity systems that would be involved in the MPT; this helps technical consultants design an interconnector that meets the current and future needs of all trading partners. Second, providing a complete and accurate set of data to project execution teams helps them deliver the FS on time and on budget, preventing duplicative, incomplete, or inaccurate work stemming from a lack of information about the systems or the environment. Finally, proper data sharing reduces risks in the later stages of the project after the FS is complete, which is crucial to attracting the foreign investment that will likely be required to construct and install expensive, high-voltage power interconnectors.

AMS have a strong history of collaboration and data sharing agreements, most notably those that facilitated the completion of the AIMS III study by ACE. HAPUA members provided technical and market data to ACE which ultimately led to a regional agreement on 18 priority interconnectors. However, some data is too sensitive to be shared in a regional context; nonetheless, this data is crucial to share throughout the process of developing an interconnector FS. During conversations with technical consultants who are responsible for delivering FS, experts revealed the types of data that are crucial to their teams:

- **Previously completed FS**: In some cases, ASEAN utilities have already completed in-house assessments for proper line routing, potential substation locations, environmental concerns, and other elements that will be covered in the FS. Utilities ought to share this previous work with technical consultants to avoid duplicative work; this will allow the FS team to focus their efforts on filling gaps in information left by previous work.
- **Geographic Information System (GIS) data of existing infrastructure**: This includes all existing transmission lines, substations, natural gas and water lines, and other infrastructure that would affect the location and routing of the proposed interconnector project.
- **Environmental and social constraints**: This includes protected lands, cultural resources, property parcel boundaries, and land resettlements, among other concerns. If utilities have access to this information, sharing it with the project execution team may prevent unnecessary site visits that increase project costs.
- **Electricity market and grid topology data**: Without granular data on existing and projected generation and transmission assets across all potential trading partners, FS project teams cannot confidently design the interconnector. Project teams also need market data to

run production cost models and provide a return on investment (ROI) projection for the interconnector, which informs the type of financing models the trading partners could pursue.

Although the data above are those most requested for an interconnector FS, this list is not comprehensive; data sharing agreements for each interconnector project should be customized based on the ToR.

There are challenges with sharing these types of technical, economic, and environmental data. Utilities may consider the data to be commercially sensitive; in these cases, existing APG confidentiality agreements may not suffice. Utilities are also burdened with the responsibility of delivering electricity to their customers, and urgent operational concerns often take precedence over long-term capital project development. Finally, projects involving MPT present unique legal and political challenges to proper data sharing. Dedicated project data sharing platforms, which are accessible by all project stakeholders and accommodate the large file sizes commonly needed for interconnector FS, can address some of these concerns while providing delivery teams the data they need to produce a quality FS. To complete FS that are impactful and drive the development of the APG, these barriers to data sharing must all be overcome.

NON-DISCLOSURE AGREEMENTS

A non-disclosure agreement (NDA) facilitates and enables data sharing, and as such must be agreed on by the potential power trading partners early on - either during the internal process of FS proposal or ToR development. Data sharing should be enabled via and NDA as part of ToR formulation or certainly before kick-off meetings commence. In some cases, there may be existing templates in various languages (if needed) that were used recently in other ASEAN FS. Using these available NDA templates may speed up the process of reviewing the NDA by legal and compliance departments among two or three potential power trading partners.

DEVELOPING A SCOPE OF WORK AND TERMS OF REFERENCE

Key Takeaways

- It is crucial that the scope of work and ToR accurately reflect the available data as well as gaps left by previous study efforts.
- The scope of work should be well aligned with the FS budget.
- Involving the project execution team early in the scoping effort improves FS delivery.

While concessional awards given for interconnector FS usually provide some details about a target delivery date, power flow requirements, and expected loads, these are insufficient to guide the work of the project team in designing the interconnector. To close this gap, it is important to develop the scope of work document, as well as ToR. Achieving alignment between the various stakeholders on the scope and basis of the study is also important because it determines the technical inputs for later stages of the FS. Changing the basis of the project later during the design phase is costly and can lead to large project delays; for this reason, the scoping documents must be agreed upon by all parties before technical work can begin.

Developing the scope of work and ToR involves all stakeholders, each playing important roles detailed below, based on conversations with various experts:

- The **utilities/potential trading partners** supply the data that is available to be shared with the project execution team to assist with completing the FS. They also provide the national priorities and goals that inform the scope of work and desired outcomes for the FS.
- The **funding entity/development partner** provides budget estimates and any scope requirements to satisfy funding program objectives.

- The **project execution team/technical consultants** provide detailed process steps and budget estimates for each activity requested by the utilities and funding entity. Often, this is an iterative process involving the prime contractor and specialized subcontractors to arrive at the detailed project scope.

Conversations with FS consultancies revealed important findings about the process of developing the scope of work and ToR:

- It is crucial that the scope of work and ToR accurately reflect the available data as well as gaps left by previous study efforts. If certain data is promised during the scoping phase, but withheld later during the execution phase, this can force consultancies to adjust their work plans, leading to project delays and additional costs.
- The scope of work should be well aligned with the FS budget. Donor partners, utilities, and FS consultancies should work together to agree on a reasonable scope that fits within the available funding.
- Involving the project execution team early in the scoping effort aids in FS delivery. They can provide valuable feedback about the budgets and timelines required for site visits and can fill in any technical gaps using their deep expertise.

A well-structured FS is critical for evaluating the viability of cross-border interconnection projects under the APG initiative. The scoping process ensures all essential elements are identified and analyzed comprehensively.

ACE FRAMEWORK FOR FEASIBILITY STUDY SCOPING

ACE has created a helpful framework for creating the SOW and ToR for an interconnector FS. The FS process can be broken down into the following steps:

- **Preliminary Study**: This involves assessing the market demand for electricity, the availability of generation resources, and conducting stakeholder consultations to identify initial concerns and opportunities. Early stakeholder engagement ensures alignment of expectations and highlights potential barriers.
- **Detailed Study**: A comprehensive analysis of technical, financial, regulatory, and environmental aspects is conducted. This phase delves into grid studies (e.g., load flow, stability, and fault analysis), investment appraisals, and compliance with regional energy regulations. The detailed study phase often forms the core of the FS and provides actionable insights for decision-making.
- **Risk Assessment**: Identifying project risks, including financial, technical, and social risks, and mitigating against them, is crucial. This component of the FS reduces the exposure of the project to known risks, and helps reduce the impact of unforeseen risks if/when they materialize.
- **Recommendations**: The final phase synthesizes the findings into actionable recommendations, including a roadmap for project implementation and a summary of benefits.

The FS for interconnection project should comprehensively address the following components:

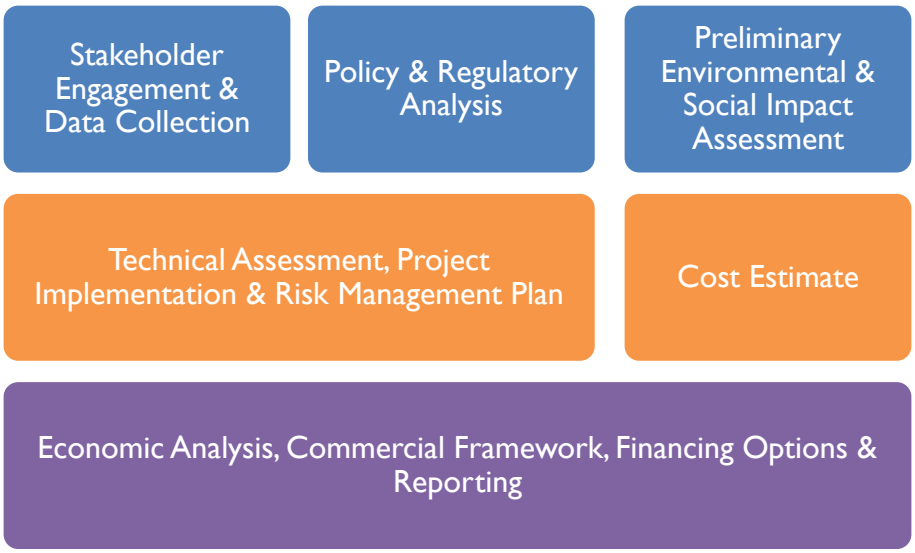
- **Technical Analysis**: Evaluate equipment selection, interconnection routing, grid compatibility and the ability of interconnected systems to maintain stability under various operational conditions. Conduct load flow studies, fault analyses, and assessments of technical standards compliance. When interconnection requires subsea cabling, additional studies will

include the route bathymetry, geotechnical conditions, metocean conditions, cable routing constraints, landfall design, installation methodology and initial engagement with potential international cable and cable installation vessel suppliers. These studies ensure the interconnection is both technically feasible and reliable. During the feasibility phase, these technical analyses may combine a desktop approach with some physical surveys, but a detailed marine survey is very expensive and usually performed later in the project lifecycle, after a final investment decision has been reached.

- **Economic and Financial Analysis**: Assess the cost-effectiveness of the project by performing a detailed cost-benefit analysis, estimating capital and operational expenses, and exploring financing options. Highlight the economic benefits of enhanced grid stability, energy trade, and integration of renewables.
- **Regulatory and Policy Analysis**: Analyze existing regulations, tariff structures, and legal frameworks governing cross-border interconnections. This includes identifying gaps in policy and proposing harmonized regulatory measures to support the project.
- **Environmental and Social Impact Assessment**: Ensure compliance with environmental standards and evaluate the potential social impacts of the project including the Right of Way (RoW) studies. This includes community consultations and developing mitigation measures for any adverse effects. When interconnection requires subsea cabling, environmental and social assessment may also require physical surveys of the offshore conditions, consultation with a wider range of stakeholders (e.g., operators of third-party subsea asset owners, fishery associations) and may require modelling of sediment transport resulting from construction phase activity, with potential to affect marine ecology.

These components, and the framework for a successful FS, are diagrammed in Figure 4 below. A suggested template for the full ToR for an interconnector FS can be found in the Appendix.

Figure 4 General Scope of Work for Cross-border Interconnection Feasibility Studies.



CASE STUDY: USTDA-FUNDED INDONESIA-MALAYSIA CROSS-BORDER INTERCONNECTOR FS

Key Takeaways

- USTDA's recent funding of Indonesia-Malaysia interconnectors is the result of consistent collaboration between stakeholders.
- As project initiator and facilitator, ACE played a key role in securing grant funding for the two USTDA-backed PLN-TNB interconnector FS.
- The PLN-TNB interconnector FS took about 16 months to go from project ideation to grant financing. There are opportunities to reduce this timeline for future FS projects.

On March 6, 2024, USTDA signed a $2 million grant agreement with Indonesian national utility PLN for an FS to support the development of two cross-border power interconnections between Indonesia and Malaysia. This agreement was the culmination of 16 months of project scoping and stakeholder alignment work, incorporating many of the elements outlined above. The AIMS III study, developed and published by ACE in collaboration with HAPUA, provided the background info for two Indonesia-Malaysia interconnectors: one connecting Sumatra to Peninsular Malaysia, and another connecting North Kalimantan with East Sabah. Although AIMS III was based on preliminary analyses such as capacity expansion modeling, production cost simulation, and grid performance analysis, the authors acknowledged the importance of conducting a full FS for each priority interconnector.

ACE took the results of the AIMS III study and presented them to several potential donors, including USTDA. The discussion with USTDA was very important; as it was explained in the previous section of this playbook, countries, and utilities, along with ACE and potential donors or partners, need to sit together for the "matchmaking" process. During that process, all involved parties can interact and express their preferences, intentions, and purposes. One of the challenges is that during the implementation of cross-border interconnection, ownership will be shared between all involved countries/utilities. This means in certain cases there will be a mismatch between two countries or utilities, and the potential donor's programmatic priorities or preferences. ACE used its convening power to talk with HAPUA members PLN and TNB, as well as the energy ministries from both Indonesia and Malaysia, to come to an agreement that would satisfy their priorities and USTDA program requirements. First, TNB—through Malaysia's Ministry of International Trade and Industry—signed an LOI in January 2023, which stated that they were "keen to explore any opportunity in the Grid interconnection business through collaboration with PT Perusahaan Listrik Negara (PLN) to develop a secure and reliable high-voltage transmission infrastructure (source link)." This LOI was an important step in attracting USTDA investment in the interconnectors that are being studied today. About seven months later, two MOUs were signed by the utilities involved, as well as ACE, on the sidelines of the 41st AMEM, held in conjunction with the ASEAN Energy Business Forum (AEBF) 2023 in Bali, Indonesia, to jointly develop feasibility studies for Sumatera Indonesia – Peninsular Malaysia and North Kalimantan Indonesia – Sabah Malaysia cross border interconnections (source link). All of this illustrates the crucial role that ACE plays in harmonizing requirements between donors and beneficiaries.

After signing the MOUs, which indicated the countries' desire to cooperate on cross-border power trade, the team moved to develop the scope of work and ToR that would ultimately be included in the grant contract from USTDA. Developing these scoping documents was an iterative process initiated by PLN involving the project initiator, the project delivery team, and the donor entity. In this case, the project delivery team included Delphos, whose prior knowledge of USTDA's program requirements and processes accelerated grant contract development. During this stage, it was

important to balance the proposed budget for the FS with the right project scope, which takes time. All engagement and alignment processes between two countries/utilities also take time and require different governance processes. ACE, through the ASEAN framework, was present as a facilitator.

Finally, the project team mentioned bureaucratic hurdles that delayed the scoping process, namely beneficiaries requiring physical signatures on some documents that had to be shipped around the world. Most donor partners are comfortable with electronic signatures on contract documents, so there may be opportunities to reduce the project scoping timeline for future FS.

FEASIBILITY STUDY DELIVERY

All expert interviews highlighted the importance of a well-structured and effective delivery process as a critical factor for project success. Consequently, each provider has implemented robust delivery frameworks for their FS and subsequent project phases. These frameworks are designed to adhere to internationally recognized standards, such as those established by the Project Management Institute (PMI), which emphasize key areas like scope management, scheduling, risk assessment, and quality control. The use of these frameworks ensures that projects maintain consistency, reliability, and alignment with global best practices throughout their life cycle. In addition, these processes foster transparent communication between stakeholders, ensure timely deliverables, and provide the flexibility to adapt to unforeseen challenges, thereby minimizing risks and improving the likelihood of successful project outcomes.

Key Takeaways

- Kickoff meetings are a critical phase of the FS that determine project success.
- An experienced FS consultant should be able to identify data gaps with their own expertise, and beneficiaries should understand there are consequences to incomplete data sharing.
- Site visits are recommended and should be given adequate funding in the project budget with input from all stakeholders.

KICKOFF MEETINGS

Kickoff meetings are a critical phase of the FS for several reasons:

- **Alignment of objectives**: They provide an opportunity for all project stakeholders to come together and align on the project's goals, expectations, and key deliverables. This ensures that everyone shares the same vision and objectives, avoiding potential misunderstandings later.
- **Clarification of roles and responsibilities**: These meetings clearly define each team member's role and responsibility, ensuring accountability. Everyone knows who is responsible for which task, reducing confusion and streamlining communication.
- **Project scope and timelines**: Kickoff meetings help in laying out the scope of the project and setting key timelines and milestones. This ensures that the project stays on track and that deliverables are aligned with agreed deadlines.
- **Risk identification and mitigation**: It is an opportunity to identify potential risks early on and plan mitigation strategies. Being proactive about risks helps in smoother execution and minimizes disruptions. Two main risks identified during the interviews were data collection and site visits, which are discussed in more detail in the next section of the Playbook.

- **Building team relationships**: Kickoff meetings also serve as a platform to build rapport among team members, especially in projects involving cross-functional teams or external stakeholders. Building strong relationships can significantly improve collaboration and communication throughout the project.

In essence, a successful kickoff meeting sets the tone for the entire project, providing a strong foundation for collaboration and execution.

DATA COLLECTION

All interviewees cited the importance of data collection for a successful study. However, insufficient data sharing practices still pose a big hurdle for FS consultants even after establishment of project MOUs and NDAs. Data sharing agreements were covered in detail earlier in this Playbook; however, once an adequate data sharing process is established for an interconnector FS, then FS consultants have the responsibility to collect the right data early in the FS process. This involves frequent meetings with utilities and other stakeholders to discuss data needs.

Incomplete data sharing or collection can lead to a range of serious consequences, such as:

- **Inaccurate feasibility assessments**: FS rely on comprehensive and accurate data to evaluate technical, environmental, regulatory, and financial risks. Missing data can result in incorrect conclusions, leading to poor project decisions.
- **Delays in project timeline**: Lack of critical information can slow down the decision-making process and overall project development. It can cause delays in regulatory approvals, environmental assessments, or technical planning stages.
- **Cost overruns**: Incomplete data can result in underestimation of costs, or the need for rework when new information comes to light. This could lead to significant budget overruns.
- **Increased risk exposure**: Stakeholders need to identify and mitigate risks early in the project. Incomplete data might lead to unforeseen issues such as environmental impacts, technical failures, or legal/regulatory hurdles, which could escalate the project's risk profile.
- **Reduced investor confidence**: Investors and partners rely on complete, accurate data to assess the viability of the project. Missing data can erode trust and confidence, making it harder to secure funding or investment for the project.
- **Poor design and engineering decisions**: For subsea cable projects, technical data related to seabed topography, soil conditions, and marine environmental factors is crucial. Incomplete data might result in inadequate design, leading to increased maintenance costs, operational inefficiencies, or system failure.
- **Regulatory and compliance issues**: Projects that involve multiple jurisdictions need clear data on legal and regulatory requirements. Incomplete information can lead to non-compliance with local, national, or international regulations, which could halt the project or result in fines.
- **Misaligned expectations between stakeholders**: Without full data, there may be misunderstandings or misaligned objectives between partners, leading to conflict and inefficient collaboration throughout the project's life cycle.
- **Reduced long-term performance**: Incomplete data during the planning phase can affect the long-term reliability and operational efficiency of a subsea cable project, leading to higher maintenance costs or reduced operational life.

As discussed in the previous section, an experienced FS consultant can leverage their deep expertise to identify data gaps left by incomplete data sharing and should be able to quickly provide a comprehensive list of data needs during the kickoff meeting of the project. However, ASEAN utilities are reminded of the substantial risks of incomplete data sharing to project scope, budget, and schedule as outlined in the previous section.

SITE VISITS

Site visits play a critical role in minimizing incomplete data gathering and are a unique opportunity for the FS provider to test some assumptions with stakeholders and visit some landing sites to verify the current conditions. These visits are crucial to accurate technical and environmental assessments and should be given adequate consideration in the project scope.

For cost optimization purposes, site visit programs are often designed to include the maximum number of visits within a short timeframe. However, since the FS consultant experts typically come from overseas, it is crucial that when developing this program, sufficient emphasis is placed on the quality of the visits rather than just the quantity. Allowing adequate time for thorough evaluations will ensure better outcomes, as will providing the survey team with a local host who understands the culture and norms. Some FS consultants expressed concern that asking their employees to work abnormally long hours while attempting to access remote sites can adversely affect worker health and safety, especially if workers are not given adequate time to acclimate after arriving in-country. Travel budgets should be agreed on between all parties at the outset of the project, considering the number of site visits required and the schedules of teams traveling internationally.

PROJECT MANAGEMENT BEST PRACTICES

Electricity interconnection projects are critical due to their pivotal role in global energy transitions, as outlined in the AIMS III report. Developing these complex projects requires advanced engineering and specific technical studies to ensure long-term reliability and sustainability. Hence, in regions with limited experience, like ASEAN, such projects or studies often rely on international FS consultants with strong expertise in interconnector feasibility studies covering all aspects from design to installations.

Under these conditions, where data collection might be a challenge, having an international FS consultant with effective project management practices is crucial to minimize risks, define clear study scopes, and engage stakeholders. This structured approach helps ensure that all aspects of the project are covered, from technical requirements to regulatory approvals and stakeholder coordination, reducing the likelihood of unforeseen issues.

All interviewees have put in place a strong project management organization adhering to project management best practices. Using frameworks such as those provided by PMI or PRINCE2 can ensure a structured approach to managing the life cycle of the project. Risk management strategies, milestone tracking, and contingency planning ensure that projects remain on schedule and within budget. The use of these best practices not only improves the chances of a successful FS but also builds confidence among stakeholders and investors.

SUBSEA CABLE CONSIDERATIONS

Effective data collection and kick-off site visits are essential components of both overhead and subsea FS study. The identification of appropriate landing sites plays a pivotal role in subsea study, as it enables the provider to refine the study and explore various technical, environmental, and logistical options based on the optional routes deriving from the landing site selection. Without this foundational information, it becomes challenging to assess the feasibility of different scenarios and their associated risks.

Key Takeaways

- For subsea cabling projects, it is critical that some preliminary decisions on site selection have been made by the stakeholders, which will help the provider to carry on their FS.
- For subsea cabling projects, it is crucial to prepare an O&M strategy, including standby cable-laying vessels and spare cabling, and identify the providers to perform the control, fault investigations, and repairs.
- The HVDC cable supply chain is severely constrained in SE Asia and must be improved to achieve desired commissioning dates for future ASEAN interconnectors.

Thorough planning is crucial to minimize risks during implementation. The study should encompass key aspects to ensure the feasibility of laying subsea cables such as:

- Site selection
- Environmental and unexploded ordnance (UXO) assessments
- Geophysical surveys (bathymetric, sub-bottom profiling, seismic, etc.)
- Geotechnical surveys (soil sampling, bearing capacity, etc.)
- Metocean modelling (impacts on vessel selection, construction timeframes, seabed mobility and cable protection design)
- Route analysis (desktop study, Google Earth) and identification of routing constraints

The study should also adequately address engineering challenges such as seabed conditions, water depth, and cable protection. These must be addressed early to avoid costly rework, delays, and cost overruns.

Additionally, securing appropriate regulatory approvals, permits, and considering local stakeholder requirements are essential steps. To mitigate risks in these areas, choosing experienced contractors with a strong track record in subsea projects can enhance project execution, and early identification of technical, environmental, and logistical constraints helps reduce uncertainties during the construction phase. Regular communication between stakeholders, developers, and regulatory bodies also ensures smoother progress and alignment of project goals.

Subsea studies are relatively new in Southeast Asia, and it is crucial to include knowledge-building components within the main project scope, particularly for national utilities and implementation agencies. These institutions often lack the specialized knowledge and experience necessary for the successful execution of subsea projects, which involve complex technical, environmental, and regulatory challenges. By integrating knowledge-building efforts such as training workshops, knowledge transfer sessions, and technical collaborations, local teams can enhance their skills and knowledge, which will benefit later stages of project implementation.

This approach not only ensures a smoother implementation process but also fosters long-term sustainability by empowering national utilities to maintain and operate subsea infrastructure effectively.

Additionally, developing local expertise reduces dependency on external consultants and international contractors.

Expert interviews revealed additional considerations that are specific for subsea interconnector studies, and which warrant further discussion: O&M and the cable supply chain.

OPERATION AND MAINTENANCE

If there are no design or manufacturing issues, the subsea cable is expected to have a useful life of 30 years. However, external factors such as seabed movement, anchoring activities, seismic conditions, and other environmental impacts may pose potential risks to the subsea cable. Therefore, implementing optimized protection strategies for the buried cable is essential to safeguard it from these hazards. Furthermore, it is crucial to have means in place to quickly address and repair any damages, ensuring prompt rectification to minimize downtime and maintain cable functionality for as long as possible, as any downtime will directly result in loss of revenue.

Expert interviews revealed a few important but overlooked considerations for subsea cable projects. Firstly, having standby cable laying vessels would significantly reduce the time required to repair the subsea cable, if necessary, potentially saving months of lost revenue. These costs could be shared across multiple AMS who benefit from subsea interconnection. Additionally, FS consultants must ensure they evaluate spare cable requirements considering the water depth.

SUPPLY CHAIN

A common consensus among all interviewees was that the subsea power cable supply chain is under considerable strain, particularly for cables rated at 320 kilovolts (kV) and above. This is largely due to the limited number of manufacturers capable of producing these high-capacity cables. The following section will provide insights into the current manufacturing conditions for subsea cables and explore some challenges within the supply chain.

Due to the lack of established project references in the region, stakeholders involved in subsea projects may have to search globally for manufacturers with sufficient experience. Manufacturers with significant HVDC project experience are often more expensive due to the current HVDC market state. Regions like Southeast Asia struggle to attract the attention of subsea cable manufacturers, particularly in the face of a global peak in HVDC projects. Most of these projects (over 90 percent) are concentrated in Europe and North America, leaving the rest of the world, including ASEAN, as a lower priority in the eyes of many cable manufacturers. A list of some major HVDC and HVAC cable manufacturers, along with representative project references, is supplied in Table A.1 in the appendix for readers.

Expert interviews revealed that these supply chain constraints are causing very long lead times (in some cases 10-12 years) for securing HVDC cabling, as well as converter stations. This would delay project commissioning dates and require project teams to secure manufacturing slots well before reaching the final investment decision on specific interconnector projects. Experts also indicated that Europe has experienced similar supply chain issues in the past and overcome them with public support to increase cable manufacturing capacity. Although outside the scope of an interconnector FS, alleviating these supply chain issues will be a prerequisite to fully developing the APG.

CONCLUSION AND NEXT STEPS

Early success with mobilizing grant finance for the Indonesia-Malaysia interconnector FS has spurred interest by both AMS and donor partners in supporting additional FS for priority interconnectors included in the AIMS III study. To continue this momentum, AMS are encouraged to review and adopt

the best practices outlined in this Playbook, notably by creating an improved framework for data sharing, scoping FS projects in alignment with available funding, and choosing highly qualified FS consultants to lead these studies. A list of key takeaways is provided below.

LIST OF KEY TAKEAWAYS

MOBILIZING GRANT FINANCING OF FEASIBILITY STUDIES

- Collaboration between development partners and beneficiary countries is crucial.
- Developing a shared or standardized ToR and Study Contents can accelerate the funding process.

BUILDING QUALIFIED FS DELIVERY TEAMS

- FS consultants with local expertise or partnerships can help bridge the cultural gap that can be left by remotely based international consultancies.
- Strong experience with similar interconnector projects will allow the FS consultant to identify any gaps left by a lack of available data during the FS execution.

TAKE ADVANTAGE OF EXISTING COLLABORATION FRAMEWORKS

- The primary body of the APG is the HAPUA, which plays a crucial role as the SEB in ASEAN.
- HWG 2 will play a role in inviting countries and utilities, along with ACE and potential donors or partners, to participate in a matchmaking meeting.

MEMORANDA OF UNDERSTANDING BETWEEN POTENTIAL TRADING PARTNERS

- Project-specific MOUs signal commitment to potential donors, create frameworks for data sharing and transparency, align projects with ASEAN energy goals, and clarify roles and responsibilities of trading partners.

DATA SHARING ARRANGEMENTS

- AMS have a strong history of collaboration through data sharing agreements.
- Some data is too sensitive to be shared in a regional context but is crucial to share in the process of developing an interconnector FS.
- Data sharing agreements for each interconnector project should be customized based on the ToR.

CASE STUDY: USTDA-FUNDED PLN-TNB INTERCONNECTORS

- USTDA's recent funding of Indonesia-Malaysia interconnectors is the result of consistent collaboration between stakeholders.
- As project initiator and facilitator, ACE played a key role in securing grant funding for the two USTDA-backed PLN-TNB interconnector FS.
- The PLN-TNB interconnector FS took about 16 months to go from project ideation to grant financing. There are opportunities to reduce this timeline for future FS projects.

DEVELOPING A SCOPE OF WORK AND TERMS OF REFERENCE

- It is crucial that the scope of work and ToR accurately reflect the available data as well as gaps left by previous study efforts.
- The scope of work should be well aligned with the FS budget.
- Involving the project execution team early in the scoping effort improves FS delivery.

FEASIBILITY STUDY DELIVERY

- Kickoff meetings are a critical phase of the FS that determine project success.
- An experienced FS consultant should be able to identify data gaps with their own expertise, and beneficiaries should understand there are consequences to incomplete data sharing.
- Site visits are recommended and should be given adequate funding in the project budget with input from all stakeholders.

SUBSEA LINE CONSIDERATIONS

- For subsea cabling projects, it is critical that some preliminary decisions on site selection have been made by the stakeholders which will help the provider to carry on their FS.
- For subsea cabling projects, it is crucial to prepare an O&M strategy, including standby cable laying vessels and spare cabling, and identify the providers to perform the control, fault investigations, and repairs.
- The HVDC cable supply chain is severely constrained in Southeast Asia and must be improved to achieve desired commissioning dates for future ASEAN interconnectors.

Finally, AMS should leverage the results from the AIMS III study, leaning on convening organizations such as ACE, SPP, and others to connect with IFIs and other donor organizations and initiate more FS for high-priority interconnectors. If executed in accordance with the best practices outlined in this Playbook, future FS will catalyze further investment in the region and increase the likelihood of realizing the APG.

APPENDIX

GLOBAL HVDC AND HVAC CABLING MANUFACTURERS INDEX

The table below shows major HVDC and HVAC cable manufacturers, along with prominent project examples showcasing their experience. The information provided in this table is sourced from publicly available data, is for information only, and aims to assist the reader in understanding the global HVDC/HVAC cable manufacturer landscape. As such, the information is not comprehensive, and appearance on this table does not imply author endorsement of any specific manufacturer. Readers are strongly advised to perform their own due diligence, and APG stakeholders should choose FS delivery teams with deep expertise in global HVDC/HVAC cable supply chains to help select a manufacturer that best meets a project's needs.

Table A.1 Global HVDC and HVAC cabling manufacturers, with project references.

CABLE MANUFACTURER	MANUFACTURER LOCATION	PROJECT REFERENCES
LS Cable	South Korea	Jindo-Jeju System (HVDC, South Korea); SydVästlänken, South-West Link (HVDC, Sweden-Norway)
Nexans	France	Skagerrak Transmission System (HVDC, Denmark-Norway); North Sea Link, onshore component (HVDC, UK-Norway); Tyrrhenian Link, western component (HVDC, Italy); BalWin3, LanWin 4, and LanWin 2 (HVDC, Germany); Maritime Link Project (HVDC, North America)
NKT	Denmark	SuedLink Project, SuedOstLink Project (HVDC, Germany); Dogger Bank Wind Farm (HVDC, UK); Viking Link, Circuit 1 (HVDC, UK-Denmark); Champlain Hudson Power Express (HVDC, North America)
Prysmian	Italy	Viking Link, Circuit 2 (UK-Denmark); North Sea Link, offshore component (HVDC, UK-Norway)
Sumitomo	Japan	Nemo Link (HVDC, UK-Belgium); Hokuto-Imabetsu Link (HVDC, Japan); Neuconnect (HVDC, UK-Germany); MON.ITA (HVDC, Montenegro-Italy); A-Nord (HVDC, Germany); Kontek (HVDC, Germany-Denmark); Greenlink (HVDC, Ireland-UK)
Hellenic	Greece	Crete-Peloponnese Interconnection (HVAC, Greece); Seagreen Offshore Wind Farm (HVAC, UK); MOG (HVAC, Belgium); Hollandse Kust (zuid) (HVAC, Netherlands); Grid Connection OST-6-1, Circuit 2 (HVAC, Germany)
ZTT	China	Dolwin6 (HVAC, Germany); Grid Connection OST-6-1, Circuit 1 (HVAC, Germany); Kaskasi II, Gode Wind 3 (HVAC, Netherlands)
Taihan Cable	South Korea	SPPA cable tunnel (oil-filled EHV, Singapore); Silicon Valley high-voltage projects (HVDC/HVAC, USA)
GE Vernova	United States	Eastern Green Link 1 (HVDC, UK)

SUGGESTED FEASIBILITY STUDY TERMS OF REFERENCE TEMPLATE

The objective of this template ToR is to provide an easy reference and actionable framework for AMS and donor partners interested in contracting out new feasibility studies. This ToR template is specific for the study of a new subsea link between two countries, and covers the technical scope; policy, regulatory, and legal scope; economic, commercial, and financing scope; and environmental scope. Adjustments should be made based on the specific requirements of your scope of work. While every effort has been made to make it relevant and practical, not all types of studies can be covered comprehensively.

PROJECT INTRODUCTION AND PURPOSE OF THIS FEASIBILITY STUDY

The purpose of this feasibility study (FS or "Study") is to determine the technical, financial, and economic feasibility of two proposed transmission interconnectors between "xxx" and "yyy". The goal of the FS shall include preliminary engineering design and important technical parameters for major equipment, including conductor engineering specifications, preliminary structure spotting, foundations, and routes for the interconnectors. The FS shall provide technical recommendations on substations needed for the interconnectors and perform a policy and regulatory review on potential regulation that would be necessary for implementation. It also outlines the development of cost estimates, an economic model, and a commercial framework/arrangement. FS shall include comprehensive environmental, social, and development impact assessments and provide recommendations on mitigation measures/plans for both the construction and operation phases. Lastly, FS shall suggest an implementation plan and outline which government protocols/agreements need to be completed for a successful implementation.

TASK 1.0: INCEPTION MEETING AND DATA COLLECTION

Sub-Task 1.1: Inception Meeting

The Beneficiary shall grant the FS Consultant access to an online virtual data room containing all relevant data sets, documents and reports regarding the Projects that are available. Following the FS Consultant's review of the data room materials, the FS Consultant shall arrange and conduct an Inception Meeting with the Beneficiary and other relevant stakeholders at the Beneficiary's facilities, or at another appropriate venue agreed upon by the FS Consultant and the Beneficiary, or through virtual tools.

The main objective of the Inception Meeting is to finalize the work plan and schedule for the Study.

Before the Inception Meeting, the FS Consultant shall: coordinate with the Beneficiary on appropriate meeting content and objectives; prepare an agenda and presentation materials; and draft a work plan and schedule for the Study.

During the Inception Meeting, the FS Consultant shall introduce their team; conduct the meeting and facilitate discussion; review communication procedures and contact information; review the objectives of the Study, the Tasks to be performed under this ToR, the Study Deliverables, and other contractual obligations; review and present the FS Consultant's work plan and schedule for the Study, including a review of planned meetings; and gather input from the Beneficiary regarding the Beneficiary's goals for the Study, salient issues surrounding the Beneficiary's plans for the Projects, and the Beneficiary's requests for changes to the work plan. Based on the Beneficiary's input, the FS Consultant shall revise the work plan for the Study, if necessary. The FS Consultant shall receive Beneficiary approval for the final work plan for the Study.

Following the Inception Meeting, the FS Consultant shall issue a brief report (the 'Inception Report') summarizing its understanding of the Projects' status, identify data gaps, and plan for additional data collection, setting out the communication and reporting plan, proposing a final work plan and timeline for the completion of the Study, and highlighting any areas of concern regarding the ToR (e.g., specific challenges in completing any Task under these ToR, any missing information, etc.), and/or specific risks or challenges to the implementation of the Projects that the FS Consultant has identified.

Sub-Task 1.2: Data Collection

Following the Inception Meeting, the FS Consultant shall immediately proceed to collect any additional data not collected in Subtask 1.1 and make plans with the Beneficiary for collecting any additional data and information that are required for the Study. The FS Consultant shall gather and compile relevant technical, economic, and cost data on the electricity networks necessary for the Study. The data shall include but is not limited to:

- New and existing substation locations;
- Transmission line route maps;
- Current power generation profile and capacity expansion plan;
- Power system planning and grid analysis study;
- Energy policy landscape on carbon neutrality, net-zero emission targets, RE targets, etc.; and
- Local utility standards used for the transmission line and substation design.

TASK 2.0: TECHNICAL FEASIBILITY STUDY

The FS Consultant shall perform "Preliminary Engineering Analysis" to establish technical feasibility of the proposed interconnectors.

The scope of work will vary considering variances in HVDC and HVAC technology. The technical assessment includes the preliminary engineering to produce design criteria and establish technical parameters for the major equipment to be incorporated into the functional specifications at the next project development stage.

The FS Consultant shall develop the requirements of the substations and transmission interconnection line based on the results from the power system studies, the topographical features of the route, and the prevailing meteorological conditions of the area. The specific technical evaluations shall be prepared as per the following sub-sections.

Sub-Task 2.1: Technical Assessment of Transmission Routes

The FS Consultant shall assess the necessary information required regarding site conditions based on a site visit to the Projects' locations. Findings from the site assessment shall be incorporated into the transmission line and substations design. The FS Consultant shall visit at least the following locations:

- Possible substation ("S/S") connection points.
- Possible subsea landing points.

Immediately before or after the site visits, the FS Consultant shall meet with the Beneficiary and their power trading partners. The meetings may take place during the site visits or at one or more of their respective headquarters.

The transmission route shall consider both overhead lines and submarine cables. The following

activities shall be performed for the line design:

- Conductor and shield/optical ground wire ("OPGW") selection;
- Selection of structure type and miscellaneous hardware;
- Typical structure configurations and preliminary structure spotting using Power Line Systems – Computer Aided Design and Draft (PLS-CADD) or using the configurations/ structures typically used by the Beneficiary on comparable projects;
- Recommendations on suitable foundations for the Projects and description of typical foundation details;
- Route selection (transmission line routes proposed in prior studies shall be used as a baseline, if available). If information on preliminary environmental and social impact assessments is available from prior studies or after completion of Task 7, route modifications shall be recommended;
- Mapping subsea route and definition of cable electrical parameters, including studies of the route bathymetry, geotechnical conditions, metocean conditions, cable routing constraints, landfall design, installation methodology and initial engagement with potential international cable and cable installation vessel suppliers; and
- Description of logistical challenges. For example, logistics for transportation of heavy equipment such as transformers, towers installation (helicopter installation), staging and laydown areas for the materials.

This approach shall be common to HVDC and HVAC lines or cables.

The results of power systems planning analyses (i.e., capacity expansion planning and production cost simulation) carried out through support from USAID SPP shall be taken as inputs for the interconnectors design, particularly for determining the size of conductor, technical parameters, and substation equipment by performing a simple load flow study and short circuit current analysis.

Sub-Task 2.2: Technical Assessment of Substations

The FS Consultant shall work together with the Beneficiary to determine if there are existing substations or whether new substations would have to be constructed for power delivery. Any existing substations shall be evaluated for expansion plans based on available space in the yard and in the control building; new equipment required; and the feasibility of reuse of existing cable trenches.

The FS Consultant shall consider local meteorological conditions to identify the locations of new substations. Substation design shall be based on applicable international and local codes and industry standards. For example, design shall follow international standards for electrical equipment from the American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), International Electrotechnical Commission (IEC) and/or Japanese Industrial Standards Committee (JISC). Applicable local grid codes for special requirements shall be followed. The following activities shall be performed for the new substations:

- Configuration;
- Selection of major equipment parameters;
- Design Criteria;
- Single-line diagram (electrical and protection and metering);
- Physical layout;

- Control room layout and arrangement;
- Converter station configuration and layout;
- Interconnections to existing utility infrastructure;
- Communications and Supervisory Control and Data Acquisition (SCADA) Transformer;
- Civil and structural works; and
- Site access.

Sub-Task 2.3: Logistics and Constructability

The FS Consultant shall develop technical criteria and establish equipment parameters for the Projects which can become the basis for tender documents to be developed by the Beneficiary following completion of the FS. FS Consultant shall also provide recommendations related to construction planning and logistics for transportation and installation of heavy weight equipment. The FS Consultant's construction specialists shall work with the Beneficiary project teams to define project details that result in a balanced risk, schedule, and cost profile with the intent of potentially supporting an EPC project delivery process by others in the future.

TASK 3.0: POLICY, REGULATORY, AND LEGAL FEASIBILITY STUDY

The FS Consultant shall assess the policy and regulatory frameworks relevant to the project implementation, including:

- Conduct a detailed review of the relevant policies and regulations in all countries involved in the MPT;
- Build a working list of decision-makers from the government/policymakers' side;
- Conduct high-level policy dialogues and interviews with the above policymakers to exercise the key policy enablers for cross-border interconnection and identify the policy actions that could either act as potential barriers to the implementation of the Projects or would be necessary for implementation;
- Conduct the interviews with the regulators from each of the utilities to exercise the current regulation frameworks and regulatory actions that could either act as potential barriers to the implementation of the Projects or would be necessary for implementation;
- Develop a plan to overcome existing and potential policy and regulatory barriers that could affect the Projects in the short-term;
- Develop the policy and regulatory recommendations to support the implementation of the Project; and
- Conduct the second round of high-level policy dialogues with relevant Ministries and regulators to convene and disseminate the recommendation.
    - NOTE: ACE has unique role in the policy development process for the AMS. As an intergovernmental organization, ACE can share the policy recommendations with the relevant policymakers and stakeholders either at the ASEAN Official Meetings or at High Level Policy Dialogues.

TASK 4.0: COMMERCIAL FRAMEWORK FEASIBILITY STUDY

The FS Consultant shall develop an appropriate commercial framework, including Levelized Transmission Cost (LTC) proposal that would govern the Projects and prepare templates of commercial agreements required to deploy the commercial framework of the Projects, including the Power Purchase Agreements (PPAs) and Transmission Service Agreements (TSA).

The FS Consultant shall review any existing framework for commercial agreements between potential MPT partners to make a recommendation on whether these would be sufficient for implementing the Projects or require amendments to accommodate the Projects, taking into consideration the prevailing context in which the Projects are being developed. The FS Consultant shall propose amendments to the existing commercial agreements, if applicable, with language that effectively integrates the specific characteristics of the Projects, the Economic Analysis, LTC proposals, and the prevailing related institutional frameworks in both countries. These proposed amendments and the Commercial Framework shall be included in a "Commercial Framework Report."

The Commercial Framework Report shall include, but is not limited to:

- Quantify and describe from analyses performed in Task 2, the available power that each utility can contract through the interconnection, and the demand requirements;
- Determine whether arrangements must be made with any third parties (power projects, distribution utilities, industrial consumers, subsea asset owners, etc.);
- Catalogue all the contract elements that need to be negotiated as part of the commercial agreements for the Projects and determine necessary documentation to be prepared and approved in order to establish an appropriate commercial framework for the Projects;
- Review existing commercial contracts (such as PPAs and TSAs) governing existing interconnections projects involving potential power trading partners (examples of existing cross border agreements that may be reviewed include those of the interconnectors between Kalimantan-Sarawak and Peninsular Malaysia-Thailand);
- Hold consultation discussions with utilities and energy ministries, as well as the potential funding agencies that shall be involved in the financing of the Projects (e.g., World Bank and ADB), in order to define a suitable commercial framework;
- Highlight the services that would be governed by the commercial framework (such as firm energy supply, reserve capacity), and the requirements for sharing technical and commercial information, billing, and settlement procedures;
- Propose a mechanism to determine tariffs, which shall take into consideration capital costs, O&M costs, replacement costs, transmission tariff methodologies of involved utilities and other regulatory requirements; and
- Propose amendments to commercial agreement(s) that effectively integrate the adopted outcomes of the Study, in particular, the economic analyses, and the prevailing related institutional frameworks in each of the countries. These draft commercial agreements must include, at a minimum, a draft form of PPAs and draft form of TSAs for the Projects ("Commercial Agreements"). Other commercial agreements reviewed may include Wheeling Contracts, Transmission Concessions, Balancing Services Agreements, etc.

TASK 5.0: COST ESTIMATES AND ECONOMIC ANALYSIS

Sub-Task 5.1: Cost Estimates

FS Consultant shall develop cost estimates for the Projects. Specific work packages shall be identified

and the cost of each work package of the Projects shall be estimated with consideration of local and foreign currency requirements. Appropriate allowances for contingencies shall be included in each estimate.

For the major items of civil construction (excavation, concrete, reinforcing steel), the estimates of civil works costs shall be "bottom-up" estimates based on estimates of labor, equipment, materials, and production rates required. Prices for local labor and locally available materials shall be derived from local information sources. Minor items could be priced based on recent comparable bid pricing or cost references. Estimates of major equipment costs shall be derived from manufacturers' quotations, recent comparable bid prices or relevant empirical data. Other cost items such as those related to land acquisition, engineering, legal costs, financing costs will be estimated based on consultation with the Beneficiary.

The target level of accuracy of the cost estimate is Class 4 as described by AACE (Association for the Advancement of Cost Engineering) International Standards. Class 4 estimates are used for feasibility studies and have an accuracy range of -15 percent to -30 percent on the low side and +20 percent and +50 percent on the high side.

Sub-Task 5.2: Economic Analysis

The FS Consultant shall conduct a detailed economic and financial analysis for the Projects over a 20-year horizon. The Economic Analysis shall be based on a standard methodology that is accepted by IFIs. The Economic Analysis shall include:

- A fully functional proforma Economic Model capable of demonstrating how changes in key variables impact the economic and financial performance indicators and profitability calculations ('the Economic Model'). The Economic Model shall be user-friendly and interactive allowing the Beneficiary and other stakeholders to test various scenarios by adjusting key variables;
- Relevant economic and financial performance indicators and profitability calculations (e.g., economic and financial internal rates of return, and economic and financial net present values);
- Fully adjustable assumptions used for the economic analysis;
- Funding or credit support mechanisms, if relevant;
- A sensitivity analysis that evaluates the impact of key variables (such as capital and operating costs, tariff, usage level, costs of generation and fuels on the interconnected systems in both Indonesia and Malaysia, commercial operations date, load factor, losses) on the economic and financial performance indicators and profitability calculations;
- Calculation of an LTC; and
- A Cost Benefit Analysis for the various interconnection options.

TASK 6.0: FINANCING OPTIONS ASSESSMENT

The FS Consultant shall identify and assess potential sources of financing for the Projects, including, but not limited to: multilateral DBs (such as the JICA, Asian Infrastructure Investment Bank [AIIB], AFD, World Bank and ADB); bilateral lending agencies (such as the U.S. International Development Finance Corporation [DFC] and the Export-Import Bank of the United States [EXIM], KfW from Germany); and private sector financing mechanisms (such as commercial banks and equity investors).

The FS Consultant shall contact the mostly likely potential sources of financing identified to discuss the Projects and gather feedback and information about financing requirements. For each potential source of financing, the FS Consultant shall determine its capacity and level of interest in the Projects; availability, key lending terms, and/or other requirements; and the type of financing available.

The FS Consultant shall then develop a financing plan ('the Financing Plan') with identified sources of financing for the implementation of the Projects based on the FS Consultant's knowledge of the project finance market and exploratory discussions with funding sources. The financing plan shall consider the commercial framework proposed in Task 5. The FS Consultant shall develop an executive summary ('the Executive Summary') of the economic and financial performance indicators of the Projects, which the Beneficiary can use to solicit the interest of lenders when it is ready to initiate fundraising. The FS Consultant shall also identify the requirements and steps that the Beneficiary and other relevant stakeholders need to take to secure financing for the Projects. For the avoidance of doubt, the FS Consultant shall not be required to assist the Beneficiary with any direct fundraising for the Projects.

The FS Consultant shall develop a risk matrix and shall advise on the risk allocation that will ensure Projects' bankability, including risk minimization strategies.

TASK 7.0: ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

The FS Consultant shall, in coordination with the Beneficiary, conduct a Preliminary Environmental Social Impact Assessment (PESIA) in accordance with requirements of each power trading partner, as applicable, and those of multilateral agencies such as the International Finance Corporation (IFC). The assessment shall identify anticipated environment and social impacts, both positive and negative, associated with the Projects; and provide recommendations for maximizing positive environmental and social impacts and minimizing negative impacts. The FS Consultant shall identify steps that the Beneficiary should take after the completion of the Study and prior to Projects' implementation to comply with the environmental and social requirements of both countries, as applicable, and those of multilateral lending agencies.

The task shall require assessing both environmental and social matters, taking into consideration typical requirements of relevant financiers and the relevant authorities, as further described below.

- "Relevant financiers" are debt and equity providers who have expressed interest in investing or could reasonably be expected to invest in the Projects.
- "Relevant authorities" are the national, regional, and local governments of each potential MPT partner. The FS Consultant shall identify and consider all relevant environmental and social regulations pertinent to the development of the Projects.

The analysis and assessment of environmental matters in the PESIA shall include:

- Reviewing the policy, legal and administrative framework for the environmental aspects of the Projects;
- Reviewing the requirement from prospective key stakeholders in the Projects, i.e., the financiers and/or multilateral lending agencies;
- Screening the existing environment prior to the Projects, such as topography and drainage, soil, geology and hydrogeology, climate, and its flora and fauna;
- Defining potential environmental impacts and mitigation measures during pre-construction, construction, O&M, and decommissioning/ future strengthening or upgrading of the Projects.

The analysis and assessment of social matters in the PESIA shall include:

- Impact of construction and site access on the local community including potential population relocation, and agricultural/commercial land compensation;
- For subsea cables, characterization of marine ecology using appropriate physical surveys, to assess impact of construction on both marine ecology and maritime activities such as fishing;
- Employment opportunities for the local community;
- Ancillary benefits of infrastructure development (roads, transmission infrastructure, etc.);
- Safety issues including associated electrical equipment that produce Electromagnetic Fields (EMF) which may create a harmful effect on human health;
- General community concerns about the Projects, including noise and interference with television and radio signals, which may be caused by the electrical equipment; and
- Impact on maritime traffic.

The FS Consultant shall focus on reviewing the publicly available data and secondary sources of information, rather than collecting primary field data.

FS Consultant shall provide recommendation steps to prepare a provisional environment and social management plan (ESMP) which cover active remedial measures and monitoring activities to be continuously carried out to prevent or minimize impacts on environments.

TASK 8.0: IMPLEMENTATION PLAN

The FS Consultant shall prepare an implementation plan for the Projects based on the analysis performed in the previous Tasks. The implementation plan shall include a schedule and timeline for the Projects' implementation activities and identify important milestones. The FS Consultant shall include a detailed description of each implementation milestone in the implementation plan. The FS Consultant shall identify all steps that need to be taken to implement the Projects, including but not limited to:

- Compliance with institutional, legal, regulatory, and standards requirements, including required approvals, certifications, and permits;
- Action plan to enact the necessary policy and regulatory changes to implement the Projects;
- Implementation of the commercial arrangements for the Projects;
- Environmental and social impact requirements;
- Procurement of goods and services;
- Identification of potential third-party sources that could supply power through the Projects (if necessary);
- Identification and shortlisting of most suitable engineering, procurement, construction, installation, and management providers; and
- Financing arrangements.

TASK 9.0: FINAL REPORT

The FS Consultant shall prepare and deliver to the Beneficiary and the Funding Entity a substantive and comprehensive final report of all work performed under these ToRs (the "Final Report"), which must conform to the requirements under Clause I of the Mandatory Contract Clauses (as defined in

Annex II). The FS Consultant shall organize the Final Report into chapters and sections with clear labels corresponding to each of the above Tasks and Subtasks of these ToRs, and the FS Consultant shall include in the Final Report all Deliverables and other documents that have been provided to the Beneficiary under these ToRs. The FS Consultant shall incorporate into the Final Report, as applicable, (i) all the findings, recommendations and conclusions related to the Activity under these ToR, and (ii) all other documents, analyses, reports and/or work product provided pursuant to the Tasks and Subtasks noted above, in each case clearly organized and labeled according to each Task and Subtask under these ToRs. The FS Consultant shall also include an executive summary to the Final Report as a whole and provide a summary for each Task under these ToRs.

Before completing and delivering the Final Report to the Beneficiary or Funding Entity, the FS Consultant shall prepare a draft Final Report in accordance with the instructions in the above paragraph and deliver the draft Final Report to the Beneficiary for review and discussion. Once the Beneficiary has provided comments and revisions to the draft Final Report, the FS Consultant shall make the necessary changes and modifications to the draft Final Report, it being understood that the FS Consultant shall not make any changes or modifications that are inconsistent with any of these ToRs.