

Beyond Borders: How Strategic Subsea Cable Deployment Can Unlock Energy Potential



Author: Mohanan Panayamadam, Principal Project Manager



As nations set ambitious decarbonisation targets, subsea power cables are becoming an essential infrastructure to facilitate the cross-border transmission of renewable energy. Singapore, in particular, is making significant strides toward importing green energy from neighbouring countries to meet its sustainability objectives.

This paper presents the strategic planning and analysis of an HVAC subsea cable route, using the corridor between Tanjung Pinggir (Batam) and Jurong Island (Singapore) as a theoretical example. This 50 km segment illustrates the technical considerations involved in cross-border power transmission to support regional renewable energy integration.

Bridging Remote Renewables to Mainland Grids for a Sustainable Energy Future

Subsea power cables are crucial for linking remote renewable energy sources, such as offshore wind farms and solar projects, to mainland grids. They offer an efficient and reliable solution to overcome the geographic challenges that limit traditional land-based transmission networks. Subsea cables have become a cornerstone of future energy infrastructure, enabling seamless cross-border energy flow and supporting sustainable energy transitions.

Desktop cable route planning, landing site visits, and comprehensive geophysical and geotechnical surveys, ensure a robust and effective subsea cable design and planning process. These steps enable the creation of optimal cable corridors, ensuring both feasibility and efficiency in the deployment of subsea power cables for renewable energy importation.

ICPC Recommendation No. 9: Desktop Study Guidelines

The International Cable Protection Committee (ICPC) provides essential guidelines for subsea cable route planning through Recommendation No. 9, which outlines the minimum requirements for the desktop study phase. Key objectives and practices from ICPC Recommendation would directly influence the desktop study for our theoretical HVAC cable route between Tanjung Pinggir and Jurong Island and are outlined as follows.

The desktop study requires a comprehensive route selection process to identify potential hazards and ensure the proposed route avoids obstacles such as boulders, shipwrecks, existing infrastructure (e.g. pipelines, cables), environmentally sensitive areas, and critical zones like anchorages. This phase also includes an initial risk assessment to evaluate operational risks, environmental impacts, and safety concerns based on the available data.

For the Tanjung Pinggir to Jurong Island route, this process would be particularly crucial, as the route needed to navigate busy shipping lanes and environmentally sensitive areas,

ensuring both operational efficiency and environmental protection.

Environmental and regulatory compliance is another key focus. The proposed cable route must align with environmental regulations, and initial environmental impact assessments (EIAs) should be conducted or updated based on the available data. Regulatory compliance would be a significant factor in this study, ensuring the cable route met legal requirements and environmental safeguards in both Indonesia and Singapore, especially considering the cross-border nature of the project.

Seabed and geological assessments are integral to the desktop study to understand the topography, soil composition, and any potential hazards along the proposed route. Recommendations for cable protection are also a vital element. Based on preliminary seabed conditions and environmental factors, these recommendations ensure the subsea cable's long-term durability and integrity.

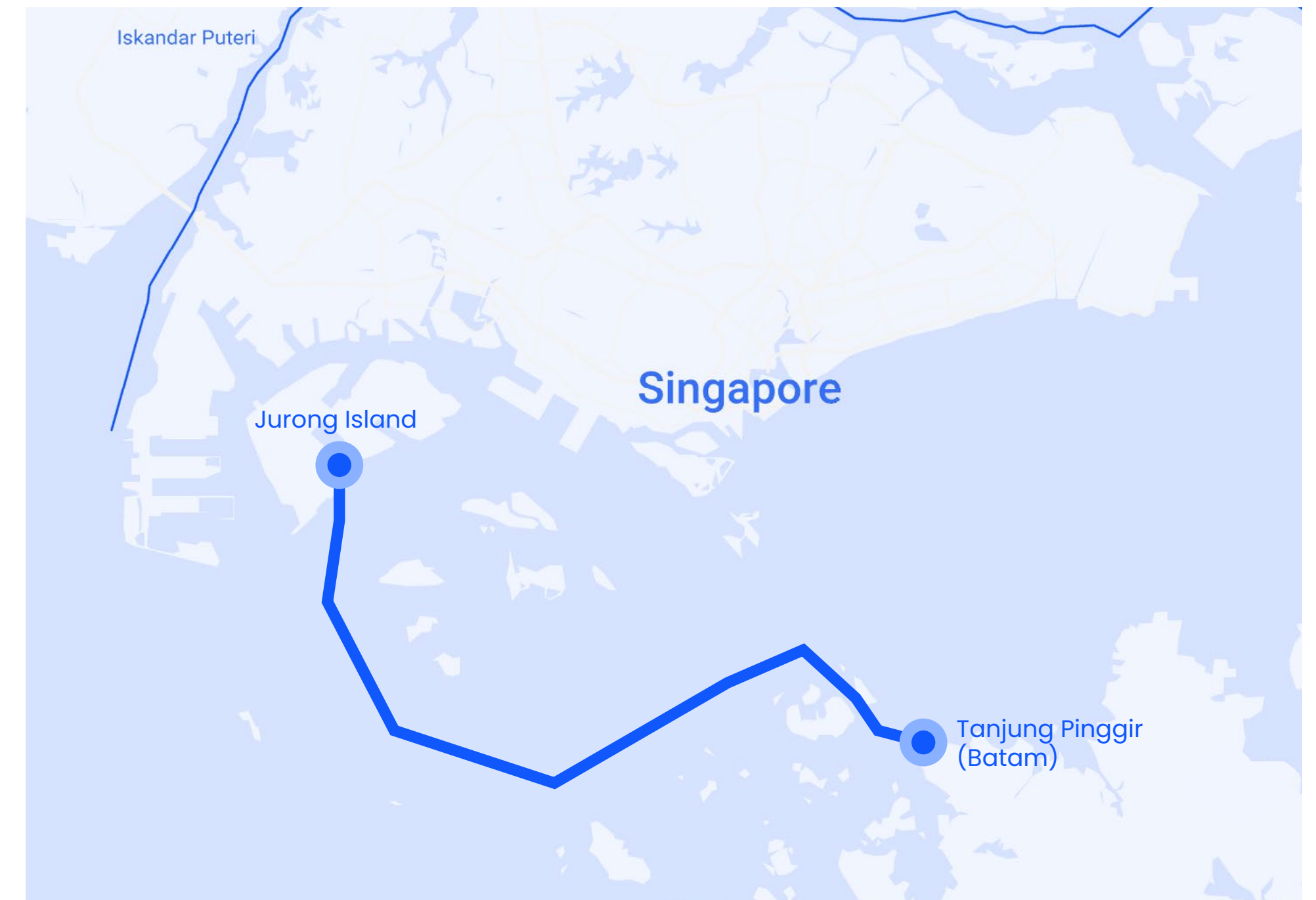


Figure 1: Tanjung Pinggir – Jurong Island subsea power cable study conducted by Surbana Jurong, part of the ongoing efforts to facilitate green energy power imports. Route shown is illustration only.

Stakeholder Engagement and Regulatory Compliance: Ensuring Smooth Project Progression

Stakeholder consultation is a critical component of the desktop study process. This phase involves mapping relevant stakeholders, including maritime authorities, environmental agencies, and other key parties, and engaging with them early in the planning phase. By proactively involving these stakeholders, potential concerns and requirements can be identified and addressed at the outset, ensuring smoother project progression.

For the Tanjung Pinggir to Jurong Island route, this early engagement would help ensure that the proposed route would not conflict with shipping lanes or other critical infrastructure. Engaging stakeholders early in the desktop study phase fosters regulatory compliance, reduces project risks, and enhances the overall feasibility of the subsea cable route.

Navigating the permitting landscape is crucial for subsea cable projects. For example, in Singapore, the Energy Market Authority (EMA) oversees subsea cable installations, ensuring compliance with the nation's energy security and sustainability goals, while the Maritime and Port Authority of Singapore (MPA) regulates offshore infrastructure and maritime traffic. Whilst in Indonesia, the Ministry of Energy and Mineral Resources (MEMR) governs energy infrastructure, including power imports and exports, while the Ministry of Marine Affairs and Fisheries (MMAF) is involved in marine energy infrastructure permitting. Experience working with the different authorities streamlines the permitting process, aligning project requirements with strict regulatory standards and ensuring timely approvals.

Overcoming Challenges in Cable Route Planning

The Tanjung Pinggir to Jurong Island cable route would present several challenges, including navigating busy shipping lanes, protecting sensitive marine environments, and ensuring regulatory compliance across two nations. However, through meticulous route selection, environmental assessments, and cross-border cooperation, the study could potentially confirm that the HVAC subsea cable route offered a feasible solution to connect Indonesia's renewable energy generation capabilities with Singapore's power grid. Following this, it would be recommended to conduct geophysical and geotechnical surveys to gather further data. This would enable a more detailed cable route study and final alignment, ensuring optimal installation conditions and the long-term viability of the subsea cable.

Post-Desktop Study: The Role of Marine Surveys in Subsea Cable Projects

Following the initial desktop study phase, which focuses on preliminary route selection based on available data, the next crucial step in subsea cable route planning is the marine survey. Marine surveys, encompassing both geophysical and geotechnical surveys, provide site-specific data that are vital for refining the cable route design, ensuring installation feasibility, and addressing environmental concerns.

Geophysical Surveys

A geophysical survey offers a comprehensive understanding of the seabed's physical properties. Using advanced technologies such as multibeam echo sounders, side-scan sonars, and sub-bottom profilers, these surveys capture essential data on seabed topography, water depths, and potential underwater hazards that could impact cable installation.

The key data points gathered from geophysical surveys include:

- **Seabed Topography:** Mapping the seabed profile, including slopes, ridges, valleys, and identifying potential obstacles such as boulders or wrecks.
- **Hazard Identification:** Detecting submerged hazards like rocks, wrecks, existing cables, pipelines, or offshore infrastructure, which must be avoided during installation.
- **Water Depths and Bathymetry:** Accurately measuring water depth to assess cable burial depths and determine the appropriate type of cable protection.

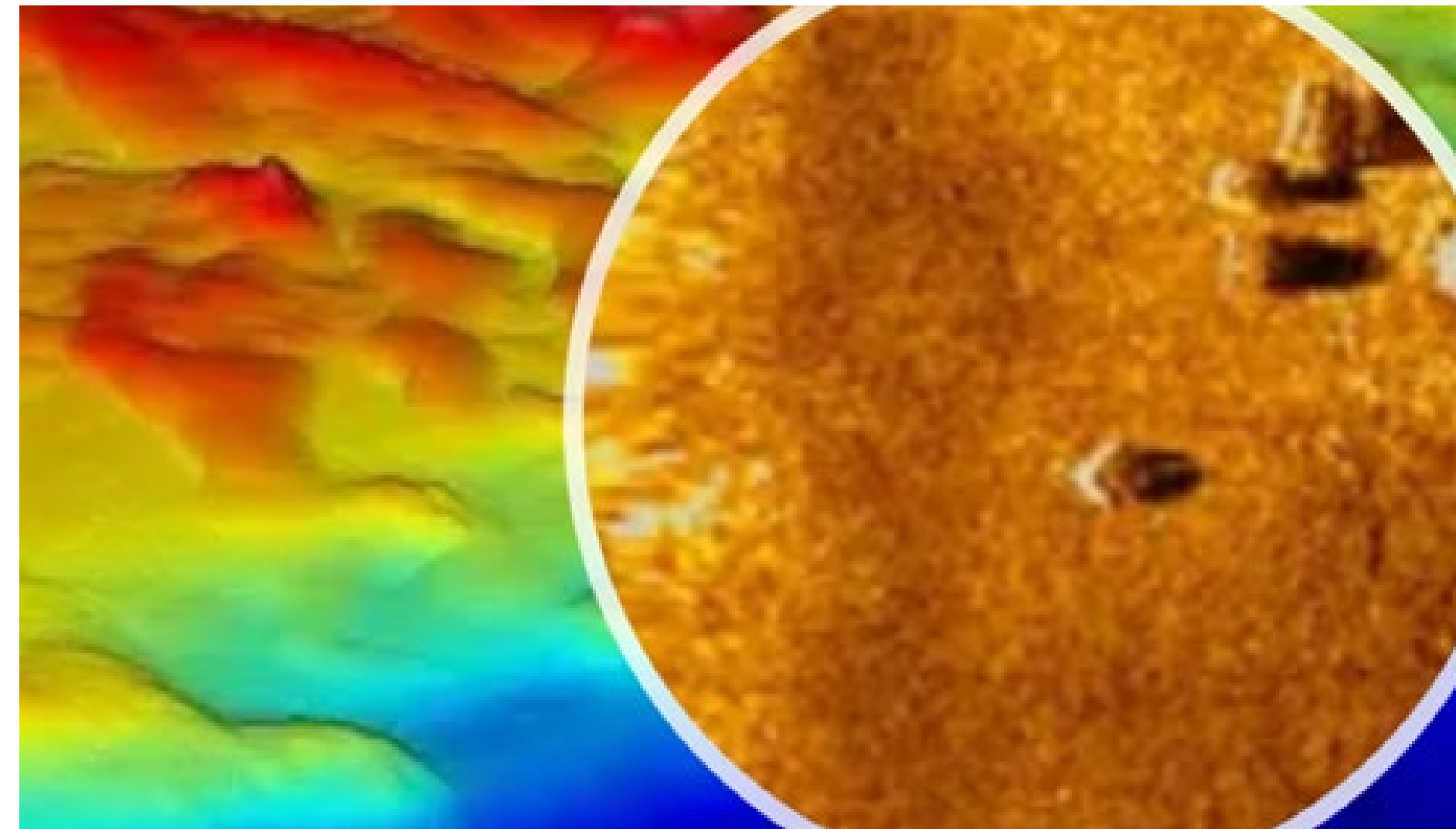


Figure 2: Geophysical survey data revealing the presence of sand waves and seabed debris.

Geotechnical Surveys

In contrast to geophysical surveys, geotechnical surveys focus on the physical properties of seabed sediments and subsurface conditions. These surveys, conducted through penetration tests, soil sampling, and seismic testing, help determine the suitability of the seabed for cable burial.

Key data from geotechnical surveys include:

- **Soil Composition and Strength:** Understanding soil types (sand, clay, silt, etc.) and their strength to assess how well the seabed can support the cable.
- **Subsurface Conditions:** Analysing underlying geotechnical layers, such as bedrock or soft sediments, which influence installation methods and burial depth.
- **Cable Burial Feasibility:** Assessing soil resistance to penetration, which informs the choice of installation methods (e.g. trenching or ploughing) and burial depth.



Figure 3: Deployment of Cone Penetrometer Testing (CPT) equipment, used to assess the soil properties and strength of the seabed for subsea cable installation.

The Role of Cable Route Surveys and Site Investigations

Cable route surveys and site investigations are integral to subsea cable projects, particularly offshore installations.

These surveys provide critical data that inform route selection, design decisions, and regulatory compliance and include:

- **Assessing Seabed Conditions:** Detailed seabed surveys are vital for determining optimal cable burial and protection locations. These surveys map seabed topography, identify potential hazards like boulders, and evaluate soil characteristics, ensuring the safe and secure installation of the cable.
- **Environmental Impact Assessment:** Site investigations are essential for evaluating the potential impact of subsea cable installations on marine ecosystems. These assessments identify sensitive habitats, evaluate possible disturbances, and develop mitigation strategies to protect marine life.
- **Identification of Existing Infrastructure:** Surveys identify existing infrastructure, such as pipelines and shipping lanes, that could pose risks to the proposed cable route. This helps prevent conflicts during installation, ensuring a smooth and safe cable laying process.
- **Cable Route Optimisation:** The data gathered from these investigations allows for the optimisation of cable routes, ensuring minimal environmental disruption, avoiding obstacles, and reducing the likelihood of delays or complications during construction.

Route Position List (RPL) and Its Significance

A key outcome of the marine survey phase is the generation of the final Route Position List (RPL), which provides precise geographic coordinates for the subsea cable route. While a preliminary RPL is created during the desktop study, the final RPL is updated with data from geophysical and geotechnical surveys. This final RPL ensures accurate alignment of the cable, guides the installation process, mitigates risks, and ensures compliance with regulatory, environmental, and safety standards, ensuring that subsea cable projects are optimised for installation, environmental sustainability, and long-term viability.

Conclusion

In conclusion, the strategic deployment of subsea power cables is pivotal in facilitating the cross-border transmission of renewable energy.

The theoretical Tanjung Pinggir to Jurong Island cable route exemplifies the complexities and opportunities in this domain, requiring meticulous planning, stakeholder engagement, and regulatory compliance. By integrating desktop studies, geophysical and geotechnical surveys, and stakeholder consultations, it is possible to navigate the challenges of busy shipping lanes and environmentally sensitive areas while ensuring operational efficiency and environmental protection.

This approach not only supports the integration of remote renewable energy sources into mainland grids but also underscores the critical role of subsea cables in enabling sustainable energy transitions. As nations continue to set ambitious decarbonisation targets, the development of such infrastructure will remain essential for achieving a more sustainable energy future.



smec.com