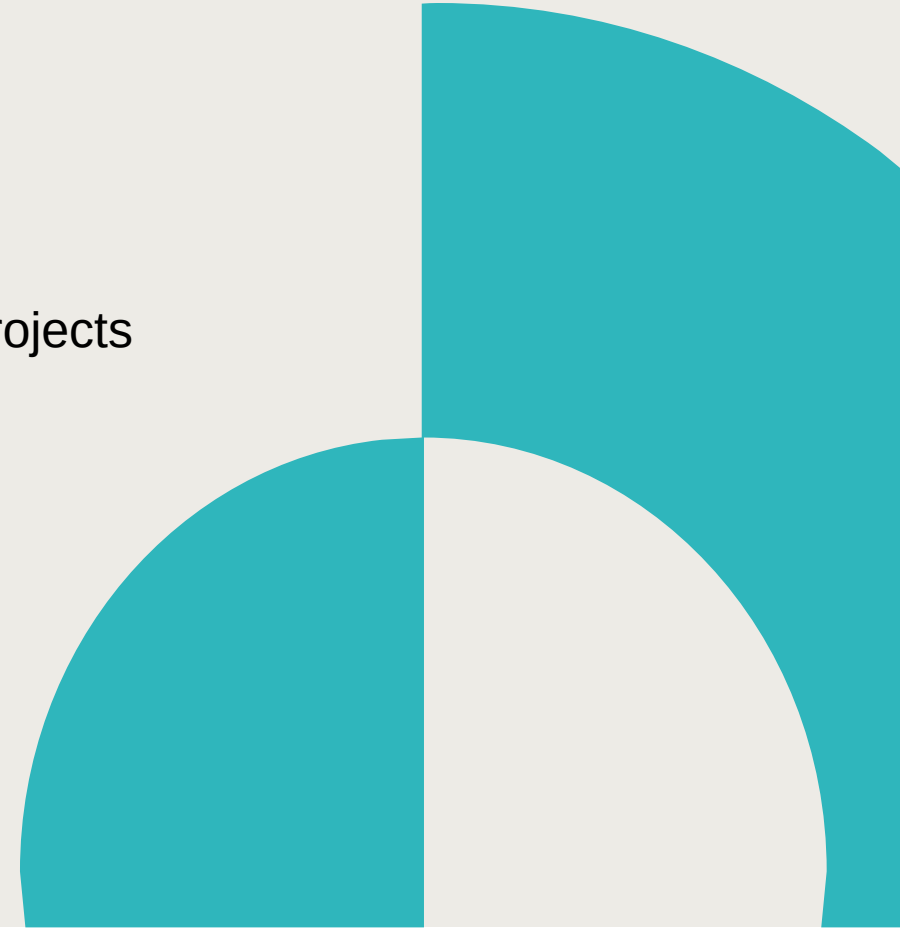
MOTT MACDONALD

Building the ASEAN grid using firmed renewables

A case study of scaling up hybrid and ESS technology projects

Philip Napier-Moore

Energy Sector Leader, Asia



A Leading Track-Record in Asia

Technical Advisor to >260GW of renewable projects in the last 10 years

120GW

of wind (offshore and onshore) power projects, including 20GW in Asia Pacific

70GW

of hydro power projects, including 40GW in Asia Pacific

70GW

of solar power projects, including 40GW in Asia Pacific

30GW

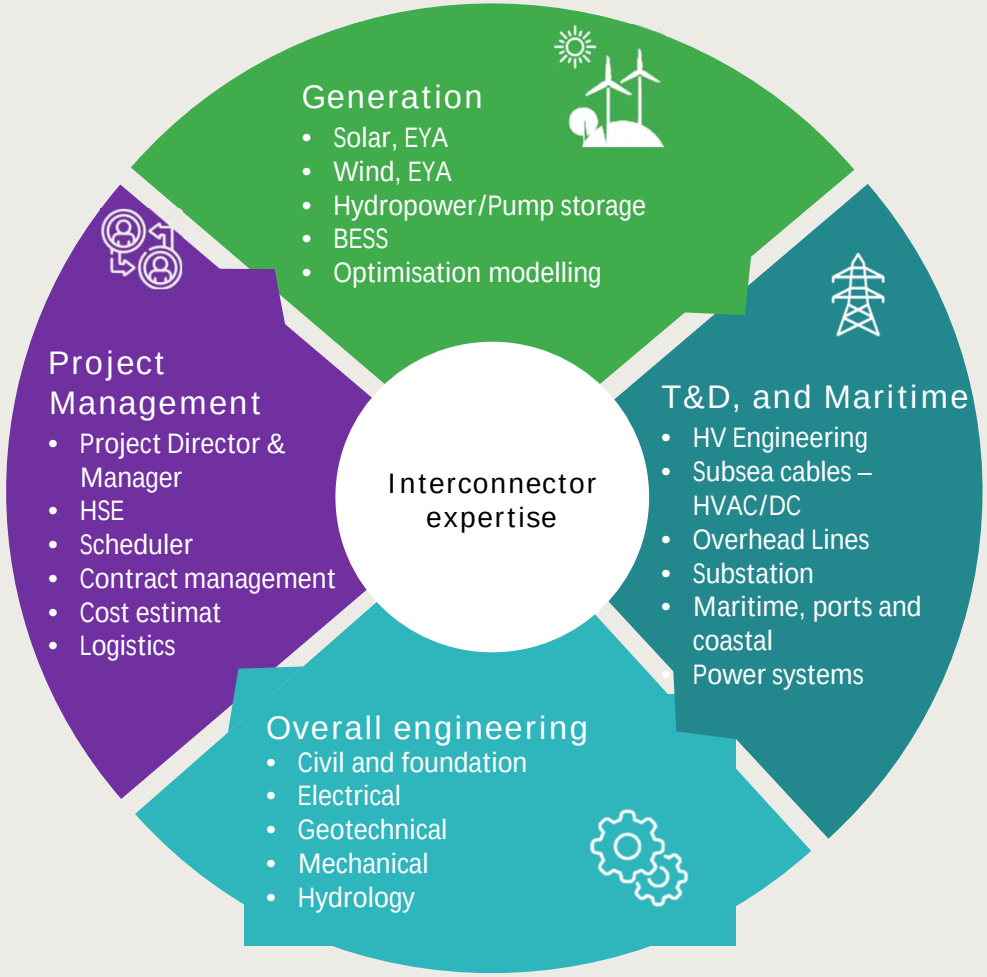
of power transfer capability in Cables related projects

30GWh

of BESS projects, including 20GWh in Asia Pacific

Integrated cross sector expertise

Interconnector projects require intimate knowledge of multiple disciplines, integrated for successful completion. We have this capability and expertise.



Our Offshore Interconnector Experience

We bring practical experience on some of the world's iconic interconnector projects, embedded links and HVDC offshore connections

Our expertise:

- Selection of cable route, landfall and grid connection
- Technology selection and sizing
- Support with route surveys, metocean studies, cable burial risk assessments per Carbon Trust
- Front-end engineering design (FEED) and EPC procurement package development
- Review of EPC tender returns, technical specifications, implementation and operation plans, financial model, O&M strategies, and project risks.
- Contracts development for delivery, operation and maintenance of the interconnector
- Reliability & availability assessment
- Testing and commissioning of interconnector and post-energisation problems resolution

USA

- Clean Path New York 1300MW HVDC project to supply renewable energy to New York
- Beacon Wind – HVDC solution to connect offshore wind to the US mainland
- Humboldt offshore wind – HVDC solution to connect offshore wind
- Birch Creek Embedded HVDC link 2GW 525kV VSC

Ireland

- Greenlink Interconnector to Wales (504MW VSC)
- Celtic Interconnector to France (700MW VSC)
- Ireland-Wales HVDC Interconnector

Western Europe/North Africa

- Xlinks – 2xHVDC links connecting 11.5GW installed capacity renewables in Morocco to GB
- North Sea Wind Power Hub – Connection of offshore wind and hydrogen facilities using HVDC technology
- France-Italy HVDC Interconnector

Japan

- Ukujima VSC interconnector connecting solar farm on an island to mainland transmission system

Australia

- Marinus Link – 750MW interconnector between Tasmania and Victoria

United Kingdom

- Sofia VSC Offshore windfarm ElecLink VSC HVDC Interconnector UK-France
- Offshore Transmission Owner Due Diligence and Operations Monitoring
- NeuConnect 1400MW VSC interconnector to Germany
- Western Link LCC HVDC Embedded Link between England and Scotland
- East Coast portfolio of HVDC embedded links (2GW VSC 525kV solutions)
- Caithness/Moray/Shetland – world's first multi-terminal HVDC interconnector
- Confidential client 2GW VSC 525kV framework solutions
- IFA1 – LCC HVDC interconnector between GB and France
- GB – Europe HVDC interconnector
- Greenwich MVDC Project

South America

- Brazil – Novatrans transmission project

South-East Asia

- HVDC/AC subsea Interconnector Projects (Confidential)
- Java – Sumatra HVDC connection 2600MW

Middle East

- Abu Dhabi Offshore Long-Term Power Supply Masterplan 3GW HVDC offshore network
- ADNOC Lightning/Zirko – HVDC interconnectors for electrification of offshore oil and gas

What's new?

Why now for firmed renewables?

1 **Solar and onshore wind power lower cost than alternatives *for 96% of new global capacity from 2023**

2 **But subject to a maximum grid penetration limit…**

3 **Limits can be addressed by storage, interconnection to larger demand centers, or both…**

4 **Solar with BESS becoming competitive with mid-merit coal and gas-fired plant in ASEAN**

5 **Industry demand for firm RE due to RE100 and EU carbon border – changing drivers for governments**

6 **Lower-cost firm RE possible through cross-border imports? Especially with pump-storage…**

** "Renewables 2023", IEA, as revised January 2024*

Mid-merit Hybrid – 3.5GWp PV / 4.5GWh BESS

Project Owner

Terra Solar Philippines Inc. (TSPI)

Mid-merit renewable power

Annual average load factor of 50%, at a competitively tendered tariff

Location

Nueva Ecija, Luzon, Philippines

Land Area

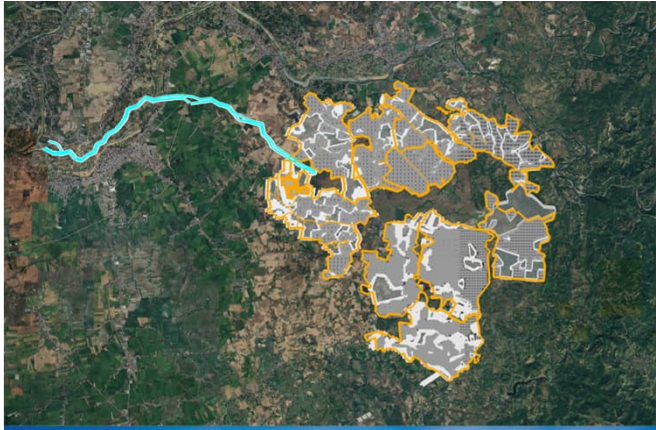
3,500 hectares, almost the same size as Pasig City

Opportunity

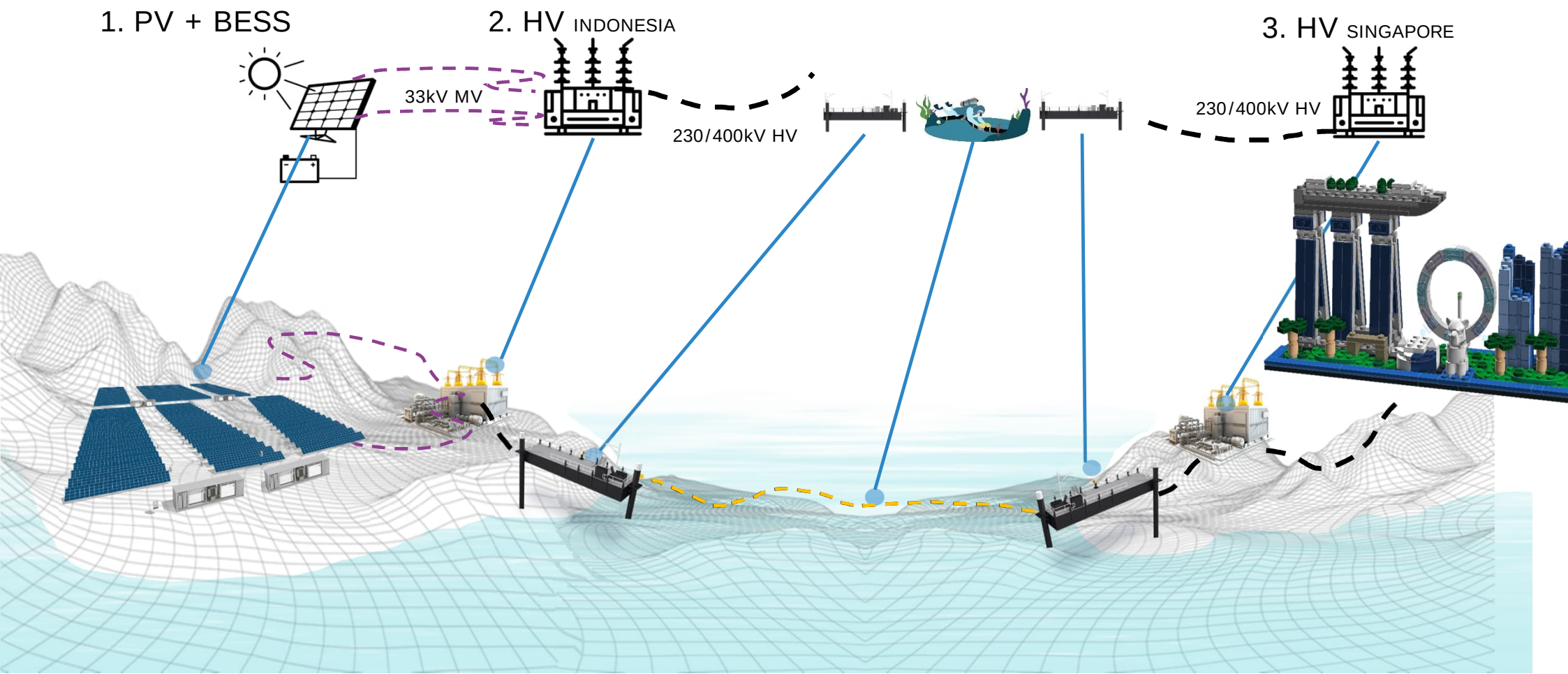
TSPI executed a Power Supply Agreement (PSA) to provide firm 600MW in 2026 and increasing to 850MW in 2027 during peak hours from 8am to 9pm from the solar PV and BESS, at a power tariff competitive with traditional thermal mid-merit plants. Groundbreaking occurred in November 2024 and debt financing of ₱150B (US$2.7B) closed in April 2025.

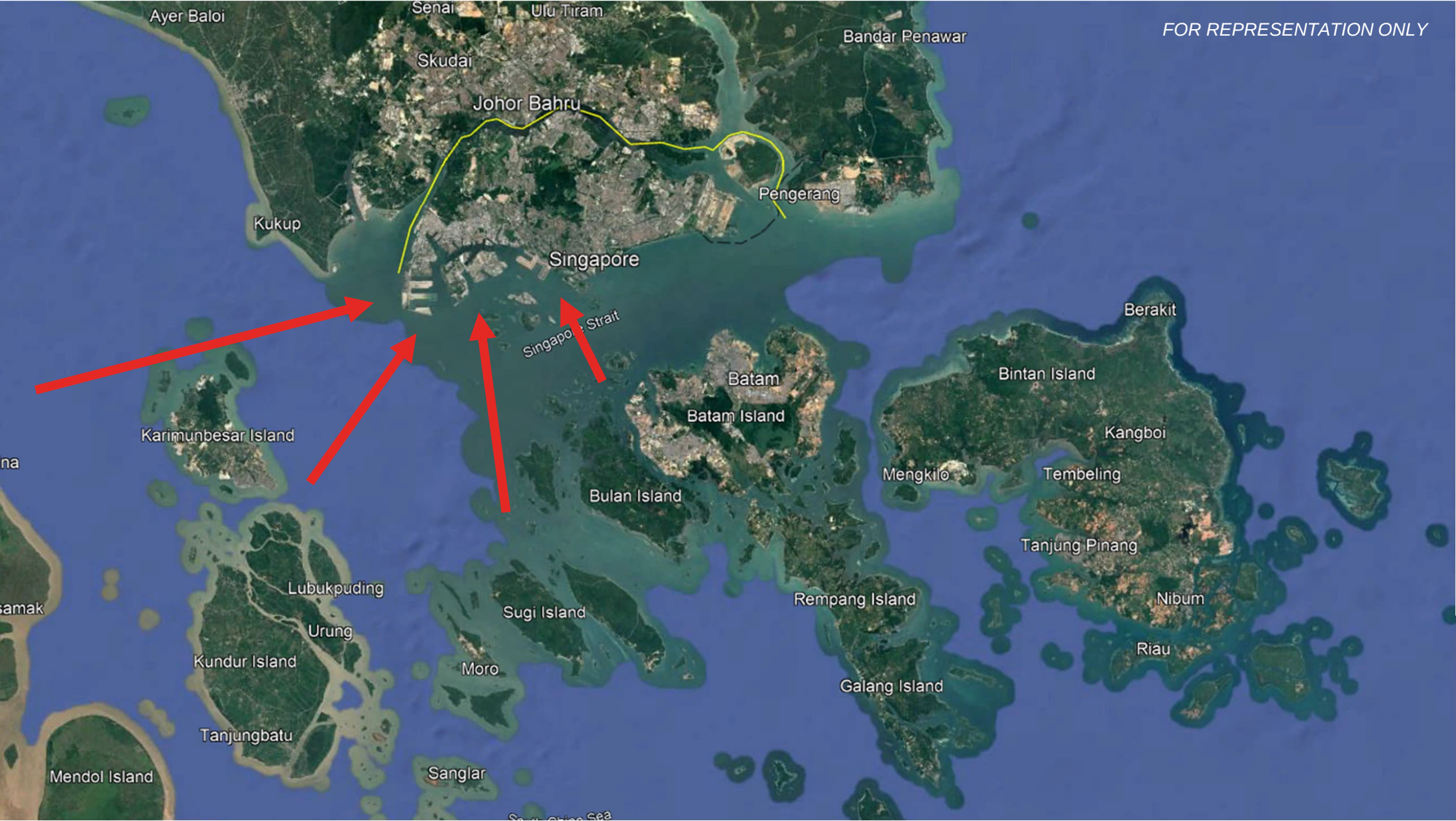
Challenges

- Design to meet PSA firmed dispatch requirements, with maximum flexibility to additionally provide wholesale power exports and future ancillary services
- EPC contracting strategy to facilitate a globally unprecedented rate of PV deployment, at up to 160MW per month
- Site-wide infrastructure design and transport logistics, to facilitate parallel activity by multiple contractors
- Huge construction workforce – the project owner has projected up to 20,000 workers needed



Firmed Solar imports to Singapore from the Riau islands

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Ayer Baloi
Senai
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Johor Bahru
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Karimunbesar Island
Kangboi
Mengkilo
Tembeling
Bulan Island
Tanjung Pinang
Lubukpuding
Rempang Island
Nibum
Sugi Island
Urung
Riau
Kundur Island
Moro
Galang Island
Tanjungbatu
Mendol Island
Sanglar

Renewable Energy Imports from the Riau Islands

Multi gigawatt-scale Solar-BESS hybrids with 0.3-1GW Subsea Cables

Project Owners

Seven conditional concessionaires

Location

Various Riau islands, Indonesia

Mid-merit renewable power

Importing firmed renewable power to Singapore, under conditional licenses / awards issued by the Energy Market Authority (EMA)

Opportunity

Under Singapore's energy transition, the nation aims to meet 30% of electricity needs with renewable imports by 2035.

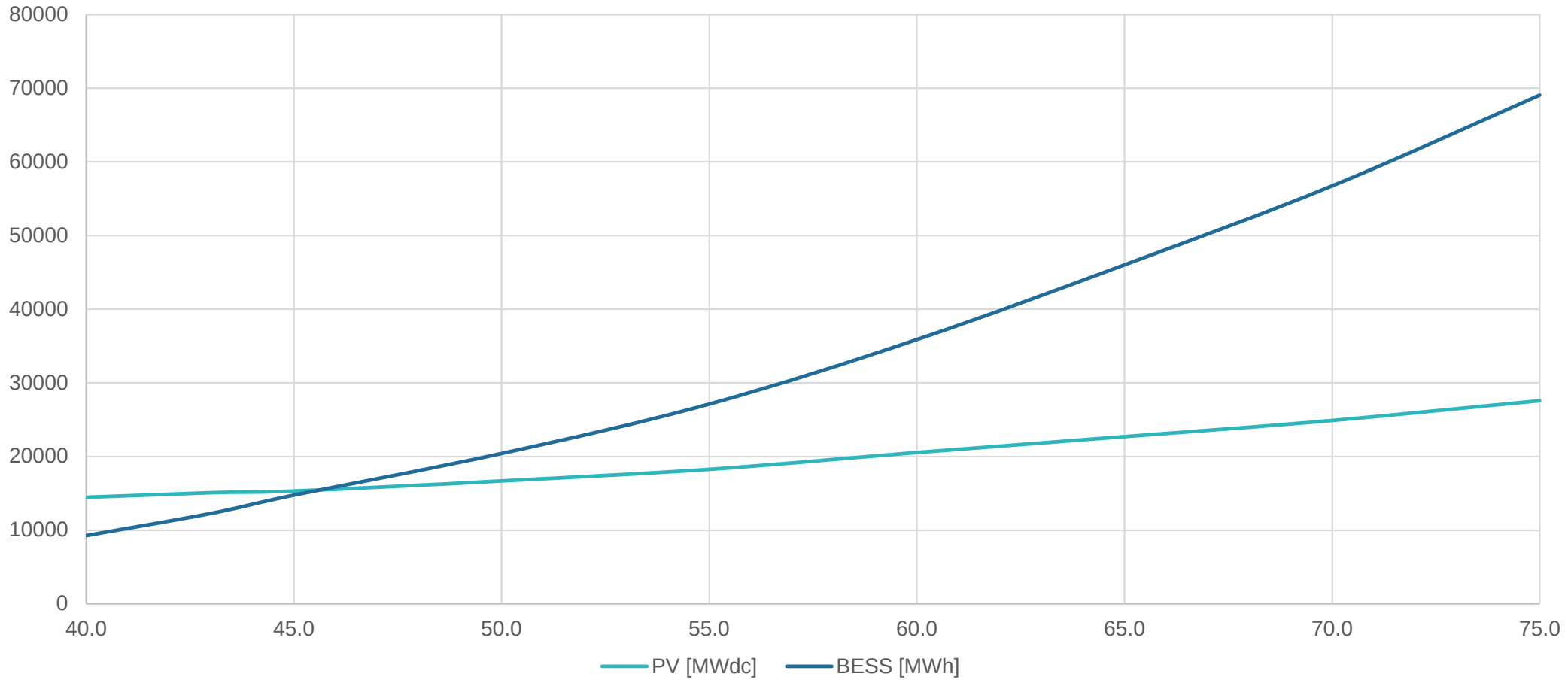
Seven developers have secured either a Conditional License or Conditional Award for import of 3.4 GW of firmed renewable energy from Indonesia to Singapore via high-voltage subsea power cables.

Challenges

- Constrained subsea corridors, landing points and grid interconnections for subsea cables landing in Singapore
- Indonesian local content (TKDN) for PV modules and BESS – requires giga-scale new equipment manufacturing facilities
- Multiple multi-gigawatt deployments in parallel will strain supply chain and EPC contracting capacity
- Complex marine logistics for isolated island project locations
- EMA and power retailer coordination to balance extent of power output firming with affordability to customers

3.4GW Firmed Renewable Energy Imports from the Riau Islands

Scenarios for required installed capacity of Solar PV and BESS, varying annual Plant Load Factor (PLF)



Wider implications for ASEAN energy transformation

1

Diversified generation

Firming RE with hybrid solar / wind / hydro / BESS will be even lower cost

2

The new role of BESS

No longer only grid support; time shifting now cost-effective for 50-60% load factors

3

Other energy storage

Pump-storage can play a wider role ub firming, including for cross-border power flows

4

In-region PV and BESS manufacture

Potential to unlock greater regional value from RE use

5

ASEAN grid

How to plan around integration of captive interconnectors?

6

Subsea interconnection

How to unlock supply chain constraints?

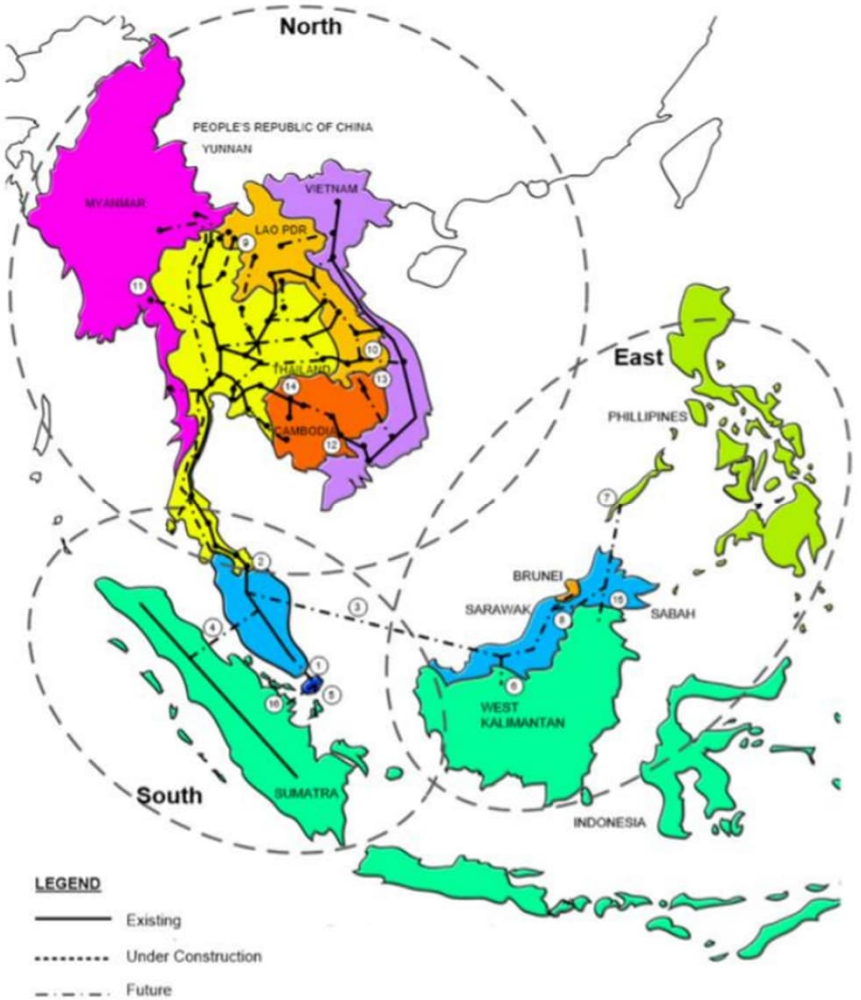


Figure source: "ASEAN Interconnection Masterplan Study III Report", 2021

Thank you

Philip Napier-Moore

Mott MacDonald’s Energy Sector Leader for Asia, responsible for the Group’s regional support to clients on the global energy transition.

Working across the energy value chain for over 20 years, he has supported multilateral agencies, national governments and diverse private companies on low-carbon power projects in 30 countries around the world, in particular within Asia and Europe.

With a focus on utility-scale solar and wind power, from their infancy in the region in 2008, he has supported more than 80 GW of projects in Asia, including several hundred plants now successfully in operation.

A Chartered Engineer and Fellow of the Energy Institute, he obtained his Masters of Engineering from Oxford University.

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