Offshore Wind Roadmap for Sri Lanka

Consultation Webinar

13th September 2022

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World Bank Group
The World Bank IBRD • IDA
IFC International Finance Corporation

ESMAP
Energy Sector Management Assistance Program

Roadmap Purpose and Status

PURPOSE

- Independently **evaluate the potential** of the Sri Lankan offshore wind market, and its capacity to support the growing regional offshore wind market.
- Provide the Sri Lankan Government with an insight into the **challenges and opportunities** of developing the offshore wind sector.
- Create a practical roadmap to **help inform policy-making decisions**.
- **Produce a roadmap report that is relevant and informative** to a wide range of stakeholders interested in Sri Lanka's 'green transition'.
- To propose and identify a potential "**Demonstration Project**" for further development.

STATUS

- Offshore Wind Roadmap for Sri Lanka – Draft report completed and shared with government.
- Suitable potential areas for Sri Lanka's first offshore project are identified.
- Final iteration of the report, incorporating feedback received from this consultation and following report review by the government, is to be issued during Q4 2022.

Why Offshore Wind?

- Government commitment to renewable energy and reducing dependence on imports
- Huge national potential and can supply more energy than the country needs – opportunity to produce other fuels (hydrogen, ammonia etc)
- Resource is close to coastal demand centers
- Potential for high output and lower variability – well suited to displace coal generation
- Avoids land constraints and using land areas
- New industry creates and supports skilled jobs and boosts inward investment
- Regional supply and cooperation opportunity: India targets 30 GW by 2030 and will develop significant capacity in Tamil Nadu

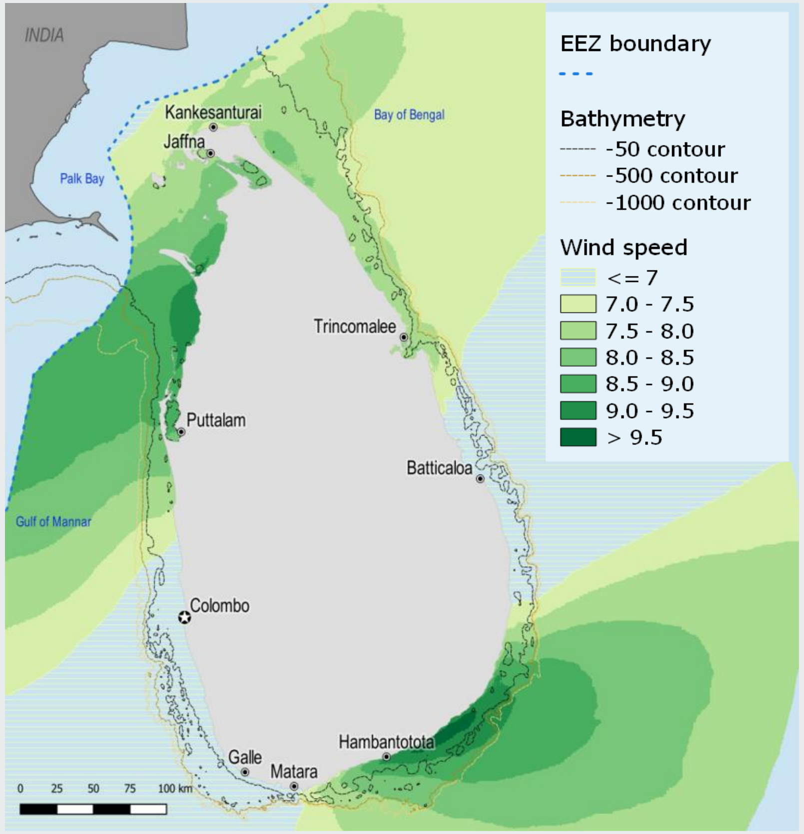
Summary of Roadmap Findings

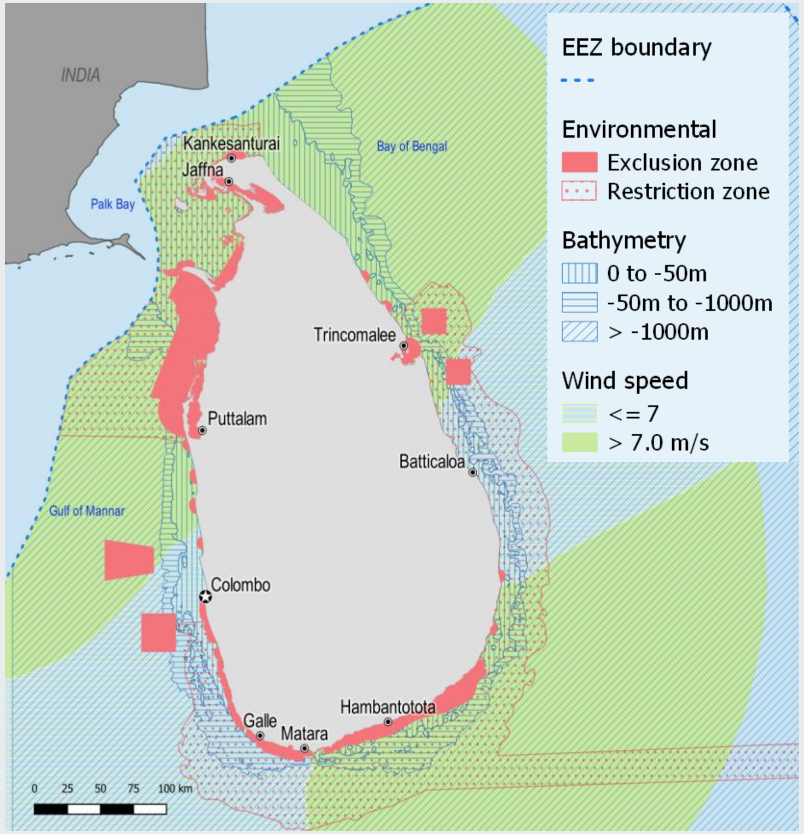
- **Opportunities**:
  - Sri Lanka has good offshore wind resources in areas that are suited to development of large-scale offshore wind.
  - Strong commitment to renewable energy from the Sri Lankan Government will attract investors both financially and technology, and contribute to a cleaner energy mix.
    - **Aim**: 7% Wind Energy production, of which 1 GW Offshore Wind by 2030.
  - Potential for collaboration with Indian offshore wind market and possible interconnector.
  - Cost competitive local labor for long term operations and maintenance.

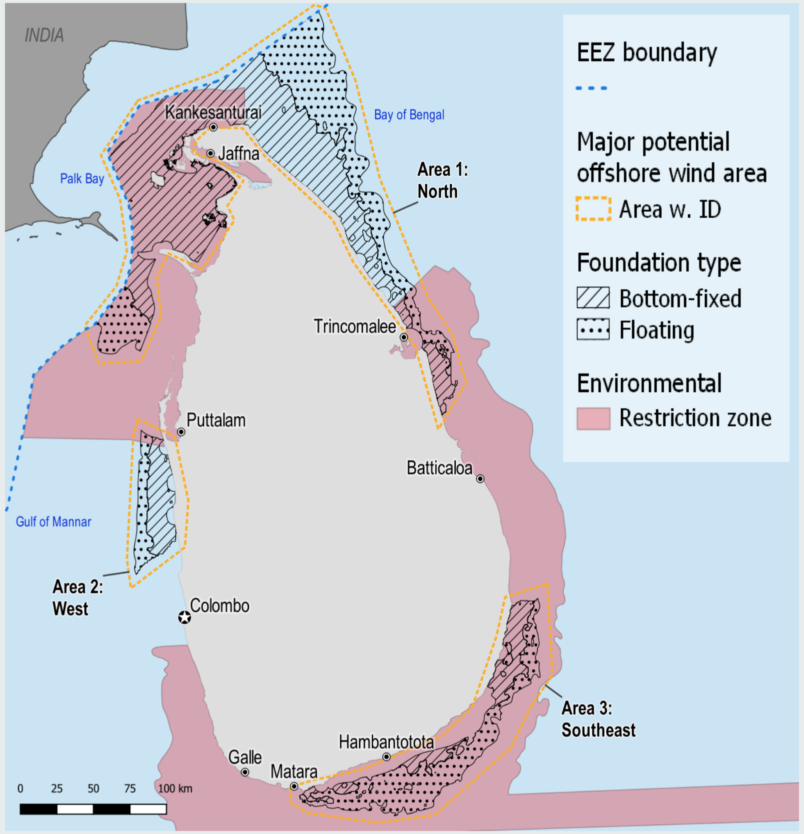
- **Challenges**:
  - Sri Lanka currently does not have a sufficient supply chain to execute the construction of an offshore wind farm with a significant proportion of "local content".
    - **Potential opportunity**: investment in local content and education of local resources.
  - The regulatory framework does not currently support the implementation of industrial scale offshore wind power. *Note that this does not preclude the construction of a demonstration/first project.*
    - **Potential opportunity**: modifying the regulatory framework to better support offshore wind could reduce the risk of the development process, help lower the cost of finance, and open the Sri Lankan market.
  - Sri Lanka's current grid infrastructure will require upgrades and expansions to support industrial scale offshore wind.
    - **Potential opportunity**: further economic investment and collaboration with India on the Interconnector.

Potential Development Areas

- By combining the data sets on wind speed, environmental and social constraints, and bathymetry, it becomes clear that there are three broad areas suitable for development of fixed offshore wind.
  - The maps below show progressively the available wind resources, exclusion and restriction zones and then potential fixed and floating offshore wind resources.







Note: all maps are draft

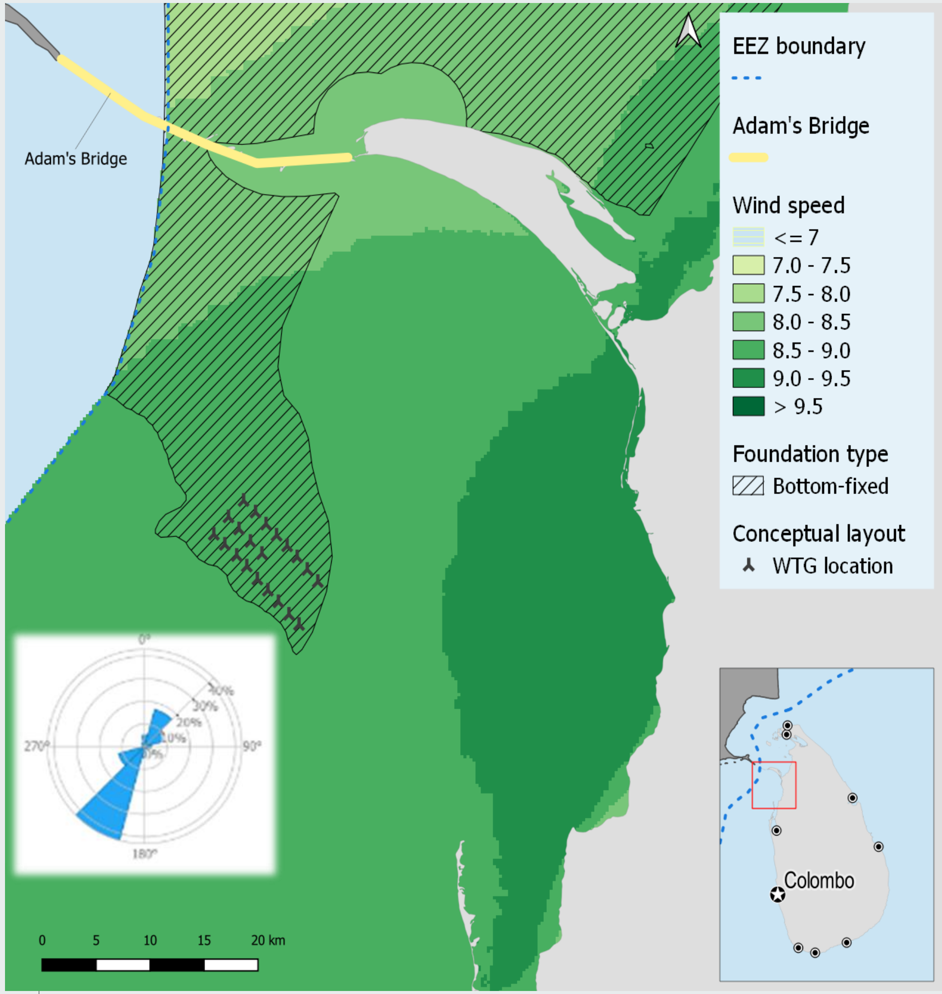
Potential Development Areas

- Considering the potential areas, the estimation of the total potential is as follows:

	Fixed Potential		Floating Potential		Typical Wind speed at 150m
	km^2	GW	km^2	GW	m/s
Area 1: North	4,564	18	3,697	15	7–9
Area 2: West	1,027	4	624	2	7–8.5
TOTAL	**5,591**	**22**	**4,321**	**17**	

- Note following assumptions and points:
  - Wind Turbine Generator (WTG) density of 4 MW/km^2.
  - Technical, environmental, and social constraints will limit the feasible capacity - it will not be possible to deliver all of the fixed and floating potential summarised above.
  - Furthermore, these potential figures do not consider the economic factors, and projects in some areas will be deemed too expensive.
  - This table only considers areas without environmental restriction and exclusion zones.

Example Demonstration Project Concept



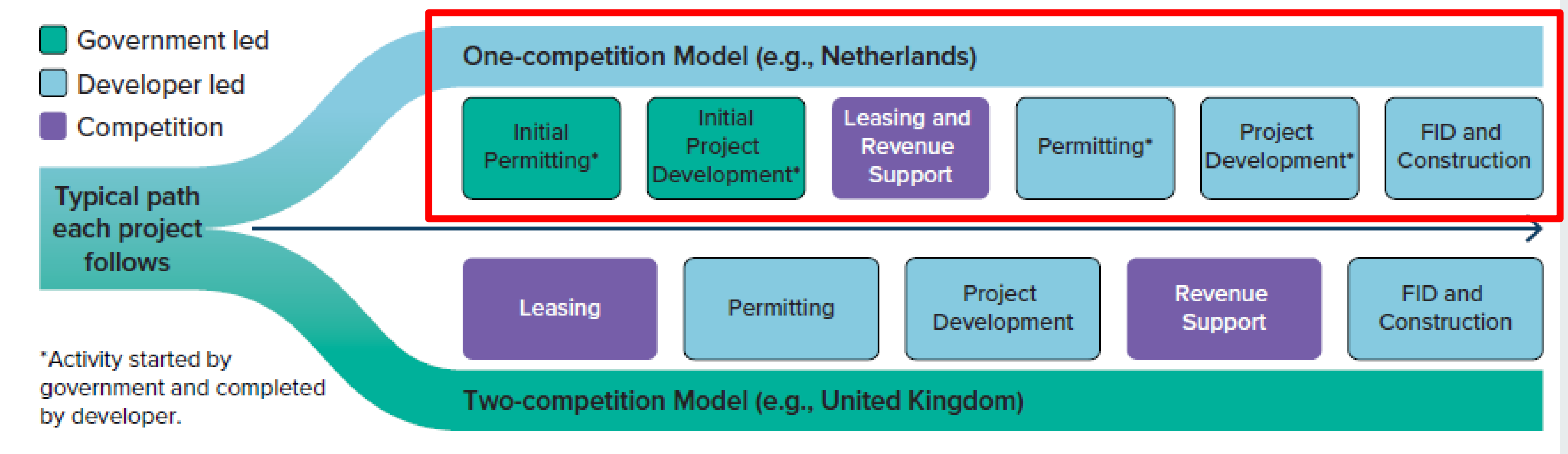
- Based on the assessment of the available sites and associated challenges and opportunities, the site to the north-east in the Gulf of Mannar is presented as one of the most suitable options for Sri Lanka's first offshore wind farm.
- This is based on a generic model offshore wind turbine:
  - Wind-Class I, 12MW, hub height of 150m and rotor diameter of 220m
- Total project nameplate capacity: 252MW
- Estimated LCOE (levelized Cost of Energy): USD 70-80 / MWh
  - Based on WACC of 6% (reduced through financial mechanisms and risk mitigation measures)

Wind speed	8.8 m/s
Nos. of 12 MW WTGs (150m HH)	21
Annual gross energy production (P50)	1,274 GWh
Wake loss – 3.2%	40.3 GWh
Annual park production (P50)	1,234 GWh
Capacity factor - Park	55.9%
Other losses – electrical, outages etc. (10% of P50)	123 GWh
Net AEP	1,109 GWh

Note: all maps and findings are draft

Options for Delivering Sri Lanka's First Offshore Wind Projects

Possible timeline for activities: 2023 2025 2027/28



Government-led studies and single competition for project, permits, grid, and offtake

Advantages:
De-risking for investment
Control of process and project location

Disadvantages:
Requirement for external support
Increased government risk
Hard to get it right

Source: Key factors for successful development of offshore wind in emerging markets (World Bank, 2021) – Page 35

Options for Delivering Sri Lanka’s First Offshore Wind Projects

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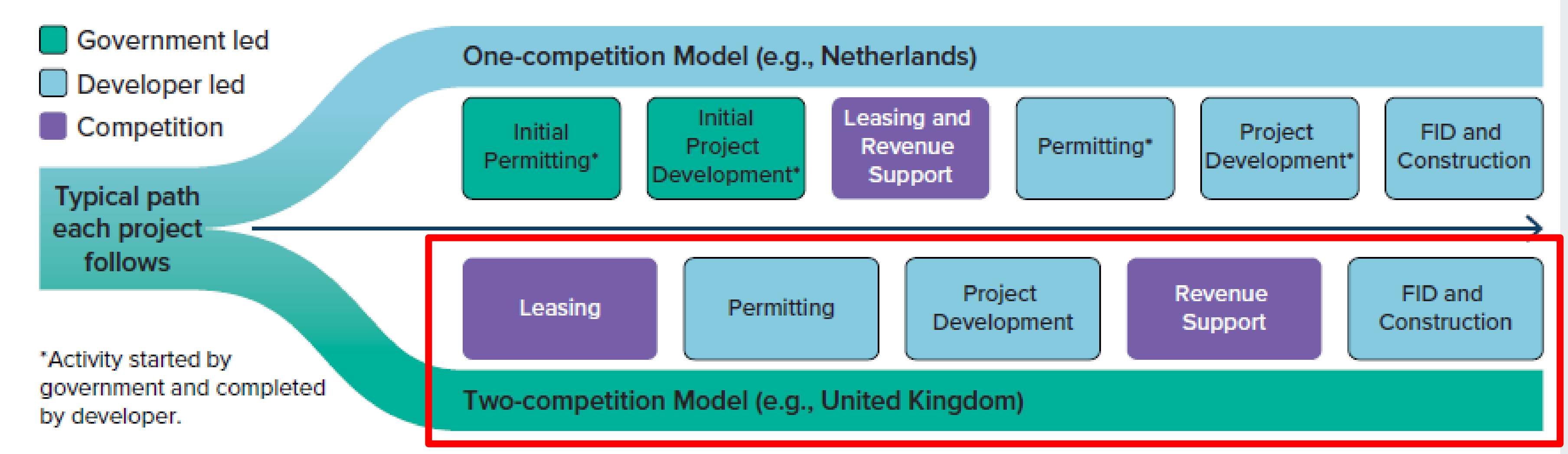

Developer-led studies with two competitions for seabed lease and offtake agreement

Advantages:
Appoints developers and sites quickly
Developers take development risk

Disadvantages:
Design two competitions
Need to have sufficient competition for offtake

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Source: *Key factors for successful development of offshore wind in emerging markets (World Bank, 2021) – Page 35*

Offshore Wind Development Roadmap for Sri Lanka

Category	Local Notable Companies	Track Record & Capacity in Offshore Wind	Capability in Parallel Sectors	Benefits of local Supply	Investment Risk in Sri Lanka	Size of Opportunity
Developing and permitting	WindForce, LTL Holdings – Ceylex Renewables	1	3	4	2	2
Nacelle, hub, and assembly	-	1	1	2	2	4
Blades	-	1	1	2	2	4
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Foundation supply	Columbo Dockyard, Access Engineering	1	2	2	2	4
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WTG and foundation installation	-	1	1	1	4	2
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Wind farm operation	WindForce, LTL Holdings	1	3	4	4	4
WTG maintenance and service	WindForce, LTL Holdings	1	3	4	4	4
Balance of Plant (BoP) and various maintenance	Access Engineering, DIMO	1	3	4	4	4
Decommissioning	Access Engineering	1	2	4	4	2

Drivers for Offshore Wind – Economic Benefits

- **Challenges** will include:
  - Initiating and integrating the new industries into the Sri Lankan economic model
  - Recruiting and educating local experts into the production, installation and maintenance of large-scale offshore wind
    - **Opportunity** to enhance education of local workforce and export technical know-how.
- **Opportunities** will include:
  - The potential for expanding the current industrial strengths of Sri Lanka and providing service to other emerging offshore markets.
  - Increased investment in local economy
  - Investment into the physical upgrades of infrastructure and industrial plants to support the offshore wind industry may feed into future development

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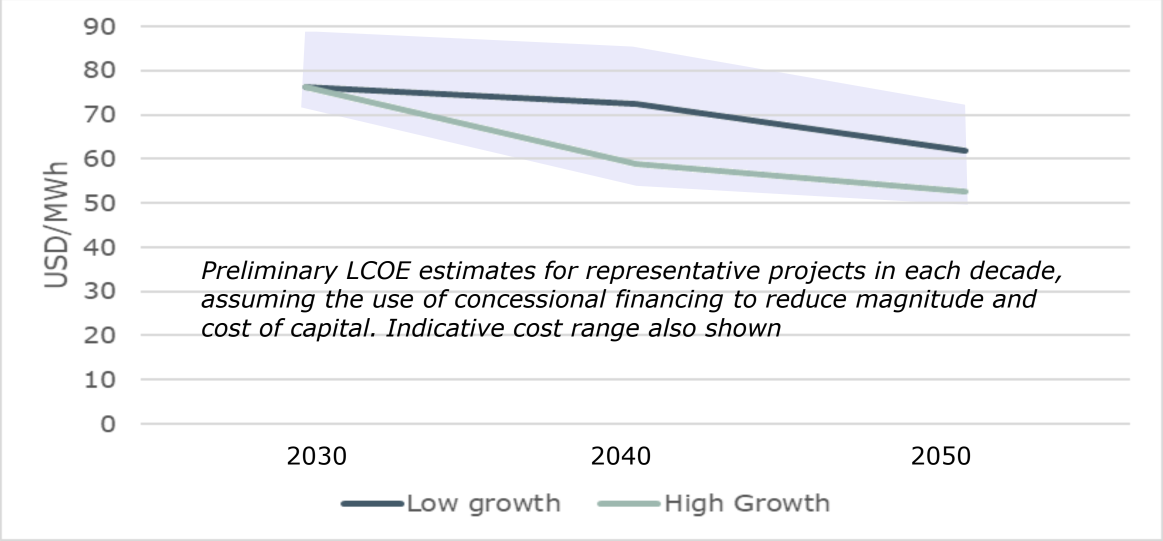
Growth Scenarios

- Hypothetical scenarios of how offshore wind could grow in Sri Lanka
- LCOE for low and high growth is expected to be similar due to capacity factor limitations, especially during the first phases of offshore wind implementation.
- The LCOE only begins to drop for the „high growth scenario" beyond 2030 as the industry becomes established.
- Key considerations for offshore wind growth will be the grid integration, energy balance and potential for an inter-connection with India to allow sale of energy.
- Cost reduction in relative terms of 10-15% by 2050, when compared to 2030.

Offshore wind	By 2030	By 2040	By 2050
Low growth (cumulative)	**0.5 GW**	**1 GW**	**2 GW**
Bottom-fixed	0.5 GW	1 GW	1.5 GW
Floating	0 GW	0 GW	0.5 GW
High growth (cumulative)	**1 GW**	**2.5 GW**	**4 GW**
Bottom-fixed	1 GW	2 GW	3 GW
Floating	0 GW	0.5 GW	1 GW



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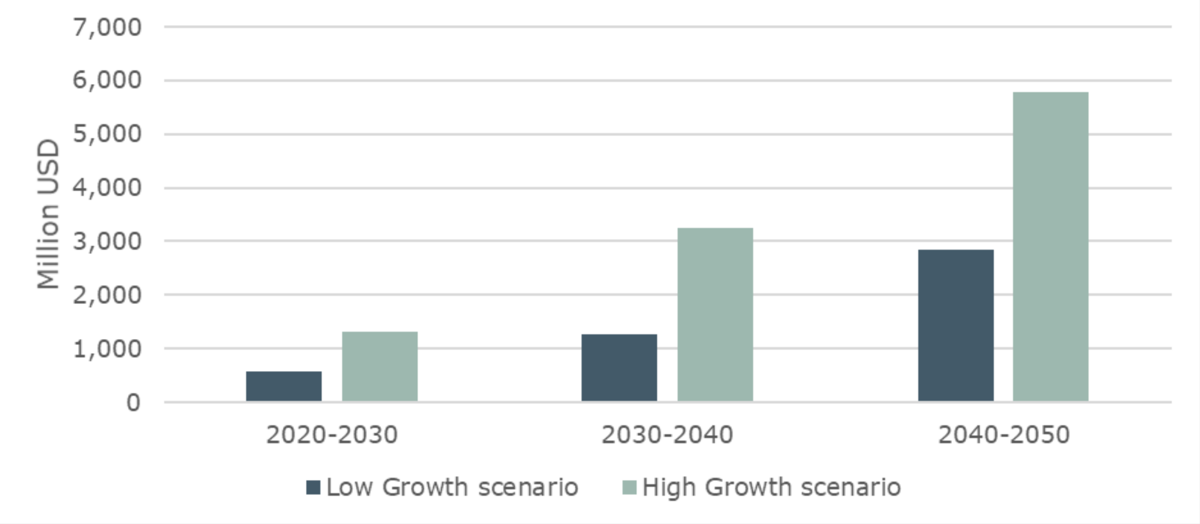
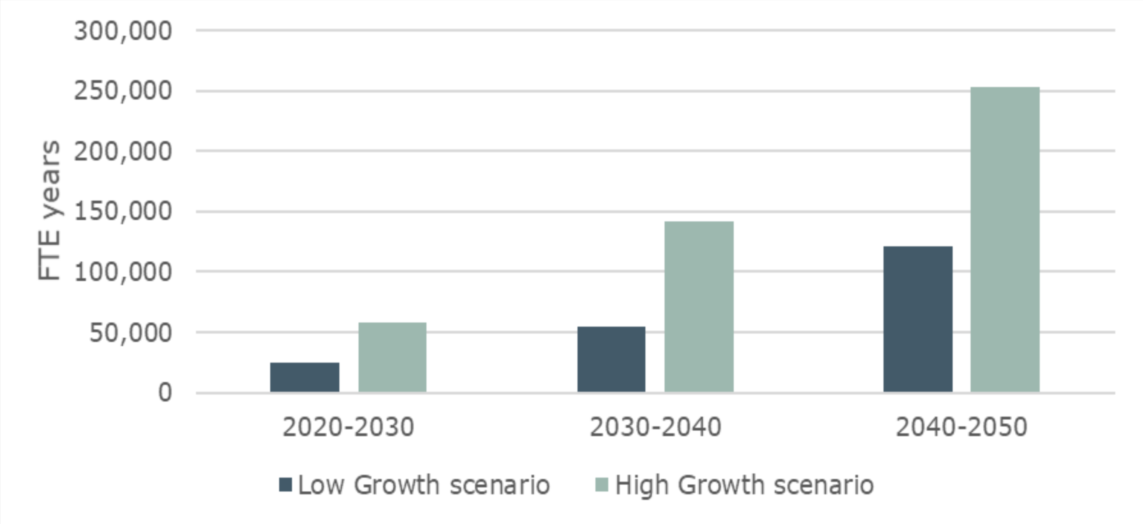
Growth Scenarios

Total investment over the roadmap period



Accumulated employment effects from offshore wind



Breakdown of investment until 2030

	Direct Investment (mUSD)	Indirect Investment (mUSD)	Total impact on GVA (mUSD)
Low Growth scenario (500 MW)	380	190	570
High Growth scenario (1 GW)	880	450	1,330

Breakdown of employment types due to offshore wind

	Direct FTE	Indirect FTE	Total FTE
Low Growth scenario (500 MW)	15,600	9,100	24,700
High Growth scenario (1 GW)	36,200	21,400	57,600

GVA = Gross Value Added   FTE = Full Time Employee

Offshore Wind Development Roadmap for Sri Lanka
Regulation and Policy Frameworks

- Clear and robust regulatory framework for offshore wind will greatly de-risk the potential for investment and directly influence the LCOE by reducing the barriers to financial investment and cost of capital.

- Currently no specific regulatory framework for offshore wind farms (OWF) in Sri Lanka. Some legal references are already made to offshore wind farms.

- The current regulatory framework could support the early implementation of offshore wind energy but the sustainable development of further offshore wind would require a OWF regulatory reform.

- Activities to reduce risks in the regulatory framework include:
    - Streamline the regulatory framework in permitting – such as improving the current coordinating role of central authority/-ies by facilitating project developers in the permitting process and their applications to different authorities.
    - Regulatory uncertainty relates to the completeness of site preparation and the comprehensive outcome/account of environmental and social impact assessment (ESIA). Specific offshore wind farm-related legal requirements for site preparation and for ESIA could assist in de-risking by eliminating the uncertainty perceived by stakeholders.
    - Based on the current procurement regime, for current large-scale projects based on private financing, a significant risk is allocated the private developer in undertaking studies, investigations and the ESIA.

Key Take-aways

1. Offshore Wind in Sri Lanka has significant potential in areas that are reasonably well suited for development.

2. The supply and demand for electricity and specifically offshore wind energy will need to be carefully managed and planned, especially given the grid limitations.

3. Offshore wind will provide a gateway for investment and job creation in Sri Lanka, but will also require commitment and early investment internally to pave the way for later long-term growth. This is especially relevant in establishing a stable supply chain.

4. Short term implementation of offshore wind could be possible within the current regulatory framework but long term, the regulatory framework should be adapted to support lower-cost, large-scale offshore wind.

5. Offshore wind will need to be affordable. This may result in needing to collaborate with neighboring markets also looking to invest in offshore wind.

6. A demonstration project has been identified that fulfils the basic requirements and constraints to move Sri Lanka's offshore wind future forward.

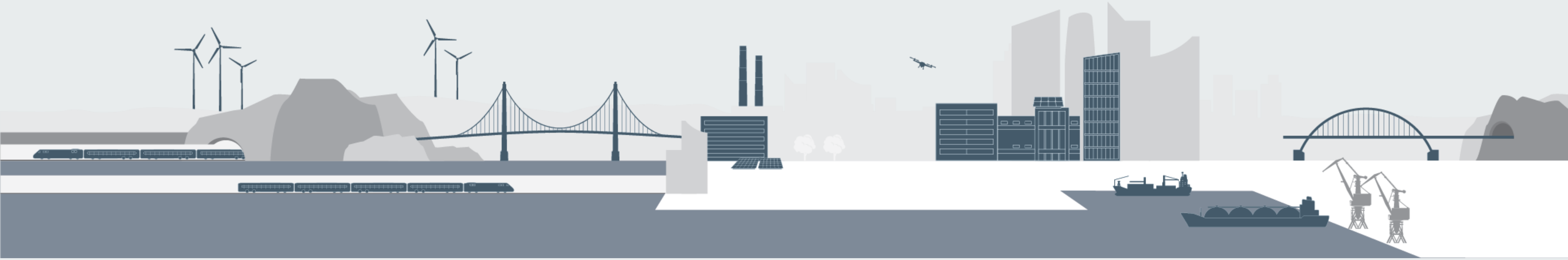
Consultation

- Presentation slides available at www.esmap.org/offshore-wind
- Send written feedback to jvayrynen@worldbank.org and A207380-project@cowi.com by Monday 3rd October
- Some short meetings will be available to discuss, please contact us to find out more
- Meet us at WindEnergy Hamburg – World Bank Group Offshore Wind Study Tour
- Please respond on any points of interest or concern, or address the following:
  - Provide your general views on the main findings of the offshore wind roadmap for Sri Lanka
  - Are there findings that you strongly agree with?
  - Are there findings that you strongly disagree with?
  - Are there any major issues or risks that you do not feel this roadmap has covered?
  - Do you have any other comments?

Thank You!

Credit: AWEA – Block Island OWF

Appendix List



A1.
High Growth Roadmap

A2.
Financial and Economic Analysis

A3.
Environmental and Social Constraints

A4.
Grid Infrastructure

A5.
Port Infrastructure

A6.
Supply Chain

A7.
Summary Recommendations

Project Team

Team lead: Jari Vayrynen
Technical lead: Mark Leybourne

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IFC International Finance Corporation

COWI team details

COWI

Lead consultant, with a global reach in engineering, economics and environmental science

THE BIODIVERSITY CONSULTANCY

Key player in the world of business and biodiversity with a growing global presence

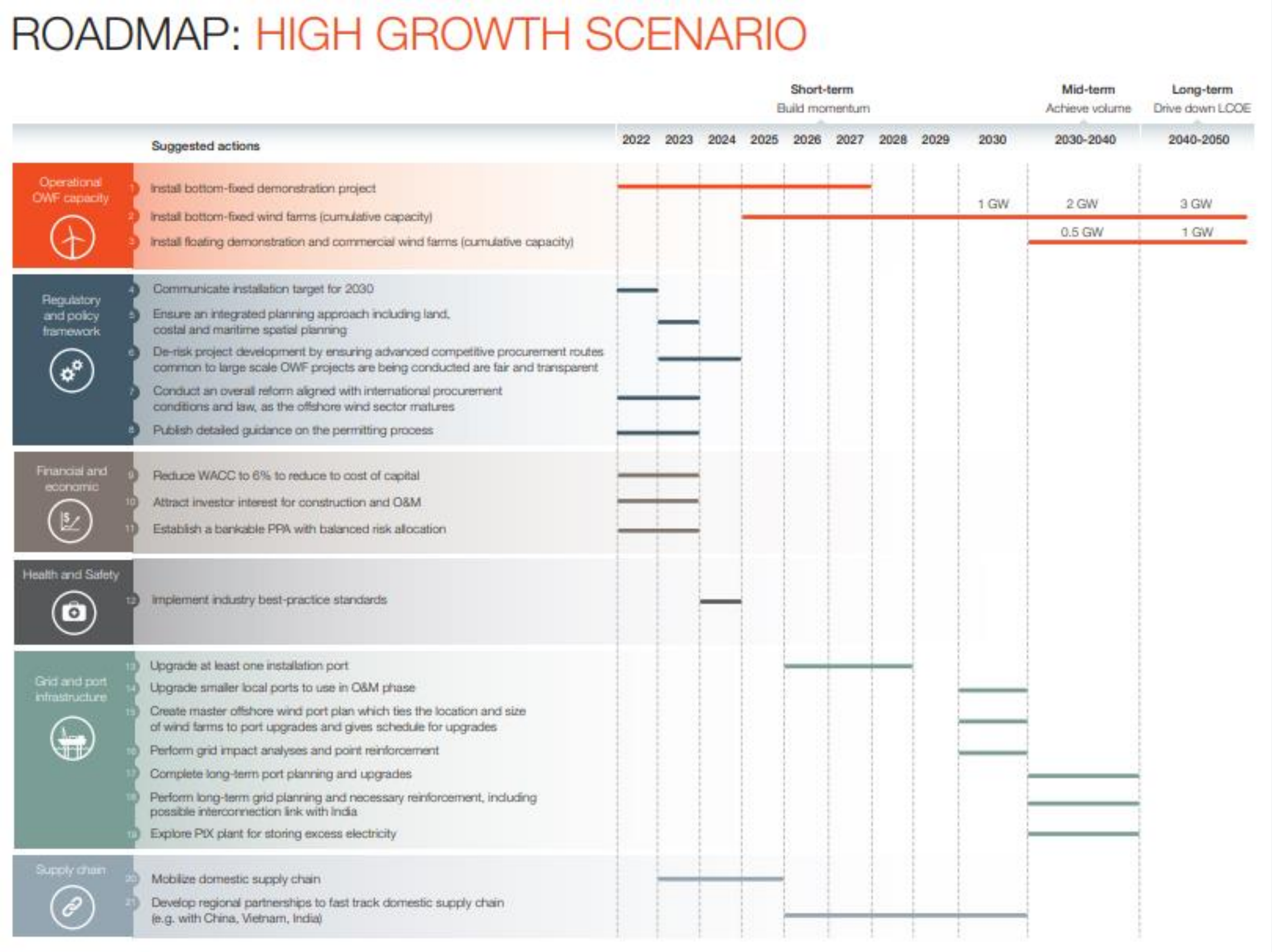
EML Consultants

Technical and Management consultancy company specializing in Sri Lankan energy and environmental sector

LHI Coast and Water

Sri Lankan based Engineering consultancy service company in the coastal and hydraulic area.

A1. High Growth Roadmap



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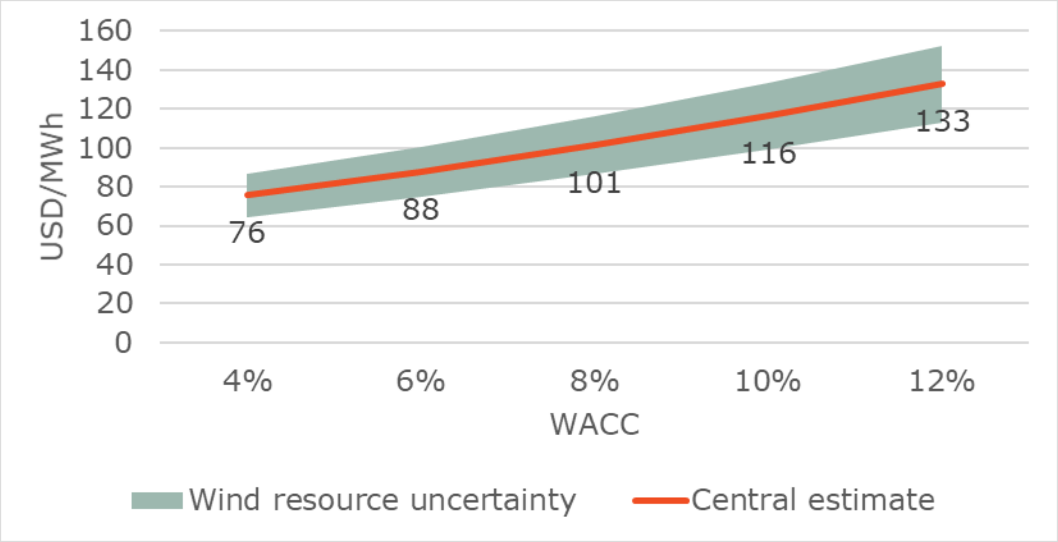
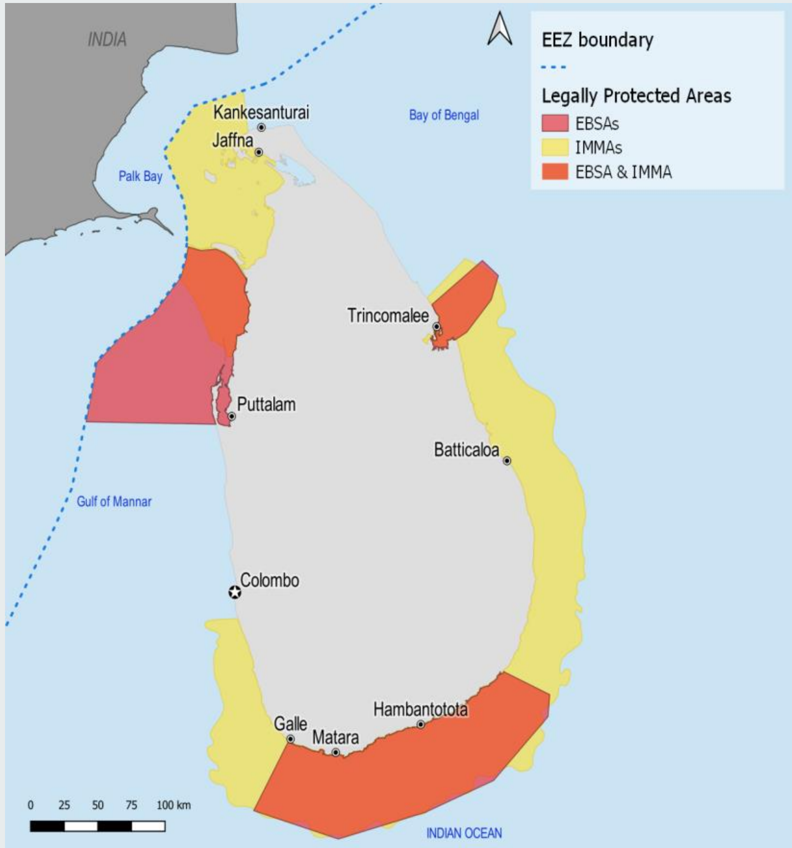
A2. Financial and Economic Analysis

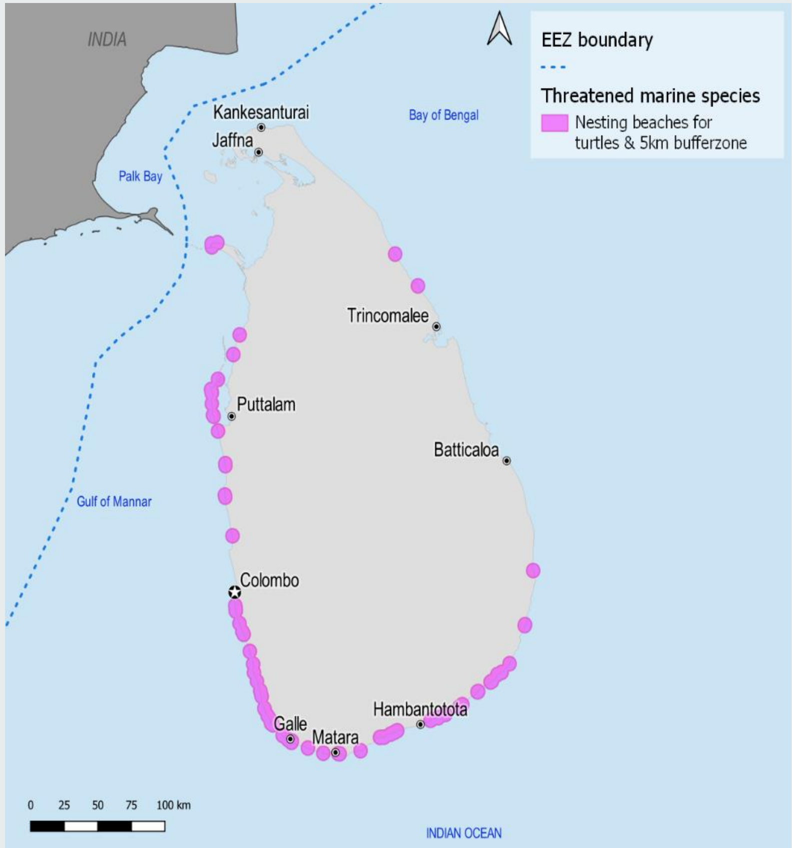
- Input to LCOE estimations are presented in adjacent table.
- Below is the high growth scenario LCOE for the WACC spread of 4-12%. Note LCOE values should always been considered in context of long-term cost and benefit. Assuming aggressive concessional financing, and a WACC of 6 %, the LCOE is expected to be around **88 USD/MWh** and possibly as low as **75 USD/MWh** depending on the wind resource.

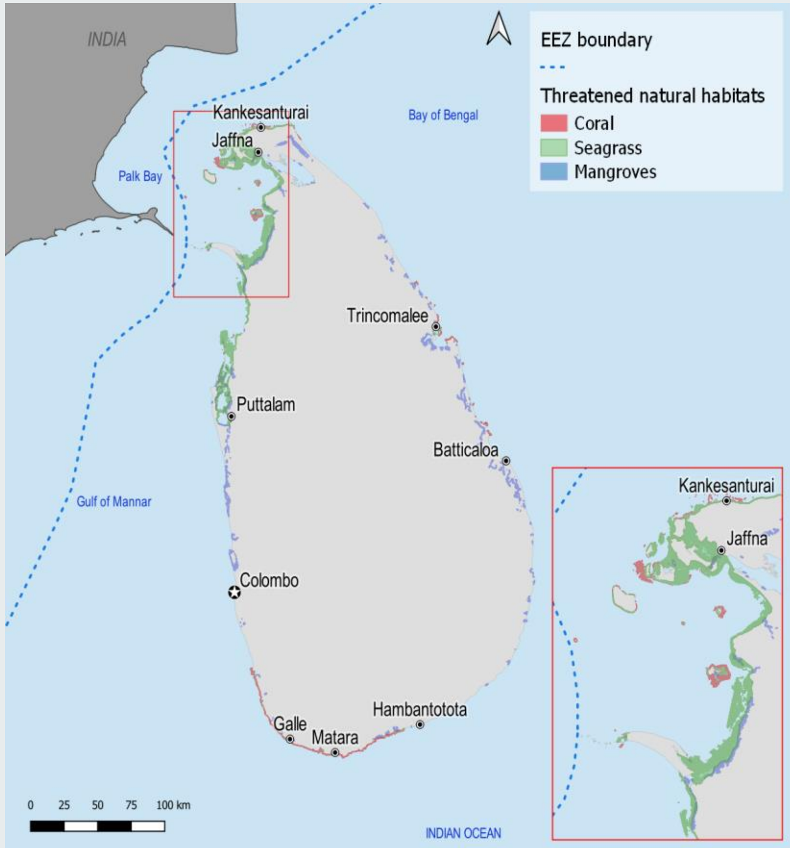


Input	2030 Low growth scenario (0.5 GW)	2030 High growth scenario (1 GW)
CAPEX (USD/MW)	2.5 million	2.5 million
OPEX (USD/MW)	100,000	100,000
Net AEP (GWh/year)	Central: 1,907 High: 2,188 Low: 1,627	Central: 3,821 High: 4,383 Low: 3,259
Technical life (years)	25	25
Weighted Average Cost of Capital (WACC) (%)	4 %-12 %	4 %-12 %

A3. Environmental, Social, and Technical Constraints







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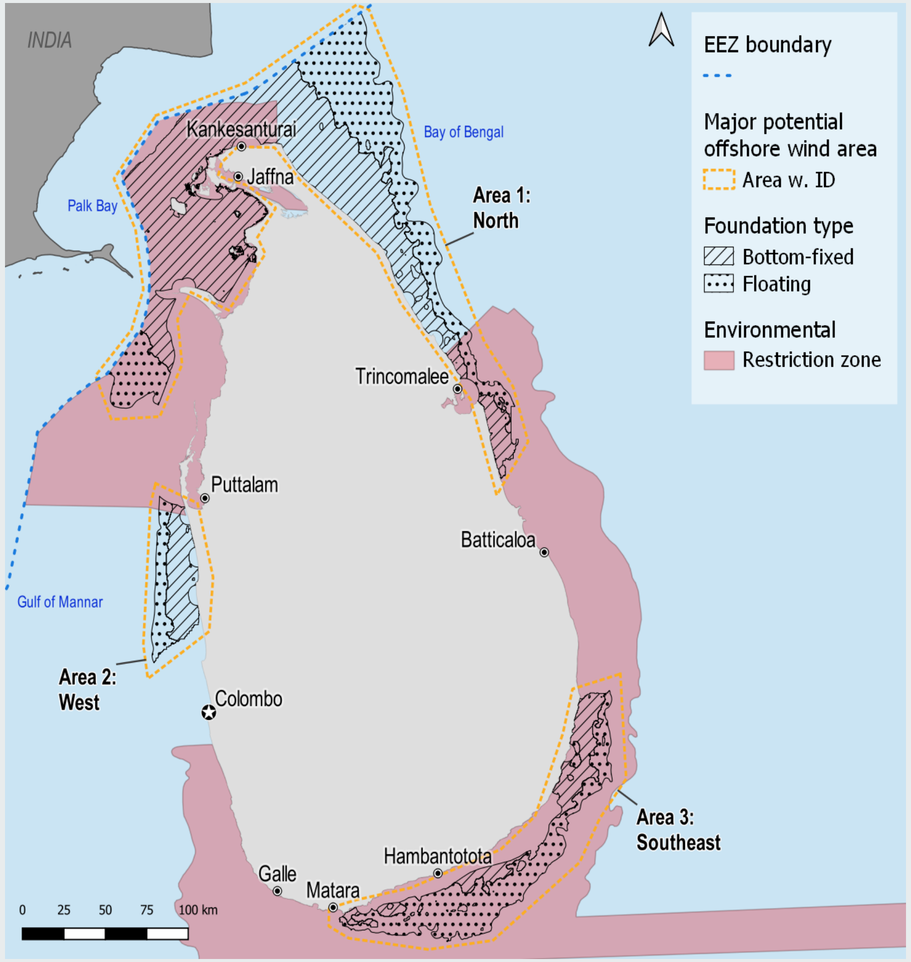
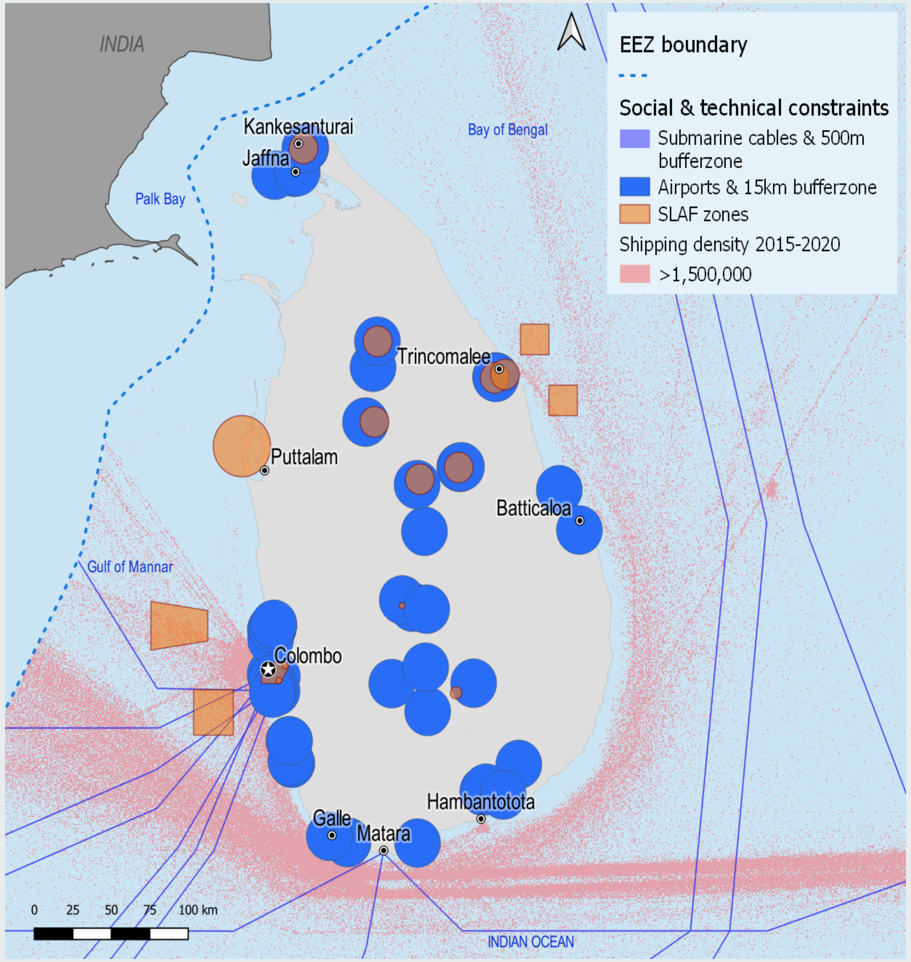
Note: all maps are draft

A3. Environmental, Social, and Technical Constraints





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Offshore Wind Development Roadmap for Sri Lanka

A4. Grid Infrastructure

- Island network with a complex mix of primary energy sources (constant and variable)
- No interconnection with India or other countries for import / export of power.
- Existing energy mix is apr. 48% renewable energy.
- Expansion plans for the transmission system in Sri Lanka up to and beyond the year 2030 are summarised here:

Year	Description of planned upgrades
2022	**Transmission Lines & Underground Cables** Sampoor = New Habarana 2×400 kV transmission line (400 kV operation) 95 km **New Grid Substations** Sampoor 2×500 MVA 400/220 kV **Grid Augmentations** New Habarana 2×800 MVA 400/220 kV
2034 (reference)	**Transmission Lines & Underground Cables** Kirindiwela = Padukka 2×400 kV transmission line (400 kV operation) Padukka = Ambalangoda = Hambantota 2×400 kV transmission line

A5. Port Infrastructure

- The driving infrastructure for offshore wind farms are the ports used for installation of the wind farms.
- Many ports have been completely discounted due to the level of infrastructure upgrades or other practical considerations.
- Colombo and Hambantota are the 2 ports considered with the least amounts of significant upgrades needed and suitable distance to the proposed development areas.
- Ports could also support the construction of projects in southern India

Property	Requirement Range (Minimum to Recommended)	Colombo	Hambantota
Distance to OWF	<200-<400 km	The part of Area 1 south of Adam's bridge is within range. Area 2 is very close: 50 km and 100 km from port. Approximately half of Area 3 is within 200 km.	All of Area 3 is within 200 km, and Area 2 is within 300 km.
Depth at channel entrance	9-12.5 m	OK	OK
Harbour entrance width	200-300 m	OK	OK
Presence of lock/gate	Not acceptable	OK	OK
Vertical clearance	120 m-no restriction	OK	OK
Berth length	200-400 m	OK	OK
Depth at berth	8-12 m	OK	OK
Load capacity	50-100 kN/m^2 (UDL)	Unknown, but likely within required range	Unknown, but likely within required range
Yard area	15-20 hectares	OK, assuming availability	OK, assuming availability
Conclusion		Suitable, with minor upgrades and assuming yard area can be made available	Suitable, with minor upgrades and assuming yard area can be made available

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Offshore Wind Development Roadmap for Sri Lanka

A6. Supply Chain

- Scoring metric used to evaluate supply chain in Sri Lanka:

Track Record and Capacity in Offshore Wind	1	No experience
	2	Experience in supplying wind farm ≤ 100 MW
	3	One company with experience of supplying wind farm > 100 MW
	4	Two or more companies with experience of supplying wind farm > 100 MW
Capability in parallel sectors	1	No relevant parallel sectors
	2	Relevant sectors with relevant workforce only
	3	Companies in parallel sectors that can enter market with high barriers to investment
	4	Companies in parallel sectors that can enter market with low barriers to investment
Benefits of local supply	1	No benefits in supplying projects locally
	2	Some benefits in supplying projects locally but no significant impact on cost or risk
	3	Work for projects can be undertaken from outside country but only with significant increased cost and risk
	4	Work for projects must be undertaken locally
Investment risk	1	Investment that needs market certainty from offshore wind for five or more years
	2	Investment that needs market certainty from offshore wind for two to five years
	3	Low investment ≤ US$50 million that can also meet demand from other small sectors
	4	Low investment ≤ US$50 million that can also meet demand from other major sectors with market confidence
Size of the opportunity for Turkey	1	< 2% of lifetime expenditure
	2	2% ≤ 3.5%
	3	3.5%–5.0%
	4	> 5% of lifetime expenditure

- Supply chain assessment:

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Decommissioning	Access Engineering	1	2	4	4	2

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A7. Summary Recommendations

Vision and volume targets

1. The first step is to provide certainty and clarity to the industry by **communicating clear installation targets in line with the preferred growth scenarios and long-term power planning.** In the short-term (i.e., the period up to 2030), the Sri Lankan government (the Government) will first need to build momentum for the industry. This is best achieved by installing a modest scale, Government supported demonstration project.

2. The Government needs to also consider a mid-term and long-term vision beyond 2030, during which the market will **deploy further commercial bottom-fixed offshore wind farm projects** and achieve the volume required to trigger first economies of scale.

3. As a final step, the Government should consider the potential of floating offshore wind technology and look to deliver **floating offshore wind projects** beyond 2040, this will enable the industry to progressively drive down LCOE.

Regulatory and policy framework

4. The Government **implements integrated spatial planning including land, costal and maritime areas to identify the preferred locations for future offshore wind projects. The spatial planning should include robust baseline studies to ensure proper detailed site selection.**

5. The Government **designs and established competitive procurement routes that are fair and transparent.**

6. The Government **publishes detailed guidance on the permitting process**, including a list of all the permits, authorities, and timelines to be considered. This should also include the important ESIA process following GIIP. Obtaining all relevant permits is typical the task of the developer although the tender specification in the particular case may stipulate a role also for the public in order to de-risk the project.

A7. Summary Recommendations

Financial and economic

7. The Government utilizes a variety of financial tools, such as guarantees or climate finance, in order to **reduce the WACC to 6%.**

8. The Government **pro-actively attracts investor interest for construction and O&M.**

9. The Government **establishes a bankable power purchase agreement (PPA) which fairly allocates risk** between off-taker and developer, including exchange rate risk.

Health and Safety

10. The Government **introduces H&S requirements in alignment with industry best-practice standards.** Establishing widely accepted H&S standards ensures safe procedures during installation and operation.

Supply chain

11. The Government aims at **providing some supply from domestic manufacturing within the period 2025-2030, once first domestic supply has been mobilized.** The development follows a progression from initial partnerships with international suppliers to a more self-sustained domestic supply chain and **develops regional partnerships to fast-track domestic supply chain** (e.g., with China, Vietnam, India). However, it must be noted that developing a local supply chain within Sri Lanka will have a relatively long lead time and will face significant competition especially from India. Consequently, the regional partnerships may turn out to be a key factor for building a focussed local supply chain.

A7. Summary Recommendations

Grid and port infrastructure

12. The Government **enables upgrades for at least one installation port in the same region as the wind farm it serves.** By doing so, it ensures that manufacturing, construction, and installation sites are developed in close alignment with the sites that will benefit from them.

13. The Government further **upgrades smaller local ports to use in O&M phase.** While the initial focus to kick-start, the industry lies in the installation ports, it needs to be closely followed by upgrades to smaller ports for O&M use in order to enhance local job creation as well as ensure a reliable, safe and lasting operation of the wind farms.

14. The Government **completes long-term port planning and upgrades**. A long-term planning can enable the potential joint port usage for floating and bottom-fixed offshore wind.

15. The Government performs **grid impact analyses and completes necessary expansions and point reinforcement.** The government needs to clearly map the locations that will be linked to the OWF sites under development in order to ensure robust points of coupling. A possible interconnection link with India should be explored as well in order to accommodate the utilization of surplus electricity produced.

16. In order to accommodate the larger amounts of offshore wind energy expected beyond 2040, the Government **explores a Power-to-X plant for storing excess electricity**. At this stage it is not possible to determine whether power-to-X technology will be crucial for the outbuild of the two growth scenarios presented. However, in the longer run and in absence of an interconnector with India it may become an important part of the Sri Lankan energy system