WORLD BANK GROUP
OFFSHORE WIND
DEVELOPMENT PROGRAM

THE VAST POTENTIAL OF OFFSHORE WIND IN EMERGING MARKETS

JUNE 2020
Agenda

• Why offshore wind for emerging markets? - Sean Whittaker
• Technical potential in emerging markets – Clara Ivanescu
• WBG Offshore Wind Program support – Mark Leybourne
• Q&A
Why offshore wind for Emerging Markets?
Offshore wind has grown quickly …

New Offshore Wind Installations (GW)

Source: Global Wind Energy Council (GWEC)

Now ~29GW currently operational worldwide
Why? Power at a competitive price …


Source: BloombergNEF. Note: Figures refer to an estimated levelized price, taking into account tariff price and length, inflation, a merchant tail assumption and a 25-year lifetime. Prices above $150/MWh were omitted. The full cost of transmission to shore is included in some but not others.
Why? Clean power with energy security

Source: The Economist
Range of viable wind speeds for an offshore wind farm

Why? Power where you need it with no land constraints
Why? Power even in deep waters ...
But will a rising tide raise all boats?

New installations
GW, offshore

- Other
- China
- North America
- Asia ex China
- Europe

CAGR**
+8.2%

CAGR**
+12.0%

* Chinese installation adjusted to 1.6 GW new installations for 2018, Source: CWEA
** CAGR = Compound Annual Growth Rate
Source: GWEC Market Intelligence Offshore Wind Outlook 2030 (June 2019)
Need for infrastructure:
• Need large ports and staging areas for installation
• Need fleet of installation and service vessels

Need for adapted technology:
• Need typhoon-class turbines for high-risk areas
• Need special foundations for seismic conditions

Need to consider environmental and social:
• Manage impacts on avian and marine fauna
• Active engagement with stakeholders

Need for bankable projects:
• Attract experienced international players
• Reduced risks = reduced prices
Technical Potential in Emerging Markets
## Mapping the Technical Potential

<table>
<thead>
<tr>
<th>Dataset</th>
<th>Value Threshold</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind speed*</td>
<td>&gt; 7 m/s</td>
<td>Wind speeds above 7 m/s are assumed as optimal resources</td>
</tr>
<tr>
<td>Bathymetry</td>
<td>&lt; 50 m</td>
<td>Water depths of 50 m or less for fixed foundation offshore wind projects</td>
</tr>
<tr>
<td>Bathymetry</td>
<td>50 – 1,000 m</td>
<td>Water depths between 50m and 1,000m are considered suitable for floating foundations</td>
</tr>
<tr>
<td>Resulting Areas</td>
<td>&gt; 10 km²</td>
<td>The resulting areas were further filtered by size, with areas covering a minimum of 10 km² considered suitable for the installation of an offshore wind farm</td>
</tr>
</tbody>
</table>
| Technical Potential (in GW installed capacity) | 3MW/km² | The technical potential for each opportunity zone has been computed by assuming:  
  • a density of 3 MW per km² for wind speeds between 7–8 m/s  
  • a density of 4 MW per km² for wind speeds greater than 8 m/s. |

Note: All wind speeds used were annual average wind speeds, taken at 100m elevation from the sea surface – approximately the hub-height of an offshore wind turbine.
Findings – Countries Analyzed

Going Global report

- Brazil
- India
- Morocco
- Philippines
- South Africa
- Sri Lanka
- Turkey
- Vietnam

- Algeria
- Argentina
- Azerbaijan
- Bangladesh
- Bulgaria
- Chile
- China
- Colombia
- Costa Rica
- Djibouti

- Dominican Republic
- Egypt, Arab Rep.
- Eritrea
- Fiji
- Haiti
- Honduras
- Indonesia
- Jamaica
- Kazakhstan
- Kenya
- Lebanon
- Libya
- Madagascar
- Maldives
- Mauritania
- Mexico
- Mozambique
- Myanmar
- Namibia

- Nicaragua
- Pakistan
- Papua New Guinea
- Peru
- Poland
- Romania
- Senegal
- Tanzania
- Tunisia
- Turkmenistan
- Ukraine
- Uruguay
- Vanuatu
- Venezuela, R.B.
- Yemen, Rep.

- Caribbean Islands
- Caspian Sea
- Black Sea

Check out all maps online: https://esmap.org/offshore-wind
What are the opportunities in eight key emerging markets?

<table>
<thead>
<tr>
<th>Country</th>
<th>Fixed (GW)</th>
<th>Floating (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>112</td>
<td>83</td>
</tr>
</tbody>
</table>

Within 200 km of coast
<table>
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<tr>
<th>Country</th>
<th>Fixed (GW)</th>
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<tbody>
<tr>
<td>India</td>
<td>112</td>
<td>83</td>
</tr>
<tr>
<td>Philippines</td>
<td>18</td>
<td>160</td>
</tr>
<tr>
<td>Turkey</td>
<td>12</td>
<td>57</td>
</tr>
<tr>
<td>Vietnam</td>
<td>261</td>
<td>214</td>
</tr>
<tr>
<td>Brazil</td>
<td>480</td>
<td>748</td>
</tr>
<tr>
<td>Morocco</td>
<td>22</td>
<td>178</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>55</td>
<td>37</td>
</tr>
<tr>
<td>S. Africa</td>
<td>57</td>
<td>589</td>
</tr>
</tbody>
</table>

Within 200 km of coast

1,016 GW fixed + 2,066 GW floating = 3,082 GW

Technical potential in eight emerging markets

Visit the report: [https://esmap.org/going_global_offshore_wind](https://esmap.org/going_global_offshore_wind)
What are opportunities in regions?

Offshore Wind Technical Potential in the Caribbean Islands
Fixed: 238 GW || Floating: 513 GW || Total: 751 GW

Offshore Wind Technical Potential in the Black Sea
Fixed: 269 GW || Floating: 166 GW || Total: 435 GW

Offshore Wind Technical Potential in the Caspian Sea
Fixed: 509 GW || Floating: 336 GW || Total: 845 GW
<table>
<thead>
<tr>
<th>Region</th>
<th>Total technical potential</th>
<th>Highlights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>6,343 GW</td>
<td>Highest regional potential, strong wind resource, good proximity to demand centers</td>
</tr>
<tr>
<td>Europe &amp; Central Asia</td>
<td>1,192 GW</td>
<td>Favorable conditions in the Black Sea and the Caspian Sea which could become regional markets</td>
</tr>
<tr>
<td>East Asia Pacific</td>
<td>4,369 GW</td>
<td>Strong offshore wind resource, China has the largest potential of any country</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>2,260 GW</td>
<td>Strong potential primarily in floating wind due to relatively deep waters off the southern coast</td>
</tr>
<tr>
<td>Middle East &amp; North Africa</td>
<td>1,145 GW</td>
<td>Moderate resource in Northern Africa, primarily in floating wind</td>
</tr>
<tr>
<td>South Asia</td>
<td>306 GW</td>
<td>Some good but limited resources, primarily in fixed foundation offshore wind</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15,615 GW</strong></td>
<td></td>
</tr>
</tbody>
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Check out all maps online: [https://esmap.org/offshore-wind](https://esmap.org/offshore-wind)
What are opportunities in regions?

- Offshore Wind Technical Potential in the ECA Region
  - Fixed: 6.47 TW || Floating: 12.3 TW || Total: 19.04 TW

- Offshore Wind Technical Potential in the LAC Region
  - Fixed: 7.3 TW || Floating: 15.2 TW || Total: 22.3 TW

- Offshore Wind Technical Potential in the SA Region
  - Fixed: 187.4 GW || Floating: 120.1 GW || Total: 307.5 GW

- Offshore Wind Technical Potential in the EAP Region
  - Fixed: 3.04 TW || Floating: 9.57 TW || Total: 12.61 TW

- Offshore Wind Technical Potential in the MENA Region
  - Fixed: 0.47 TW || Floating: 1.78 TW || Total: 2.25 TW

Soon on ENERGYDATA.INFO
Next steps: assessing country-level hard and soft constraints

- **Hard Constraints**:
  - Major commercial shipping routes, oil and gas platforms, cable and pipeline infrastructure, protected wrecks, radar proximity, etc.
  - Fishing activities, disposal sites, marinas and bathing beaches, tourism spots, sites of cultural/religious importance, indigenous communities, etc.
  - Coastal and marine protected areas, bird migration routes, key biodiversity areas, sensitive habitats etc.
  - Electrical transmission grid, location of power plants, location of ports, natural hazard risks, etc.

- **Soft Constraints**:
  - Social
  - Environmental
  - Planning
Where to find our analysis and data?

- **Going Global report**: ESMAP Website [https://esmap.org-going_global_offshore_wind](https://esmap.org-going_global_offshore_wind)
- **Maps for 48 emerging markets**: ESMAP Website [https://esmap.org/offshore-wind](https://esmap.org/offshore-wind)
- **Global Layers (.shp format):**
  1. [ENERGYDATA.INFO](http://energydata.info/)
  2. [DDH](https://datacatalog.worldbank.org/) ¹

¹ soon – pending approval from Cartography Unit
WBG Offshore Wind Program Support
Accelerating the uptake of offshore wind in emerging markets

Led by

Energy Sector Management Assistance Program
Partnership between the World Bank and 18 partners to help low and middle-income countries reduce poverty and boost growth through sustainable energy solutions.

In partnership with

International Finance Corporation
Largest development financial institution focused exclusively on the private sector in emerging markets.
Objective:
• Support the inclusion of offshore wind into policies
• Help establish a pipeline of bankable projects
• Five year program; budget ~$US 10 million
• Collaboration with Global Wind Energy Council (GWEC)

Program components:
1. Knowledge generation, dissemination and exchange
2. Roadmap studies and technical assistance
3. Investment plan preparation
Typical Activities Supported by the Program

Global Work

Knowledge generation, dissemination and exchange:
• Reports on good practice, lessons learned and opportunities for emerging markets
• Mapping to identify and quantify offshore wind development potential
• Events, workshops and training to inform, educate and gather country support

Country Specific Work

Exploratory country studies and planning work:
• Provide funding for roadmaps, planning and pre-feasibility level activities
• Demand-led, focus on countries with potential for bankable projects within 3-4 years

Preparation of investment plans:
• Assistance in scoping and funding detailed feasibility & site investigation work
• Draw on Good Practices for technical, E&S, procurement
Typical Country Activities Supported by the Program

Activities that can be supported by the program

- Initial Workshop
- Roadmap
- Client Government Request for Support

Market Development Activities
- Policy & Regulatory Studies
- Market Strategy Advice
- Marine Spatial Planning
- Grid Integration Analysis
- Port & Infrastructure Assessment
- Supply Chain & Economic Analysis

Project Development Activities
- Site Characterization Surveys
- Wind Speed Measurements
- Environmental & Social Assessments
- Stakeholder Engagement
- Tender Design & Management
- Capacity Building & Technical Advisory

Financing for Projects and Infra

- **World Bank**: Public Sector Lending (grid, shared infrastructure etc.)
- **IFC**: Private Sector Lending (offshore wind projects, ports, supply chain etc.)

**Activities**

- **Initial Workshop**
- **Roadmap**
- **Client Government Request for Support**

**Market Development Activities**

- Policy & Regulatory Studies
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**Financing**

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Vietnam: Engaged BVG in February 2020 to undertake roadmap. Initial roadmap drafted for focused consultation

Sri Lanka: Roadmap to be launched in Summer 2020. Highly engaged; focus on Gulf of Mannar – possible link to India grid interconnection

Turkey: Roadmap to be launched in Summer 2020. Focus on economic analysis, regulatory gap analysis, E&S risks.

Azerbaijan: Roadmap under discussion with Government. Roadmap launch anticipated in mid-2020

Brazil: Stakeholder workshop event postponed due to COVID-19. Continued engagement with EPE on possible support options

Colombia: Discussions with government; exploring potential in Caribbean Sea

India: Continuing dialogue with MNRE & SECI. Exploring interest in Tamil Nadu demonstration project.

• **Training: Virtual study tour – September 2020:**
  – Three day event with virtual tours around offshore wind supply chain firms, seminars on key development topics, Q&A sessions with experts – organized by GWEC

• **Training: Offshore Wind MOOC (Massive Open Online Course):**
  – Online training course covering a wide range of topics relevant to offshore wind development

• **Report: Key Factors for the Successful Development of OW**
  – Flagship report to capture important lessons learnt, good practice and relevant recommendations for government and stakeholders

• **Report: Environmental & Social Frameworks:**
  – Support the planning and siting of offshore projects with lower environmental & social risks to help ensure bankability and uptake of good practice

• **Tool: REZoning geospatial planning tool for renewable energy:**
  – Online geospatial planning tool incorporating constraints and economic analysis to identify and prioritize potential development zones

• **Report: Large-scale green hydrogen and offshore wind:**
  – Report analyzing the main design considerations when incorporating green hydrogen production into offshore wind projects
Concluding thoughts

- Offshore wind is growing quickly and needs to move to emerging markets soon
- Huge technical potential and opportunity is bigger than expected
- WBG Program’s activities focused on accelerating this over the next few years
Questions?

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Mark Leybourne, Senior Energy Specialist, ESMAP, World Bank
Clara Ivanescu, Geographer, World Bank
Oliver Knight, Senior Energy Specialist, World Bank
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