Transportens Innovationsnetværk
Medfinansieres af Uddannelses-og Forskningsministeriet

Continuation of PhD Reference Group

Initial meeting to inaugurate the new version of the network

”Wind Logistics Group” (**WLG**)

After work / ”gå-hjem” meeting presentation by Thomas Poulsen
May 6, 2019
Stilling, Denmark

Expansion of offshore wind industry

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- Primarily driven by...
  - Decarbonisation / climate change
  - Cost competitiveness against conventional power technology sources
- Manifested through...
  - **Globalization** of offshore wind markets
- Attracting new players, therefore...
  - increasing competition, which has encouraged...
  - ...falling government support – feed-in tariffs to auctions to zero subsidy
- With cost...
  - ...still being a crucial factor, hence, driving the need to...
    - ✓ Understand **offshore wind logistics** as a separate cost discipline and therefore a candidate for *levelised cost of energy* reduction
    - ✓ Employ **digitalization** as a tool to reduce costs

Source: Panticon, 2019

Taking us to today's 3 main topics:

- Globalization
- Logistics
- Digitalization

} in offshore wind

Source: Panticon, 2019

1. Globalization

Globalization of offshore wind markets

- From Northern Europe to...
  - Rest of Europe
  - Asia
  - Americas

Source: Panticon, 2019

Globalization of offshore wind markets | Drivers | 1

- **Political resolve**:
  - Many emerging offshore wind market countries have announced ambitious offshore wind capacity targets
    - ✓ China is ahead of the pack, with overall provincial targets of up to 93 GW
    - ✓ Taiwan (5.5 GW by 2025) and the USA (up to 12 GW aggregate state level targets by 2030) follow
    - ✓ Japan, South Korea, & India, also bringing their offshore wind policies up to speed with ambitious targets
- **Good offshore wind resources and long coastlines**:
  - The emerging offshore wind markets have good to excellent offshore wind resource, averaging above seven metres per second
  - They also rank among countries with the longest coastlines in the world
  - Some, e.g. Brazil, have coastlines with a shallow continental shelf
- **Conventional power plants reaching end of lifecycle**:
  - Coal power plants (Australia, India, and the USA) as well as nuclear power plants (Australia and the USA) are nearing the end of their lifecycles
    - ✓ Besides environmental costs, replacing them is not as economical as new build renewable energy power plants
  - Meanwhile, large hydro in countries like China and Vietnam has peaked
    - ✓ In January 2019, **China Three Gorges**, citing various factors including high local costs and limited domestic hydro (river) resources, announced it will no longer develop more hydro power in China but rather focus on offshore wind.
- **Post-Fukushima disaster opposition to nuclear power**:
  - There is continued public backlash against power generation from nuclear following the Fukushima disaster in 2011

Source: Panticon, 2019

Globalization of offshore wind markets | Drivers | 2

- **Proximity to population centres**:
  - Offshore wind resources, unlike other renewable energy resources, are typically located close to densely populated coastal cities, thereby reducing investment costs in long transmission lines
- **Growing power demand:**
  - Population growth, urbanization, and industrialization are driving electricity demand, especially in developing countries (e.g., India and Vietnam) which are expanding their status as global centres for outsourcing manufacturing
  - In developed countries such as the USA, there is increasing demand for renewable energy power from corporations such as **BMW**, **Microsoft**, **Google**, **Apple**, **Facebook**, and **IKEA**.
    - ✓ This trend, epitomised by increased focus on *Environmental, Social and Governance* (ESG), is expected to expand globally, and encompass offshore wind eventually, thanks to the globalised supply chains of these corporations.
    - ✓ In February 2019, **IKEA** acquired a 25% stake in Germany's second largest offshore wind farm, the 402 MW Veja Mate
- **Limited land for onshore wind power and solar power development**:
  - Renewable energy technologies currently more cost competitive than offshore wind, namely onshore wind and solar, are competing for land in the typically densely populated emerging offshore wind markets.
  - Where the land is available, the population densities are low and hence the need for further investment in transmission infrastructure.

Source: Panticon, 2019

Globalization of offshore wind markets | Drivers | 3

- **Employment and offshore wind supply chain hubs**:
  - Governments in emerging offshore wind markets, most of which face either youth unemployment or dying industries in coastal areas, see employment creation opportunities in offshore wind development.
  - These emerging markets are also seeking to position themselves as supply chain hubs in an industry that is about to become truly global
  - After years of trying to develop offshore wind with exclusive local players, developers and owners, esp. state-owned (China, South Korea), have acknowledged the complexity and are now opening up to collaboration with experienced European players.

- **Deteriorating air quality**:
  - Many of the emerging offshore wind market countries face rapidly deteriorating air quality which is largely driven by fossil (mainly coal) fuel power generation.
    - According to **IQAir AirVisual** and **Greenpeace**'s *2018 World Air Quality Report*'s ranking of the most polluted capital cities in the world, Delhi (India), Dhaka (Bangladesh), Beijing (China), and Hanoi (Vietnam), ranked first, second, eighth and 12th, respectively. India and China have 22 and five, respectively, of the 30 most polluted cities globally.
- **Energy independence and security**:
  - Most of the emerging offshore wind markets are poor in fossil fuel resources and are therefore major importers of coal, oil, gas or uranium.
    - This is true for China, India, Japan, South Korea, and Vietnam.

Source: Panticon, 2019

Globalization of offshore wind markets | Drivers | 4

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- **Industry diversification and synergies:**
  - Many of the emerging offshore wind markets host major industries seeking opportunities to diversify because of downturns in this decade.
    - ✓ These industries, from offshore oil and gas in Brazil and the USA to shipbuilding in China, South Korea, and Vietnam, provide synergies with the globalising offshore wind industry
  - Most of the emerging offshore wind markets have an existing onshore market and supply chain bases that already host European suppliers
  - As part of the global energy transition, a number of global oil and gas corporations have entered the offshore wind space as developers or asset owners and are seeking growth in emerging markets
    - ✓ This trend includes state-owned companies in emerging markets (China, South Korea, Taiwan) which are diversifying into offshore wind

- **Cost competitiveness**:
  - Emerging offshore wind markets have been encouraged by the declining *levelized cost of energy* of offshore wind in the North Sea and the Baltic Sea
    - Offshore wind is increasingly becoming cost competitive against conventional power generation sources
    - Offshore wind is nearing levels where no government subsidies are required
    - In the densely-populated North East US states, power prices from conventional sources are higher

Source: Panticon, 2019

Globalization of offshore wind markets | Challenges | 1

- **Cultural differences**:
  - European players aiming to conquer the emerging markets are faced with cultural differences at business level as well as at the political level
- **Political uncertainty**:
  - The political divide in some emerging offshore wind markets, such as Australia, South Korea, and the USA, has contributed to a lack of policy consistency and hence little progress on previously announced ambitious offshore wind targets or plans
    - ✓ As recent as November 2018, local elections cast doubt in the otherwise well progressing Taiwan offshore wind market
    - ✓ In addition, powerful nuclear and coal lobbies in countries such as South Korea and the USA have contributed to slower offshore wind policy development
  - Meanwhile, general political and economic crises, e.g. in Brazil, have meant that renewable energy policy has not been prioritised
- **Declining electricity demand**:
  - In some of the emerging offshore wind markets, growing manufacturing costs (e.g., China) and slowing economic growth (e.g., South Korea) threaten offshore wind development
- **Regulatory hurdles**:
  - A lack of policy realignment across various local stakeholders has been a major hindrance in countries such as Japan and South Korea
  - Brazil, with maritime territory under federal ownership, still lacks a corresponding regulatory framework to lease offshore areas for offshore wind
  - Though the USA, with similar maritime law architecture as Brazil, has leased zones for offshore wind development, much of the current momentum is driven at state level rather than at Federal level

Source: Panticon, 2019

Globalization of offshore wind markets | Challenges | 2

- **Preference for other renewable energy technologies**:
  - All the leading emerging offshore wind markets have, on average, more cost competitive onshore wind and solar than offshore wind
  - Others, e.g. Australia and Brazil, have abundant uninhabited areas for, e.g., solar power development.
  - At the same time, hydro power import opportunities exist in the north of the USA, from Canada.
- **Fossil fuel dependence**:
  - The leading emerging offshore wind markets count among the major global consumers of fossil fuel power generation. Using coal as an example, the dependence goes beyond power generation to employment as well as sustaining other industries such as the railway industry. At the same time, banks, which financed the newest power plants, are keen to maintain the status quo.
- **Other low carbon energy sources**:
  - Asia is driving the growing demand for liquefied natural gas (LNG) and major energy exporters (Russia, Saudi Arabia, and the USA) are aggressively courting the region
    - ✓ Japan is the number one global importer of LNG
    - ✓ India and China will lead the global growth in LNG imports up to 2030
    - ✓ Thailand became an LNG importer in 2011 and imports have grown ever since.
    - ✓ Vietnam state companies are investing in LNG infrastructure for gas power plants planned for early 2020s
- **Project financing**:
  - For developing countries, e.g. India and Vietnam, where the ambition is present, the business climate to attract project financing from abroad is lacking.
    - ✓ These countries are unlike the European countries that had the local financial support to kick-start offshore wind development or China whose state-owned enterprises have driven the offshore wind development

Source: Panticon, 2019

Globalization of offshore wind markets | Challenges | 3

- **Grid issues**:
  - The emerging offshore wind markets face the challenge of either upgrading or expanding their existing grid infrastructure to accommodate renewable energy
    - ✓ Development of energy storage technology will help accelerate offshore wind development in these new markets
  - Anti-renewable energy constituents use renewables' intermittency as a strong political argument
- **Inadequate port infrastructure**:
  - Compared to the announced offshore wind targets, the emerging offshore wind markets' port infrastructure is insufficient to support construction of offshore wind farms
- **Competing interests for the seas**:
  - The national navy and fishing groups, among other key stakeholders, have expressed concerns over the impact of turbines on their operations.
- **Water depth and seabed conditions**:
  - Identified offshore wind sites in most parts of Asia are characterised by extensive layers of weak clay and loose sands (India) or soft and muddy seabed (South Korea), making it difficult for vessels to jack up
  - Moreover, compared to Europe, most planned OWF projects are in deeper waters (e.g., Japan, South Korea, US West Coast) at comparable offshore distances and therefore only suitable for floating offshore wind

Source: Panticon, 2019

Globalization of offshore wind markets | Challenges | 4

- **Challenging weather conditions**:
  - Offshore wind resources in most parts of Asia are in a typhoon-prone zones, conditions starkly different and more challenging than the North Sea and Baltic Sea where most of the offshore wind capacity is currently installed.
- **Local content requirements (LCR):**
  - Governments are keen on localizing the offshore wind supply chain, via direct (e.g., Taiwan) or indirect (e.g., the USA) local content requirements, whilst reducing state incentives to support offshore wind diffusion

- **Limited offshore wind supply chain**:
  - Besides China, the emerging offshore wind markets have very limited offshore wind supply chains
  - Though some have industries with synergy potential, seen in the light of the announced targets, they have a steep learning curve to reach European levels.
  - Compounding such efforts are, for example, Taiwan's prohibition of Chinese companies, which are geographically closer to Taiwan than European companies, to work on infrastructure projects
  - For vessels, the US' *Merchant Marine Act of 1920* (the *Jones Act*) is an example of a key challenge
    - ✓ Meanwhile, as offshore turbine capacity size transitions into the 10-12MW range and demand in Europe continues to grow, next generation vessels will be a major bottleneck

Source: Panticon, 2019

2. Logistics

Logistics in offshore wind

- **<u>Offshore wind logistics</u>** proposed to be a separate cost discipline and therefore a candidate for *levelized cost of energy* reduction
  - Opportunities
  - Challenges
  - Across offshore wind farm life-cycles
  - Reducing LCoE

Source: Poulsen, 2018

Offshore wind life-cycle phases and logistics

Offshore Wind Farm life-cycle phases:	**Development & Consent (D&C)**		**Installation & Commissioning (I&C)**		**Operations & Maintenance (O&M)**		**De-commissioning (De-comm)**	
Supply chains:	**D&C chain**		**I&C chain - Inbound**	**I&C chain - Outbound**	**O&M scheduled**	**O&M unscheduled**	**De-comm chain**	
LCoE	= **Development expenditure (DevEx)**	+	**Capital expenditure (CapEx)**	+	**Operational expenditure (OpEx)**	+	**Abandonment Expenditure (AbEx)**	
Phase share* of LCoE:	**2.4%**		**46.8%**		**44.8%**		**6.0%**	
Logistics	✓ (N/A)		✓ (23%)		✓ (25%)		✓ (N/A)	

***1GW OWF with 10MW WTGs coming online in 2020 in Northern Europe with 30 years lifespan**

Source: Poulsen & Hasager, 2016
Poulsen, Jensen & Hasager, 2017
Poulsen, 2018

3. Digitalization

Digitalization in offshore wind

- Use of operations data effectively to further cut the LCoE and extend the life of wind assets (components)
  - Cloud computing
  - The internet of things (IoT)
  - Big data analytics
  - Blockchain
- Drivers
  - Cost reduction strategy increasingly employed in other energy technologies, competitors with wind technology, including offshore
  - CapEx reduction efforts nearly exhausted thereby increasing focus on OpEx
  - Expanding focus from wind turbine data (output and revenue) and workforce management to focusing on entire grid ecosystem
- Challenges
  - Requires open communication between owner/operators, OEMs and suppliers
  - Engineering-led datasets typically more reliable and provide an in-depth view of the condition of critical components… but costly to gather
  - Cyber security threats

Source: Panticon, 2019

Digitalization in offshore wind

Offshore Wind Farm life-cycle phases:	Development & Consent (D&C)	Installation & Commissioning (I&C)	Operations & Maintenance (O&M)	De-commissioning (De-comm)
Supply chains:	D&C chain	I&C chain - Inbound / I&C chain - Outbound	O&M scheduled / O&M unscheduled	De-comm chain
LCoE =	Development expenditure (DevEx) +	Capital expenditure (CapEx) +	Operational expenditure (OpEx) +	Abandonment Expenditure (AbEx)

Digitalization in offshore wind…

- Facilitates optimization of use of assets, particularly turbine components which have a shorter lifespan than the turbine and breakdown frequently, e.g. bearings
- This way, the lifespan of an offshore wind farm can be prolonged
- Investors gain confidence buying more assets

Source: Panticon, 2019

Cost savings from digitalization for…

- Wind farm owners/operators

  (estimated to potentially recover up to 13% of an asset's revenue)

  - Logistics costs, e.g., less unscheduled O&M
  - Investment companies willingness to invest, e.g. Pension funds
  - Project management costs reduced across all life-cycle phases
  - Insurance costs

Source: Panticon, 2019

Conclusion

Today's key take-aways were

1. Offshore markets are expanding globally – exponential expansion expected in decade up to 2030
   - Rapid expansion in Asia-Pacific and the Americas with China taking the lead
   - The mature markets of the North Sea and Baltic Sea regions continue to evolve and add volume
   - Other parts of Europe are being added as well
2. Falling subsidies, new industry entrants (competitors), and competiton from other technologies to intensify pressure to reduce levelized cost of energy
3. Increased focus to reduce costs at O&M life-cycle phase
4. Logistics costs (make up at least 18% of levelized cost of energy) crucial in reducing levelized cost of energy
5. Digitalization is an underutilized frontier with a promise and potential to create efficiencies, ensuing cost savings, and help enhance asset predictability

Thank you!

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Questions and answers!

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