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5th SINRENOVA Wind Power Offshore

November 2020



Panelists



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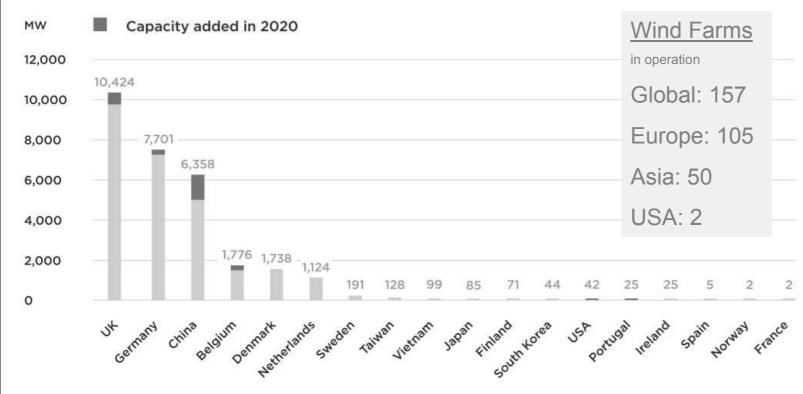
Offshore Wind Energy in Brazil – The Next Big Market?





Offshore Wind Energy in Brazil – The Next Big Market?

Global Operational Capacity Close to 30 GW - by country



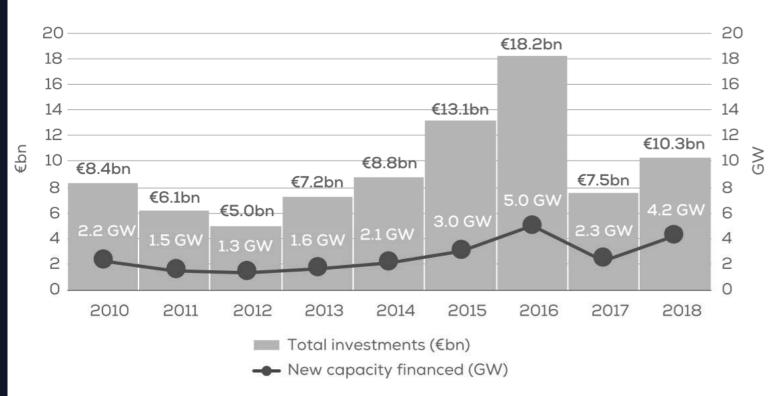
- 1st Half of 2020: 29.839 MW
- Global: > 8 GW under construction
- Northern Europe biggest market (installed capacity)
- China: 4,6 GW under construction (August 2020)



Notes: In operation = all turbines installed and first electricity being generated (cumulative illustration), GW = Gigawatt, MW = Megawatt Source: WFO (2020): https://wfo-global.org/; 27.10.2020

Offshore Wind Energy Investments - Europe

New asset finance in offshore wind energy, 2010 - 2018



- The global weighted-average LCOE 2019: US\$ 0,115/kWh
- Auction and tender results suggest that from 2023: US\$ 0,05/kWh - US\$ 0,10/kWh
- "This can be achieved even in relatively new markets"

Source: IRENA (2020) https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jun/IRENA_Po wer_Generation_Costs_2019.pdf; 07.11.2020



Notes: In operation = all turbines installed and first electricity being generated (cumulative illustration), GW = Gigawatt, MW = Megawatt

Source: WindEuope (2019): https://windeurope.org/wp-content/uploads/files/about-wind/reports/Financing-and-Investment-Trends-2018.pdf; 31.07.2019

Offshore Wind Farms – German Tenders

Zero Cent (incentives) proposals in the German offshore tenders

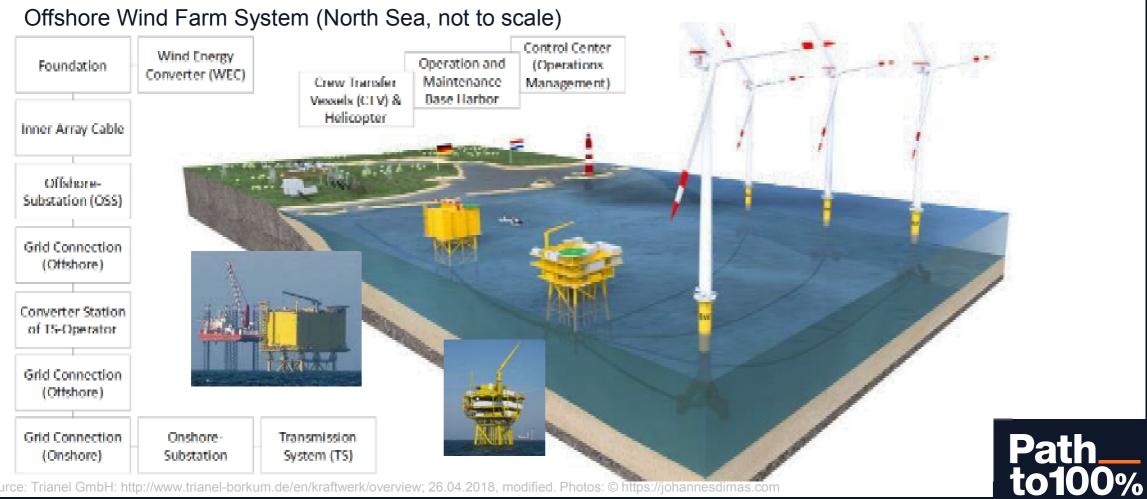
Project (Nort Sea)	Tender	Bidder	Capacity	Commissioning	Awarded
Kaskasi II	2018	Innogy	325,00 MW	2022	unbekannt
OWP West	2017	Ørsted	240,00 MW	2024	0,00 ct/kWh
Borkum Riffgrund West 2	2017	Ørsted	240,00 MW	2024	0,00 ct/kWh
Gode Wind 3	2017	Ørsted	110,00 MW	2024	6,00 ct/kWh
Borkum Riffgrund West 1	2018	Ørsted	420,00 MW	2024/2025	0,00 ct/kWh
Gode Wind 4	2018	Ørsted	131,75 MW	2024/2025	9,83 ct/kWh
EnBW He Dreiht	2017	EnBW	900,00 MW	2025	0,00 ct/kWh

Project (Baltic Sea)	Tender	Bidder	Capacity	Commissioning	Awarded
Arcadis Ost 1	2018	Parkwind NV	247,25 MW	2021	unbekannt
Wikinger Süd	2018	Iberdrola	10,00 MW	2022	0,00 ct/kWh
Baltic Eagle	2018	Iberdrola	476,00 MW	2022/2023	6,46 ct/kWh

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Source: WindGuard (2019): https://www.windguard.de/jahr-2018.html?file=files/cto_layout/img/unternehmen/windenergiestatistik/2018/Status%20des%20Offshore-Windenergieausbaus%20in%20Deutschland%2C%20Gesamtjahr%202018.pdf, 23.02.2019, modified by https://johannesdimas.com

Offshore Wind Farms – A Brief Introduction



Source: Trianel GmbH: http://www.trianel-borkum.de/en/kraftwerk/overview; 26.04.2018, modified. Photos: © https://johannesdimas.com

Offshore Wind Farms – Construction

Turbine construction offshore wind park Trianel Borkum 1 (TWB I), German Bight







Source: © https://johannesdimas.com

Offshore Wind Farms – Substructure Types

Substructure Types (not to scale)



Source: Right: Stiftung OFFSHORE-WINDENERGIE: https://www.offshore-stiftung.de/sites/offshorelink.de/files/mediaimages/Fundamentarten%20von%20Offshore-Windenergieanlagen.jpg; 01.08.2019, modified.

Left: Northland Deutsche Bucht GmbH: https://www.owf-deutsche-bucht.de/Pilot-Project/default.aspx; 31.07.2019, modified



Offshore Wind Farms – Substructures

Turbine construction and installation offshore wind park Trianel Borkum 1 (TWB I), German Bight



Source: @ https://johannesdimas.com

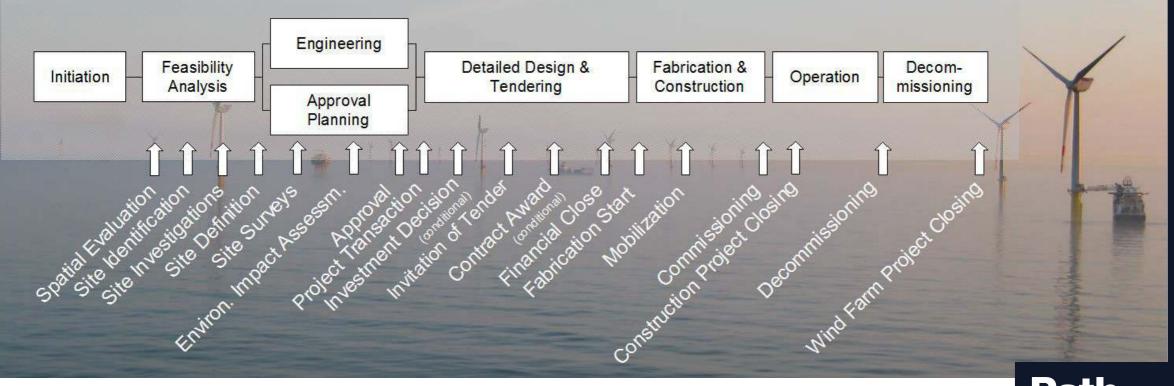
Source bubble curtain: Trianel GmbH: http://www.trianel-borkum.de/en/kraftwerk/overview, 24.04.2018





Offshore Wind Farms – Project Phases

Project Phases and Milestones (here: open door policy)

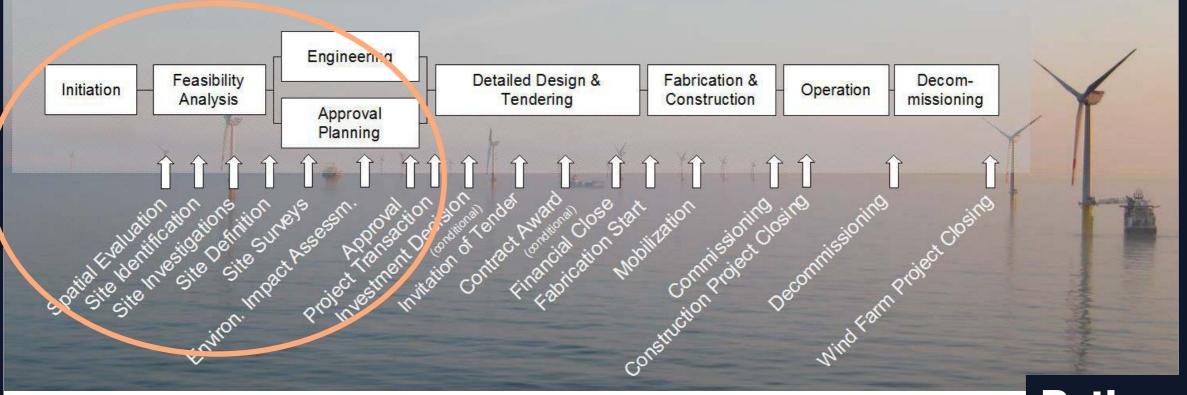




Background: Construction and Commissioning Trianel Offshore Wind Park Borkum I. © https://johannesdimas.com

Offshore Wind Farms – Project Phases

Project Phases and Milestones (here: open door policy)





Background: Construction and Commissioning Trianel Offshore Wind Park Borkum I. © https://johannesdimas.com

Why Offshore?

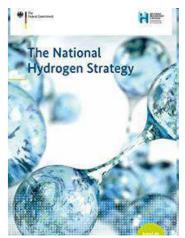
- Outstanding wind conditions
 - Energy yield increases with the wind force cubic ($n^3 \rightarrow 2 \times 2 \times 2=8$)
 - Wind profile is more suitable regarding a uniform flow (less wear and tear)
- Spatial aspects
 - Space constraints
 - Cities at coastline
- Incentives
 - Incentive schemes are highly relevant up to market maturation
 - But: Zero Cent proposals in the German offshore tenders for projects commissioning after 2022



Why Offshore?

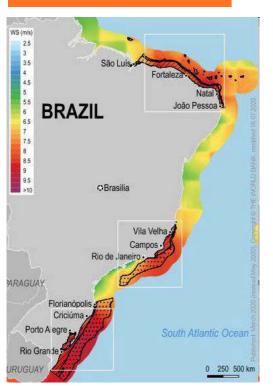
- Politics
 - Climate objectives: Reducing carbon footprint, precondition for electro-mobility, green H2-economy
 - Location factors: Strengthen innovation, attract investments, employment creation
 - Energy independency
- Market Player
 - Developer: Alternative investment targets to substitute obsolete business models
 - **Manufacturer and supplier:** Emerging business opportunities and a long-term development perspective
 - **Equity capital:** (Institutional) investors and big utilities searching for large scale direct investment targets (current interest rates are low, growth strategies, decarbonisation of own energy asset portfolio)
 - Debt capital: Billion Euro projects attracting banks in a difficult market environment. Successful risk reduction.







Why in Brazil?



Map: World Bank Group (2020):

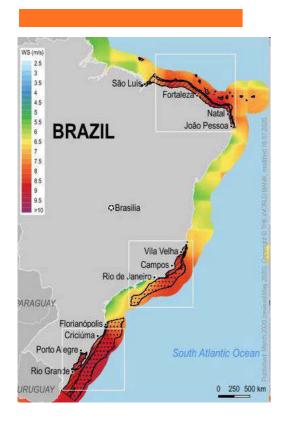
http://documents1.worldbank.org/curated/en/90234158684 7107376/pdf/Technical-Potential-for-Offshore-Wind-in-Brazil-Map.pdf; 16.07.2020, modified

- Extraordinary wind conditions / capacity factors
- Vast extent of coast-line
- Combines well with hydropower
 - Hydropower Brazil: 12,4% of total energy matrix 2019, incl. imports ²⁾
- With 3,1 billion US\$, Brazil is ranking as 6th development country for clean asset finance in 2018¹⁾
- Vital project development activities ("green field")
 - Global players have already entered with multi-GW-projects (Equinor, Neoenergia / Iberdrola)
- Energy transition & decarbonisation in Brazil:
 - Renewable: 83,0% of electrical energy matrix 2019²⁾
 - Renewable: 46,1% of total energy matrix 2019²⁾
 - Energy transition demand for even more electrical power to substitute fossil power and fuels of total energy matrix
- Globalisation of energy transition & decarbonisation:
 - Multinational groups seek to decarbonise portfolio
 - Power export, e.g. in form of H₂

Sources: 1) Bloomberg Finance L.P. (2019) http://global-climatescope.org/assets/data/reports/climatescope-2019-report-en.pdf; 30.10.2020; 2) EPE (2020):https://www.epe.gov.br/sites-pt/publicacoes-dados-abertos/publicacoes/PublicacoesArquivos/publicacao-479/topico-521/Relato%CC%81rio%20Si%CC%81ntese%20BEN%202020-ab%202019_Final.pdf; 04.11.2020. Given numbers including imports of electricity



Offshore in Brazil



Complexo Eólico Marítimo Asa Branca I - CEMAB I ¹⁾

- Eólica Brasil Ltda.
- North-East (Ceará)
- 50 OWEC ¹⁾ (60 OWEC),
- 400 MW ¹) (700 MW)

Caucaia²⁾

- BI Energia
- North-East (Ceará)
- 48 OWEC + 11 Nearshore-OWEC,
- 576 MW + 22 MW = 598 MW

Camocim³⁾

- BI Energia
- North-East (Rio Grande do Norte)
- 1,2 GW

Aracatu I & II 5)

- Equinor Brasil
- South-East (Rio de Janeiro and Espírito Santo)
- 320 OWEC
- 2 x 2 GW (+)

IBAMA-Licenses for about 15 GW Requested

Águas Claras⁴⁾

- Neoenergia
- South (Rio Grande do Sul)
- 4 x 50 OWEC
- 4 x 750 MW

Maravilha⁴⁾

- Neoenergia
- South-East (Rio de Janeiro)
- 4 x 50 OWEC
- 4 x 750 MW

Jangada (CE)⁴⁾

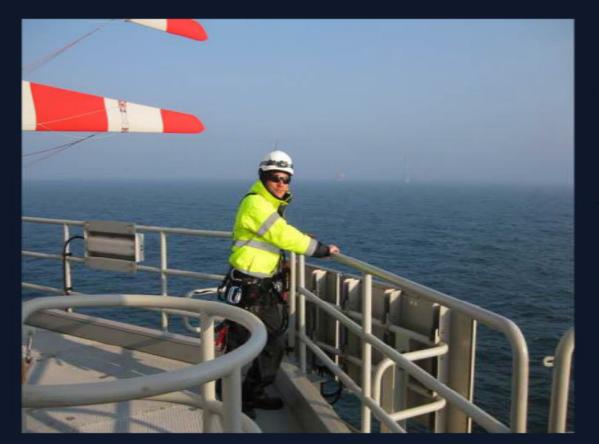
- Neoenergia
- North-East (Ceará)
- 4 x 50 OWEC
- 4 x 750 MW



As of October 2020, information subject to confirmation, OWEC = Offshore Wind Energy Converter, GW = Gigawatt, MW = Megawatt

Sources: 1) IBAMA FCA n°: 140661/2017, 30/06/2017 2) https://www.bienergialtda.com 3) https://epbr.com.br/rio-grande-do-norte-assina-protocolo-de-intencoes-com-bienergia-para-instalar-parque-eolico-offshore/ 4) https://epbr.com.br/eolicas-offshore-novos-projetos-somam-9-gw-de-capacidade-instalada/ 5) IBAMA FCA n°: 148490/2020, 19/08/2020

Thank you! Obrigado! Vielen Dank!



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