Socioeconomic impacts of offshore wind

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About Wind Denmark

22 employees across four offices in Denmark

Established in March 2019 - A merger between Danish Wind Industry Association and Danish Wind Energy Association (2019).

The only organization focusing solely on wind energy in Denmark

More than 3,000 members – from private persons, wind turbine owners and large and small industry players

Promoting the conditions for wind energy through lobbying in relation to energy, trade and industry policies

Network facilitator promoting cooperation and generating knowledge about the market benefitting both members and the public

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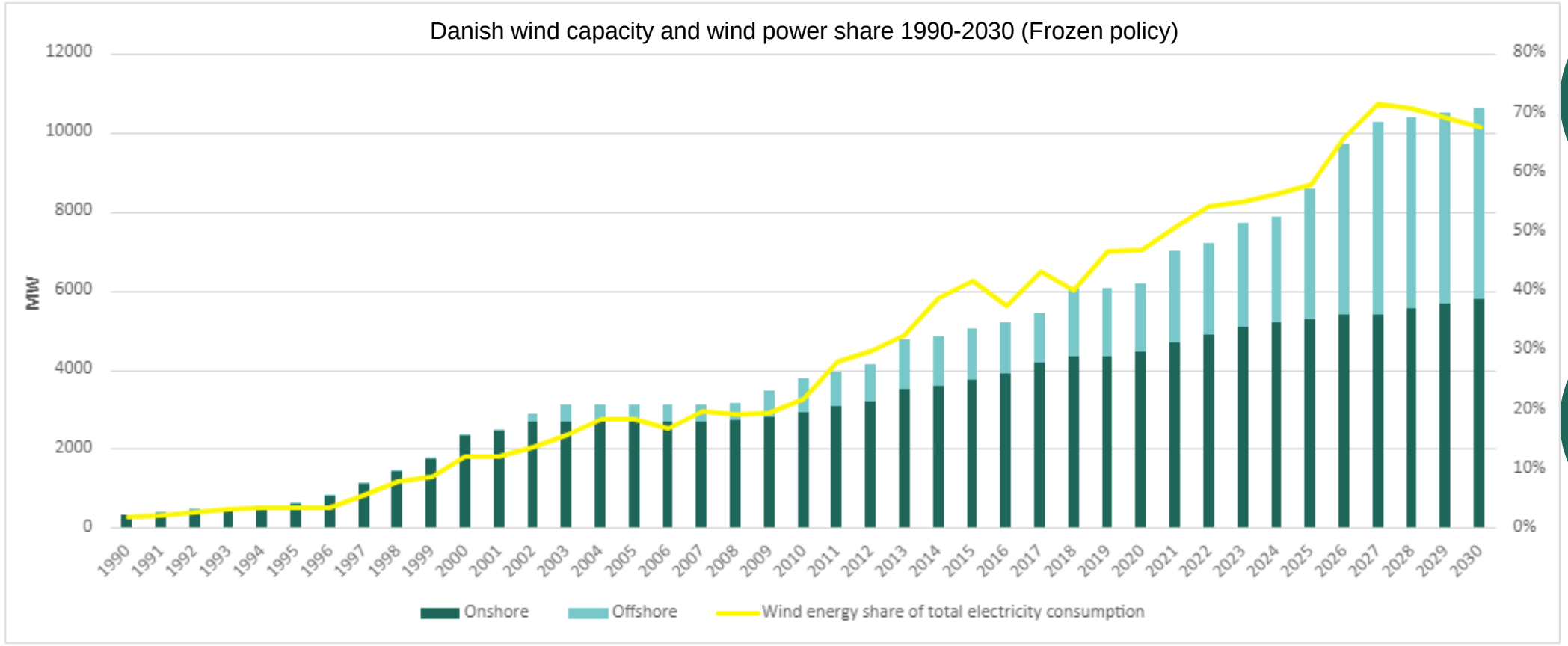
World record in share of wind in electricity consumption

- Now and in the future



51%
in 2021

68%
in 2030

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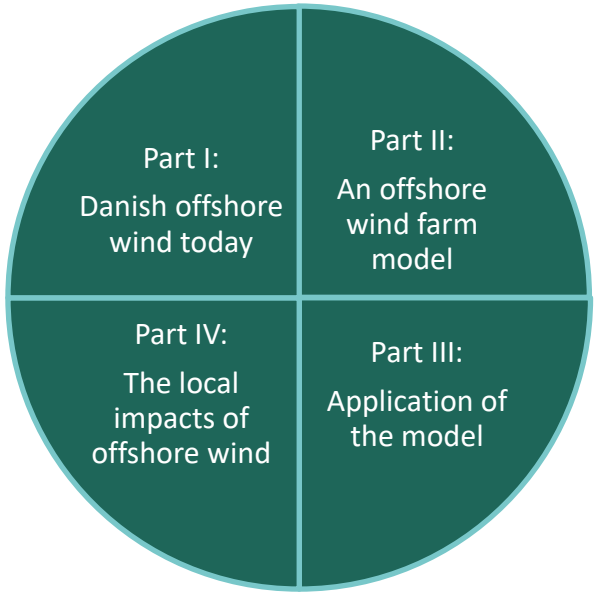
Source: Wind Denmark based on historical data and Frozen policy assumptions 2021

The study consists of IV parts

The report can primarily be seen as a literature study, compiling much of the information on the European wind energy market, in order to estimate socioeconomic impacts.

- Part I: Danish offshore wind today
  - - Turnover and market share of Danish offshore wind
- Part II: An offshore wind farm model
  - - Structure and key results of the model
- Part III: Application of the model
  - - The offshore wind model is used to simulate economic impacts of Thor, Kriegers Flak, Horns Rev III, and Bornholm and North Sea energy islands.
- Part IV: The local impacts of wind
  - - Cases on how offshore wind resonates through local societies



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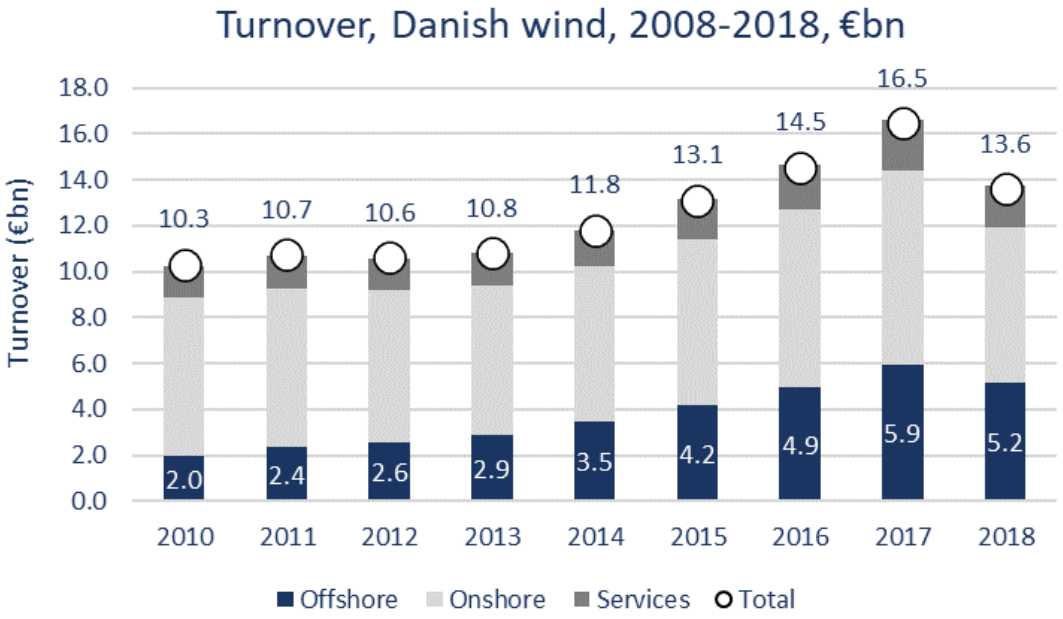
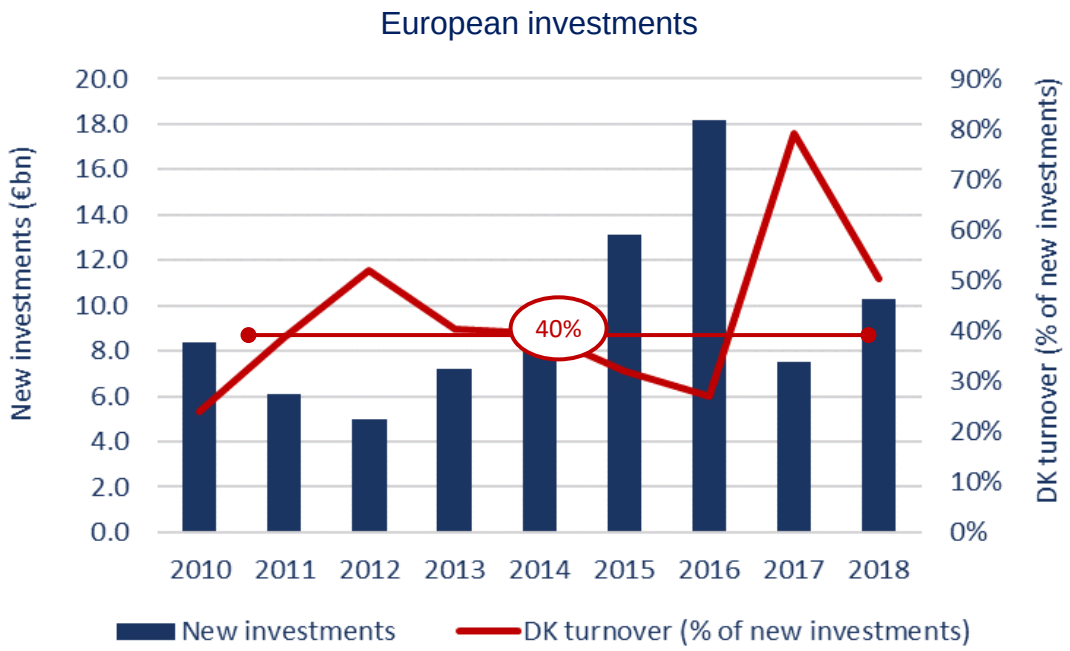
Result 1: Turnover and market share

- Estimations based on data from Wind Europe and Wind Denmark





Result 2: Cost estimation of OFW

1GW, 60km from shore, 30m water depth, using 10MW turbines:

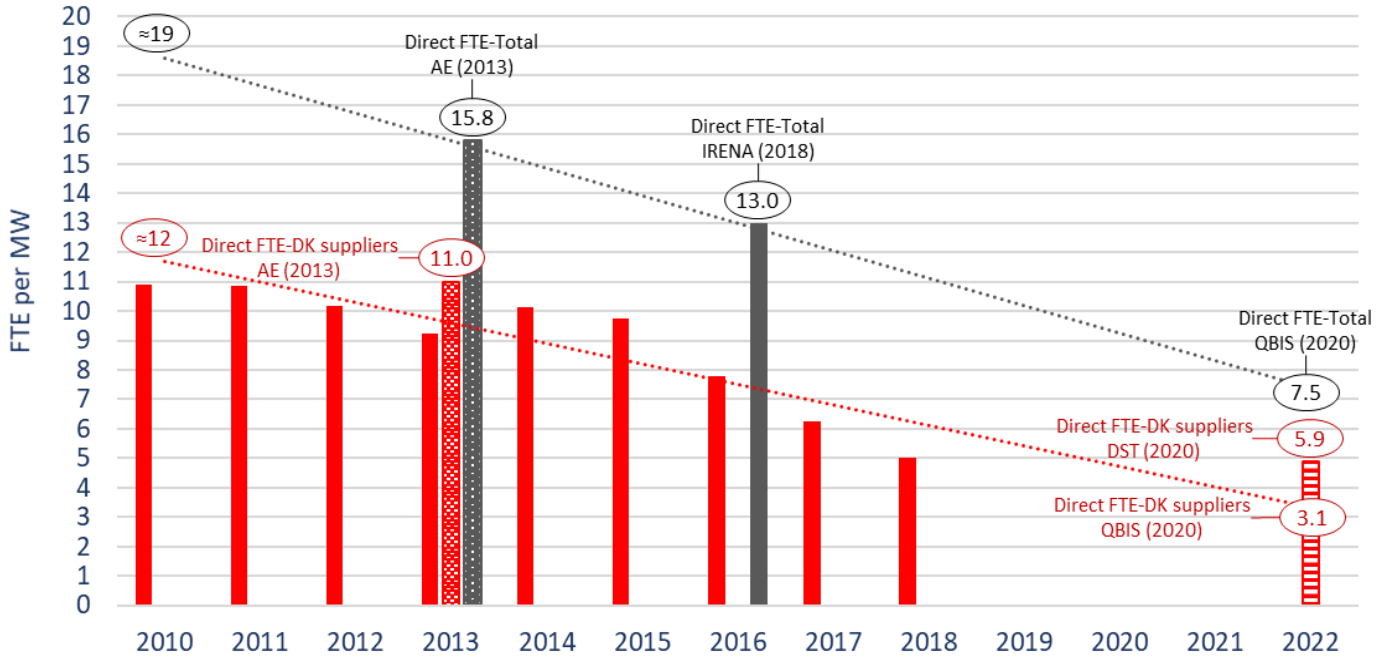
- CAPEX+DEPEX: 3.70 M.USD/MW whereas;
  - 3.23 M.USD/MW is CAPEX.
  - 0,47 M.USD/MW is DEPEX.
- OPEX: 0.058 M.USD/MW pr. year corresponding to 1.74 M.USD/MW over 30 years.

Estimated based on data from Wind Europe, BVG associates and extensive dialog with OEMs and offshore wind developers in Denmark, and cross-checking with other similar estimates, e.g., the Danish technology catalogue and the Danish Energy Agency

	Phase 1 Development[1]			Phase 2A Production Wind turbines			Phase 2B Production Balance of plant			Phase 3 Installation & grid connection			Phase 4 Operation & maintenance			Phase 5 Decommissioning[1]			Total		
	CAPEX			CAPEX			CAPEX			CAPEX			OPEX			DEPEX					
	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
CAPEX and DEPEX (million EUR/MW)	0.145	0.145	0.145	1.250	1.260	1.270	0.771	0.813	0.855	0.330	0.429	0.523				0.392	0.392	0.392	2.887	3.038	3.184
CAPEX and DEPEX (million EUR/GW)	145	145	145	1,250	1,260	1,270	771	813	855	330	429	523				392	392	392	2,887	3,038	3,184
CAPEX and DEPEX (million DKK/GW)	1,080	1,080	1,080	9,338	9,412	9,486	5,760	6,073	6,387	2,465	3,204	3,906				2,925	2,925	2,925	21,568	22,694	23,784
OPEX (million EUR/MW/year)													0.033	0.048	0.090				0.033	0.048	0.090
OPEX (million EUR/GW/25 years)													819	1,188	2,259				819	1,188	2,259
OPEX (million DKK/GW/25 years)													6,115	8,871	16,875				6,115	8,871	16,875
Time	12-30 months			6 months						6 months			25 years			6-36 months					

Result 3: Labor needed for 1MW

- Estimated 7.5 direct FTEs/MW due to the capex/depex costs and associated phases.
- Estimated 2 direct FTEs/MW due to the opex costs and the associated phase.



Result 4: Labor needed for 1 GW

- Total direct labor: 9,451 FTEs/GW
- Suppliers' direct labor: 8,991 FTEs/GW
- DK suppliers' labor share for DK:
  4,923 FTEs/GW - 56% of total FTEs.
- DK suppliers' labor share in EU:
  3,133 FTEs/GW - 35% of total FTEs.
- Combined equally as many indirect and induced FTEs.

(Full Time Equivalent-FTE)	**Phase 1** Development	**Phase 2A** Production Wind turbines	**Phase 2B** Production Balance of plant	**Phase 3** Installation & grid connection	**Phase 4** Operation & maintenance (25 years)	**Phase 5** Decommis-sioning	**Total**
	CAPEX	CAPEX	CAPEX	CAPEX	OPEX	DEPEX	
Total farm direct labour - EU and DK offshore wind							
Direct	574	2,655	2,820	781	1,907	713	9,451
Suppliers' direct labour - EU and DK offshore wind							
Direct	547	2,655	2,820	741	1,585	642	8,991
DK suppliers labour – EU offshore wind (excl. Denmark)							
Direct	178	1,244	878	167	506	160	3,133
Indirect	99	1,287	680	210	713	202	3,190
Induced	127	1,208	478	183	595	175	2,767
Total	404	3,739	2,036	560	1,813	377	9,090
DK suppliers labour – DK offshore wind							
Direct	314	1,486	1,345	169	1,287	321	4,923
Indirect	174	1,538	1,042	213	1,814	403	5,184
Induced	224	1,443	733	185	1,515	351	4,451
Total	713	4,467	3,119	568	4,616	1,075	14,558

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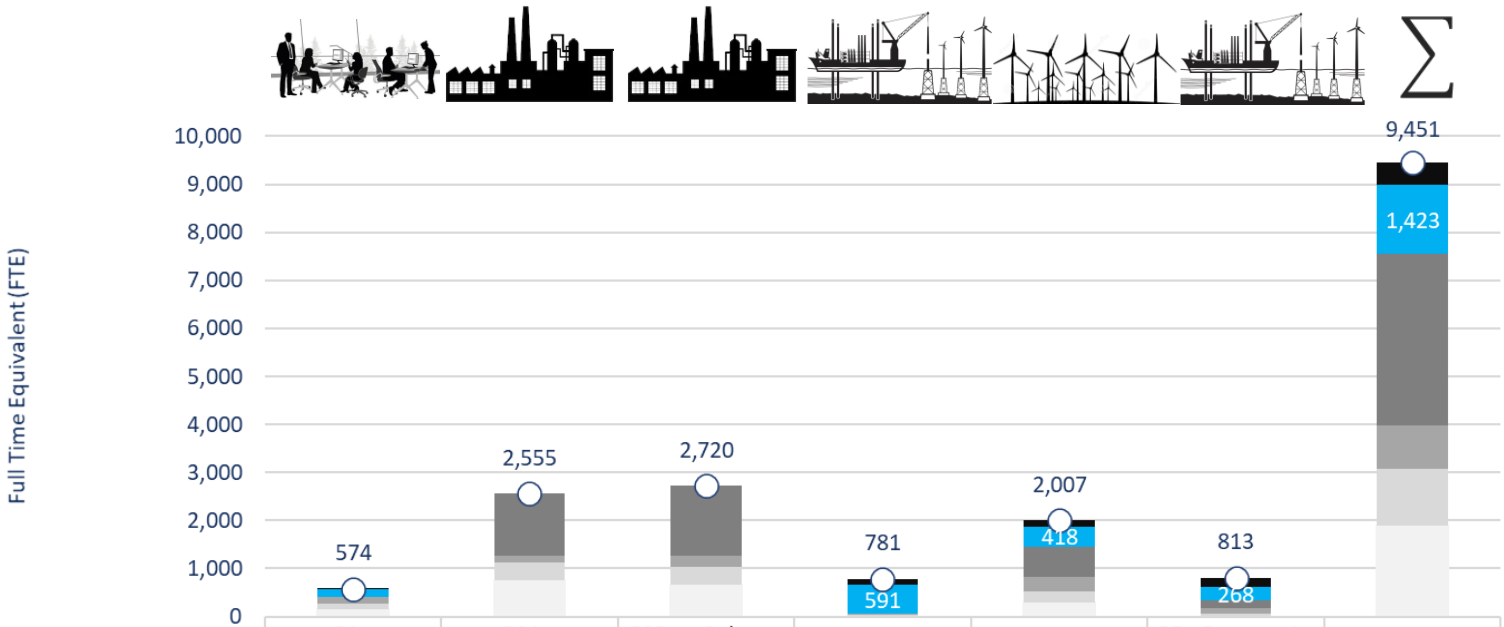
Result 5: Labor according to profession



	P1 - Development	P2A - Wind turbines	P2B - Balance of plant	P3 - Installation	P4 - O&M	P5 - Decommis-sioning	Total
Operators	12	0	0	126	127	202	467
Ship crews	146	0	0	591	418	268	1,423
Workers + technicians	10	1,293	1,459	2	636	176	3,575
Engineers	136	126	222	30	297	106	917
Outdoor experts	113	379	378	16	239	61	1,186
Indoor experts	157	757	662	16	291	0	1,882
Total	574	2,555	2,720	781	2,007	813	9,451

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Results 6: Lifetime costs, GDP and supplier contracts

- **Lifetime costs** are assessed to around USD 5.18 billion for 1GW. (1)
- **GDP** is assessed to around USD 1.6 billion (31% of lifetime costs) for EU offshore wind and around UDS 3.33 billion (64% of lifetime costs) for DK offshore wind. (2)
- **Supplier contracts** is assessed to USD 4.85 billion for both EU and DK offshore wind. (3)
- **DK supplier contracts** are assessed to around USD 1.69 billion (35% of investment costs) for EU offshore wind and around USD 2,76 billion (57%) for DK offshore wind. (4)

(million DKK per GW)	**Phase 1** Development	**Phase 2A** Production Wind turbines	**Phase 2B** Production Balance of plant	**Phase 3** Installation & grid connection	**Phase 4** Operation & maintenance (25 years)	**Phase 5** Decommis-sioning	**Total**	
	CAPEX	CAPEX	CAPEX	CAPEX	OPEX	DEPEX		
Lifetime costs								
- CAPEX, DEPEX and OPEX	1,080	9,412	6,073	3,204	8,871	2,925	31,565	(1)
GDP								
- Wind farm in EU	440	4,802	1,865	235	1,399	1,097	9,837	(2)
- Wind farm in DK	696	5,738	3,199	1,020	7,927	1,755	20,335	
Supplier contracts – EU offshore wind								
- All suppliers	1,029	9,412	6,073	3,040	7,374	2,633	29,561	(3)
- DK suppliers – all	336	4,409	1,890	686	2,352	658	10,331	(4)
Supplier contracts – DK offshore wind								
- All suppliers	1,029	9,412	6,073	3,040	7,374	2,633	29,561	(3)
- DK suppliers	591	5,267	2,896	695	5,987	1,316	16,753	(4)

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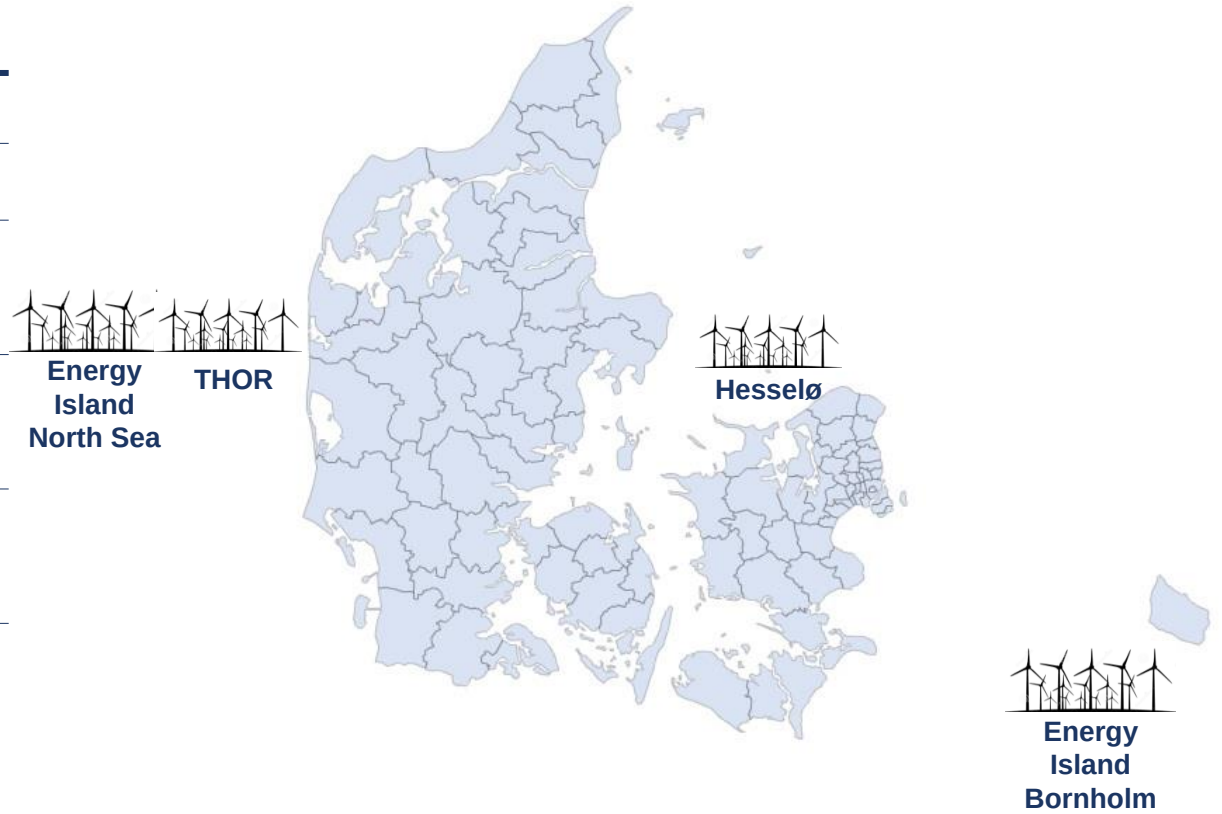
Applying the model on Danish OFW development:

7GW planned capacity

	CAPEX	OPEX	DEPEX	TOTAL
Offshore wind farm				
- Investment costs (USD million)	45,060	17,680	4,810	67,550
- Work load direct all (FTEs)	39,700	12,000	3,800	55,550
- Work load indirect + induced DK (FTEs)	15,300	26,400	4,300	46,000



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Offshore development in EU

- From **12 GW** today to **60GW** in 2030 and **300 GW** in 2050.
- Will require approx. **9GW** annually
- Generating **67,500 permanent direct jobs** annually, equivalent of **2 mio. direct FTEs** in total.
- The North- and Baltic Sea surrounding Denmark has a potential of 235GW, whereas it is not unrealistic that **20GW will be utilized within the Danish territory** potentially generating **54 bill. USD** for Danish suppliers.

Photo courtesy of MHI Vestas

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Key study results

3.04 MEUR/MW

In 2022, CAPEX+DEPEX for 1 GW, 60km offshore, 30m water depth, and using 10 MW turbines are assessed to 3.04 MEUR/MW, while CAPEX alone is assessed to 2.65 MEUR/MW.

0.048 MEUR/MW

In 2022, OPEX for 1 GW, 60km offshore, 30m water depth, and using 10 MW turbines is assessed to 0.048 MEUR/MW per year corresponding to 1.19 MEUR/MW over 25 years.

40%

DK companies' market shares are assessed to 40% for EU/DK offshore wind and DK companies are considered to offer most complete supply chain in the world (a global one-stop-shop).

7.5/9.4 FTE/MW

In 2022, CAPEX/DEPEX are assessed to be associated with 7.5 FTE, down from 19 FTE/MW in 2010. CAPEX/OPEX/DEPEX are assessed to associated with 9.4 FTE/MW.

3.1/4.6 FTE/MW

For DK contractors, CAPEX/OPEX/DEPEX are assessed to be associated with 3.1/4.6 FTE/MW for EU/DK offshore wind corresponding to 35%/55% of contract FTEs (8.9 FTE/MW).

9.1/14.6 FTE/MW

Indirect labour can add 3.2/5.2 FTE/MW, while induced labour can add 2.8/4.5 FTE/MW making total Danish labour potential sum to 9.1/14.6 FTE/MW for EU/DK offshore wind.

1.2%-5.0%

1GW DK offshore wind farm may generate EUR 11-28 million turnover and 30-96 FTEs to the local **installation port** and suppliers corresponding to 1.2%-5.0% of Phase 3 contracts.

1.4%-15%

1GW DK offshore wind farm may generate EUR 3.2-9.1 million turnover and 59-81 FTEs per year in 25 years to the local **O&M port** and suppliers corresponding to 1.4%-15% of Phase 4 contracts.

Ignite

Installation or O&M port contracts can ignite a local development where first offshore contract is followed by conversion, internationalization and transformation phases increasing contract share significantly (Esbjerg has 35%-57%).

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Thank you!

Full report:
https://winddenmark.dk/udgivelser/socio-economic-impact-study-of-offshore-wind

Executive presentation:
https://winddenmark.dk/udgivelser/socioeconomic-impacts-of-offshore-wind-executive-presentation

If you have any questions, I will do my best to answer them at:
tyj@winddenmark.dk

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