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Offshore Wind

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Offshore Wind Power Projects

Figure 33: UK offshore wind development projects

Consented: Wind farms that have received consent but not yet secured a Contract for Difference.

		Up to capacity MW
01	Blyth Demonstration Phases 2 & 3[1]	58
02	East Anglia ONE North[R3]	950
03	East Anglia TWO[R3]	980
04	Norfolk Vanguard East[R3]	1,800
05	Norfolk Vanguard West[R3]	
06	Seagreen Phase 1a[R3, 2]	500
Total		**4,288**

In planning: Wind farms for which a consent application has been submitted.

		Up to capacity MW
07	Awel y Môr[Ext]	576
08	Berwick Bank[R3, 2]	4,100
09	Marr Bank[R3, 2]	
10	Dudgeon Extension[Ext]	402
11	Erebus Floating Wind Demo	99
12	Hornsea 4[R3]	2,700
13	Pentland[2]	100
14	Sheringham Shoal Extension[Ext]	317
Total		**8,294**

1 Capacity noted is rounded to the nearest whole MW.
2 Managed by Crown Estate Scotland.
3 Under construction or government support on offer.

Pre-planning: Wind farms for which a consent application has not yet been submitted.

		Up to capacity MW
15	Arven (NE1)[SW, 2]	1,800
16	Ayre (NE2)[SW, 2]	1,008
17	Bellrock (E1-3)[SW, 2]	1,200
18	Bowdun (E3)[SW, 2]	1,008
19	Broadshore (NE6)[SW, 2]	500
20	Buchan (NE8)[SW, 2]	960
21	Caledonia (NE4)[SW, 2]	1,000
22	CampionWind (E2-2)[SW, 2]	2,000
23	Dogger Bank South (East)[R4]	1,500
24	Dogger Bank South (West)[R4]	1,500
25	Five Estuaries[Ext]	353
26	Havbredey (N2)[SW, 2]	1,500
27	Machair Wind (W1)[SW, 2]	2,000
28	Marram Wind (NE7)[SW, 2]	3,000
29	Mona[R4]	1,500
30	Morecambe[R4]	480
31	Morgan[R4]	1,500
32	Morven (E1-2)[SW, 2]	2,907
33	Muir Mhòr (E2-1)[SW, 2]	798
34	North Falls[Ext]	504
35	Ossian (E1-1)[SW, 2]	2,610
36	Outer Dowsing[R4]	1,500
37	Rampion 2 (Rampion Extension)[Ext]	400
38	Rampion 2 (Zone 6)[R3]	800
39	ScotWind (NE1)[SW, 2]	500
40	Sealtainn (NE1)[SW, 2]	500
41	Spiorad na Mara (N4)[SW, 2]	840
42	Stromar (NE3)[SW, 2]	1,000
43	Talisk (N3)[SW, 2]	495
44	West of Orkney (N1)[SW, 2]	2,000
Total		**37,663**

Ext 2017 Extension project.
R3 Leasing Round 3 project.

Future potential: Projects subject to plan-level Habitats Regulations Assessment (HRA).

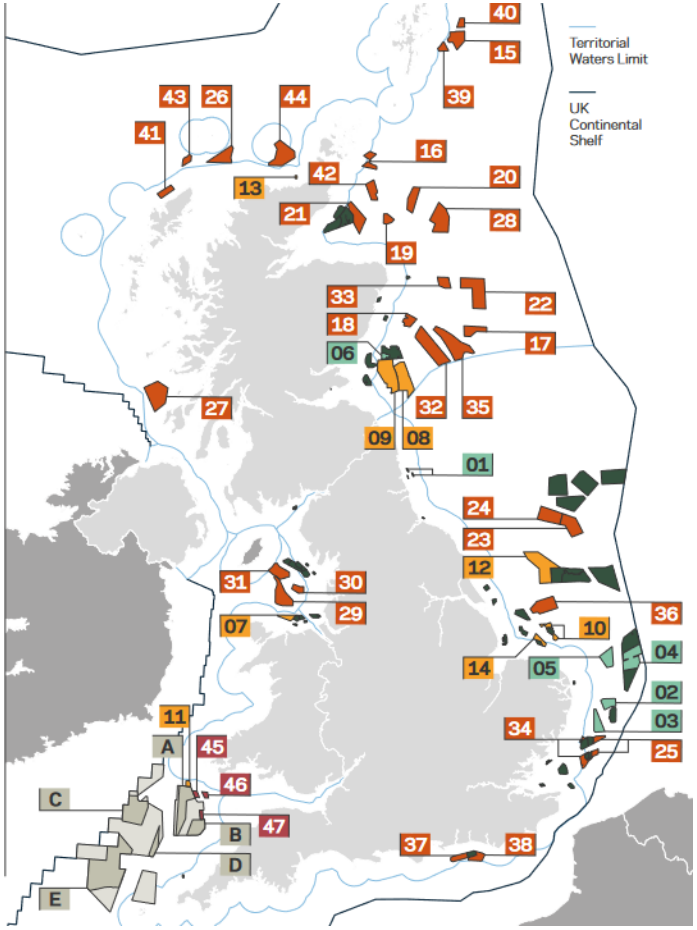
		Up to capacity MW
45	Llŷr 1	100
46	Llŷr 2	100
47	White Cross	100
Total		**300**

Celtic Sea Floating Offshore Wind:

	Areas of Search
A to E	Refined Areas of Search

Projects in operation or committed[3]

R4 Leasing Round 4 project.
SW ScotWind project (and plan area).



Crown State's Offshore wind report, 2022

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Offshore Wind Farms

Pros

- Good availability of wind energy resource.
  - Higher wind speeds
  - Low surface roughness (less sources of turbulence)
  - No restrictions on hub height.
- Good availability of space compared to mainland.
- Good manoeuvrability for large structures (no more mountain roads)
- Chances to create new connections overseas.
- Less visual impact (social).

Cons

- Expensive civil engineering required.
- Floating turbines required for deep water sites.
- Increased maintenance costs.
- Down-time after failure increases.
- Greater distance between the WF and the grid.
- Connection will be subsea cable which is not straightforward
  - AC may not be practical if cable is long.

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Sub-Sea Cables

Cables have lower ratings than overhead lines because because the cooling is poorer.

Cables have a central conductor, an insulator (typically polypropylene) and earthed outer screen and a water-proof layer.

They are expensive in themselves but also expensive to lay, especially when burying in the sea bed.

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700 MW, ±450 kV Cable for NordNed

The copper cores are 35 mm in diameter. The cable weights about 100 kg/m, of which only 17kg/m is copper.

The weight of cable for the entire route is 57,000 ton.

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AC versus DC: Dealing with Capacitance

Capacitance is much higher than for overhead lines -> significant extra current flows in the cable.

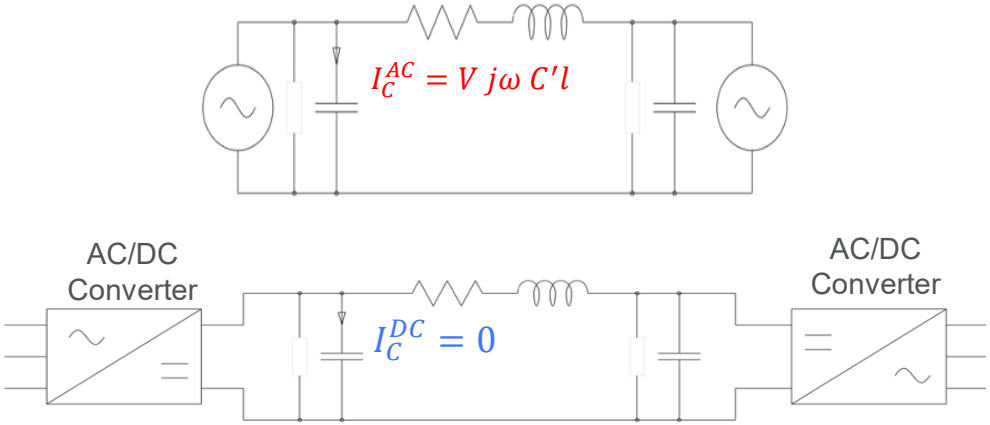
The utilisation of cable's current carrying capacity is low because of the capacitive current problem and so cable costs are high.

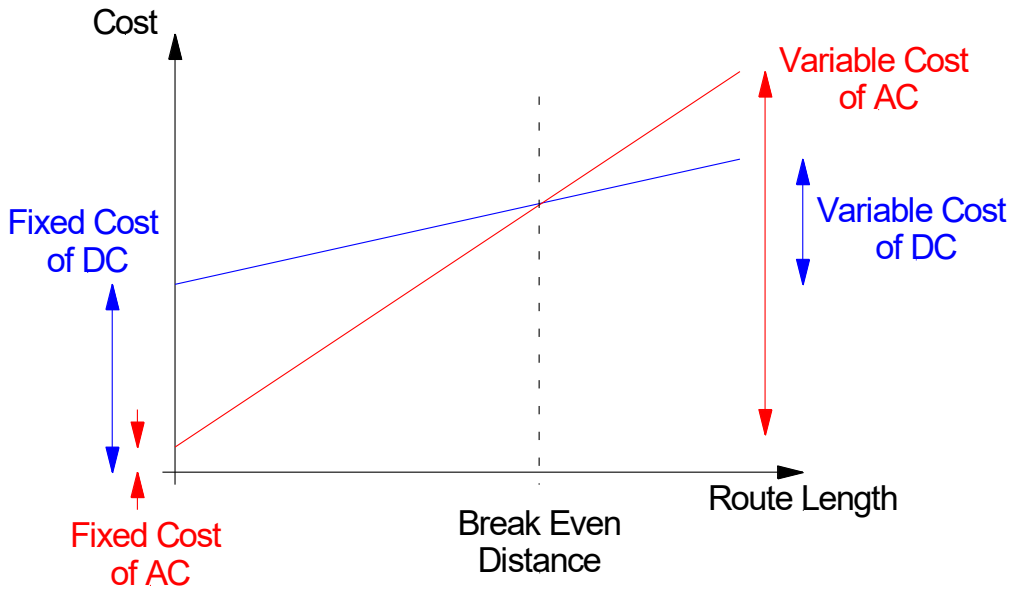
Compensation of capacitance is not cheap (by adding cancelling current at points along the cable) and is very difficult for subsea cables.

Swapping to DC can make sense for long distances.

The cross-over distance for buried cables is approximately 80 km.

The cross-over distance for overhead is approximately 800 km





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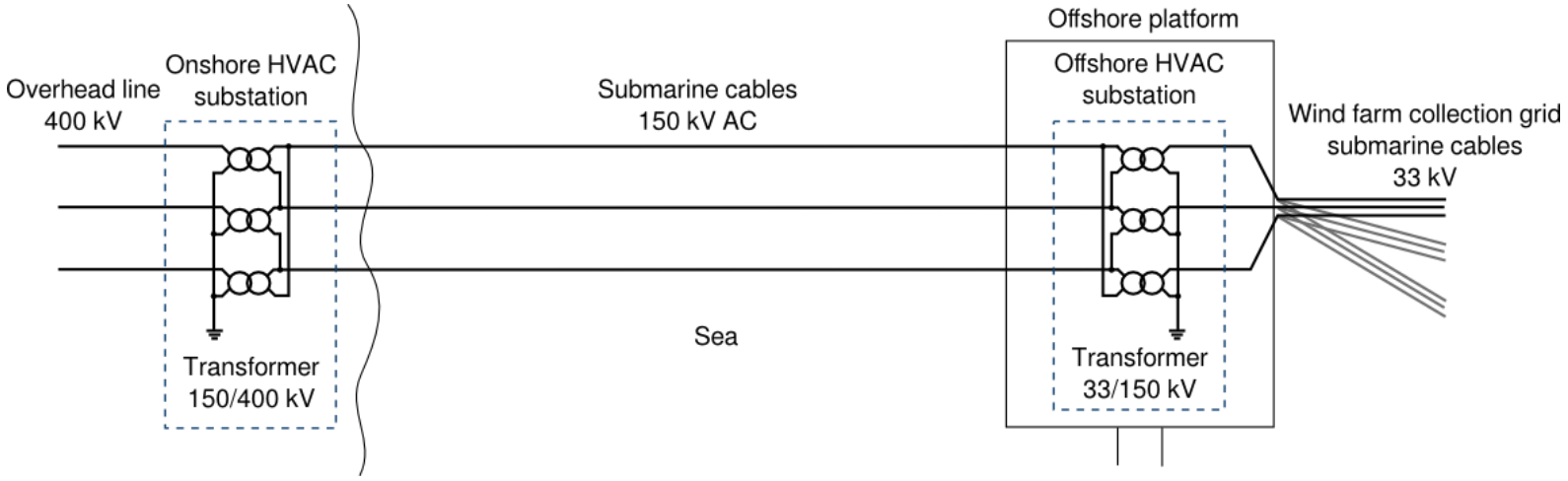
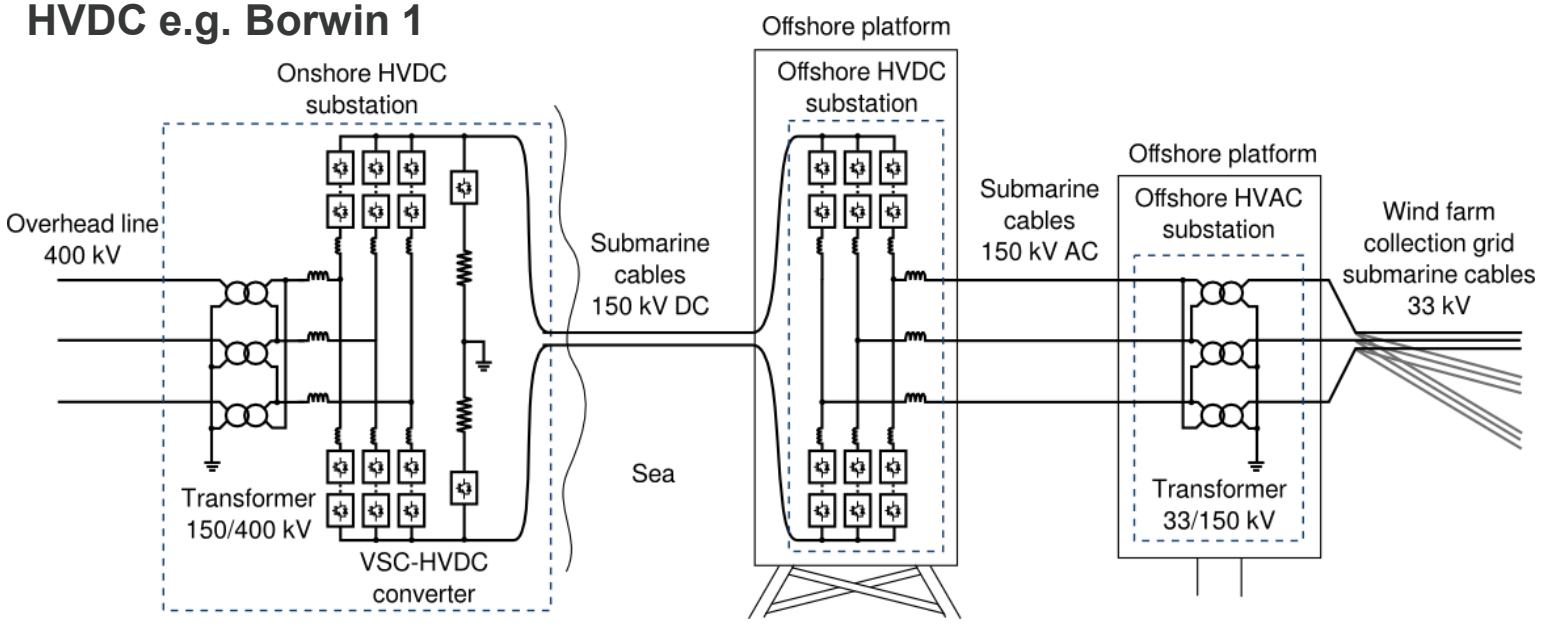
Substations: HVAC versus HVDC

HVAC e.g. London Array



HVDC e.g. Borwin 1



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Substations: HVAC versus HVDC

London Array

Borwin Alpha

Borwin Alpha pictures by Jan Berghuis, London array pictures by London Array Ltd.

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Substations: HVAC versus HVDC

London Array HVAC substations*

- Rated power: 360 MVA
- Transmission distance: **50 km**
- Technology: Siemens HVAC
- AC input: 33 kV
- AC output: 150 kV
- Size: 25x23x22 m
- Topside weight: 1,260 t
- Water depth: 20 m
- Foundation type: Monopile

**2 substations, values quoted are per substation*

Borwin Alpha VSC-HVDC substation:

- Rated power: 400 MW
- Transmission distance: **200 km**
- Technology: ABB HVDC Light
- AC input: 170 kV*
- DC output: ±150 kV
- Size: 50x33.5x22 m
- Topside weight: 3,200 t
- Water depth: 39 m
- Foundation type: Jacket

**Stepped up from 33 kV to 170 kV on a second substation platform*

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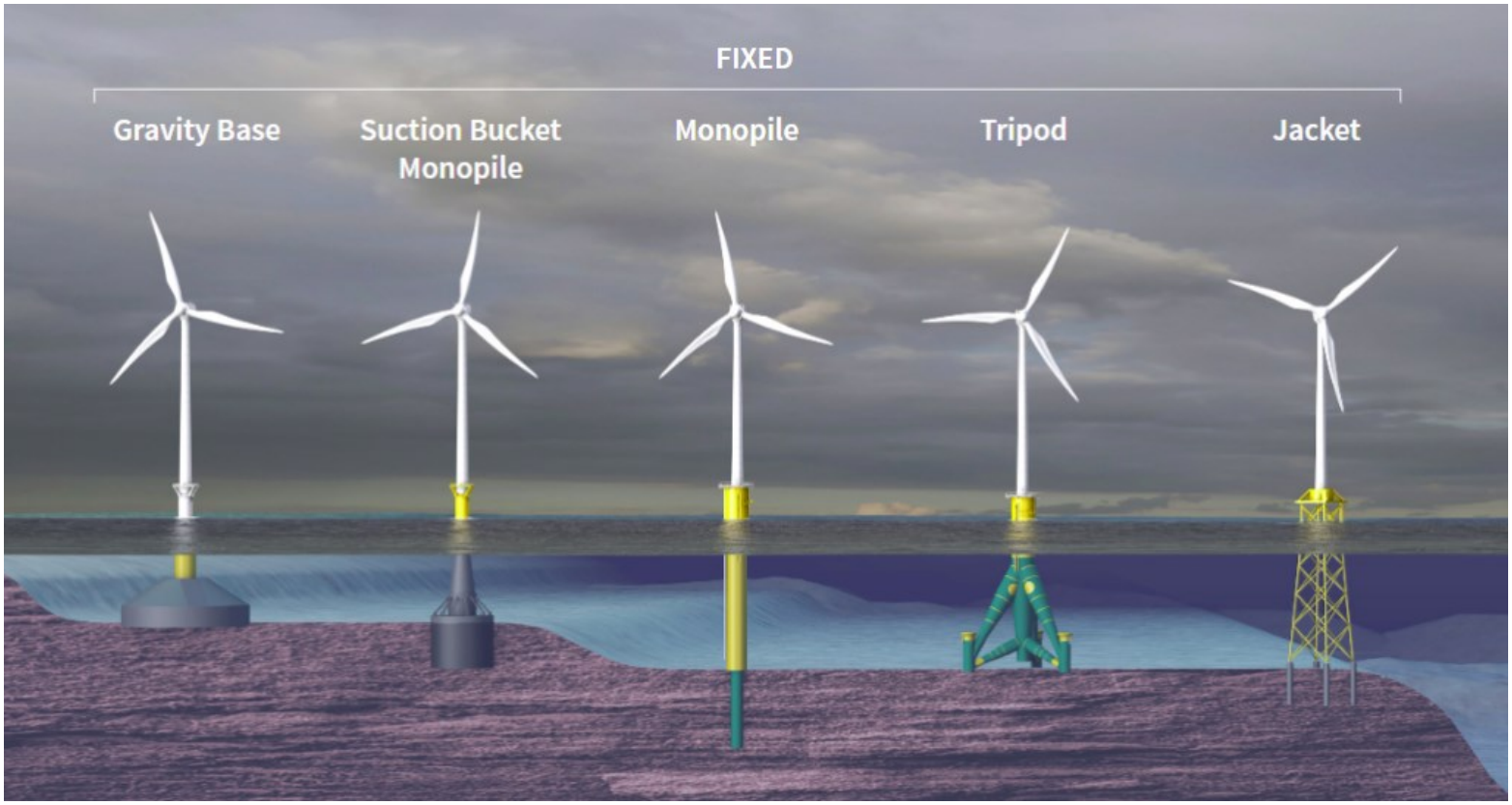
Offshore foundations



It is currently economical to install turbines up to 50-60 metres deep

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Very large moments at the base of the tower

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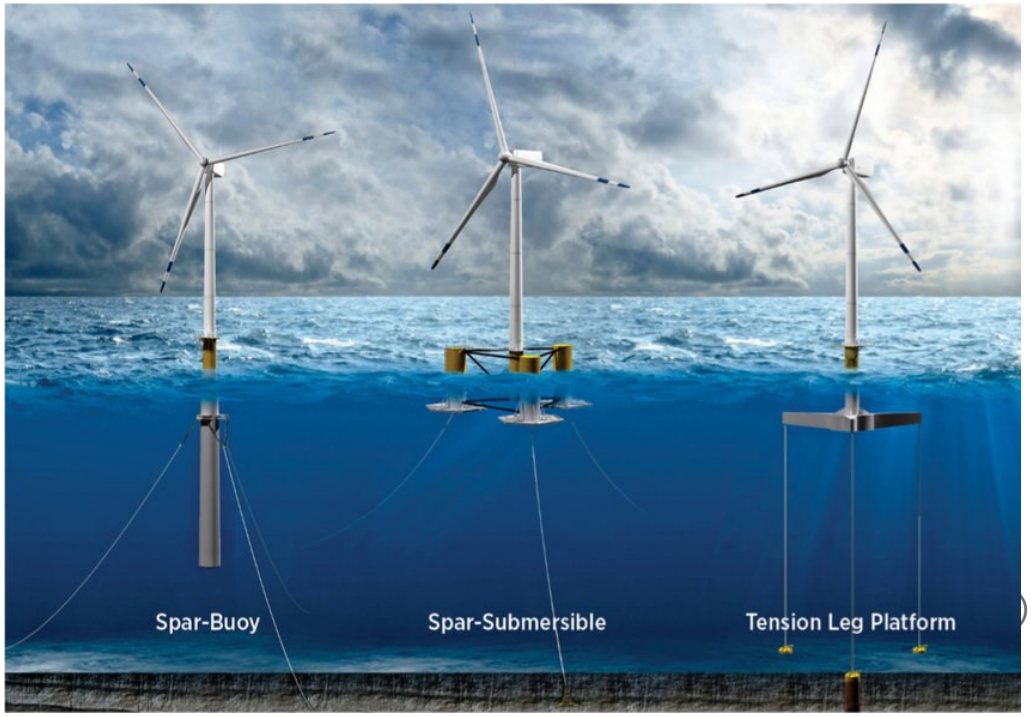
Floating wind farms

- Solution for deep waters
- Prototype farm: Hywind, 2017

- Key challenges:
  - Additional control system for platform motions
  - Dynamics of mooring systems
  - Anchoring systems
  - Forces on transmission cables



Erebus floating wing demo
* Semisubmersible designs
* 10 turbines, 100 MW
* Celtic sea off Wales
* Operational on Jan 2026

Buchan offshore wind farm
* First commercial-scale floating farm at 1GW
* 75 km off North Scotland
* Consortium established in May 2022

https://buchanoffshorewind.com/buchan-offshore-wind