



INCREASING RENEWABLES DEPLOYMENT THROUGH MARKET MECHANISMS

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Contracts for Difference – exploring the present and looking to the future

Chaired by Morag Watson, Director of Policy,
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Guide to contracts for difference for clean energy

(BVG Associates presentation for Scottish Renewables'
Market Mechanisms Seminar, October 27 2022)

Technology Pots at Round 4

- Different technologies can be considered in separate pots. Historically there have been separate pots for cheap “established” forms of generation and more expensive “less established” ones.
- For example, in the 2015 AR1 onshore wind and solar were in a pot for “established” technology while offshore wind was in a pot with other “less established” technologies. BEIS sets budget and capacity limits can be set for each pot.
- AR4 used a new look three pot structure, whereby offshore wind competed on its own Pot 3. AR4 was the first time that onshore wind and solar were eligible to compete since 2015.

- **Pot 1 (Established Technologies)**

Budget: £10 million

Capacity cap: 5GW

Delivery years: 2023 and 2024

- **Technologies eligible and ASP/MWh:**

Energy from Waste with CHP (£121)

Hydro >5MW and <50MW (£93)

Onshore Wind >5MW (£53)

Sewage Gas (£151)

- Solar (£47)

Notes: A maximum of 3.5GW of each of solar PV or onshore wind can be successful within the pot's 5GW cap.

- **Pot 2 (Less Established Technologies)**

Budget: £75 million

Capacity cap: No

Delivery years: 2025 and 2027

- **Technologies eligible and ASP/MWh:**

ACT (£190)

Anaerobic Digestion >5MW (£128)

Dedicated Biomass with CHP (£163)

Floating Offshore Wind (£122)

Geothermal (£133)

Remote Island Wind >5MW (£62)

Tidal Stream (£211)

Wave (£258)

Notes: £24m of the pot's budget ring fenced for floating, £20m ring-fenced for tidal stream.

- **Pot 3 (Offshore wind)**

Budget: £200 million

Capacity cap: No

Delivery years: 2025 and 2027

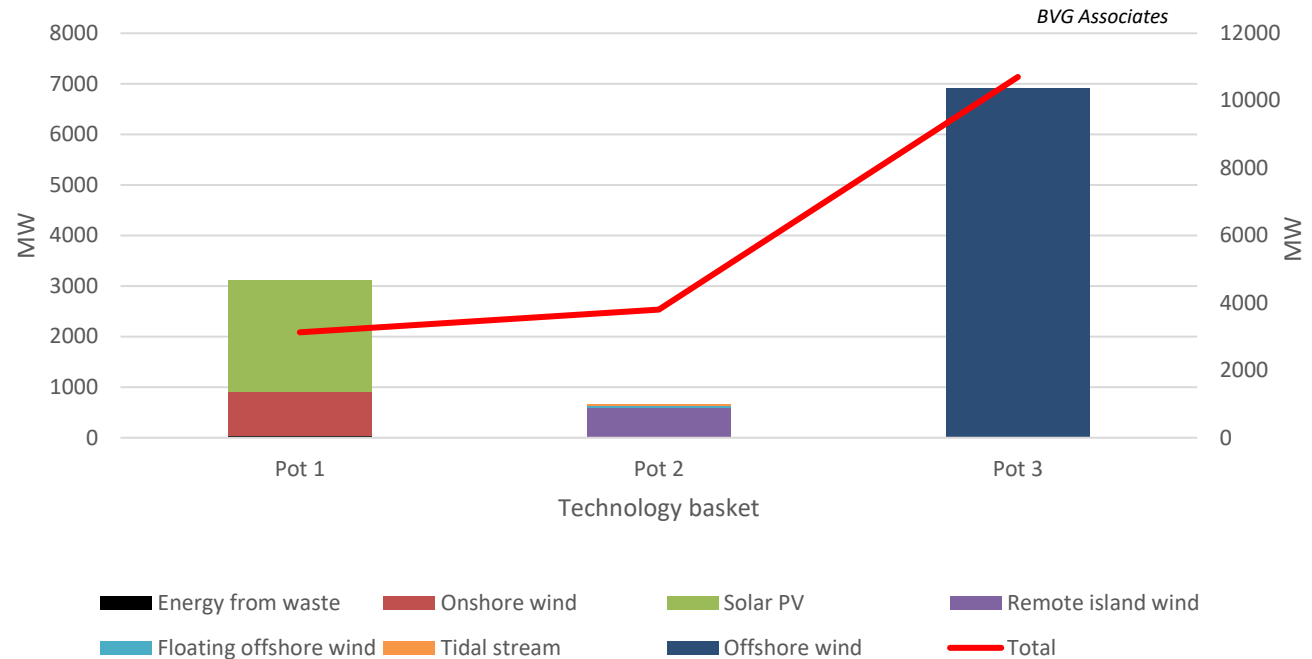
- **Technologies eligible and ASP/MWh:**

Offshore Wind (£46)

Notes: Fixed bottom offshore wind has the lowest administrative strike price of all technologies in the round.

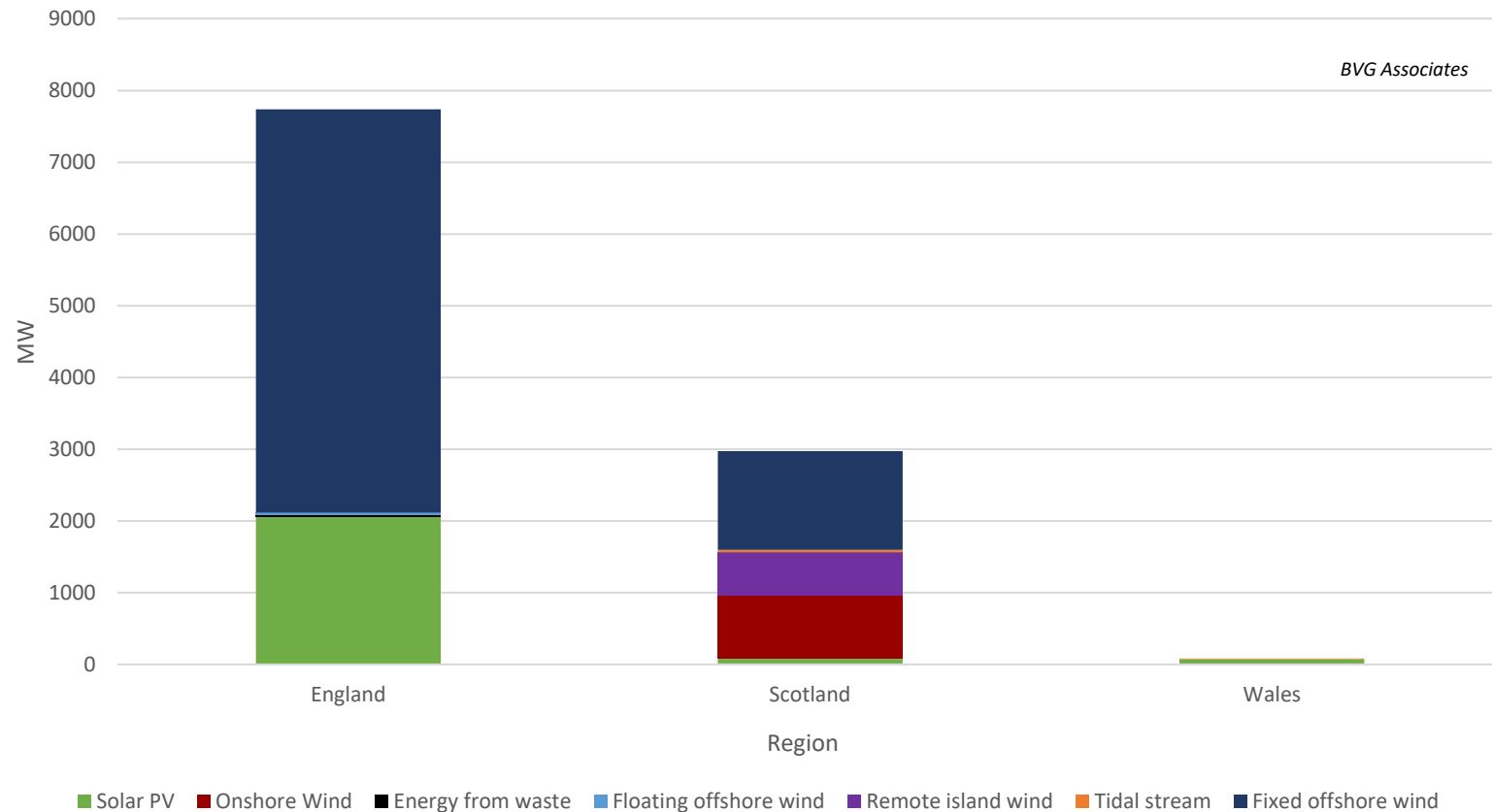
AR4 results: technology

- Some 92 clean energy projects across the UK were successful for a total of 10.7GW of new capacity.
- Offshore wind was the most successful technology securing 6.9GW in Pot 3.
- Solar PV was the most successful technology in Pot 1 securing 2.2GW of capacity across 66 projects.
- Ten onshore wind projects totalling 0.88GW made it through the round.
- Pot 1 also included a 30MW energy from waste development.
- Remote island wind was the biggest winner in Pot 2 – with 6 projects securing 597MW in capacity.
- In Pot 2, four tidal stream projects totalling 41MW and one 32MW floating offshore wind project were successful
- One 32MW floating project secured a CfD.



Pot (Total GW)	Pot 1 (3.1GW)	Pot 2 (0.67GW)	Pot 3 (6.9GW)
No. Projects	77	11	4

AR4 results: geography



- 7.7 GW of all capacity awarded was in England, split across four technologies.
- 3 GW of capacity awarded was in Scotland, split across five technologies. This included all awarded capacity for onshore wind and remote island wind.
- 82 MW of awarded was in Wales, split across solar PV and tidal stream projects.

AR4 results: delivery years

	Fixed offshore wind	Solar PV	Onshore Wind	Remote Island Wind	Tidal Stream	Floating Wind	Energy from waste	Total (GW)
2023/4		0.251						0.251
2024/5		1.958	0.887	0.89	0.05		0.03	2.881
2025/6					0.035			0.035
2026/7	6.994			0.597		0.032		7.623

- All fixed offshore wind projects, floating wind and remote island wind projects cleared for 2026/2027 delivery, the latest offered in the round. 3.85GW of offshore wind capacity is to be phased in from 2026/7.
- Developers that are able to connect their projects earlier are likely to be able to take advantage of attractive market prices until 15-year CfD payment period begins.
- All Pot 2 technologies also bid for 2026/2027 delivery with the exception of the 5.6MW Morlais project in Anglesey, Wales, which is due for delivery in 2025/6.
- Most projects in Pot 1 bid for delivery in 2024/2025, with 250MW of solar PV bidding for 2023/4 delivery reflecting the short delivery time of solar PV.

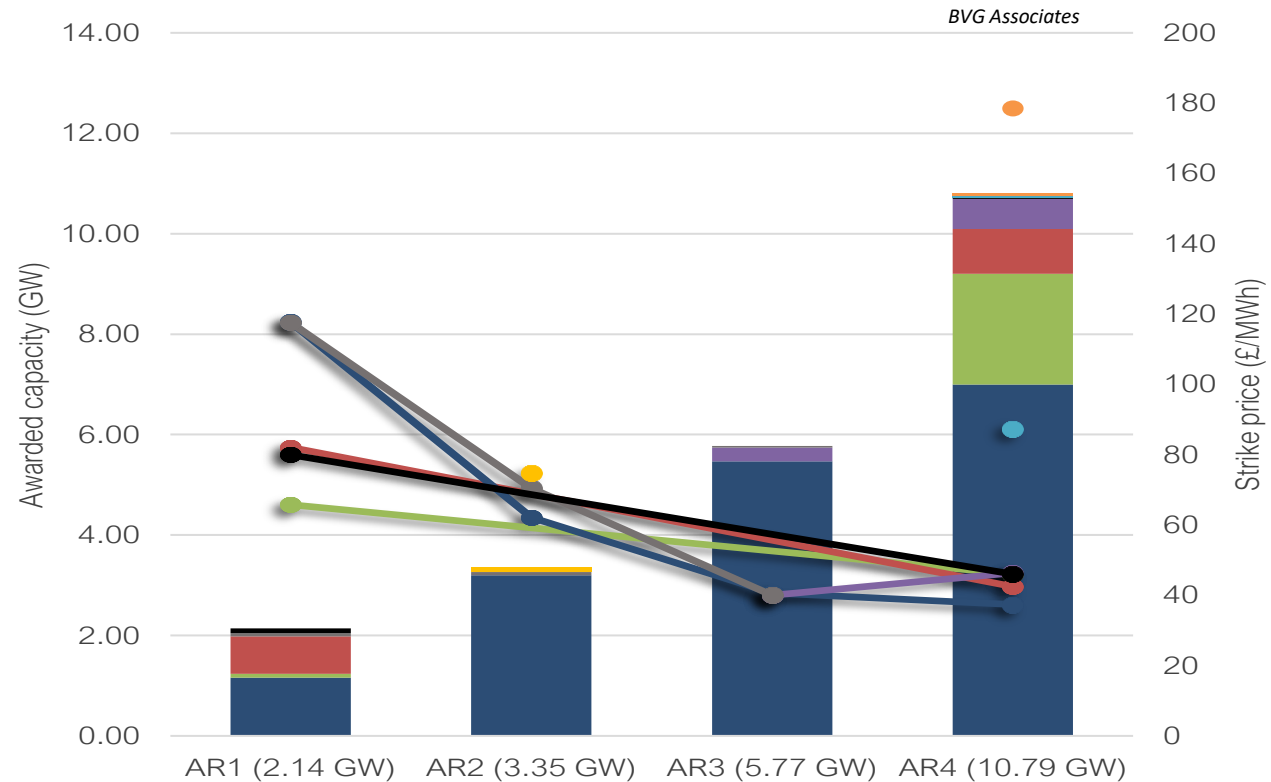
An observed quirk

Ocean Winds has delayed until the latest possible moment to trigger its CfD for its 950 MW Moray East (successful at AR2) to take advantage of high prices in the market. The net result is higher energy bills for consumers and lost revenue for the government.

A BEIS spokesperson said: We urge companies to act fairly on this matter, recognising the public support they have received for development.” An Ocean Winds spokesman said: “Moray East is proceeding according to plan within the terms set by the CfD process.”

AR4 Results: historical context

- Allocation rounds 1 to 4 have awarded 22.05 GW of renewable and low carbon generation. AR4 represents almost half of that total at 10.79 GW.
- Fixed offshore wind is the largest capacity allocated, representing 76% of the total allocation.
- AR4 sees the first increase in strike price with an increase for remote island wind between AR3 and AR4.
- AR4 introduces floating offshore wind and tidal stream.



Allocated capacity (GW)										
Allocation round	Solar PV	Onshore wind	Fixed offshore wind	Remote island wind	Advanced conversion technologies	Energy from waste with CHP	Biomass with CHP	Floating Offshore Wind	Tidal Stream	Total
AR1	0.07	0.75	1.16		0.06	0.09				2.14
AR2			3.20		0.06		0.09			3.35
AR3			5.47	0.28	0.03					5.77
AR4	2.21	0.89	6.99	0.60		0.03		0.03	0.04	10.79
Total	2.28	1.64	16.82	0.88	0.15	0.12	0.09	0.03	0.04	22.05

AR4 Pricing: results and trends

Offshore wind

- Clearing prices continued to fall. The £37.35/MWh achieved by offshore wind was the lowest for any technology at any allocation round held so far,
- The rate of price reductions between allocation rounds has slowed.
- Falling prices between 2019's AR3 (£41.61/MWh and £39.65/MWh for different delivery years) and AR4 can be attributed to the fact that successful AR4 projects are based on newer turbine hardware rated at 14MW and above, as well the more nearshore location of projects.

Floating offshore wind

- AR4's £87.30/MWh clearing price is far lower than the price paid to two existing projects in Scotland. These are the 30MW Hywind Scotland commissioned in 2017 and the 50MW Kincardine project, which was commissioned in 2020.
- Both of these existing projects were financed under the Renewables Obligation Certificate Scheme and receive around £185/MWh on top of their sale prices.
- It is difficult to understand how indicative AR4 prices are as the winning TwinHub project has some novel characteristics:
 - It will be built at a site with a pre-existing offshore grid connection
 - It will feature twin-turbine floating foundations.
 - It will be the first project in Northern Europe to use offshore turbines from Chinese supplier Mingyang Smart Energy.
- Adjusted for inflation, this AR4 price is slightly above the ceiling price of €120/MWh set for upcoming 250MW tenders in France and well below the €165/MWh starting price that has been established for upcoming offtake auctions in Italy.

**NB: All
monetary
figures are in
2012 prices**

AR4 Pricing: results and trends



Onshore wind

- Prices fell from an average of around £80/MWh at AR1 in 2015 to £42.47/MW at AR4 in 2022.
- Turbine technology has evolved considerably in this time. AR4 projects will use units rated between 4MW and 6MW, far larger than the 2MW and 3MW rated machines used by AR1 projects.
- AR4 onshore wind prices are in line with prices of around €60/MWh seen for onshore wind at recent auctions in Germany, Italy and Poland.
- Turbines rated between 6MW and 7MW are commercially available in 2024/2025, but unlikely to feature as successful projects are permitted to use tip heights of 180 and 200 metres.
- These tip height limits are a key factor in why onshore wind currently being more expensive than offshore wind in the UK.

Remote island wind

- Prices increased from £39.65/MWh at 2019's AR3 to £46.39/MWh at AR4 this year.
- There has not been a major step up in onshore wind turbine technology for remote island wind projects between its last inclusion at AR3 in 2019 and AR4 in 2022.
- Higher prices between the rounds reflect increases from turbine suppliers looking to stay profitable amid global cost inflation.
- 2022 has seen the some of the highest average selling prices for onshore wind turbines (calculated on a mEUR per MW basis) for the last decade.

AR4 Pricing: results and trends



Solar

- Prices fell from between £50/MWh and 80/MWh at AR1 in 2015 to £45.9/MWh at AR4 2022.
- This is attributable to lower production costs and increased conversion efficiencies of solar cells.
- The prices seen at AR4 are in line with prices seen in many European markets this year.
- UK prices are still far higher than those seen in some southern European countries with high levels of solar radiation. Portugal for example saw negative pricing for solar projects this year.

Tidal Stream

- Clearing price of £178.54/MWh represented a 15% saving on ASP of £211/MWh.
- Will take UK capacity with revenue support from 10.4MW today to 51.2MW by the end of 2027.

Expectations for AR5 – Future pricing

- At AR3 BEIS predicted winning projects would have no budgetary impact between 2023 and 2027. Projects were predicted to earn £307m for the treasury in 2026/7. This was based on BEIS forecasts for future reference prices for offshore wind and remote island wind of between £48.13/MWh and £51.23/MWh.
- AR4 presented a different picture:
 - Pot 1 is expected to have a budgetary impact of £9.7m in 2026/7
 - Pot 2 an impact of £60m in 2028/9
 - Pot 3 an impact of £172m in 2028/9 (even though the price for offshore wind fell from £41.61/MWh and £39.65/MWh at AR3 to £37.35/MWh at AR4)
- This is because the forecasted budgetary impact of AR4 was based on much lower forecasts of future reference prices for technologies (see table below).
- Reference price expectations published ahead of each round are key in determining how quickly the budget for each pot is consumed.
- Price expectations have changed considerably since the last auction due to geopolitical factors.

	2023/4	2024/5	2025/6	2026/7	2027/8	2028/9
Baseload reference price	£48.85	£49.71	£48.36	£45.35	£42.94	£38.15
Offshore Wind			£47.05	£42.05	£38.77	£32.85
Onshore Wind	£48.57	£48.76	£47.36	£42.80	£40.12	£34.11
Solar	£47.16	£47.11	£44.45	£41.61		

More than £10/MWh lower than at AR3 reference price forecasts.

Expectations for AR5 - design



- The UK government is expected to open AR5 for applications in March 2023.
- Qualifying bidders will submit sealed bids between June and August 2023, with results due between July and September 2023.
- As of October 2022, the pot structure, size and budget are unknown. The final details are due to be published in December.
- Some minor changes to the assessment process have already been announced.
- These changes seek to strengthen the existing Supply Chain Plan Questionnaire, (SCPQ) a scored mechanism that has been in place since AR4 that is used to pre-qualify projects over 300MW for participation in the round.
- The SCPQ assesses how much a developer is likely to invest in the UK during the realisation of its project. At AR5, projects receiving a score of 50% qualified for the round.
- Government will raise the passing score to 60%. This is because most SCPs for projects successful at the last auction only just cleared the 50% threshold, suggesting developers' commitments were not as ambitious as the government had hoped.
- The new scoring mechanism will focus each project's level of ambition; the provision of quantifiable outcomes/measurable metrics contained in the responses and evidence outlining how planned interventions will be delivered.
- Developers of floating offshore wind projects of less than 300MW will have to complete SCP questionnaires as the government looks to develop a strong domestic supply chain with rapid growth in floating offshore wind expected later this decade.
- Floating offshore wind projects will require a 50% score to pass.

Fixed offshore wind at AR5: volume and pricing



- To be eligible to enter a CfD projects must already have planning consent.
- 4GW of fixed offshore wind capacity is consented and therefore likely to bid at AR5:
 - **Seagreen 1A (0.5GW)***
 - East Anglia One North (0.8GW)*
 - East Anglia TWO (0.9GW)*
 - Norfolk Vanguard (1.8GW)
- The following project has submitted for consent approval and may qualify for the round if permit decisions are taken in time:
 - Hornsea 4 (2.6GW) – Decision due before February 22, 2023
- Scottish projects face higher installation and TNUoS costs. When combined with small size of Seagreen 1A, means that budget and/or capacity caps need to be set at an appropriate levels to ensure this Scottish project can compete.

***Denotes Scottish projects.**

**Consent approval for these projects is currently being reconsidered as part of judicial review proceedings due to finish later in 2022.*

Floating and remote island wind at AR5: volume and pricing



Floating offshore Wind

- There is currently 0.158 GW of consented floating capacity that is likely to bid at AR5:
 - ***Pentland Floating Offshore Wind Demonstrator (0.1 GW)**
 - Blyth 2 offshore wind Farm (0.058 GW)
- A further project has submitted for consent approval and may qualify for the round:
 - Erebus (0.1 GW)

Remote Island Wind

- There is 279MW of consented remote island wind capacity that is currently not backed by a CfD.
 - ***Mossy Hill 50 MW (Shetland)**
 - ***Hammars Hill Extension 4MW (Orkney)**
 - ***Viking 223 MW (Shetland)****
- A further three projects totalling 179MW are awaiting planning consent decisions.
 - ***Energy Isles 126 MW (Shetland)**
 - ***Faray 29 MW (Orkney)**
 - ***Tol Mor 24MW (Lewis)**
- The successful realisation of this capacity is dependent upon the planning and development of subsea interconnector cables between Scottish Islands and mainland UK.

***Denotes Scottish projects**

**** 220MW of this project's 443MW capacity secured support during the AR4 auction**

Other technologies at AR5



Onshore Wind

- The pipeline of eligible onshore wind projects to bid at AR5 stands at between 500MW and 2GW. The vast majority of this capacity is located in Scotland.

Solar

- The volume presentable will depend on changes to permitting rules. Possible that ~2GW of projects could present at auction, but less than 10% of this capacity is based in Scotland.
- The UK Government has announced plans to prevent solar projects from being developed on certain types agricultural land. This may limit the number of projects that present at AR5.

Tidal Stream

- Up to 160MW of tidal capacity is could present at auction, around 45% of this located in Scottish waters.
- This includes further phases of the MayGen and Morlais projects and new in-development projects in the Sound of Islay and the English Channel.

AR5: Pricing expectations

- Supply chain companies are reporting significant increases in the costs of raw materials, energy and logistics.
- They are also experiencing ongoing supply chain bottlenecks in China due to legacy effects of Covid-19 pandemic.
- These factors may drive prices for some technologies up at AR5.
- Price increases were have already been already observed for remote island wind projects at AR4 (from £39.65/MWh to 46.39/MWh) .
- Without a significant step-up the size of turbine platforms that are commercially available it is likely that prices for offshore wind, remote island wind and onshore wind will not see further decreases and may increase.
- It is not clear how indicative the £87.30/MWh paid to the TwinHub project at AR4 are, as the project has novel characteristics:
 - It will be built at a site with a pre-existing offshore grid connection
 - It will feature twin-turbine floating foundations, and
 - It will be the first project in Northern Europe to use offshore turbines from Chinese supplier Mingyang Smart Energy.
- Adjusted for inflation, floating offshore wind's AR4 price is slightly above the ceiling price of €120/MWh set for upcoming 250MW tenders in France and well below the €165/MWh starting price that has been established for upcoming offtake auctions in Italy.
- The presence of larger floating wind projects at AR4 combined with high industry learning rates at early stage projects may however make further cost reductions for floating offshore wind possible.

AR5: Conclusions

- Still a high degree of uncertainty around the structure of AR5, predicting volumes and budgets is difficult due to energy price volatility.
- Prices for some technologies may increase due to inflationary market pressures.
- Significant reductions in the prices seen for floating offshore wind are unlikely to be compatible with government plans to support the growth of a significant domestic supply chain for this technology.
- The expansion of the supply chain for floating offshore wind is a major opportunity for Scotland.
- The pipeline of consented fixed and floating offshore wind projects ready to enter the round is currently not large enough to keep the industry on track to meet 2030 government targets, of 45GW and 5GW respectively.
- Assuming up to five years between allocation round and delivery:
 - To have 5 GW of floating wind capacity installed by 2030, annual allocation rounds out to 2025 will need to deliver average volumes of at least 1.4 GW of capacity.
 - To have 45 GW of offshore wind installed by 2030 annual allocation rounds out to 2025 will need to deliver average volumes of at least 7GW capacity.

<i>Technology</i>	<i>Installed capacity</i>			
	2030 UK target	Target description	Committed UK capacity after AR4	Remaining capacity required
Offshore Wind	45 GW	UK government 2022	24 GW	21 GW
Floating Offshore Wind	5 GW	UK Government 2022	0.08GW	4.2 GW

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CfDs – exploring the present and looking to the future

27 October 2022

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Senior Regulatory Affairs Manager

RWE overview



~15 %
of UK electricity generated



over 10m
UK homes powered



~£15bn
expected investment in clean energy
infrastructure by 2030



2,600
UK based employees

UK



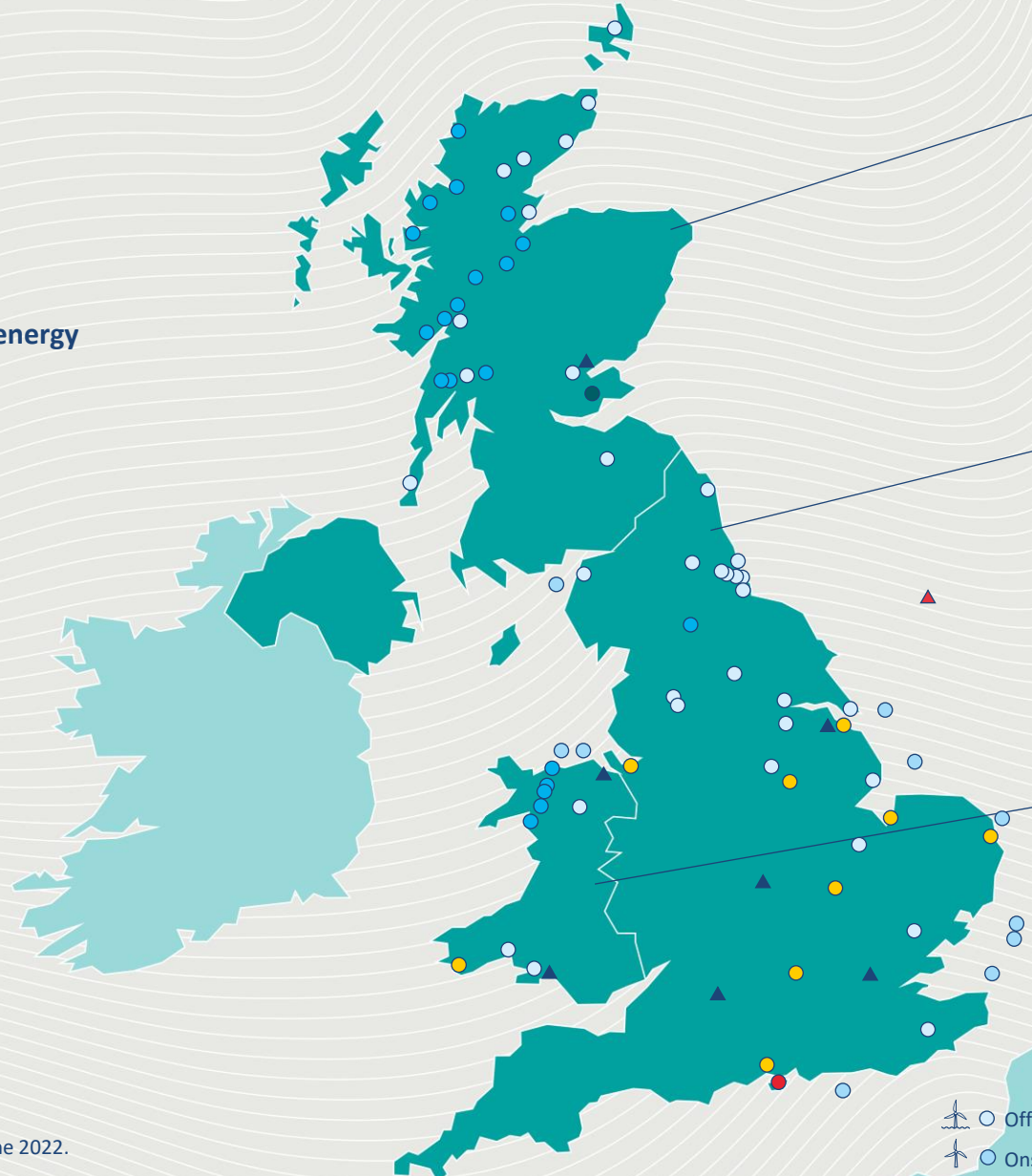
In operation		MW ¹
9	Gas	6,929
33	Onshore wind	738
10	Offshore wind	1,914
1	Biomass	55
21	Hydro	78
3	Oil	253

Sites in operation	Total installed capacity ¹
77	9,968 MW

Under construction	MW ¹
Offshore wind	1,400

¹ MW: pro rata, based on equity share. Capacity as of 30 June 2022.

Site placing is approximate. Some locations have multiple assets. Numbers may not sum due to rounding.



Scotland



Installed sites		MW ¹
10	Onshore wind	213
1	Offshore wind	174
1	Biomass	55
15	Hydro	33

Sites	Total installed capacity ¹
27	475 MW

England



Installed sites		MW ¹
8	Gas	4,748
20	Onshore wind	339
7	Offshore wind	1,407
1	Hydro	1
3	Oil	253

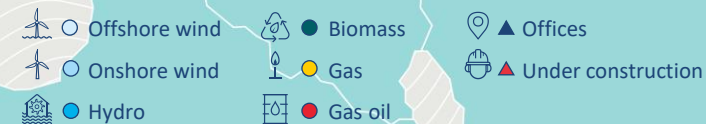
Sites	Total installed capacity ¹
39	6,748 MW

Wales



Installed sites		MW ¹
1	Gas	2,181
3	Onshore wind	186
2	Offshore wind	333
5	Hydro	45

Sites	Total installed capacity ¹
11	2,745 MW



Challenges and opportunities for the CfD: A developers view



- **Auction schedules:** The UK is a global outlier in not providing auction targets. A clear schedule of auction timings, capacity/ budget caps and prices would give developers and the supply chain the certainty it needs



- **Supply chain challenges:** A robust debate needs to be had on how best to incentivise the supply chain within the CfD scheme. We believe a strategic reset is needed in light of the global supply chain situation and accelerated offshore targets



- **Drawing the line with REMA:** The current two-way CfD is a best in class investment model. REMA alternatives need much more detail and evidence to ensure a fair comparison. Government need to provide a clear inflection point for any transition away from the current model



- **Voluntary CfD opportunities:** RWE believes that voluntary CfDs are the most efficient and investor-friendly mechanism to further ‘de-link’ the electricity price from the marginal gas price and support reductions in consumer bills. Measures could be implemented quickly when compared to “market splitting” or other design options

Anne-Marie Coyle

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Haliade-X – Shaping the Future

GE RENEWABLE ENERGY – OFFSHORE WIND



GE Renewable Energy

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Haliade 150-6MW installation at First US Offshore Wind Farm; picture courtesy Deepwater Wind





ONSHORE WIND



OFFSHORE WIND



LM WIND POWER



UNLEASHING LIMITLESS ENERGY



DIGITAL SERVICES



GRID SOLUTIONS



HYDRO



HYBRIDS

\$15.7B REVENUE	95+ COUNTRIES	38,000+ GLOBAL EMPLOYEES	~50,000 WIND TURBINES INSTALLED GLOBALLY	25%+ OF WORLD'S HYDRO INSTALLED BASE	90% OF TRANSMISSION UTILITIES WORLD-WIDE HAVE BEEN EQUIPPED WITH GRID SOLUTIONS TECHNOLOGY	400+ GW INSTALLED BASE THE WORLD'S LARGEST CLEAN ENERGY FOOTPRINT	>10% OF GLOBAL RENEWABLE ENERGY CAPACITY IS PROVIDED BY GE TURBINES
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Haliade-X: POWER MEETS EFFICIENCY

GE's Largest, High Efficiency Offshore Turbine

Innovative Blade Design by LM Wind Power

Ideal for High to Medium Wind Speeds

NOMINAL CAPACITY

- 12-14.7MW with 220m rotor

CAPACITY FACTOR

- 60-64%

ANNUAL ENERGY PRODUCTION

- ~64GWh to ~77GWh

ROTOR DIAMETER

- 220 METERS

WIND CLASS

- IEC IC

DESIGN LIFE

- 25 years & site specific life time ext.

HUB HEIGHTS

- 138 m

FREQUENCY

- 50 & 60 Hz



Design drivers:

- Design for **EHS and ergonomics**
- **High Capacity Factor for Lowest LCOE**
- **Modular design** on proven **technology** for a simple, reliable & flexible assembly
- Flexibility inside the **plant and the global supply chain**
- **Standardization** to drive continuous improvement
- **Independent testing** of modules & full validation/commissioning in manufacturing plant
- **Simple interfaces** to avoid complex tooling & simple installation



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REMA wasn't built in a day – creating an electricity market fit for net-zero

Chaired by Bob Hull, Managing Director,
Riverswan Energy Advisory



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Rachel Cary

Head of Policy, REMA, BEIS

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