AURORA ENERGY RESEARCH

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Aurora Spring Forum 2018 Highlights

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ING ADDLESHAW GODDARD Matheson PJT Partners AUGUSTA & CO

Aurora Spring Forum Highlights 2018

Dear Friends and Colleagues,

It was my very great pleasure to welcome you to Oxford this year for our fourth Spring Forum. The event has grown more than tenfold since its beginnings in 2013, and I am delighted that our Forum is regarded so highly as the place where serious big energy issues are discussed. Your contributions to this year's Forum focused on Navigating the Global Energy Transition were, as always, hugely appreciated.

We were honoured that the Rt.Hon Claire Perry, MP, Minister of State for Energy and Clean Growth, was able to take time out of her ministerial calendar to present the keynote address about the Government's Industrial Strategy and forthcoming policy focus areas. Everyone at the Forum has a stake in this and the shape of future policy will of course affect all market participants.

We were also delighted to hear from Magnus Hall, CEO of Vattenfall, Alistair Philips-Davies of SSE and Rachel Reeves MP. Vattenfall's news announced the day before the Forum, about its first subsidy-free project was a real focus of interest for the room and struck a chord with Aurora's big focus this year on subsidy-free renewables. The subsidy-free revolution was the topic of Aurora's keynote, a full copy of which is included in our Forum Highlights.

The programme this year reflected the big seismic changes we are experiencing globally in energy markets as part of the long-term transition to clean and smart energy generation. In addition to leading one of the panels, I was also privileged to listen to many of the challenging and interesting debates. As always, the level of debate was second to none.

I would like to thank again the many people who contributed to the success of Aurora's Spring Forum this year. Our speakers are central to the day and we are hugely grateful for their friendship and support. Thank you for your generosity of time, spirit and expertise!

Our generous sponsors are due special appreciation, having supported us in our greater ambition for the Forum this year. Our 2018 Title Partnership with Barclays builds on many years of fruitful cooperation. Thank you also to Partners of the Spring Forum - Addleshaw, ING, Augusta, Matheson and PJT Partners.

Finally, thank you to my own team at Aurora Energy Research for their diligence, commitment and adaptability in staging the 2018 Forum.

We look forward to welcoming you again next year, when we will have new challenging topics to discuss as part of the ongoing global transition.

John Feddersen

Co-Founder and CEO
Aurora Energy Research

The programme this year reflected the big seismic changes we are experiencing globally in energy markets as part of the long-term transition to clean and smart energy generation.

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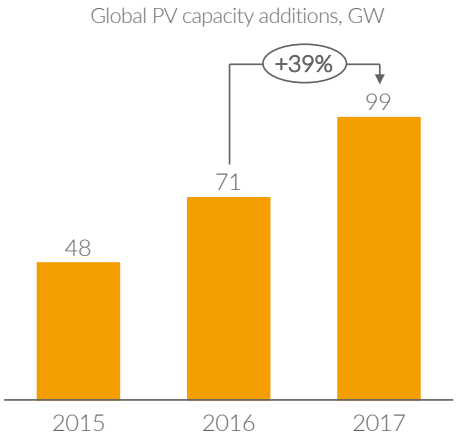
The year in review

A look-back on noteworthy energy industry headlines in 2017

Solar:

- Capital cost declines continue to exceed expectations
  - Oct 2017: Record of $17.8/MWh set in Saudi Arabia
  - Sub $30/MWh now possible in many countries, undercutting thermal
- Sep 2017: UK's first subsidy-free solar farm opens
- Feb 2018: German PV auction clears at €43.3/MWh, 34% y-o-y decline

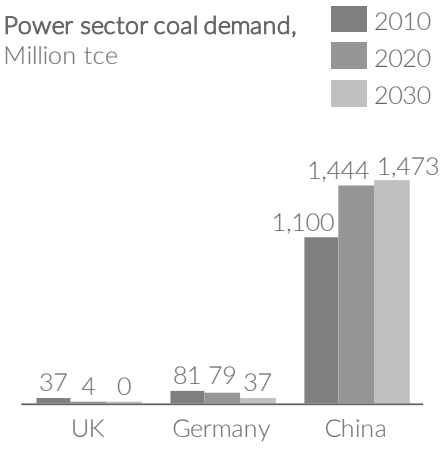


Wind:

- Apr 2017: 'zero-subsidy bids' in German CfD auction
- Sep 2017: UK auction sees bids as low as £57/MWh, subsidy-free investment nearing
- Dec 2017: Netherlands hold first tender for zero-subsidy offshore wind
- Jan 2018: German Onshore auction clears at €47.3/MWh

Coal:

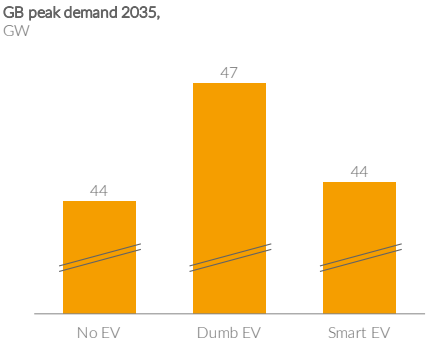
- Jan 2017: China limiting build-out of coal plant fleet, cancelling 120 GW
- 21 April 2017: first ever coal-free day in UK since 1880s
- Nov 2017: 19 countries pledge to phase out coal power generation at Bonn climate talks
- Feb 2018: German government coalition includes coal exit in coalition treaty



EVs:

- New models unveiled in 2017 include Tesla's Model 3, Proterra's electric bus, Daimler's heavy-duty electric truck
- China sets aggressive sales targets of 7m EVs by 2025
- UK to ban internal combustion engine car sales by 2040
- UK progress on charging infrastructure

Peak demand does not change if EV integration is smart:

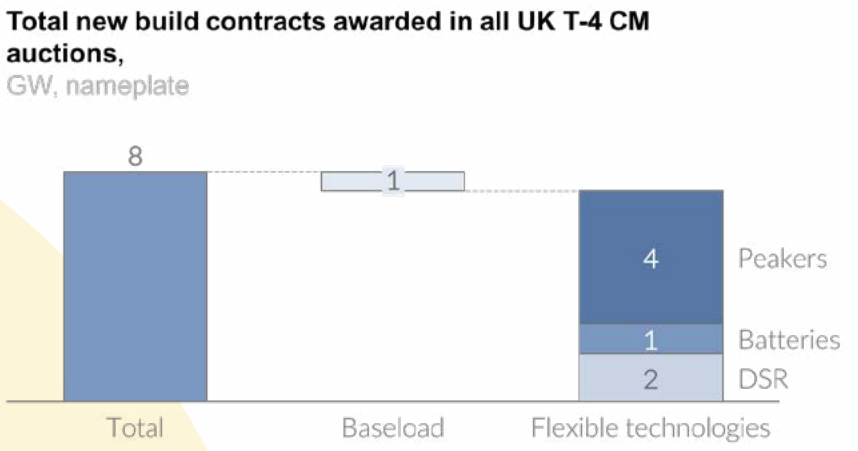


Source: Aurora Energy Research

Battery storage:

- In the UK, 1 GW of batteries have been contracted via capacity market
- In Germany, 50 % of Frequency Containment Reserve will be covered by batteries by 2018
- Tesla's 100 MW battery in South Australia has been build in 100 days
- In the US, 0.4 GW have been deployed over the last two years

Flexible technologies:




VATTENFALL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Speaker and delegate feedback:

Tom Glover, Chief Commercial Officer, RWE

"Congratulations to Aurora for an excellent conference. I must say, it really is an excellent event for both sharing knowledge but also networking – thanks!"

Tania Songini, NED Thrive Renewables plc, Founder/Board Member Hawthorn Group'

'An event that covered the key questions the energy sector is facing in this transition phase. I particularly appreciated Mateusz contribution on subsidy free Renewables... really useful insight and food for thought''

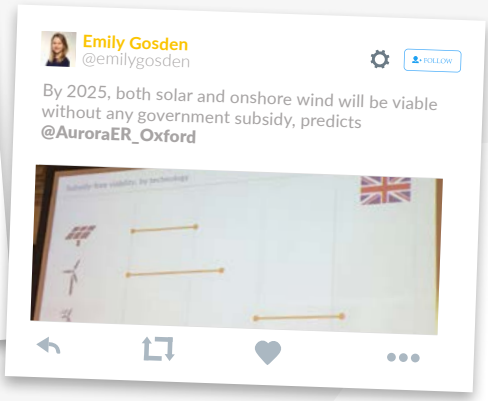
Dr Mark Jonathan Davies, Intertek

"I just wanted to thank you very much for yesterday's Aurora Spring Forum. I greatly enjoyed the conference which I thought was excellent in all dimensions (speakers, venue, content, discussion, organisation and sense of fun)."

Matthew Knight, Head of Business Development, Siemens plc

"Nothing can match the drawing power of @AuroraER, @DieterHelm and the beautiful city of Oxford. Aurora's spring conference is becoming the Davos of the energy industry." (Matthew Knight, Head of Business Development Siemens plc)

Twitter:



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Media takeaways:

The Times (21 March 2018)

Wind farms 'on course to be free of subsidy'

"The plunging costs of the technologies [onshore wind and solar farms], which were reliant on very high subsidies just a few years ago, could enable investors to build them without any government intervention by the early 2020s, said Aurora Energy Research.

The Guardian (20 March 2018)

Subsidy-free renewable energy projects set to soar in UK, analysts say

"The UK is well on the way to a new era of subsidy-free renewable energy projects that will largely kill off prospects for new gas power stations, according to industry analysts. Mateusz Wronski, an analyst at Aurora, said: "The subsidy-free revolution is here and it's big."

BusinessGreen (20 March 2018)

'The tip of a very large iceberg': 'Subsidy- free' offshore wind contract awarded, as low cost renewables trend gathers pace

"Aurora co-founder and CEO John Feddersen told the audience at its annual forum this morning that "in terms of subsidy-free renewables, we are at the tip of a very large iceberg". The latest evidence from the Netherlands, not to mention the bold ambitions of the UK's offshore wind industry and the changing strategies adopted by the world's largest energy firms, suggests he is almost certainly right."

Energyst (20 March 2018)

Scottish Power chief: You're bonkers if you think we will build offshore wind 'subsidy-free'

Scottish Power chief executive Keith Anderson has questioned the apparent obsession with achieving 'subsidy-free' renewables, warning it will not happen any time soon in the UK for technologies such as offshore wind. Anderson took part in a panel debate around 'post-subsidy' renewables at Aurora's Spring Conference.

Recharge (21 March 2018)

'No-subsidy renewables could be 60GW 'game changer': Aurora'

Subsidy-free renewables could balloon to a 60GW, €64bn ($78.6bn) investment opportunity across northwest Europe by 2030, according to latest analysis from Aurora Energy Research. The UK-based research group said the prospect of large-scale subsidy-free development had emerged rapidly, with implications beyond wind and solar as a "true game-changer" for the energy industry. Aurora released its analysis at its annual Spring Forum in Oxford, a day after Vattenfall secured up to 750MW of capacity following the world's first zero-subsidy auction in the Netherlands.

Platts (20 March 2018)

Subsidy-free renewables 'set to revolutionize NEW market': Aurora

"Subsidy-free renewables are already investible in many parts of Europe, and on the verge of breakthrough in Great Britain, Aurora Energy Research's Mateusz Wronski said at the annual forum in Oxford."

Utility Week (22 March 2018)

Britain on course for £20bn subsidy-free renewables 'revolution'

Subsidy-free Contracts for Difference would be a "game-changer", according to Mateus Wronski, Head of Product Development at Aurora, "providing a bridge before a deeper [power purchase agreement] market emerges." He said they would be essential for offshore wind to achieve Aurora's projections.


AURORA


Session Five-A
Financing the energy transition: Evolving norms, ris
conceptions and treatment of market-exposed reve
Host:
Laurie Fitch
Speakers:
George Grant
Pratima Rangajaran
James Samworth
Matt Setchell

Aurora Keynote Presentation

Renewables 2.0: The subsidy-free revolution

The growth of subsidy-free renewables has profound implications for the growth of the market and future policy development. Mateusz highlighted an investment opportunity in the region of €180 billion across North West Europe (GB, Germany, France, Ireland, the Netherlands and Belgium).

"Back in 2010 at the start of the Electricity Market Reform process in GB, few would have imagined that by 2018 we would be talking about a subsidy-free future for renewables. Yet, this is where we have arrived, and our research highlights clearly the enormous prize and potential in the market, not only in GB but across Europe. This will be a true game changer for the energy industry and policy makers, with a knock-on effect on baseload technologies as well as flexible generation."

The rise of subsidy-free renewables is a BIG deal for renewables investors with up to 18GW potentially by 2030 in GB alone, and over 60GW across North-West Europe.

> As Mateusz explains,
>
> the nature of this investment is fundamentally different too. It is merchant risk and hence investors have to understand their exposure to power price, and to the complex set of market drivers that shape the power price, including commodity prices, but also deployment of RES and the amount of flexibility on the system."

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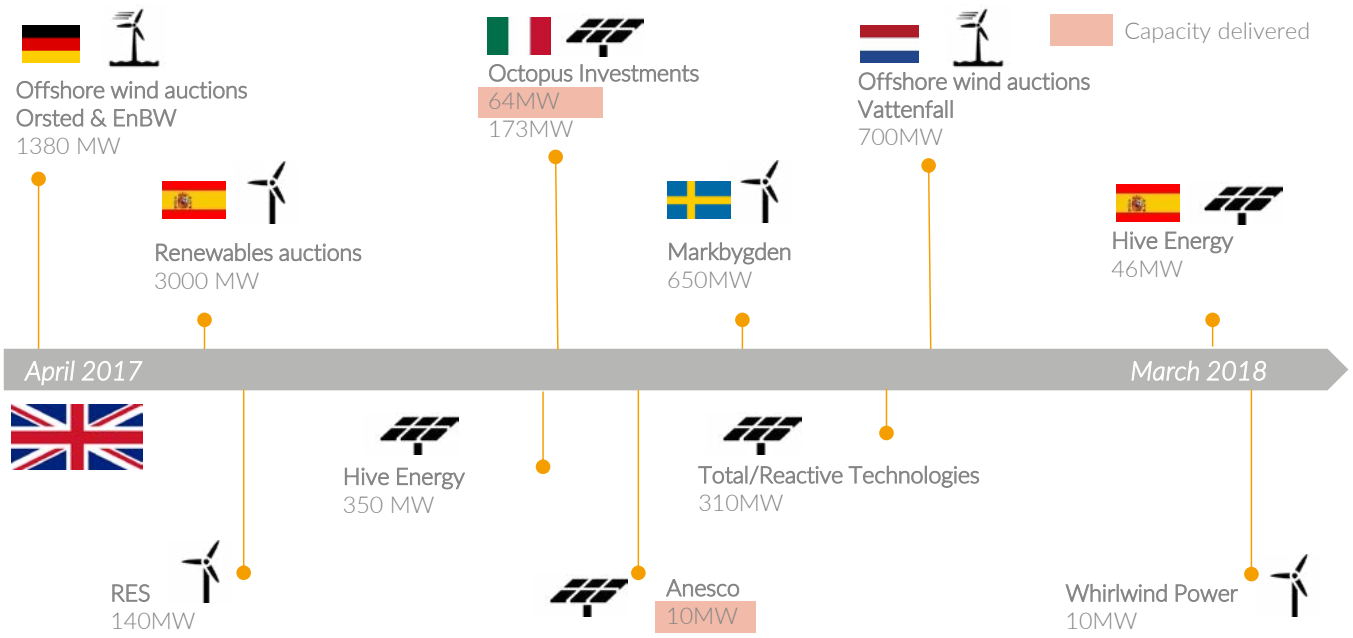
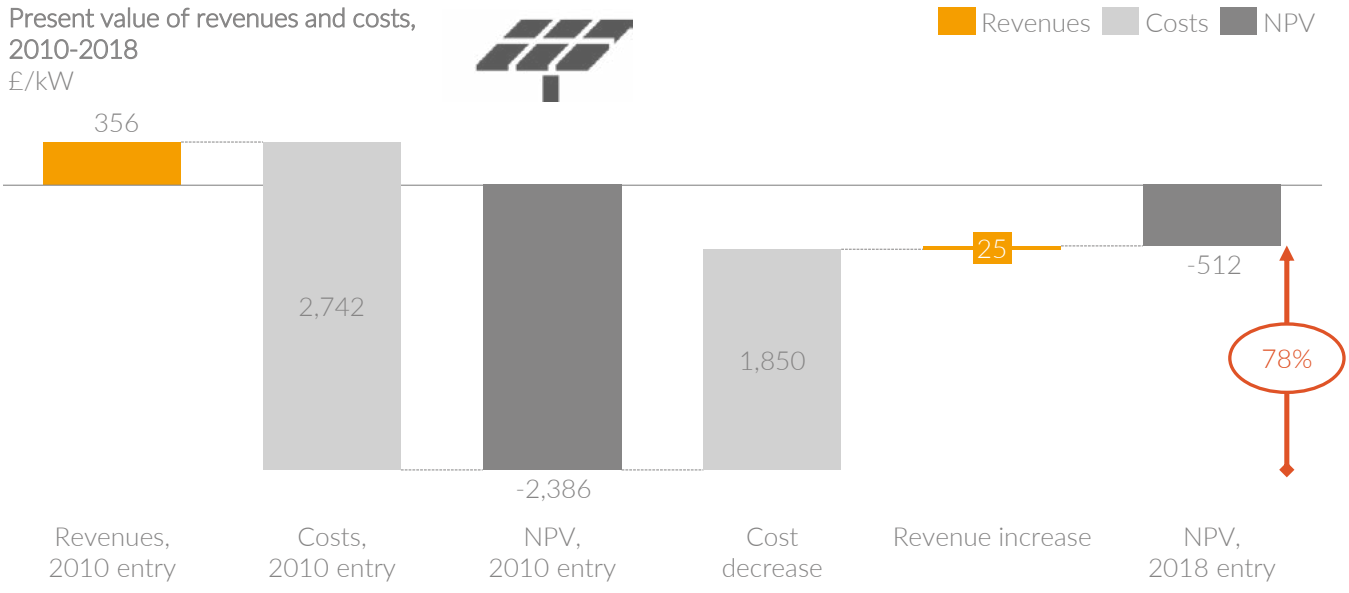
Aurora presentation: Renewables 2.0: The subsidy-free revolution

Subsidy-free RES – last 12 months



Source: Aurora Energy Research

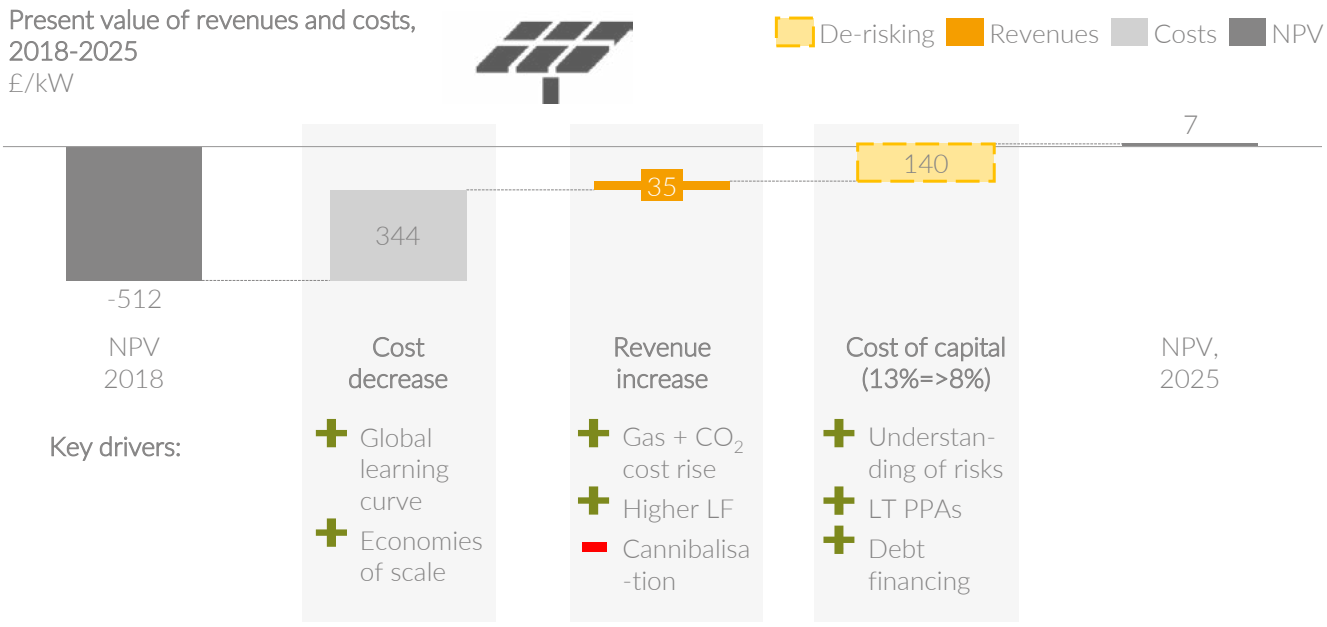
GB solar PV economics: 2010 – 2018



Source: Aurora Energy Research

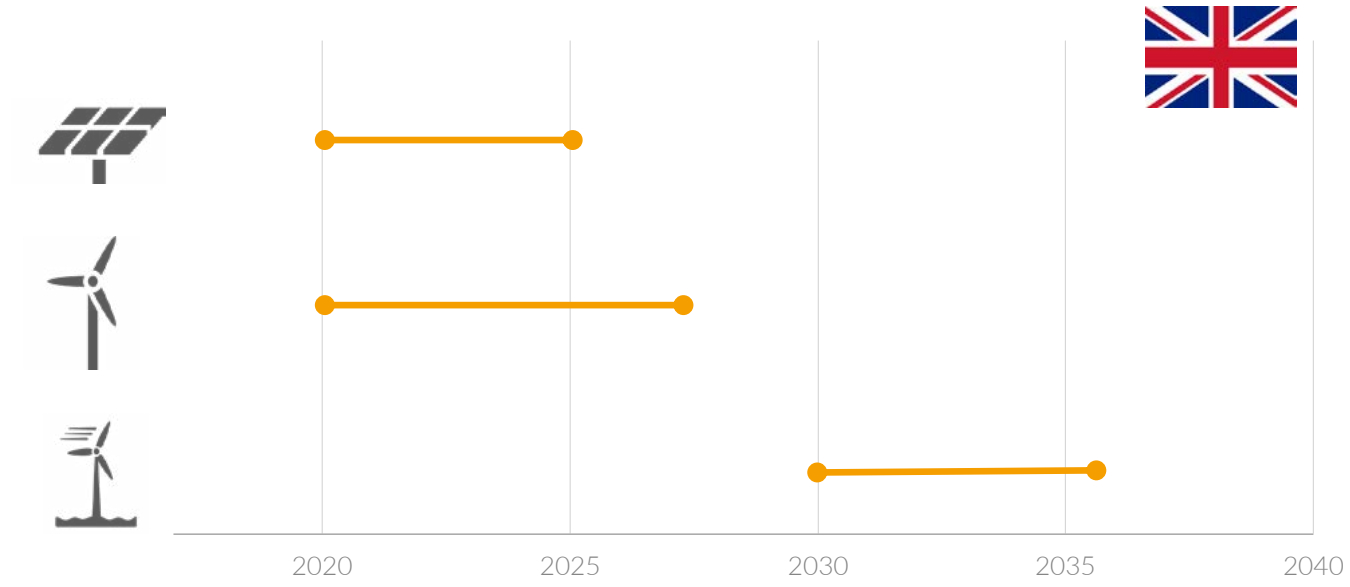
Aurora presentation: Renewables 2.0: The subsidy-free revolution

GB solar PV economics: 2018 – 2025



Source: Aurora Energy Research

Subsidy-free viability, by technology

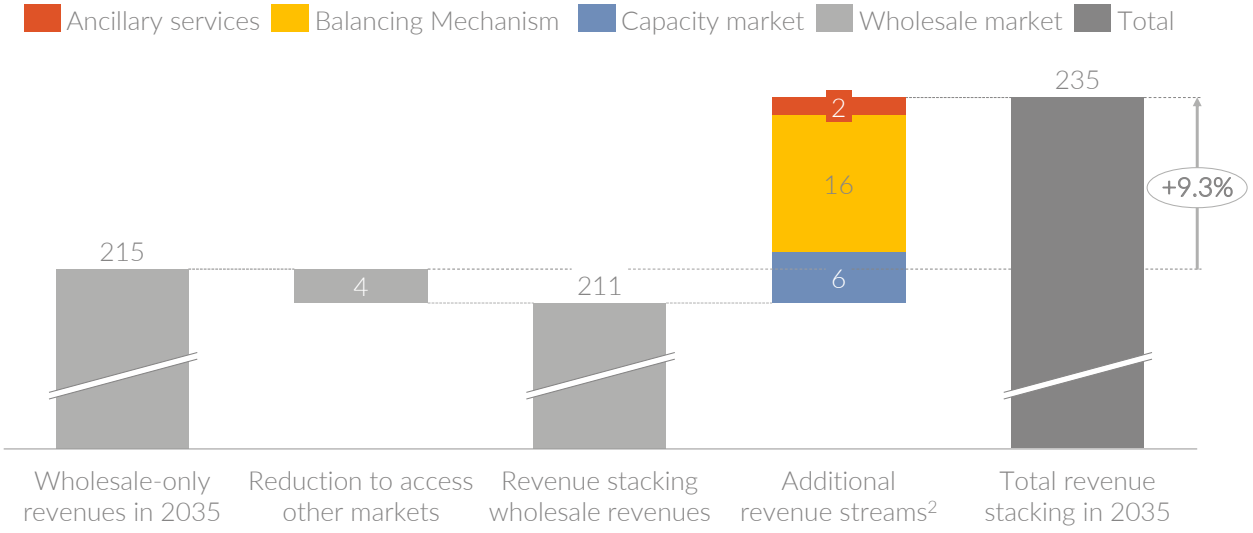


Source: Aurora Energy Research

Aurora presentation: Renewables 2.0: The subsidy-free revolution

Revenue stacking

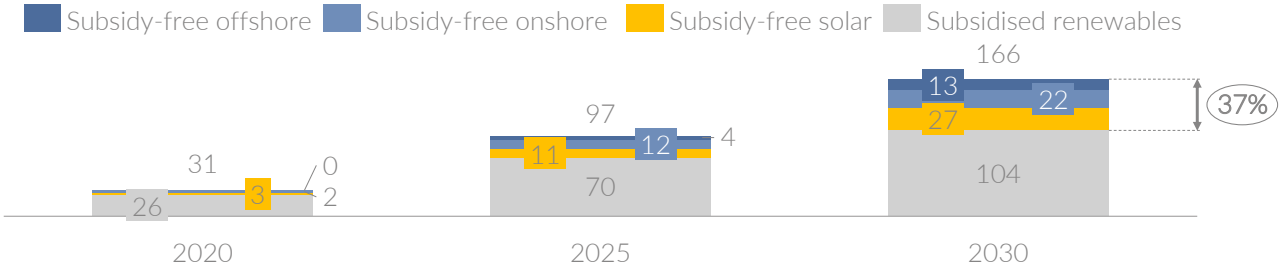
Revenues of an offshore wind farm in 2035 for revenue-stacking model, GB
£ per kW, 2016 real



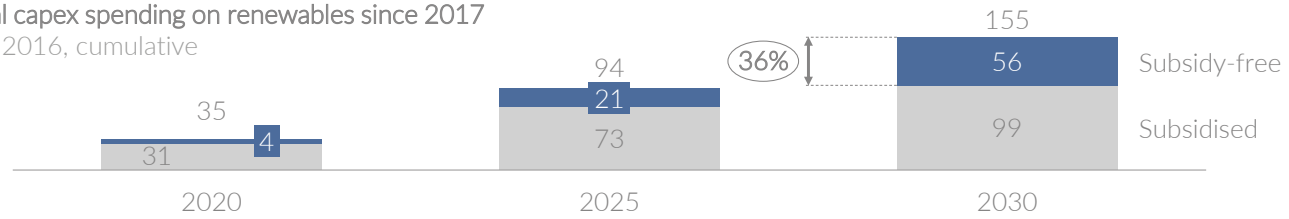
Source: Aurora Energy Research

Size of the opportunity in North-West Europe

Additional renewables capacity since 2017,
GW



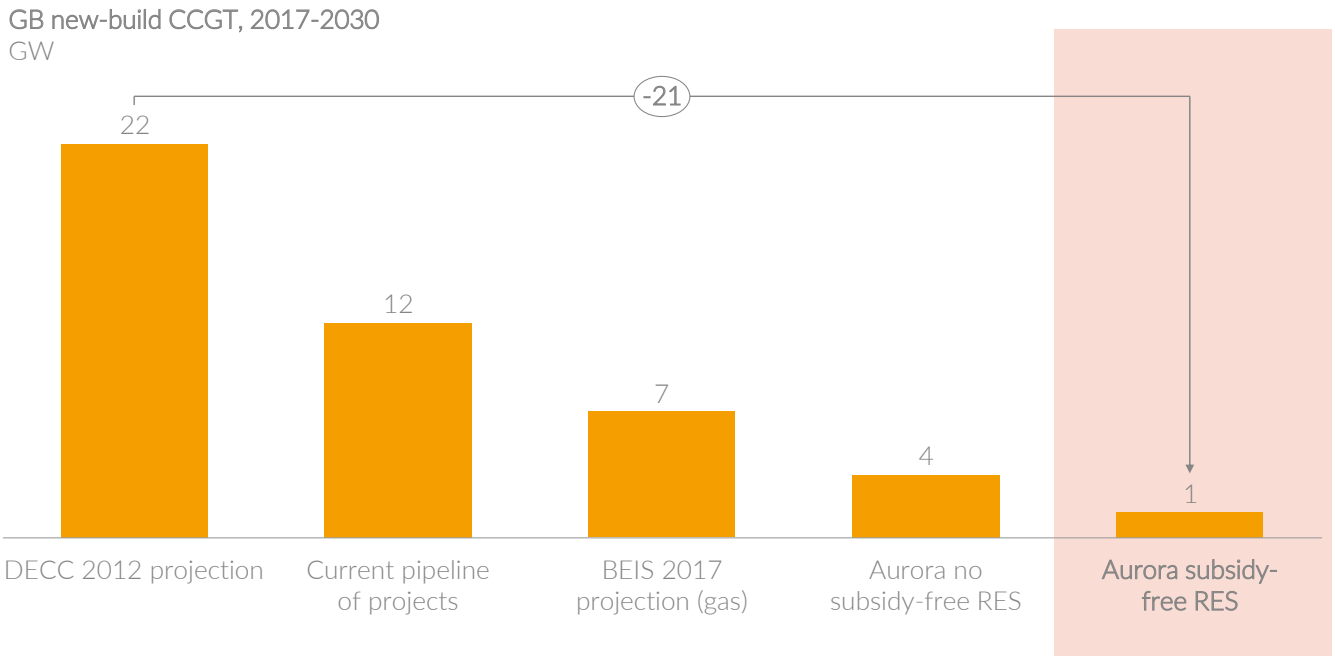
Total capex spending on renewables since 2017
£bn 2016, cumulative



Source: Aurora Energy Research

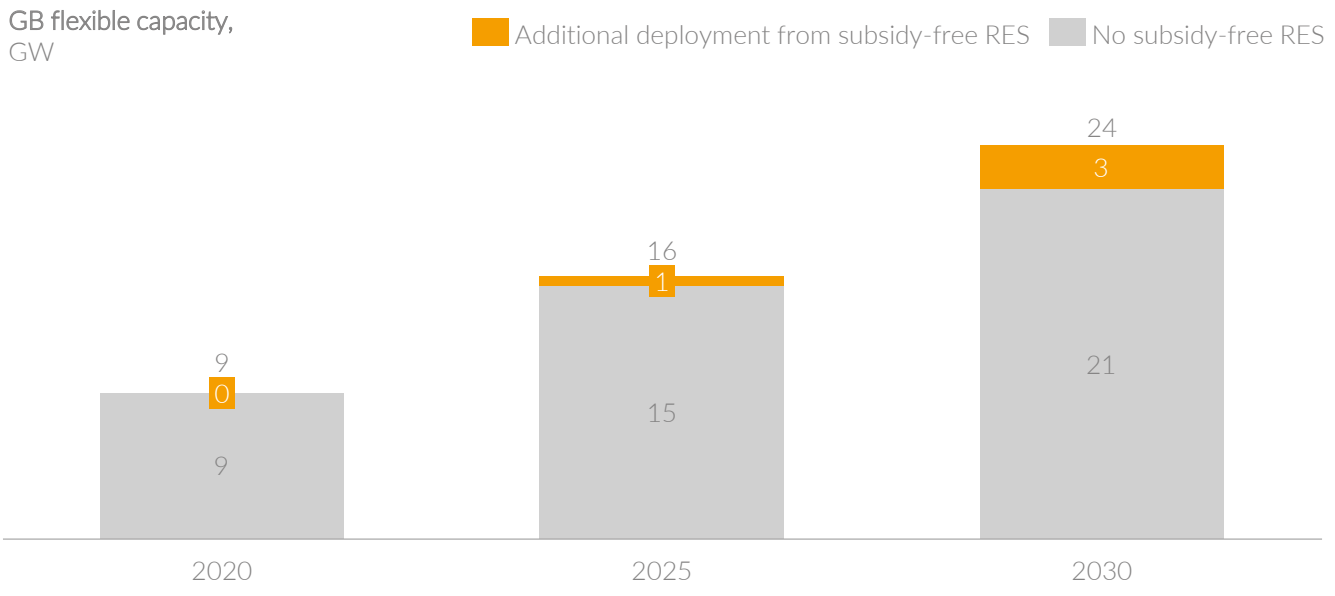
Aurora presentation: Renewables 2.0: The subsidy-free revolution

Impact on CCGTs



Source: Aurora Energy Research

Impact on flexible capacities

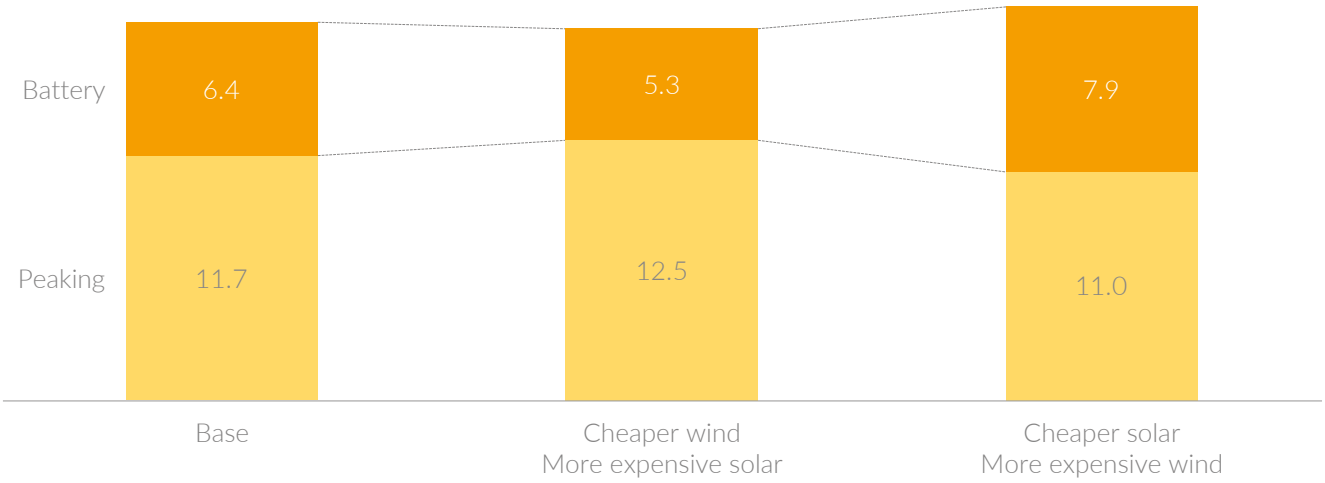


Source: Aurora Energy Research

Aurora presentation: Renewables 2.0: The subsidy-free revolution

Impact of type of renewables on type of flexible capacities

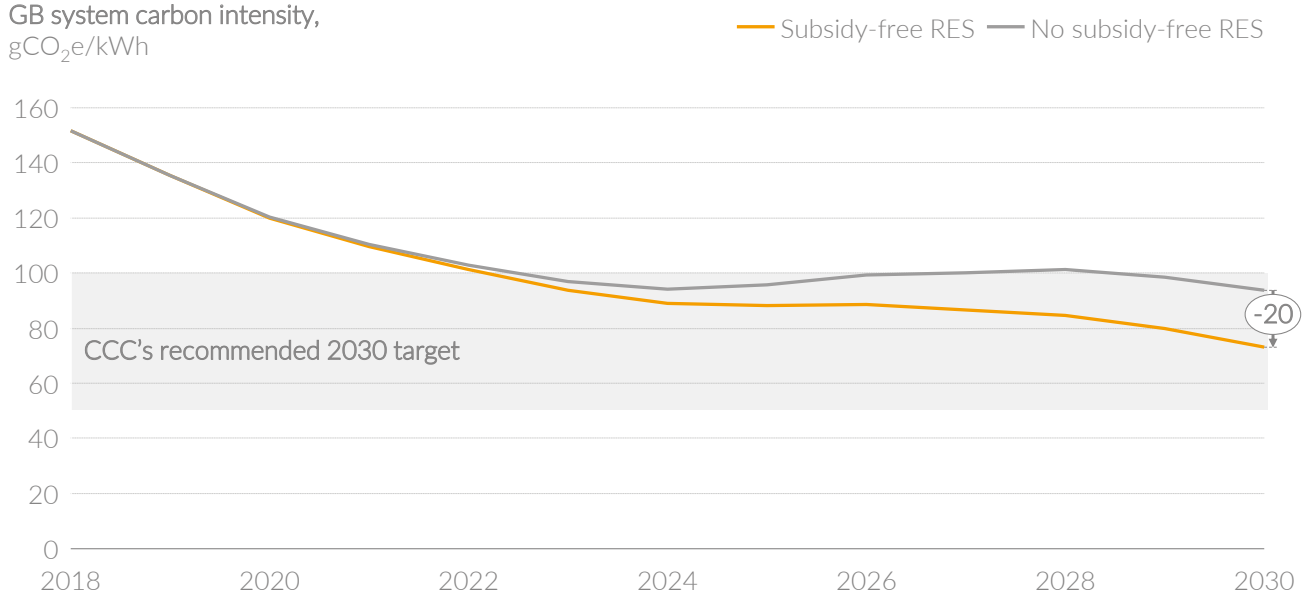
GB peaking and battery capacity in 2030,
GW



Source: Aurora Energy Research

Impact on carbon intensity

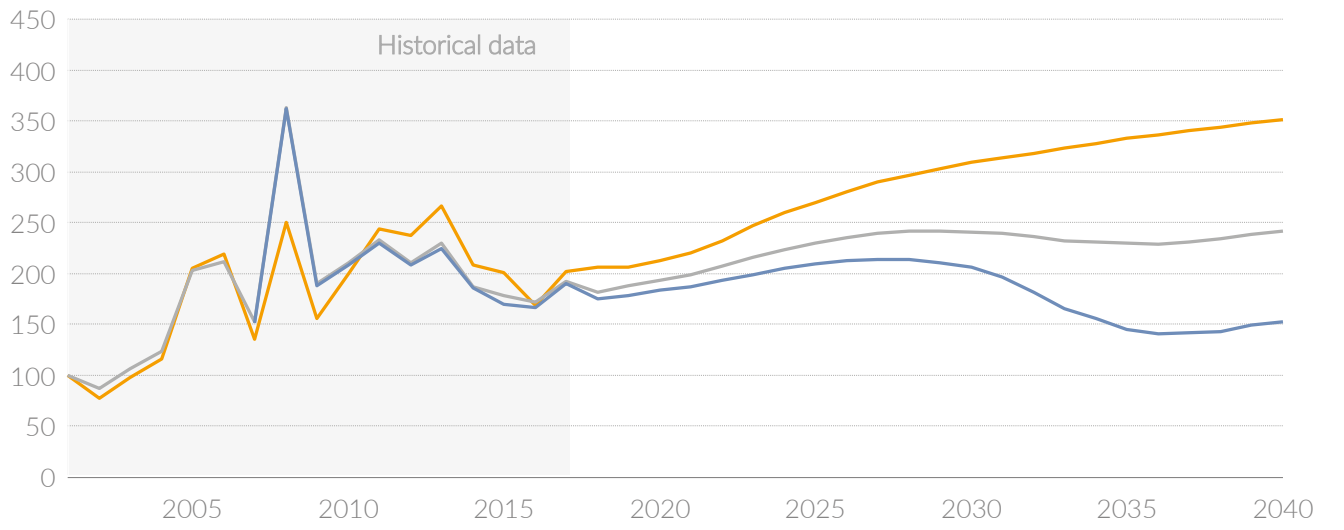
GB system carbon intensity,
gCO_2e/kWh



Source: Aurora Energy Research

Aurora presentation: Renewables 2.0: The subsidy-free revolution

Power price risks



Source: Aurora Energy Research

Capture price drivers

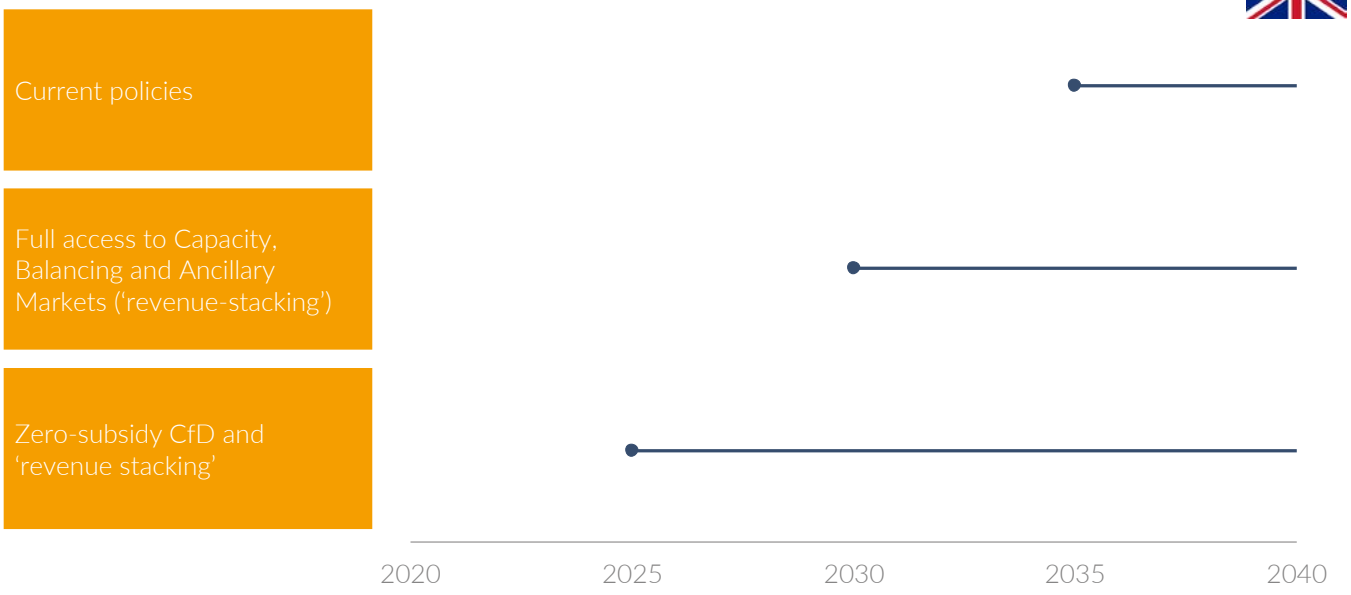
Risk category	Description	Impact on GB onshore wind capture price 2030, GBP/MWh (Base: £46/MWh)
"Traditional" merchant	Low fuel and carbon prices	-12
Cannibalisation	High RES build-out	-10
System composition	High nuclear	-6
	Low flexibility (low EVs, dumb EV charging, low I/C, high battery CAPEX)	-6
Realistic "Worst Case"	Combination accounting for feedback loops	-16

Source: Aurora Energy Research

Aurora presentation: Renewables 2.0: The subsidy-free revolution

Role for policy

First deployment of subsidy-free offshore wind under alternative policy scenarios



Source: Aurora Energy Research

Key take-aways

1. Subsidy-free renewables are quickly becoming investible, creating a **60bn GBP investment opportunity** in North-West Europe alone
2. The additional renewable capacity deployed without subsidies displaces baseload thermal generation and **boosts opportunities for flexible assets**
3. Investment in unsubisidised RES requires understanding increasigly complex merchant risks; **establishing a credible „Worst Case" is vital in risk management**
4. Long-term policy clarity, ensuring level playing field across all markets, and subsidy-free CfDs, could be **policy game changers for subsidy-free deployment**

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Aurora Conferences

Renewables Conference – London (**June 2018**)

In 2018 Aurora Energy Research launched its new subscription service focused on renewables. This conference will bring together leading industry participants to look at the issues and opportunities for investors in the renewables sector.

3rd Battery Storage & Flexibility Conference – London (**October 2018**)

Building on the success of previous Aurora battery conferences, we will host our third event in Autumn 2018. The event combines original analysis and forecasting with provocative insight and discussion from leading industry figures in a focused conference in London.

5th Aurora Spring Forum – Oxford (**March 2019**)

The Aurora Spring Forum is the leading private gathering of the global energy industry. It brings together industry leaders in an exclusive setting at the University of Oxford to engage on key issues impacting GB, European and global energy markets.

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Aurora Group Meetings 2018

GB Power Market Service

- 16 January
- 06 March
- 17 May
- 26 June
- 09 October
- 04 December

GB Distributed and Flexible Energy Service

- 17 April
- 11 September

GB Renewables Service

- 09 May
- 10 July
- October (TBC)

German Power Market Service

- 28 February
- 07 June
- 18 September
- 29 November

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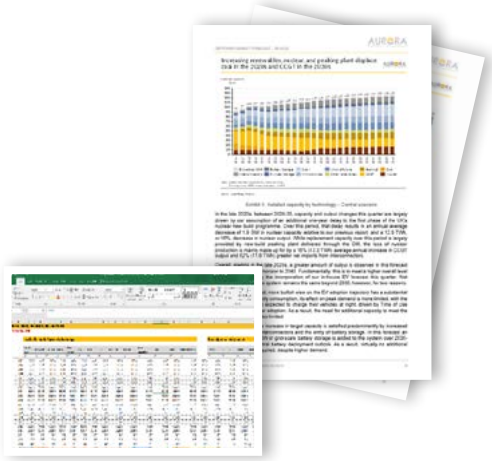
AURORA ENERGY RESEARCH

Power Market Intelligence Services

Market analysis and forecasts for all power market participants

Market Forecast Reports and Data

- Power market development until 2040 including prices, price shape, spreads, capacity and generation mix development, capacity market results, capture prices for all technologies
- Detailed review of policy and regulatory framework, including discussion of key policy uncertainties
- Forecasts are provided under three scenarios (central, low, high) plus sensitivities of key power price drivers and selected scenarios on key policy uncertainties
- Highly granular description of underlying assumptions and unrivalled level of transparency
- Additionally, provision of all underlying data in Excel



Group Meetings and Strategic Insight Reports

- Regular in-depth analysis to provide unrivalled insight on critical topics for the power industry

Planned Strategic Insight topics for 2018 include:

  - The E-mobility revolution: impact of electric vehicles on the GB/German power system, and emerging utility business models
  - Lessons learned from the fourth capacity market auction
  - Connecting the dots: power market outlook for Benelux and France and implications for interconnection
  - Gas & storage: what's the value of long-term flexibility?
  - Alternative designs for markets with high renewables penetration: thinking beyond the merit order
  - Renewable and flexible heat: power market impact and new investments opportunities

- We present and discuss these topics in our regular Group Meetings and publish our insights in Strategic Insight Reports

Extensive interaction with the Aurora team

- Bilateral workshops with senior members and subject experts of Aurora's team to discuss Aurora's analyses and views on the market
- Our analysts will provide support at short-notice on questions arising from our research

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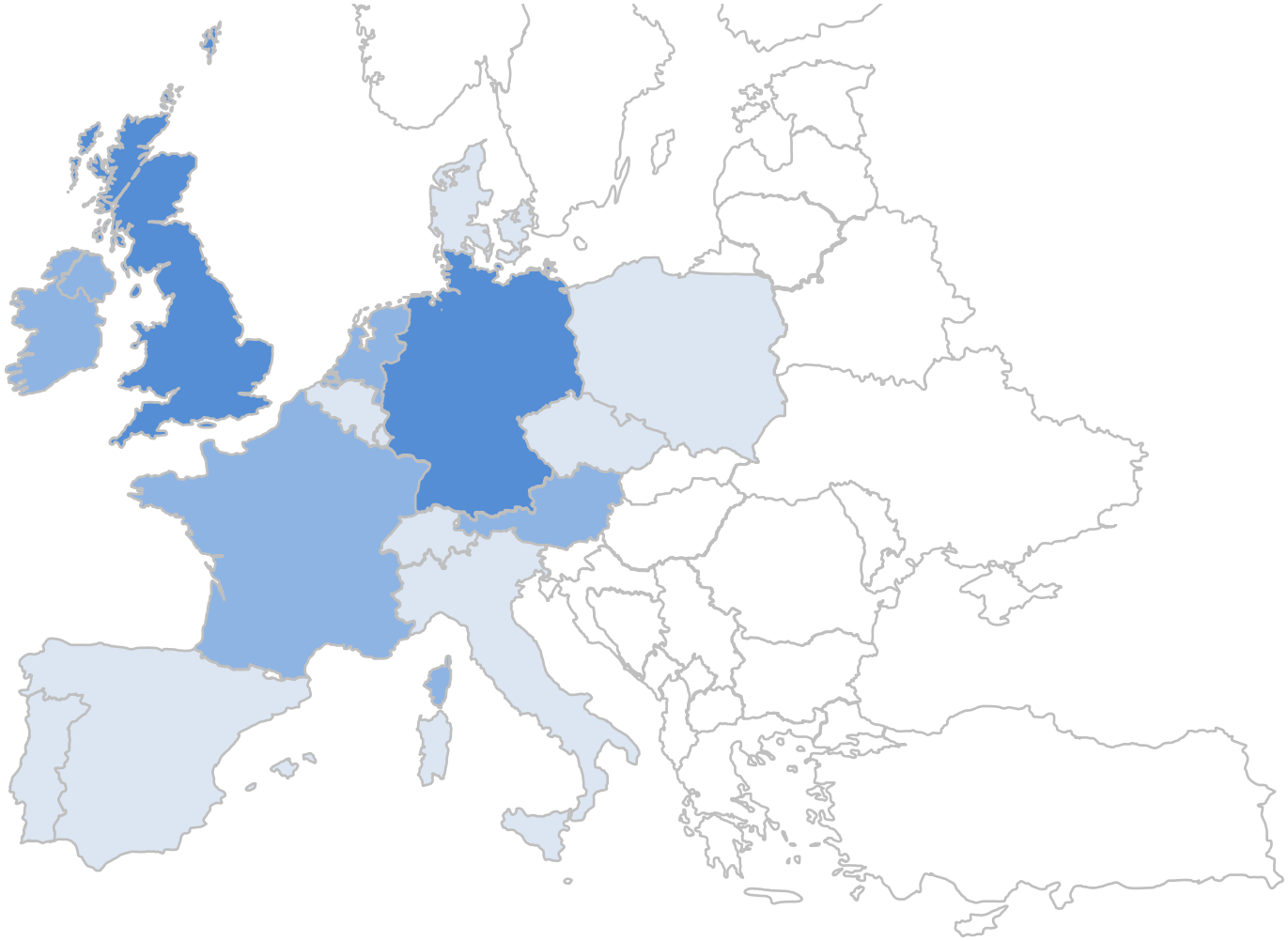
Power Market Intelligence Services

Market analysis and forecasts for all power market participants



Aurora offers power market forecasts and market intelligence spanning Europea's key markets

Comprehensive Power Market Services

- Power market forecast reports
- Forecast data in Excel
- Global energy market forecast reports
- Strategic insight reports
- Group meetings
- Bilateral workshops
- Analyst support

Power Market Forecast Reports

- Power market forecast reports
- Forecast data in Excel
- Global energy market forecast reports
- Analyst support

Bespoke forecasts

- Aurora can provide power market forecasts upon request

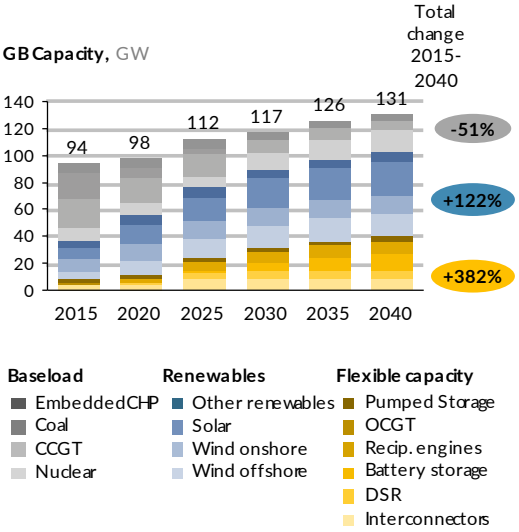
Distributed and Flexible Energy Service

Market forecasts for batteries, peakers and DSR in the GB market

Flexible technologies will be a key part of the future power

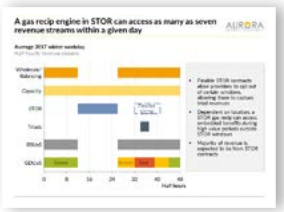
Aurora can provide answers to your most pressing questions

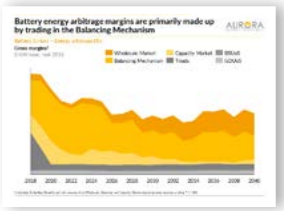
- What investment returns are available for batteries, demand side response (DSR) and peakers?
- What value should I anticipate from the underlying revenue streams (energy, balancing, capacity, embedded benefits, ancillary services) over the long term?
- What risks are there, and to what extent might they affect my investment case? (e.g. technological breakthrough, nuclear cancellation)
- Is my investment financeable? How would an equity or debt investor value my project?
- How big is the market opportunity, and where are investment funds going to flow?

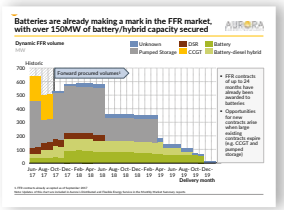


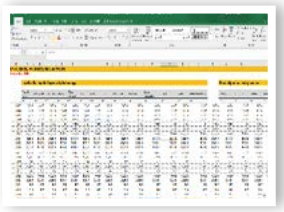
What does our subscription service include?

- Revenue forecasts for the wholesale market, balancing mechanism, capacity market, ancillary services (EFR, FFR, STOR, Fast Reserve) and embedded benefits (GDUoS, BSUoS and Triads) until 2040
- Revenue stacking and investment case analysis for batteries, peakers and DSR under various business models (e.g. batteries performing arbitrage)
- In-depth outlook of policy and regulatory frameworks
- Technology outlook including cost and performance projections
- Scenario analysis which is updated regularly to include significant market uncertainties
- Highly granular forecasts and investment case data in Excel
- Monthly summaries of the FFR auctions and balancing mechanism
- Frequent interactions with Aurora team via subscriber group meetings, bilateral workshops and ongoing analyst support









Forecasts are bankable and have been used in many transactions and for securing financing

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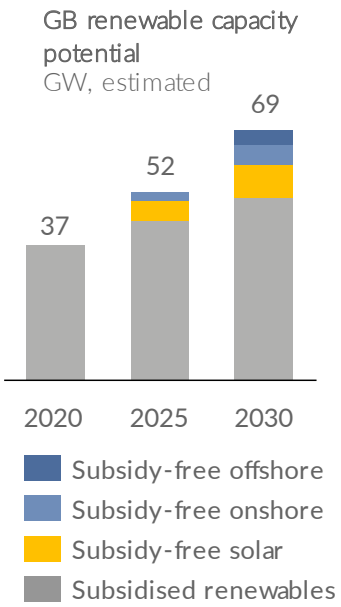
GB Renewables Service

Market analysis and forecasts for offshore, onshore and solar

As subsidies are reduced, renewable investments are increasingly exposed to merchant risk

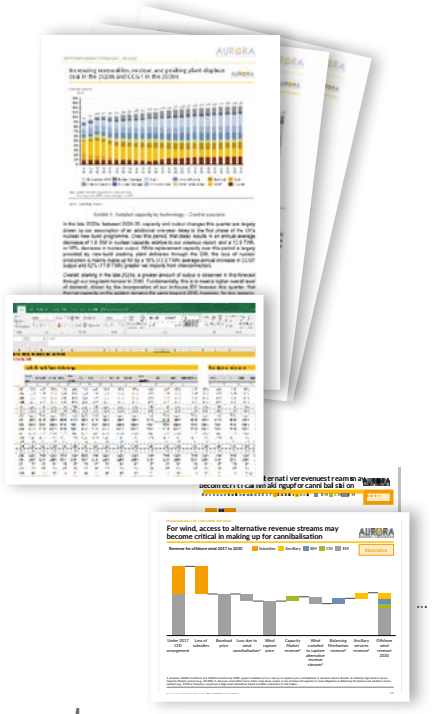
Aurora answers your most pressing questions

- What prices will wind and solar assets capture?
- What are the key technology, market and policy risks?
- How do batteries, EVs, I/Cs and DSR alleviate cannibalisation?
- What price curves should be used for debt financing, and how low can capture prices go if key risks materialise?
- What is the investment opportunity in subsidy-free RES?
- Which business models become investible first? When?
- How will subsidy-free affect margins of ROC assets?
- How much value can subsidy-free projects derive from ancillary, balancing and EFC capacity markets?
- How much debt can merchant projects sustain?
- How will the corporate PPA and utility PPA markets be?
- What are the opportunities for pairing with batteries?



What does our subscription service include?

- GB Renewable Forecast Reports – published and updated twice a year plus data in Excel
  - » Forecasts of capture prices until 2040, and other revenue streams (ROC, EFC capacity, balancing, ancillary services) and imbalance costs
  - » Regional capture prices, high and low scenarios (P90 and P10), ready to use in asset valuations and for financing cases
  - » Detailed investment case data for subsidy-free business models for offshore, onshore and solar, including pairing with batteries
  - » Supply curves and expected prices for future CfD rounds
- Strategic Insight Reports and Group Meetings to address the most pressing issues facing the renewables industry, e.g.
  - » How low can capture prices go? Understanding merchant risks in subsidy-free world
  - » EFC Capacity Markets – prospects for additional revenue for renewables
- Frequent interactions with Aurora team via bilateral workshops and ongoing analyst support



All intelligence to build a successful subsidy-free renewable business based on bankable price forecasts

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Bespoke Project Work

Aurora supports some of the biggest energy companies

Multi-client study for 15 major power market participants across utilities, developers, finance and government to evaluate the potential for investment in flexible electricity capacity and policy implications

Impact assessment of gas consumption in China on global gas markets and asset valuation for major global gas player

Analysis of intermittency and the cost of integrating solar in the GB power market – modelling the full system costs of increasing solar penetration

Assessment of the various scenarios of the German coal phase-out under the new Government as well as plant-by-plant evaluation of the implications of the BREF standards

Aurora's modelling underpinned the BP Energy Outlook 2016, 2017 and 2018 scenarios, including understanding the increasing Electric Vehicle penetration on global energy balances

Analysis of full system costs under various renewables pathways for decarbonisation of the UK, which will be used in the National Infrastructure Commission's assessment for Parliament

Analysis of power system development in Morocco and Oman (markets with a very high share of renewables) for a large multi-national energy company

Multi-client study of the 'New Economics of Offshore Wind', involving GB Government and wind industry participants. Study focused on policy mechanisms likely to drive major growth of offshore wind

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Transaction Support Work

Aurora is a leading commercial advisor for power and gas transactions

Flexible generation

- Gas peaker and battery storage portfolios, sell side advisory and debt raise for two of the largest transactions in the UK
- Battery storage, sell side advisory of the largest operational battery storage portfolio in Europe
- Pumped Hydro, multiple buy side valuations including First Hydro
- Battery project, successful debt and equity raise

Renewable generation

- Onshore wind, sell side market advisor for 400MW subsidy free project
- Borssele 3&4 offshore wind farm, buy side advisory
- Race Bank offshore wind farm, buy side for successful bidder
- Biomass plants, buy side advisor for Foresight Group for the acquisition of biomass portfolio

Thermal generation

- CCGT, sell side advisory for a large European utility
- EEW Energy From Waste (>Eur1bn), buy side advisory for Beijing Enterprise Holding
- Energy from waste, buy side for Cory Riverside
- Stake in Uniper, buy side advisory for a large hedge fund during the IPO process

Gas midstream

- UK National Grid distribution network (>£8bn), buy side advisor for successful bidder consortia
- TransitGas pipeline, buy side advisor for infrastructure fund
- Gas Connect Austria, buy side advisor for large infrastructure fund
- North-Sea gas upstream asset (>€4bn), commercial buy side advisor for successful bidder

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2018 Title Partner

BARCLAYS

Leadership in Strategic Advice and Financing for Power, Utilities and Infrastructure

fortum

has announced its intention to acquire the 46.65% stake of

e.on *in* uniper

and launched a Public Takeover Offer for all shares, implying an Equity Value of

€8.05 billion

Lead M&A Advisor and Sole Debt Underwriter

Pending

2i Rete Gas

Acquisition of

nedgia *and GasNatural Italia from* gasNatural fenosa

EV of

€727 billion

Financial Advisor to 2i Rete Gas

October 2017

VIRIDIAN

€350 million

Senior Secured 8-year Notes

€225 million

Senior Secured 7-year Notes

Joint Global Coordinator and Bookrunner

September 2017

Eneco Groep

has agreed to acquire a 50% stake in

LichtBlick
Generation reine Energie

Financial Advisor to Eneco

May 2017

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nationalgrid

Sale of 61% stake in its gas distribution network to a consortium of infrastructure investors

Corporate Broker and Advisor to National Grid

March 2017

Enel

Enel Green Power

Agreed to Merge via a Non-Proportional Spin-Off

Financial Advisor to Enel Green Power

November 2015

2018 Partners

ADDLESHAW GODDARD

A dedicated team of specialist lawyers with a proven track record of delivering on major deals, projects and disputes across the Energy, Utilities and Natural Resources Sectors.

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Wherever innovation is happening in the global energy market, Addleshaw Goddard is at the forefront, helping clients to anticipate and respond to change and to identify and capitalise on new opportunities. Many businesses are actively looking at ways to be involved in the energy value chain or manage their energy needs more proactively, whether to reduce costs, improve energy security, exploit commercial opportunities or enhance their green credentials; but making sound investment decisions in an uncertain market is risky. As advisers who understand the uncertainties and how to mitigate them most effectively, we can provide pragmatic, incisive advice that helps to minimise those risks.

Our International Energy and Utilities Group has extensive experience acting for clients including BP, Mitsubishi, National Grid, SSE and ENGIE all over the world on an extremely diverse portfolio of power and renewable energy matters. This broad coverage means that we bring not only real know-how and experience, but also new ideas and innovative ways of working.

ING

ING Wholesale Banking (WB) meets all banking needs of large corporations, multinationals and financial institutions. We are a truly international team of more than 15,000 banking professionals with local knowledge and a presence in 40 countries.

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In addition to basic banking services like lending, payments and cash management and treasury, we provide tailored banking solutions in areas including corporate and structured finance, leasing, and equity and debt capital markets. In short, we can finance your growth, manage your day-to-day banking needs and provide you with a full range of banking solutions to help you achieve your business goals.

We believe in taking the long view and in going beyond just mitigating harm—we want to drive sustainable progress and help lead the global transition to a low-carbon, climate-resilient economy.

As a financial institution, we can play a role in enabling this transition by financing change, sharing knowledge and using our influence. Being sustainable is not just about reducing our own impact, it's in all the choices we make—as a lender, as an investor and through the services we offer our customers. That's why sustainability is inherent to our purpose of empowering people to stay a step ahead in life and in business.

Matheson

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GET IN TOUCH

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