



# How to incentivise green investment in times of economic downturn via policy and regulatory action

20th ERRA Annual Conference – Budapest, 10th October 2023

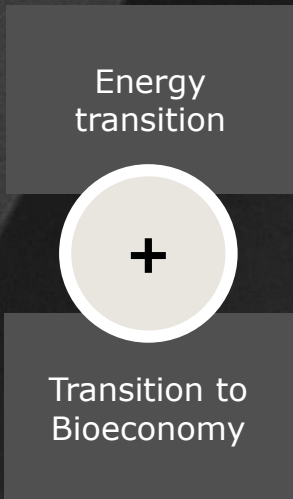
STEPHEN WOODHOUSE, AFRY MANAGEMENT CONSULTING

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# Leading advisor for the transition of the energy and bioindustry sectors

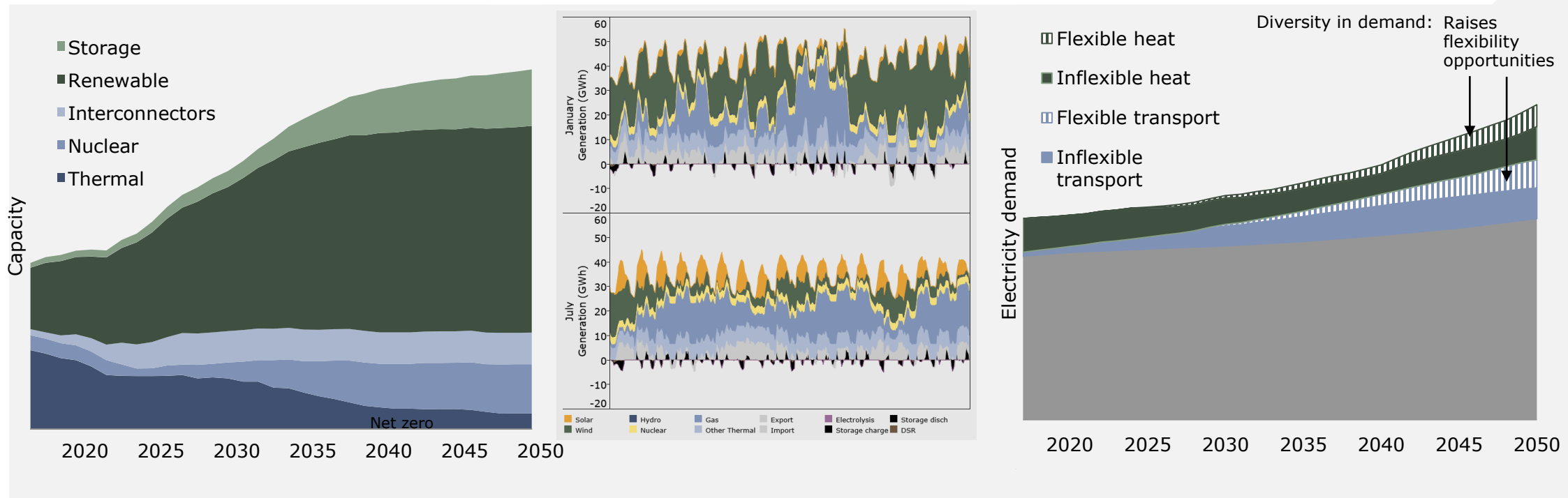
Presence	Revenue	Projects	Staff	Backed by
5	1,160 million	>100	600+	19,000
continents	SEK in 2022	countries	management consultants	experts at AFRY



- Global transition towards decarbonised energy system
- Sector integration due to decarbonisation and electrification (e.g. mobility, industries, cities)
- Need for smart infrastructure to enable transition and new decentralised business models
- Growing sustainability awareness and commitment
- Global shift in demand and products
- Need for green carbon to ensure full decarbonisation
- Resource scarcity



# The electricity sector is decarbonising with thermal generation falling rapidly



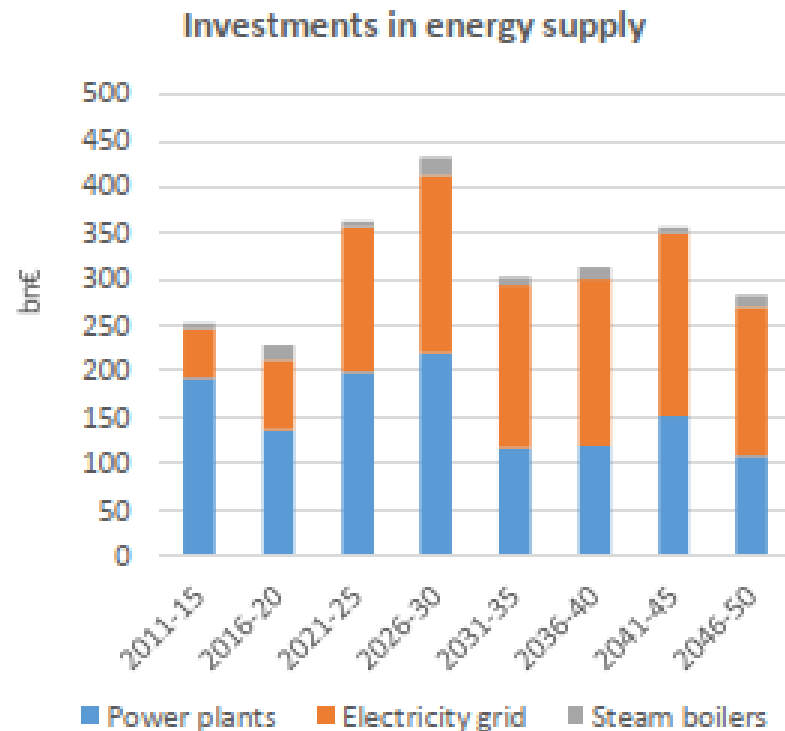
Source: AFRY analysis, [Fully decarbonising Europe's energy system by 2050](#), World Energy Outlook (2019), IEA



## DIRECTION OF TRAVEL

To meet decarbonisation objectives, we need simultaneous investment in every part of the electricity supply chain as well as supporting sectors

### INVESTMENT NEEDS IN ENERGY SUPPLY IN EU



### INVESTMENT NEEDS ARE UNPRECEDENTED

#### Generation

- renewable generation
- dispatchable generation

#### System support

- storage
- synchronous condensers
- grid forming converters

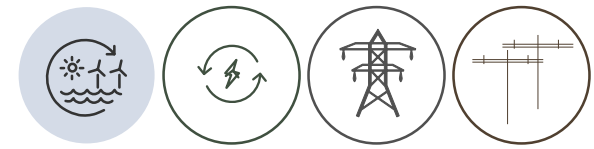
#### Network

- HVDC offshore transmission and interconnection
- national transmission
- distribution

#### Supporting sectors

- hydrogen networks and storage
- CCUS networks
- EV charging infrastructure
- electrification of heat
- electrification of heavy industry

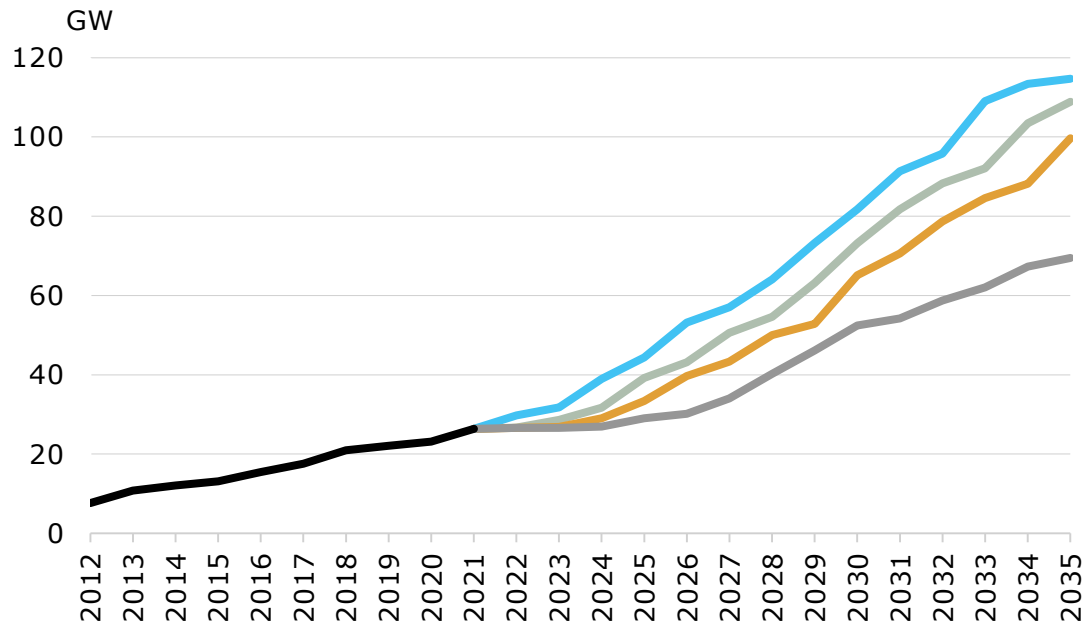
Source: PRIMES Model, EU Reference Scenario 2020



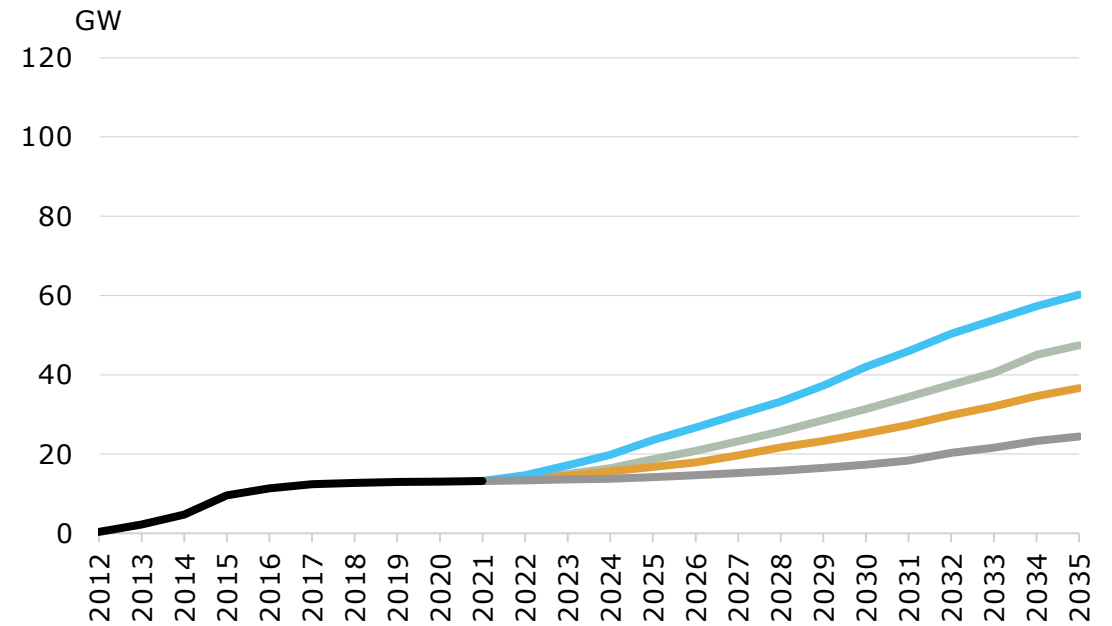
## RENEWABLE GENERATION

# The UK has had a good track record of renewable deployment but must accelerate deployment sharply to meet the 2035 targets

### HISTORIC AND FUTURE WIND DEPLOYMENT, GW



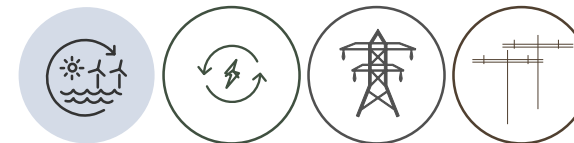
### HISTORIC AND FUTURE SOLAR PV DEPLOYMENT, GW



- Consumer Transformation
- System Transformation
- Leading the Way
- Falling Short
- Historical

Source: FES Scenarios, 2022



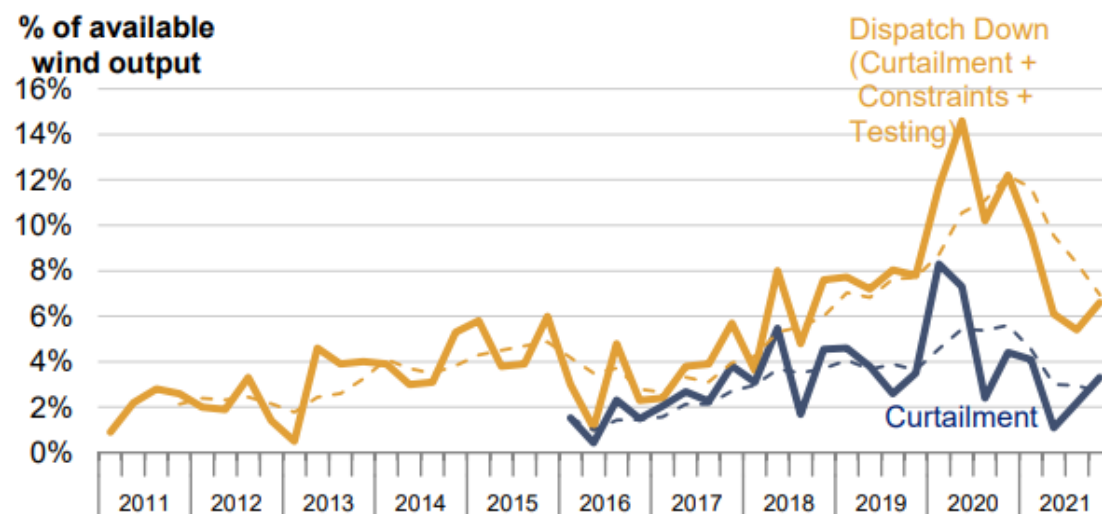


## RENEWABLE GENERATION

# Renewables are affected by curtailment and price cannibalisation, and will not be developed at the necessary scale without financial support

**EXHIBIT 7.13 – ROLLING 4 QUARTER AVERAGE DISPATCH DOWN, CURTAILMENT AND SYSTEM-WIDE WIND LOAD FACTOR (% OF AVAILAB WIND OUTPUT)**

Dispatch down and curtailment have been steadily rising, even after accounting for variations in meteorological conditions and despite increases to the SNSP limit

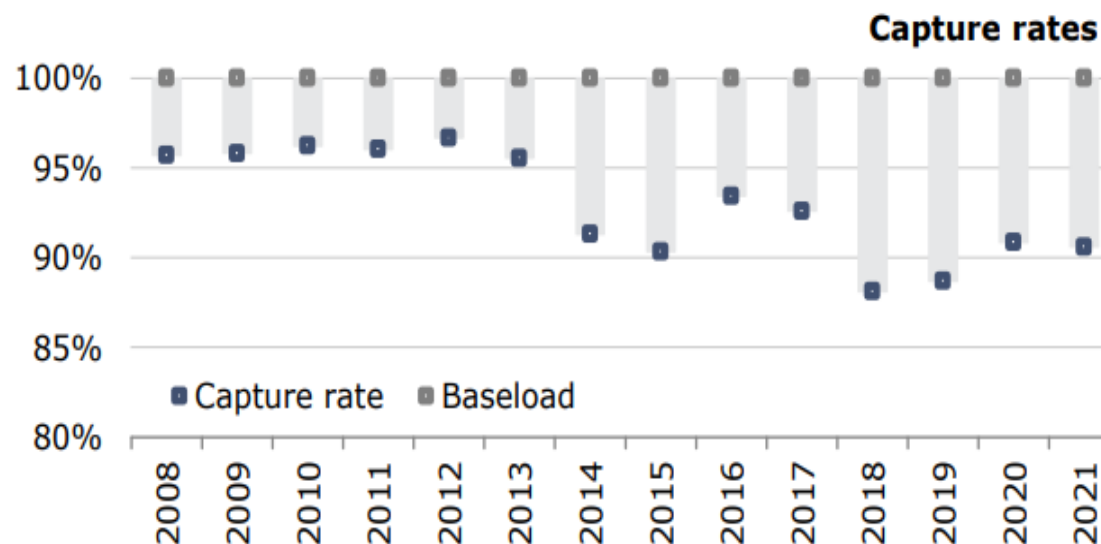


Notes: Dispatch down is comprised of curtailment + constraints + testing.

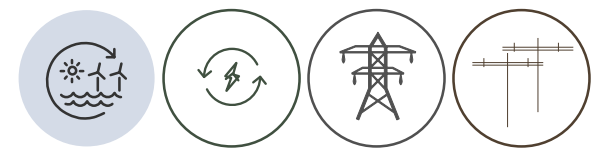
Source: EirGrid

**EXHIBIT 7.15 – MARKET-WIDE ONSHORE WIND CAPTURE PRICES (€/MWH, NOMINAL MONEY, UPPER PANEL) AND RATES (% , LOWER PANEL)**

Wind capture prices have been c. 10% lower than the baseload price in recent years.



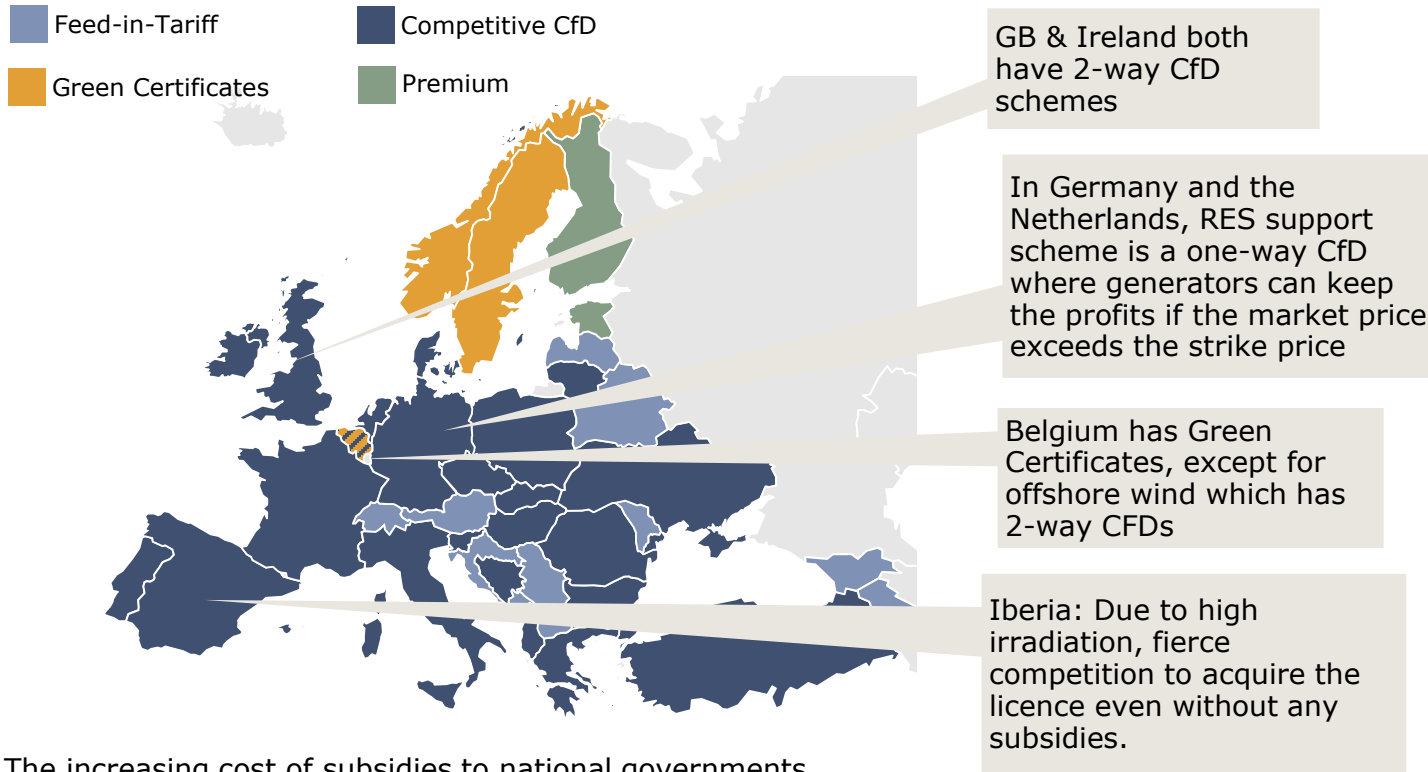
Source: AFRY. Figures relate to the Single Electricity Market of Ireland and Northern Ireland



## RENEWABLE GENERATION

# The form of renewable support varies between countries and is constantly changing : many alternative designs are under consideration

### RENEWABLE SUPPORT SCHEMES IN EUROPE



The increasing cost of subsidies to national governments, against their responsibility to meet renewable targets, have resulted in support schemes with a much greater emphasis on **competitive allocation** and **market integration** instead of direct FiT subsidies in most markets.

**Support arrangements are required (mainly in form of CfDs) for most low carbon investment**

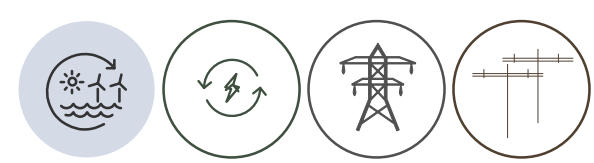
**Corporate PPAs are small in scale and generally within price zone**

**Evolution from fixed FiT with allocation to all eligible projects towards competitively allocated CfDs which link support to a reference market price**

**CfDs require the generator to market the power, and to accept balance responsibility and some market risk**

**CfDs distort the spot markets and alternatives are now being developed, e.g. deemed volume CfDs and cap/floor support regimes**





RENEWABLE GENERATION

# Over the last 18 months, the attractiveness of renewable investment in the UK has reduced for a number of reasons



### **Doubts over commitment to 2035 decarbonisation goals**

The NAO reports lack of concrete 'critical path' for delivery of target

*"A lack of clarity and changes in policy direction from government can affect investor confidence, increasing their required rate of return, and ultimately increasing costs for energy consumers"*



### **ESO proposals on nodal pricing and central dispatch**

Nodal pricing creates uncertainty for new and existing investments, with significant risk to RES generation (especially in Scotland and offshore)



### **Attempt to impose CfDs on low marginal cost generation with market exposure**

Attempt to impose an immediate mandatory CfD – pushed back by generators into a discussion on voluntary CfDs

Government and generators had different views on the strike price and the talks failed



### **Uncertainty around REMA**

REMA throws a lot of transformative changes to the market design, potentially covering all aspects of the markets



### **Introduction of a windfall tax (Electricity Government Levy)**

Provides no capital allowance and is to remain in force until 2028



### **Rising construction and financing costs**

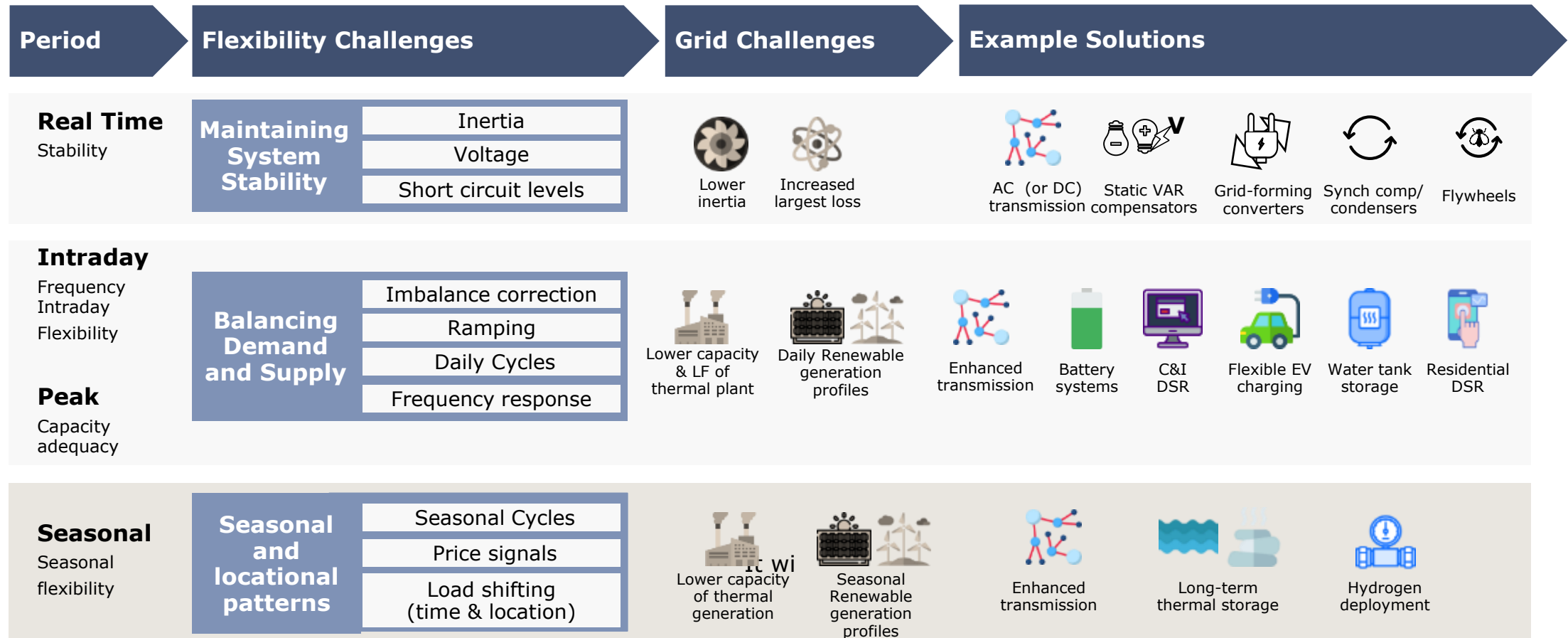
Some projects awarded CfDs in AR4 are not going ahead with investments as costs soar

AR5 received no bids for offshore wind



DISPATCHABLE GENERATION AND SYSTEM SUPPORT

The future electricity system requires providers of a range of types of flexibility, with new buyers and new product definitions



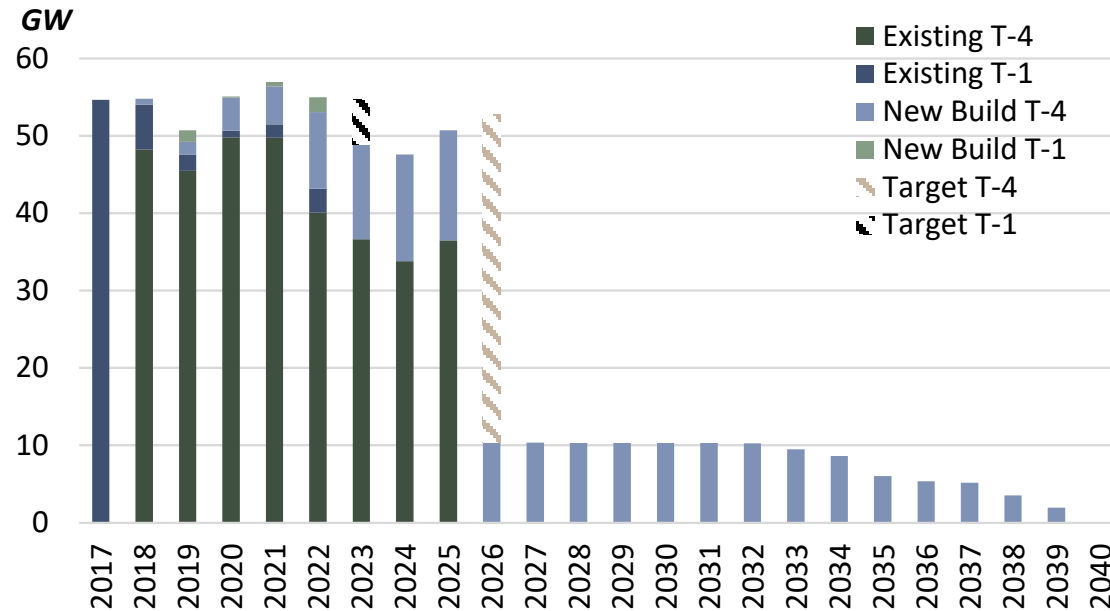
AC: Alternate Current; DC: Direct Current; LF: Load Factor; C&I: Commercial & Industrial; DSR: Demand Side Response; EV: Electric Vehicle



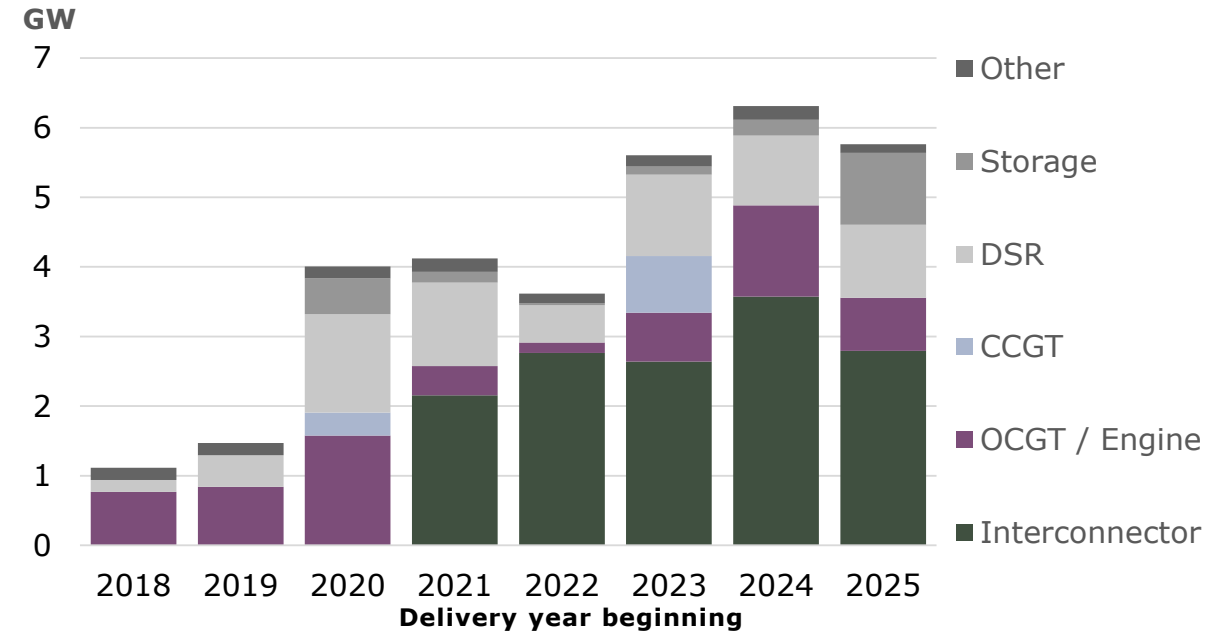
DISPATCHABLE GENERATION AND SYSTEM SUPPORT

Capacity markets in GB and Ireland have supported new investment in batteries, DSR and engines, but few larger scale projects have advanced

**CAPACITY PROCURED BY AUCTION**  
GW (derated)



**NEW ENTRANT, DSR AND IC CAPACITY PROCURED BY AUCTION**  
GW (derated)

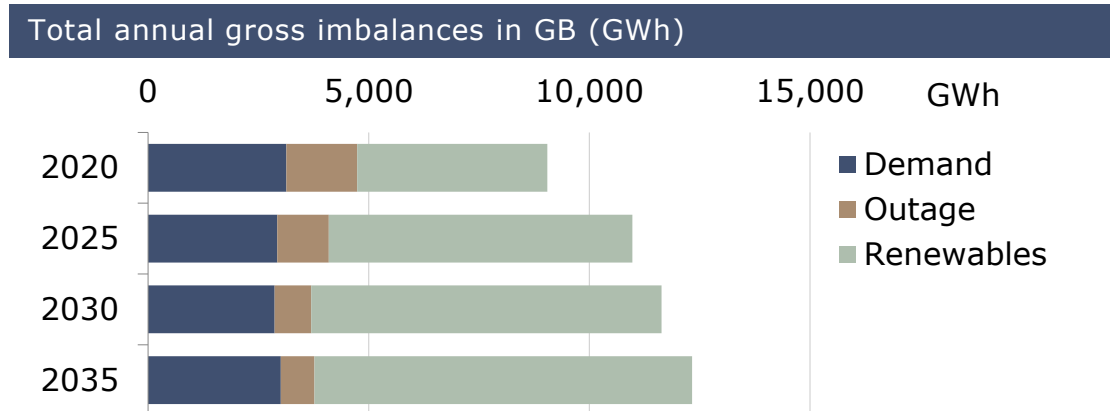




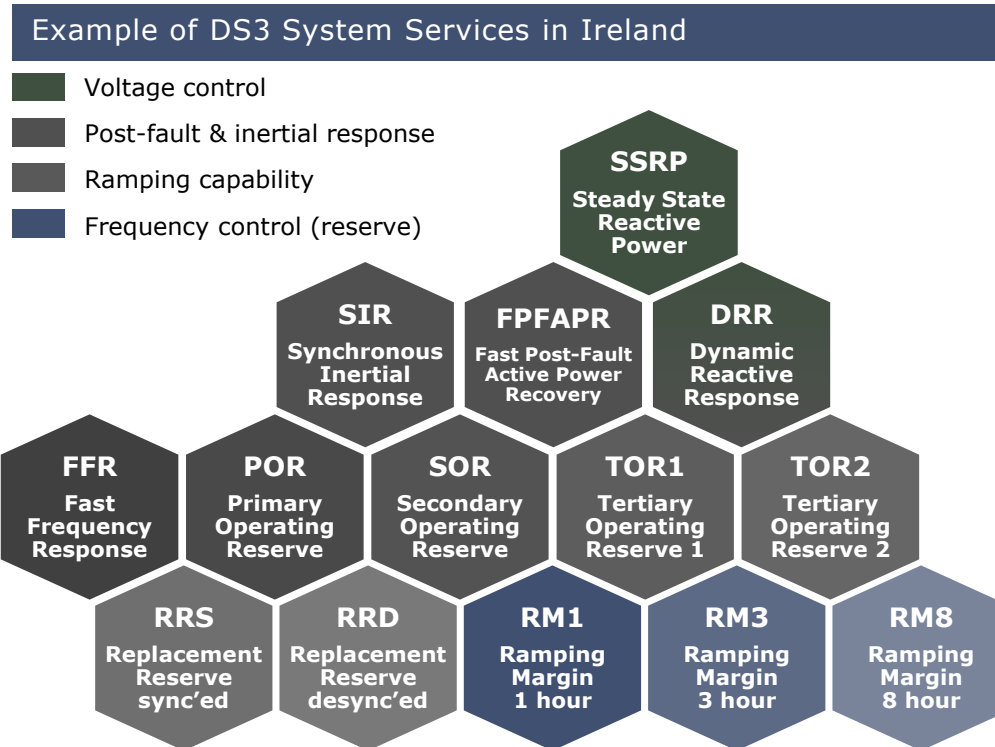
## DISPATCHABLE GENERATION AND SYSTEM SUPPORT

# The system operators will need more balancing reserves...

# ... as well as new and more varied products to ensure stability



(Based on **AFRY** modelling of the GB balancing mechanism 2019 update)



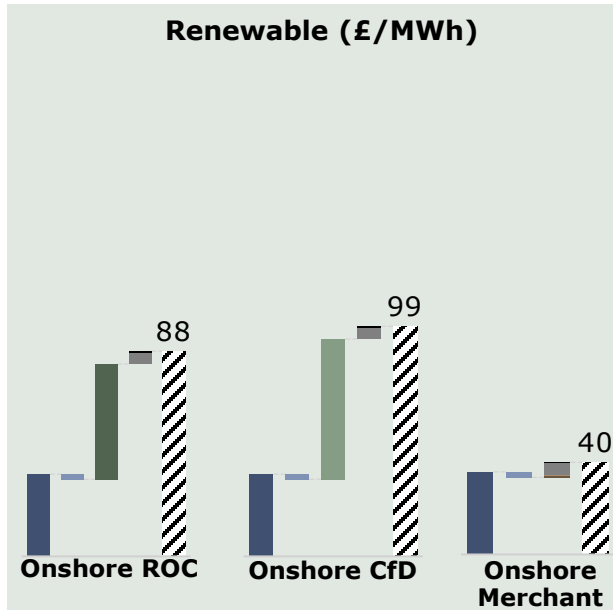
National Grid ESO is taking balancing actions up to 25% of total demand

- How to design and price flexibility products to:
- **reflect the value of each service**/type of flexibility,
  - **incentivise the appropriate level of System Services**
  - **promote investment** in existing and new sources of flexibility

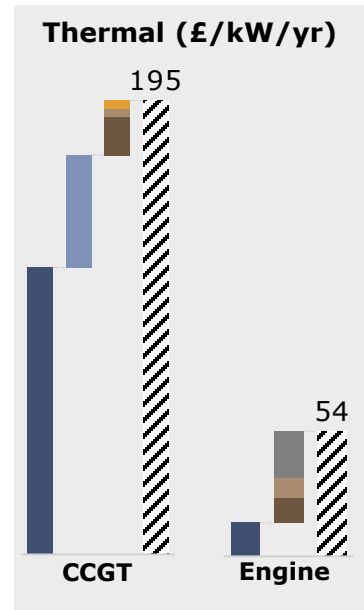


# Key value drivers vary by technology, with balancing and frequency response important for more flexible resources

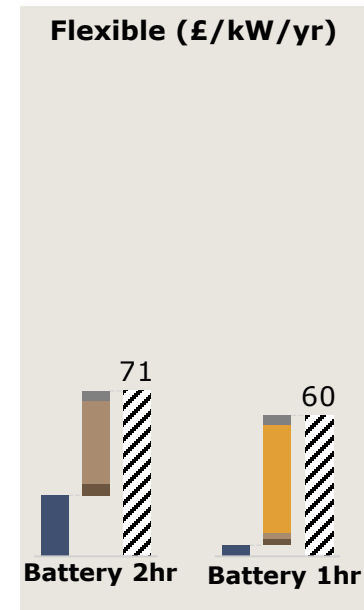
## ILLUSTRATIVE REVENUE STACKS BY TECHNOLOGY (2020)



Support revenue, where secured, is the largest source of value for onshore wind



CCGT relies mainly on wholesale market revenue supplemented by capacity market and BM revenues. For engines, capacity market and BM revenues are more important.



1 hour duration battery relies heavily on frequency response, while 2 hour duration battery captures value from BM and wholesale market activity

- Baseload WP
- Captured WP
- ROC<sup>1</sup>
- CfD top-up<sup>2</sup>
- Capacity Market
- Balancing Mechanism
- Frequency Response
- Embedded benefits
- REGOs
- ▨ Total

Notes: The revenue from embedded benefits has declined since 2020 due to the BSUoS embedded benefit being removed.

1: Onshore wind is assumed to have a banding factor of 0.9 ROC/MWh.

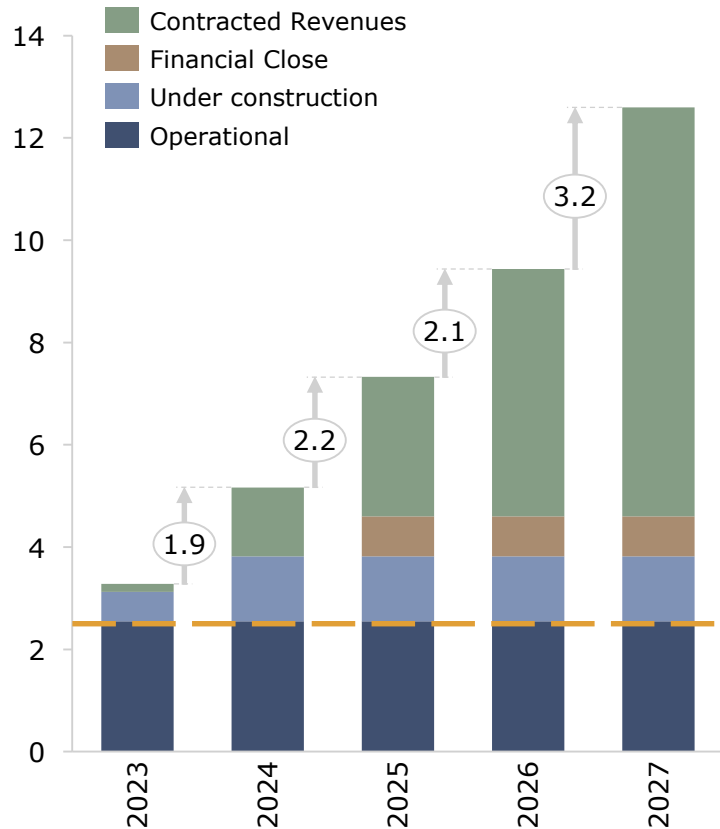
2: This is based on a strike price of £82/MWh (real 2012 money) which is a capacity-weighted strike price for the CfD Round 1 (only CfD projects from the first allocation round are operational in 2020).



### DISPATCHABLE GENERATION AND SYSTEM SUPPORT

# Batteries are being deployed at scale in GB reaching 13GW by 2027 but short duration batteries will provide only a little support in future

## EXISTING AND FUTURE BATTERY STORAGE ASSETS, GB CAPACITY (GW)



Max ancillary service market size for BESS (DFR<sup>1</sup>, residual FFR<sup>2</sup> & Quick Reserve)

## BATTERIES WILL PROVIDE ONLY A LITTLE SUPPORT WHEN DURATION OF CRITICAL STRESS EVENTS IN THE GB SYSTEM INCREASES

	Year	Distribution of length of critically tight periods (hours)										Mean length of critically tight periods (hours)
		<3	3-4	5-7	8-15	16-25	26-50	51-75	76-100	101-150	>150	
'Consumer Transformation'	2025	15	31	6	8	0	0	0	0	0	0	5
	2028	10	28	2	10	2	0	0	0	0	0	6
	2030	5	24	3	9	0	1	0	0	0	0	6
	2033	1	8	2	3	0	5	1	0	0	0	17
	2035	1	5	1	2	1	6	1	0	0	0	21
	2038	0	0	0	2	0	5	4	0	0	0	45
2040	0	0	0	2	0	5	4	0	0	0	44	
'No new CCS'	2025	15	31	6	8	0	0	0	0	0	5	
	2028	13	25	1	9	2	0	0	0	0	5	
	2030	11	12	2	2	0	4	1	0	0	10	
	2033	0	0	0	1	3	4	8	1	0	44	
	2035	0	0	0	0	2	4	4	3	1	57	
	2038	0	0	0	2	0	3	4	2	0	51	
2040	0	0	0	1	0	5	3	1	0	52		



**"Long term capacity adequacy assessment JULY 2022"**  
A public report to National Grid ESO

<sup>1</sup>DFR = Dynamic Frequency Response, <sup>2</sup>FFR = Firm Frequency Response





Remuneration schemes for capacity, flexibility and stability are changing rapidly and there is a reliance on central support for most investments



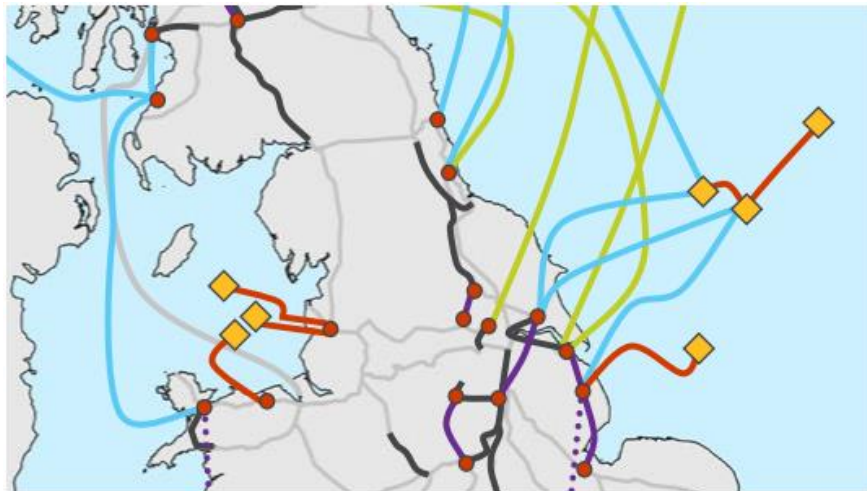
*"Capacity markets cannot appropriately value **flexibility** and we need to change the way we think about them"*

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## TRANSMISSION NETWORKS

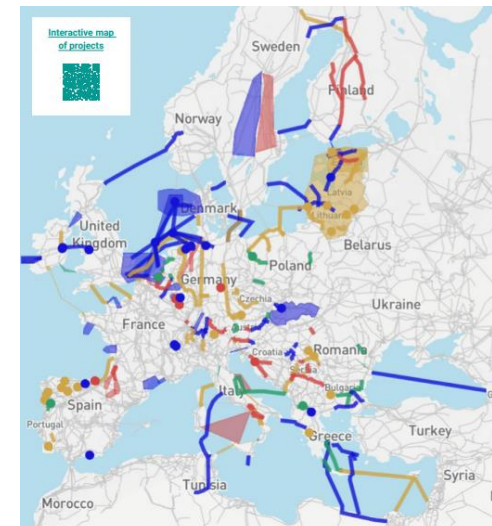
# National Grid ESO Network Options Assessment recommends £215m of investment per year in GB, with a total investment of £28bn

### ILLUSTRATIVE MAP OF OPTIONS IN CENTRAL BELT AND ANGLO-SCOTTISH BORDER



- The NOA refresh 2021/22 recommends 111 options, with a total investment of 28bn, requiring an investment of £215m of this investment / year
- 94 of these options, and £21.7bn investment are required pre 2030 to meet 2030 ambitions, including 50GW of offshore wind
- A further 17 asset-based options and £6.2bn will not be delivered in time for 2030 under current regulatory and consenting processes.
- A large amount of reinforcement between Scotland and England is recommended.

### HIGHLIGHTS OF ENTSO-E'S TEN-YEAR NETWORK DEVELOPMENT PLAN (TYNDP 2022) HIGH LEVEL REPORT



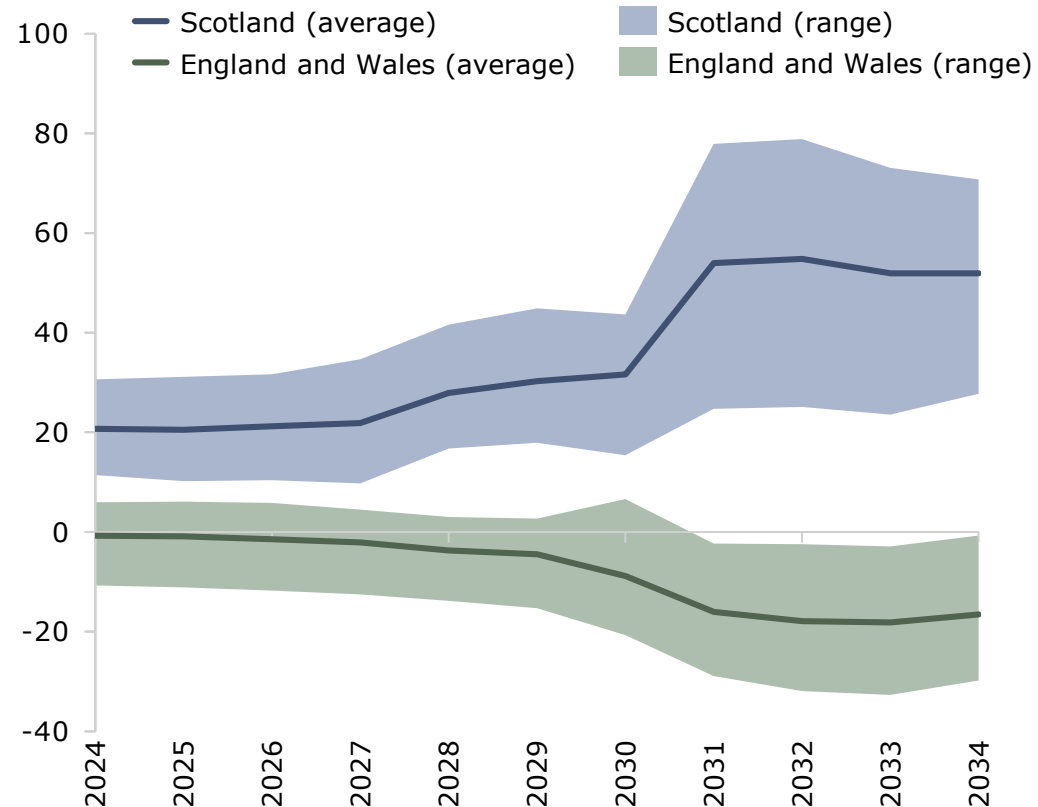
- The 141 transmission projects in TYNDP 2022's portfolio represent 285 investments in 38 countries
- Onshore transmission line projects represent around 63 % of the total number of investments, while offshore ones represents another 19%



## TRANSMISSION NETWORKS

# Case study: new 10-year network charging forecast for GB suggests tariffs will increase sharply and will diverge further between locations

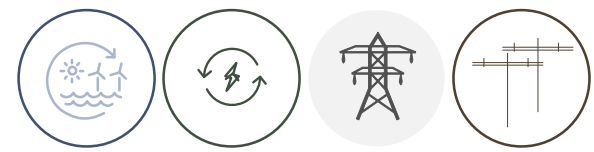
### WIDER TNUoS TARIFFS FOR AN INTERMITTENT RENEWABLE WITH 45% ALF (£/KW, NOMINAL MONEY)



Source: National Grid

### COMMENTARY

- TNUoS charges have historically been greater in Scotland than in England and Wales. This trend is expected to continue.
- However, with plans for large transmission expansion projects, TNUoS charges in Scotland are forecasted to grow significantly, resulting in a divergence of Scotland vs England and Wales tariffs
- Notable increases from 2029/30 stem from new HVDC bootstraps



TRANSMISSION NETWORKS

# ESO is exploring the idea of a nodal market in place of a single price area for Great Britain as a way of managing transmission congestion

- 1** **Physical constraints** on power flows between different regions of Great Britain are **increasing**
- 2** ESO is currently responsible for adjusting plant positions through **balancing tools** to ensure the **physical constraints** on the system are not breached
- 3** ESO is concerned that the current grid model is not suited to a **Net Zero Grid**
- 4** ESO is proposing a **nodal market design**, with **locational signals** in the wholesale market



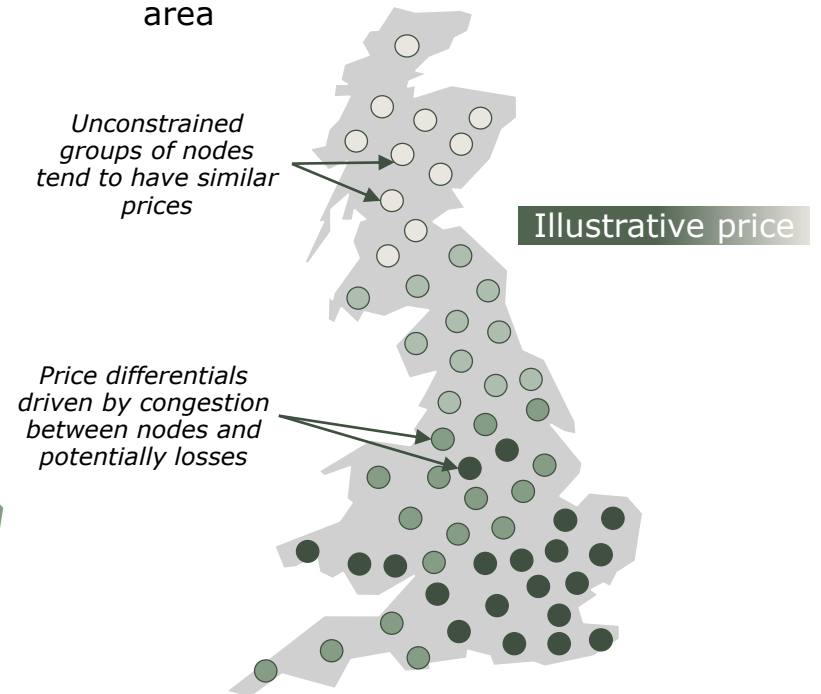
### Today

- Uniform price area
- Participants can bilaterally trade without restriction on location
- Single price in exchange auctions for all participants
- Compensation for constraints



### Future?

- Prices for each individual 'node'<sup>1</sup>
- Radical changes to trading and scheduling arrangements
- Access rights limited to local price area



Notes: <sup>1</sup>Proposed nodes yet to be defined

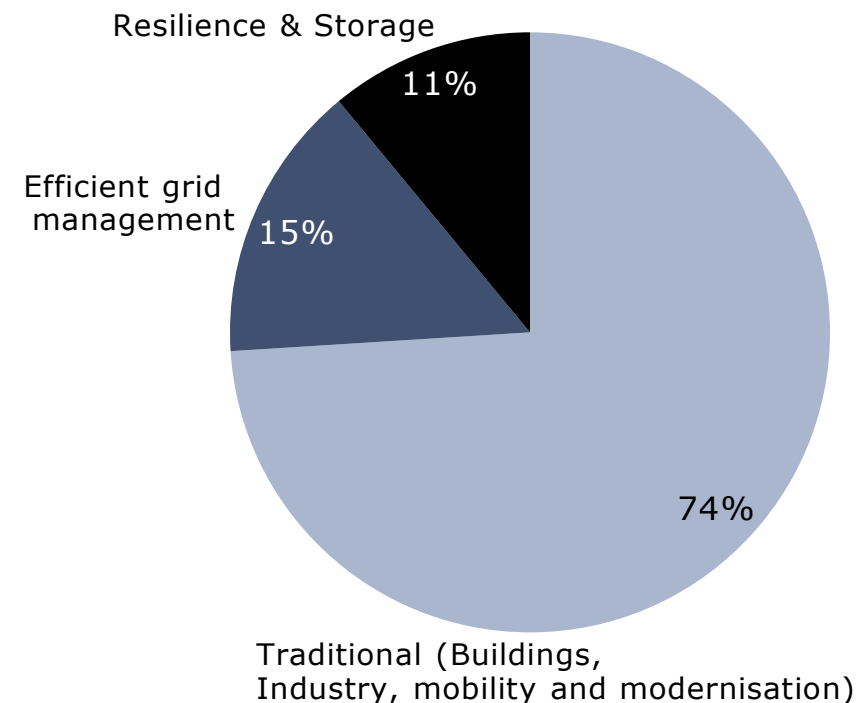
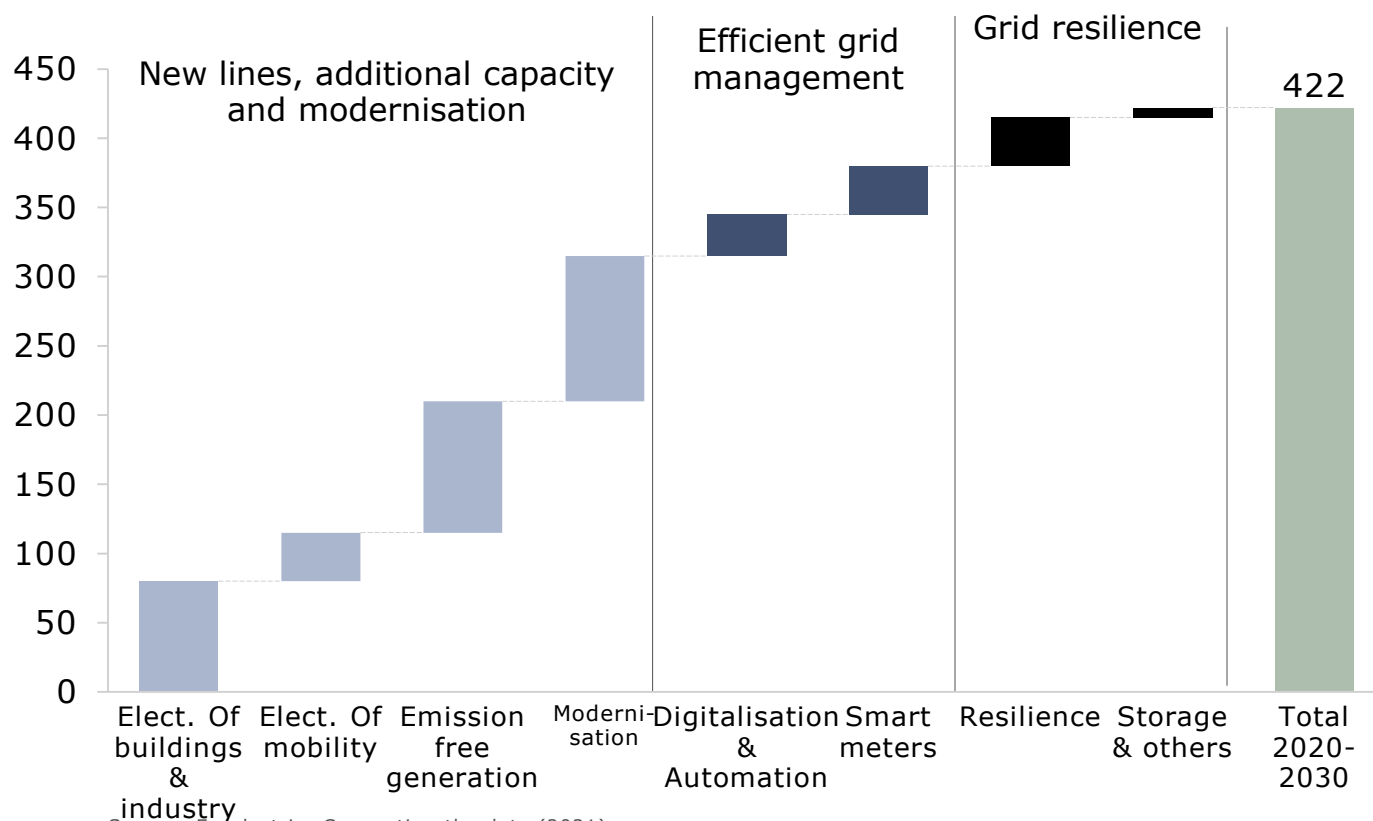


## DISTRIBUTION NETWORKS

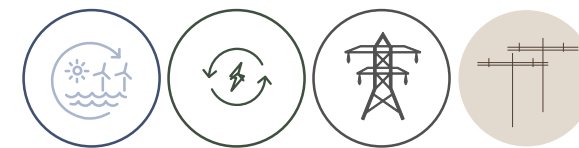
# As European DSOs prepare for active network management, their patterns of investment are shifting away from conventional infrastructure

Over 25% of future distribution grid investments in EU+UK could go to non-traditional areas such as efficient grid management and building resilience

### DSO Investment required in Bn Euros in EU+UK, 2020-2030



Source: Eurelectric: Connecting the dots (2021)



# Electrification of transport is about capacity not energy, and offers flexibility which may mitigate investment needs

## Electric car



Average distance: 10 000 miles pa  
Consumption: 4 mile/kWh  
2500 kWh per year



Baseload charging rate (7000 hour): 0.36 kW

Ionity supercharger: 350 kW  
> 1000 times baseload charging  
Home charger: anything over 7kW requires 3 phase supply

## Petrol car



Energy transfer, petrol car: ~40 kWh/US gallon  
Speed of pumping: ~10 gallon/min



Charging rate: ~ 24 MW

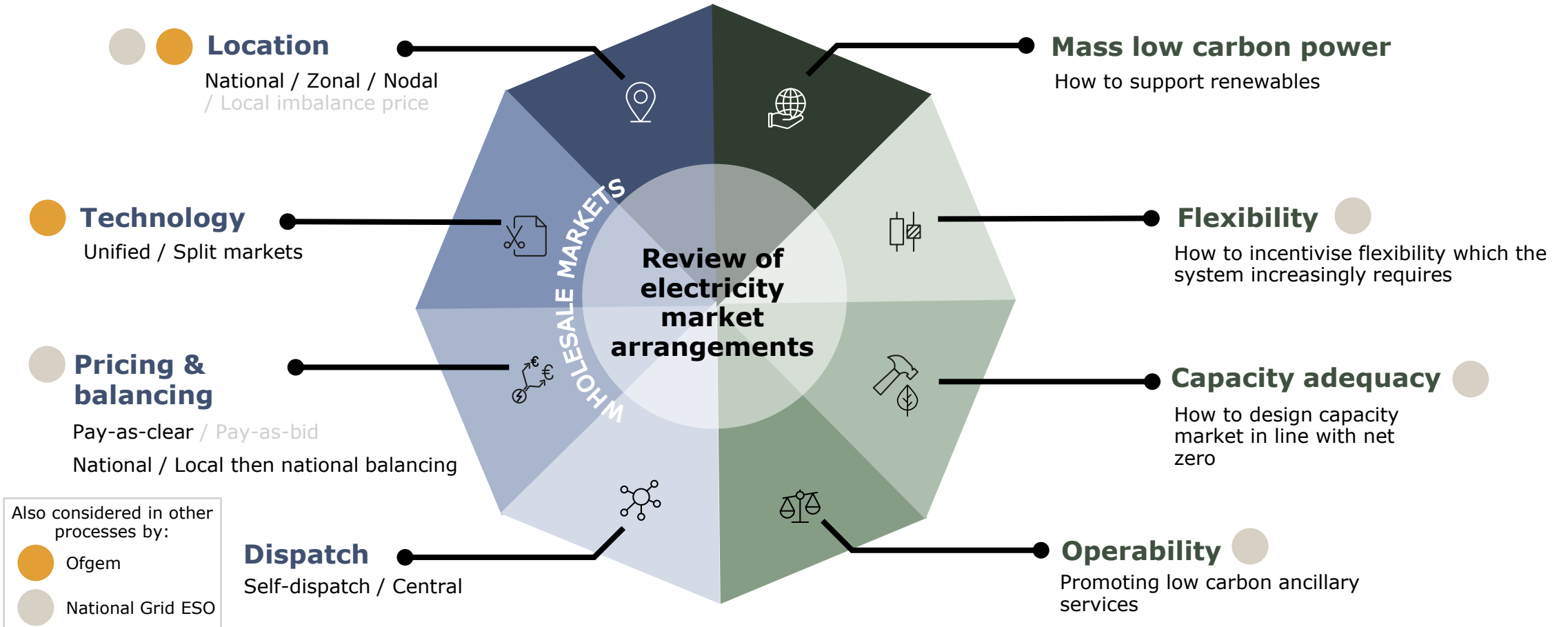
We are asking a lot of customers if we expect them to be part of the energy transition





CASE STUDY: GB MARKET REFORMS

The REMA process opens a wide range of design options to achieve net zero, with many issues being considered by Ofgem and ESO in parallel



Source: UK Government (DESNZ, previously BEIS)




## EU DEVELOPMENTS

# The EU is dealing with similar issues, implementing a temporary revenue cap on power producers, with plans for longer term structural reform

### EU REVENUE CAP ON POWER PRODUCERS


PRICE CAPS ON REVENUE



**90% of profits\***

Applies to electricity produced at a maximum of €180/MWh

TECHNOLOGIES AFFECTED



**>1MW**

Applies only to lower marginal costs generators

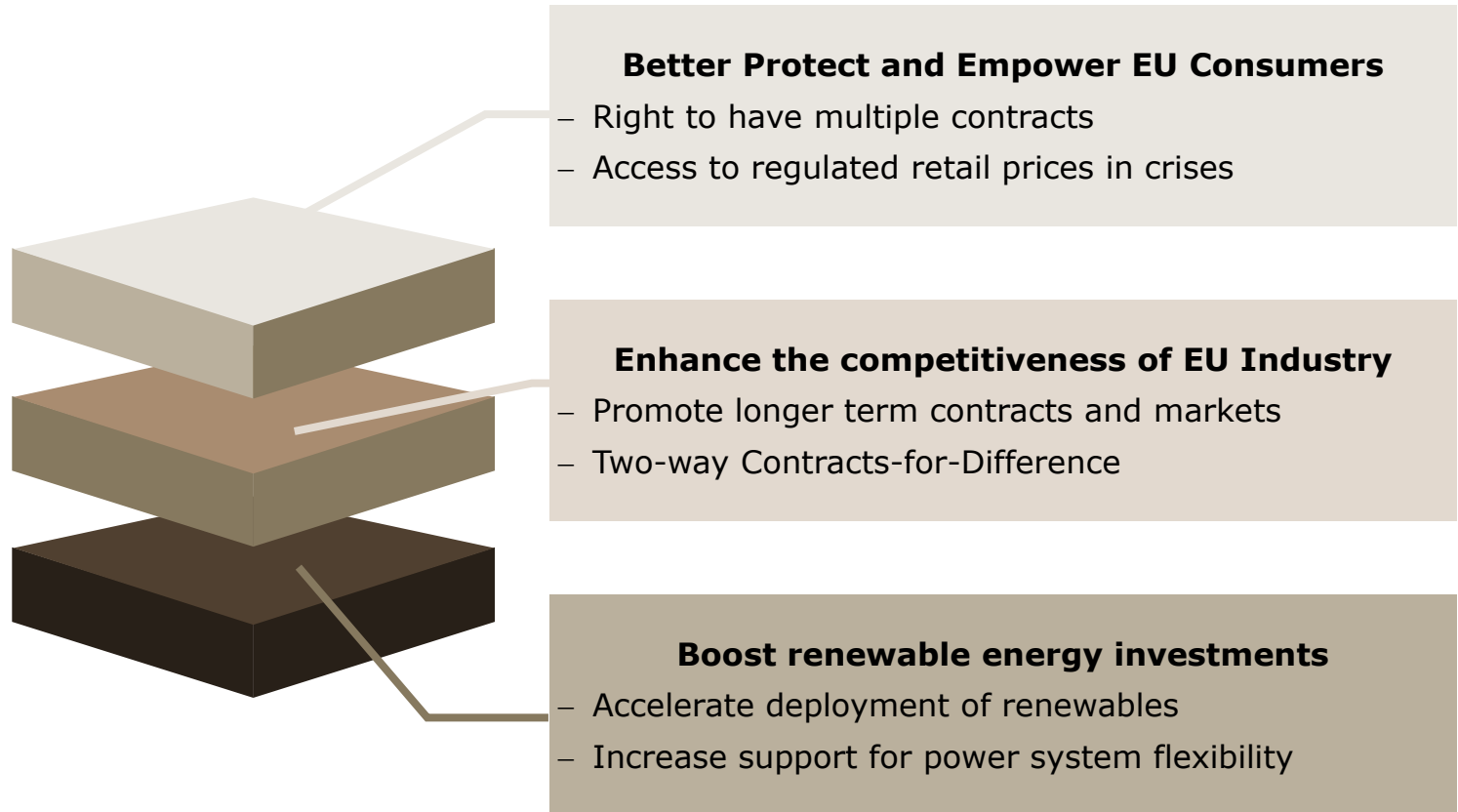
DURATION



**1 Dec 22 – 30 June 23+**

Extension up to Apr 2024

### MAIN AREAS OF THE UPCOMING STRUCTURAL MARKET REFORM



Note: \*Above the revenue cap, Member states introduced some flexibilities to reflect measures in place at national level such as the differentiating between technologies, possibility to set a higher revenue cap and use measures that further limit market revenues.

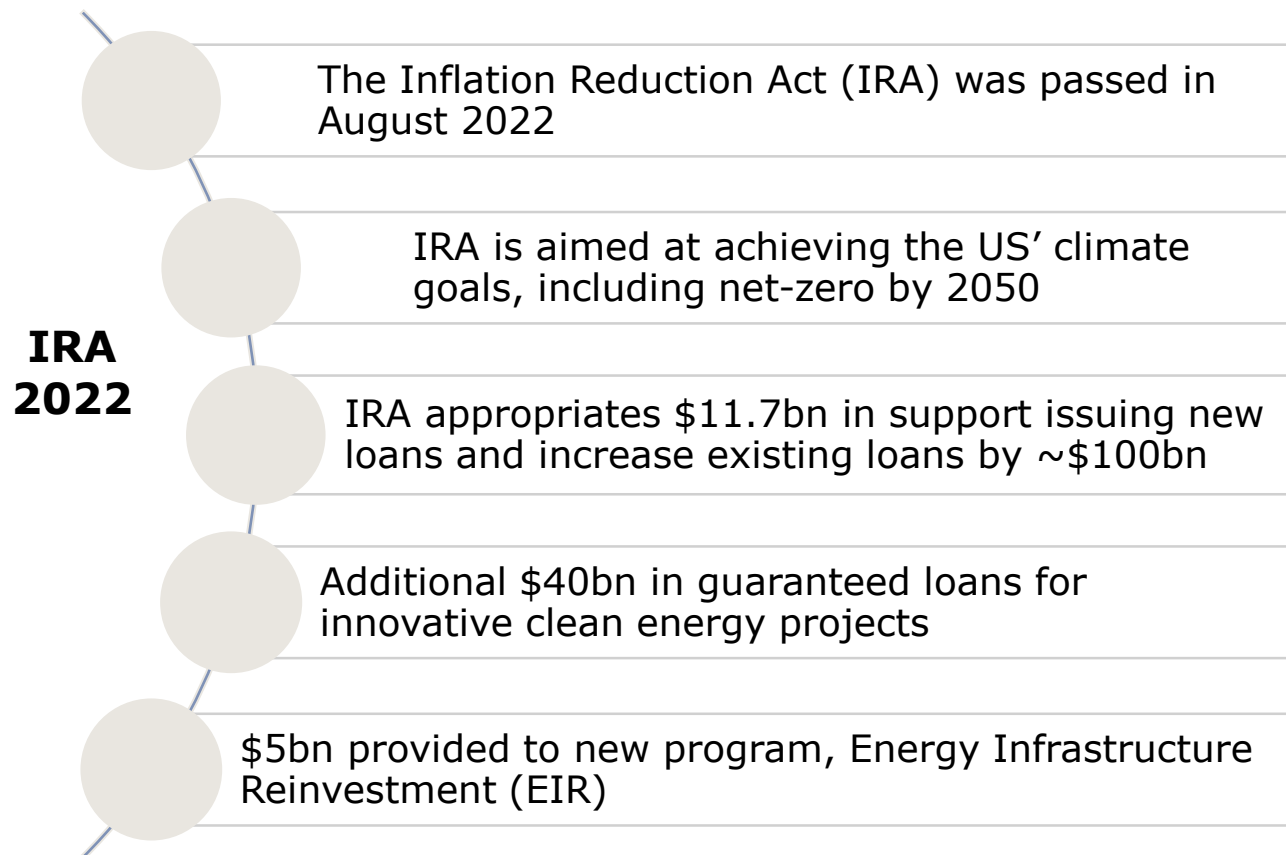


## Our recommendations for market reform in GB are relevant in most circumstances

1. Radical change would risk losing momentum
2. A holistic approach to reform is needed
3. Centralised support for capacity planning and procurement is needed for the transition
4. There is no perfect spot market, and there are trade-offs between treatment of location and flexibility
5. Spot markets should not place unmanageable risks on investors
6. Long term contracts for renewables are necessary, but must support efficient dispatch
7. Capacity support must change to meet new needs
8. Decentralised resources must be incorporated into the markets
9. The 2035 (decarbonisation of power) target requires central direction but in future we need greater a role for choice and innovation
10. We recommend an evolutionary not revolutionary approach

Thanks to IRA 2022, the US is streaking ahead in terms of investment attractiveness for renewables, meanwhile the same for UK is on a downward trajectory

**INFLATION REDUCTION ACT, 2022 - US**

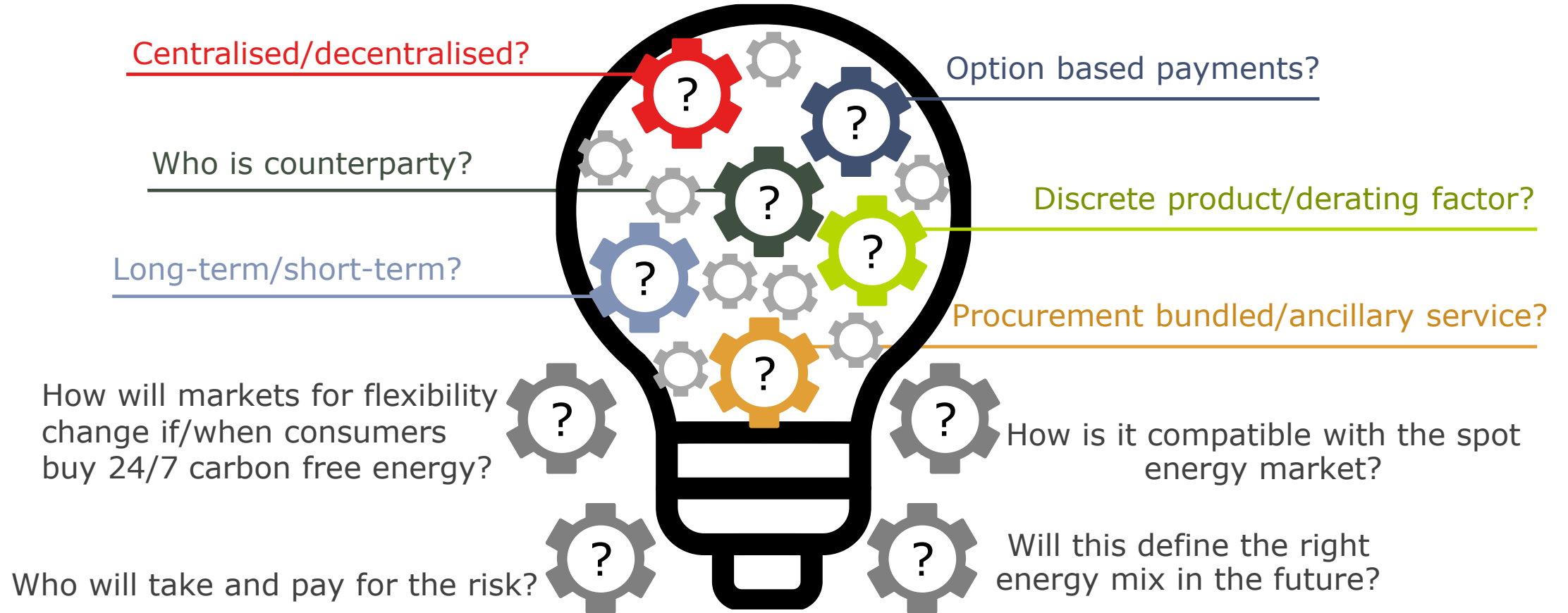


**RENEWABLE INVESTMENT ATTRACTIVENESS BY COUNTRY**

-  – The IRA is set to make US hydrogen the cheapest produced in the world
-  – China mainland is expected to see a 25% jump in renewable deployment
-  **3**  – The 2022 Easter package set ambitious targets of 80% renewables in the power mix by 2030 and up to 100% by 2035
-  **4**  – The 4<sup>th</sup> CfD round sees boost in offshore wind at record low prices
- 5**  – The Feed-in-Tariffs continue to promote renewable generation in France

Source: Loan Programs Office, Fed Gov; Renewable Energy Country Attractiveness Index (RECAI 60) Nov 2022, EY

# Challenges to address..





An aerial, high-angle photograph of a white wind turbine in the middle of a vast, dark blue ocean. The water is choppy with white foam from the turbine's rotation. The turbine's three blades are visible, extending from a central hub. The overall tone is cool and professional.

# Making Future