Impacts and implications of the British Energy Security Strategy (BESS)

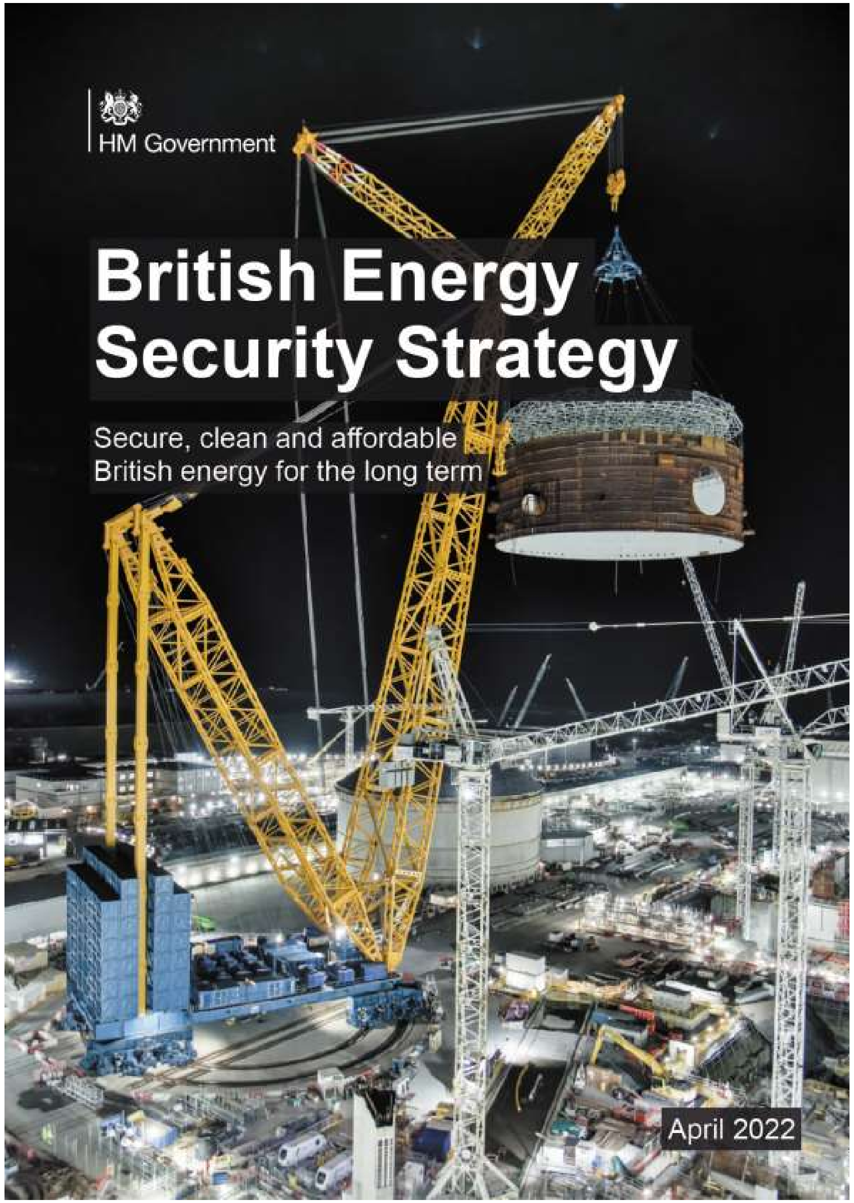
Considerations for REMA

October 2022

Introduction

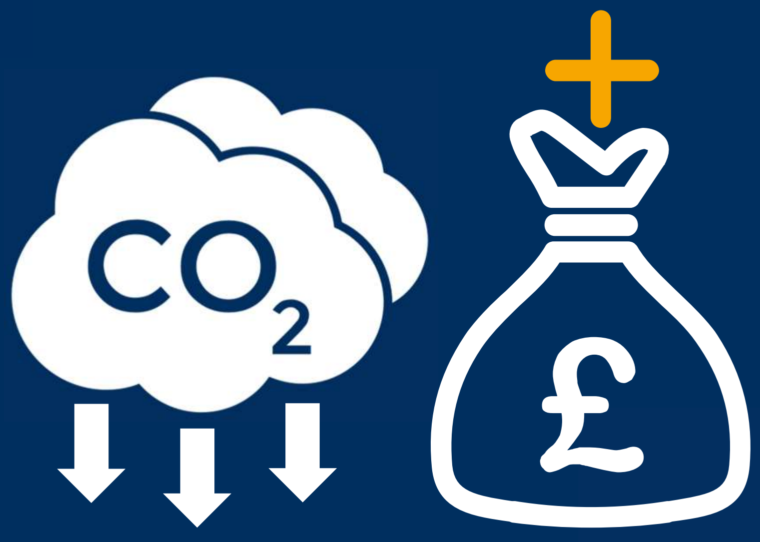
Assessing the impacts and implications of the British Energy Security Strategy (BESS)

- In April, the **UK Government published the British Energy Security Strategy (BESS).**
- In light of rising energy prices, the aim of the strategy is to reduce our exposure to volatile gas prices, reduce our reliance on fossil fuels and increase our energy security through more home grown energy sources. **The new UK Government has committed to becoming a net exporter of energy by 2040, making delivering on the BESS ever more important.**
- This included measures such as reaching **50GW of offshore wind by 2030**, **doubling the 2030 low carbon hydrogen production** capacity to 10GW and increased commitments on **nuclear and solar**.
- **SSE commissioned LCP to assess the impacts and implications of the BESS commitments on the electricity system** as a follow up to our previous Net Zero Power Without Breaking the Bank' report commissioned by SSE in July 2021.
- **The recent disruptions to European energy supplies and impact on the market only amplifies the importance of BESS**. However, the commitments included in BESS will take time to deliver, and will not address impacts on consumers in the coming winters – with nearer term fiscal support required.



BESS Impacts:

Cutting gas, carbon and costs



British Energy Security Strategy (BESS) overview

Power sector measures in the strategy

Offshore Wind	Ambition to deliver up to **50GW of offshore wind by 2030**, with up to 5GW coming from floating offshore wind by 2030.
Nuclear	Ambition to reach up to **24GW of nuclear power capacity by 2050**, serving up to 25% of electricity demand.
Hydrogen	**2030 low carbon hydrogen production target doubled to 10GW**, with electrolysers contributing at least 50% of this.
Onshore Wind & Solar	Ambition to increase **solar capacity five-fold by 2035**. Support English onshore wind projects that have community backing.
Networks & Markets	Set out plans to deliver the **transmission network** to meet the renewables ambition. Announced the **Review of Electricity Market Arrangements (REMA).**

Modelling approach

A range of scenarios and sensitivities were modelled to test the impact of BESS

Two core scenarios

Status quo scenario

- Net Zero consistent but more build in later years.
- 40GW Offshore Wind by 2030.
- Gas CCS, onshore and solar ramp up over time.
- Sizewell C included but no further new nuclear.

BESS scenario

- All power sector measures from BESS included.
- 50GW Offshore Wind in 2030.
- 70GW Solar in 2035.
- 5GW of electrolysis in 2030.
- 15GW of nuclear by 2040 and 24GW by 2050.

Two sensitivities on BESS scenario

BESS with Slower nuclear deployment

- BESS with nuclear deployment consistent with Status Quo.
- No further nuclear post Sizewell C, with this capacity replaced by Gas CCS.

BESS with Slower renewable deployment

- BESS with renewable deployment consistent with Status Quo.
- 40GW Offshore Wind by 2030.
- 55GW solar in 2035.

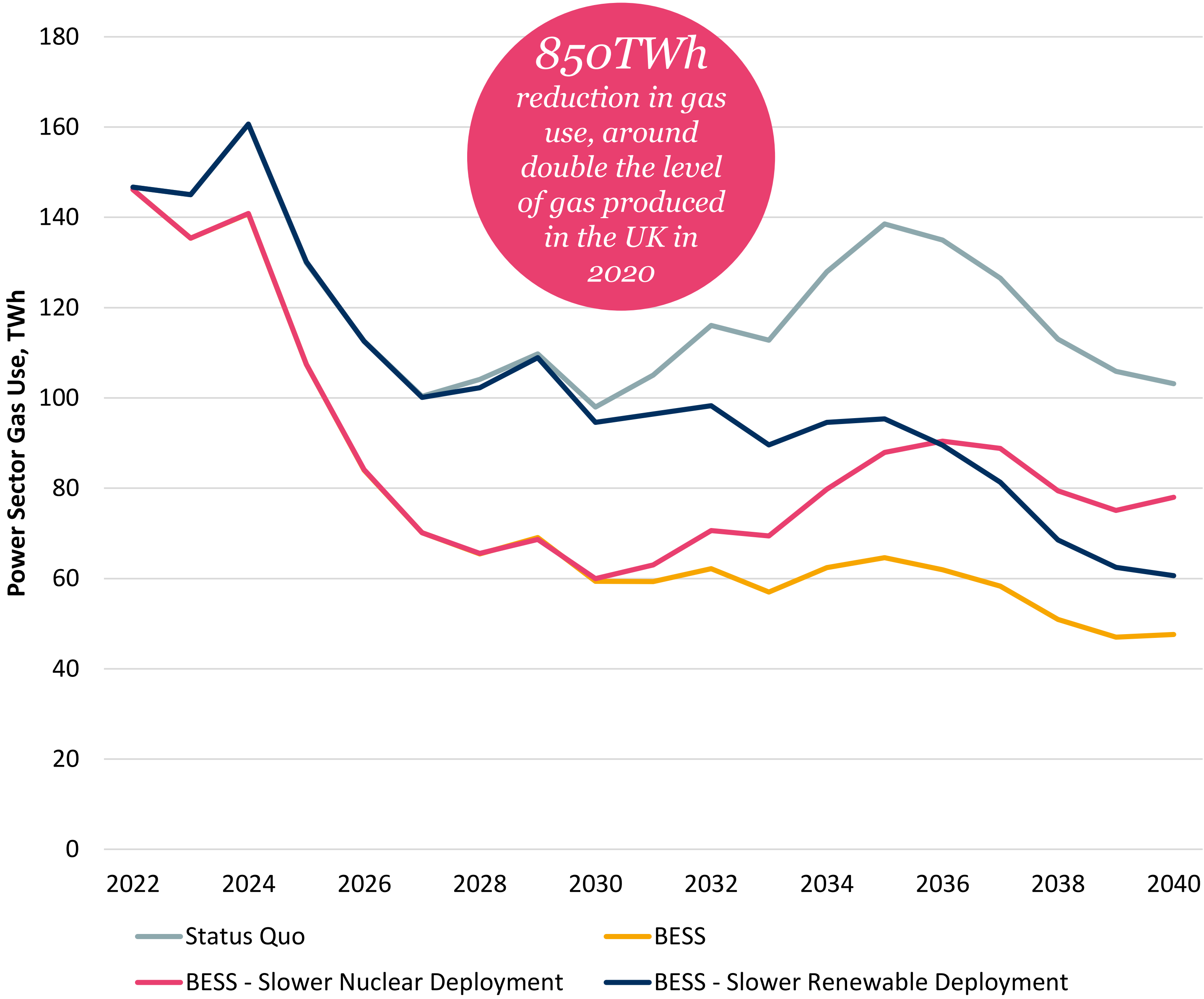
Current high gas prices assumed to fall to lower levels in longer term

Demand based on BEIS Net Zero Lower Demand scenario

All scenarios Net Zero compliant and meet security of supply requirements

BESS Impact – Power sector gas use

Lower natural gas demand



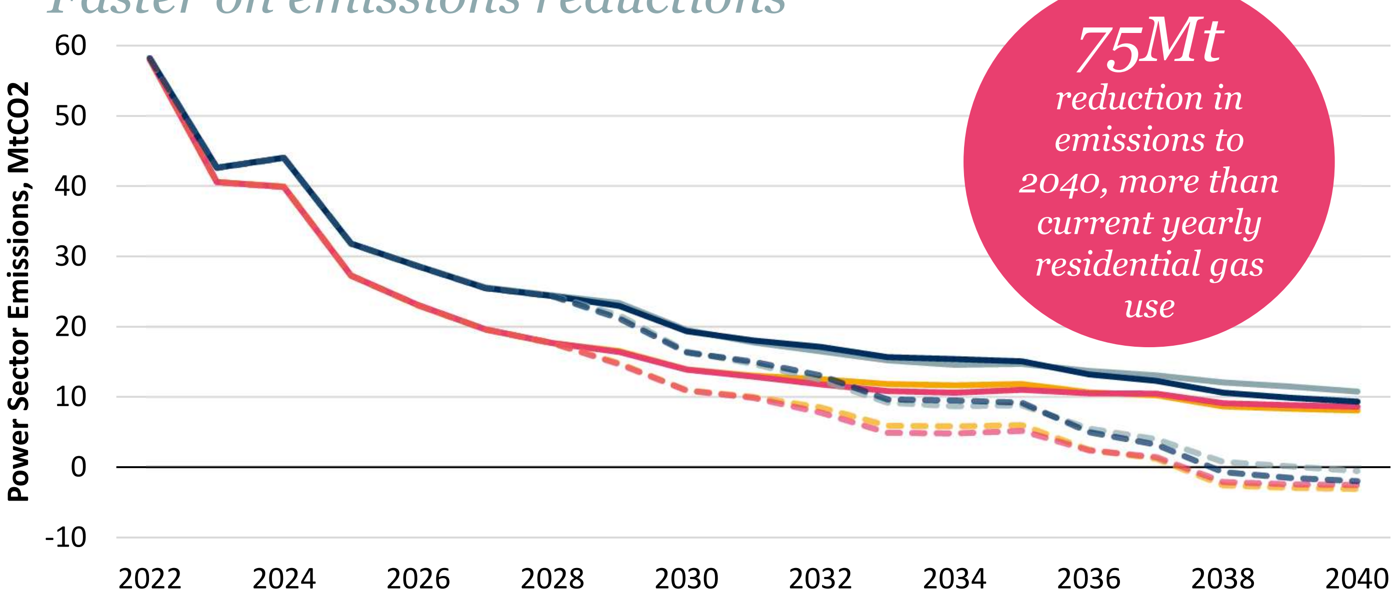
BESS scenario **reduces gas demand in the power sector by 850TWh** from now to 2040 compared to Status Quo

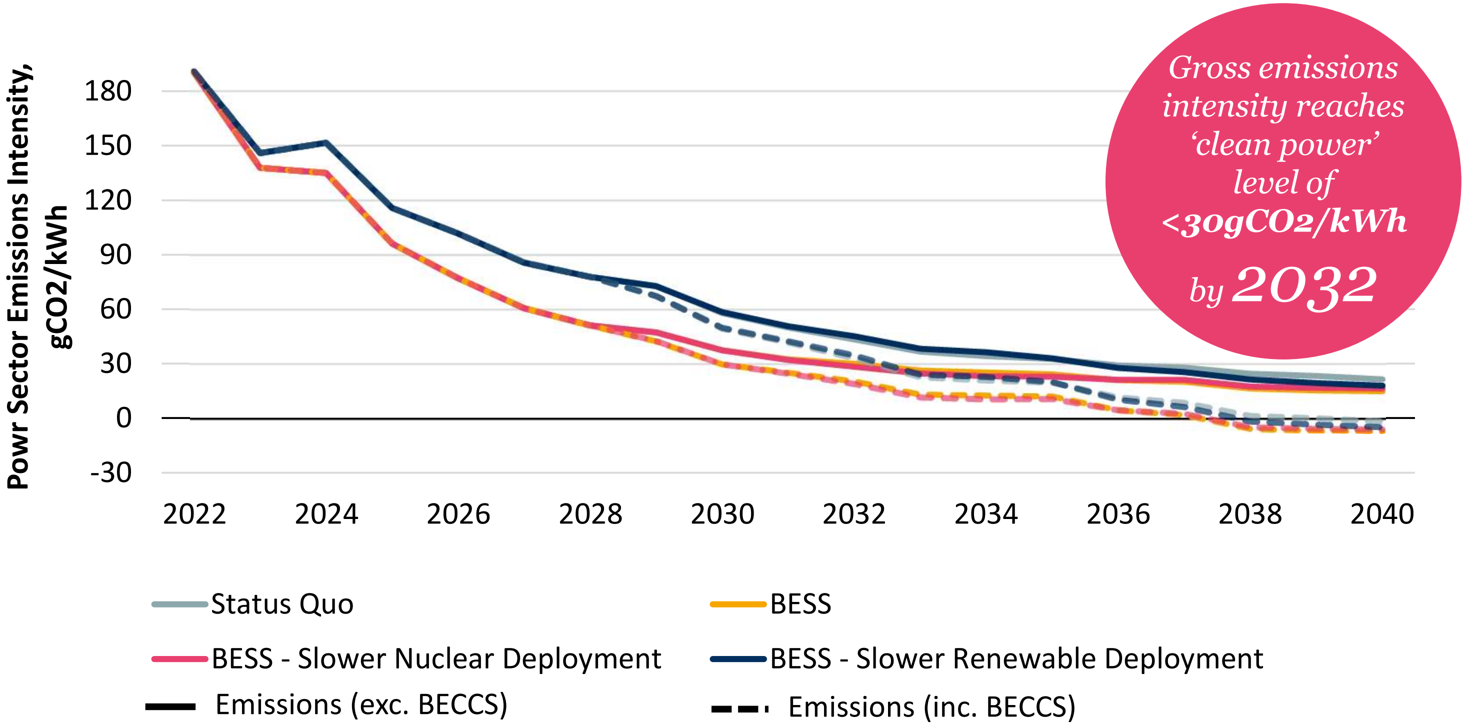
By 2030, only 5% of GB power generation will be from unabated gas compared to 40% in 2021

Faster Renewable deployment outlined in BESS has the higher impact in the short to medium term with increased **Nuclear deployment reducing gas use from CCS in the longer term**

BESS Impact – Power sector carbon emissions

Faster on emissions reductions





BESS scenario **reduces power sector emissions by 5.5Mt in 2030, and cumulative 75Mt through to 2040**

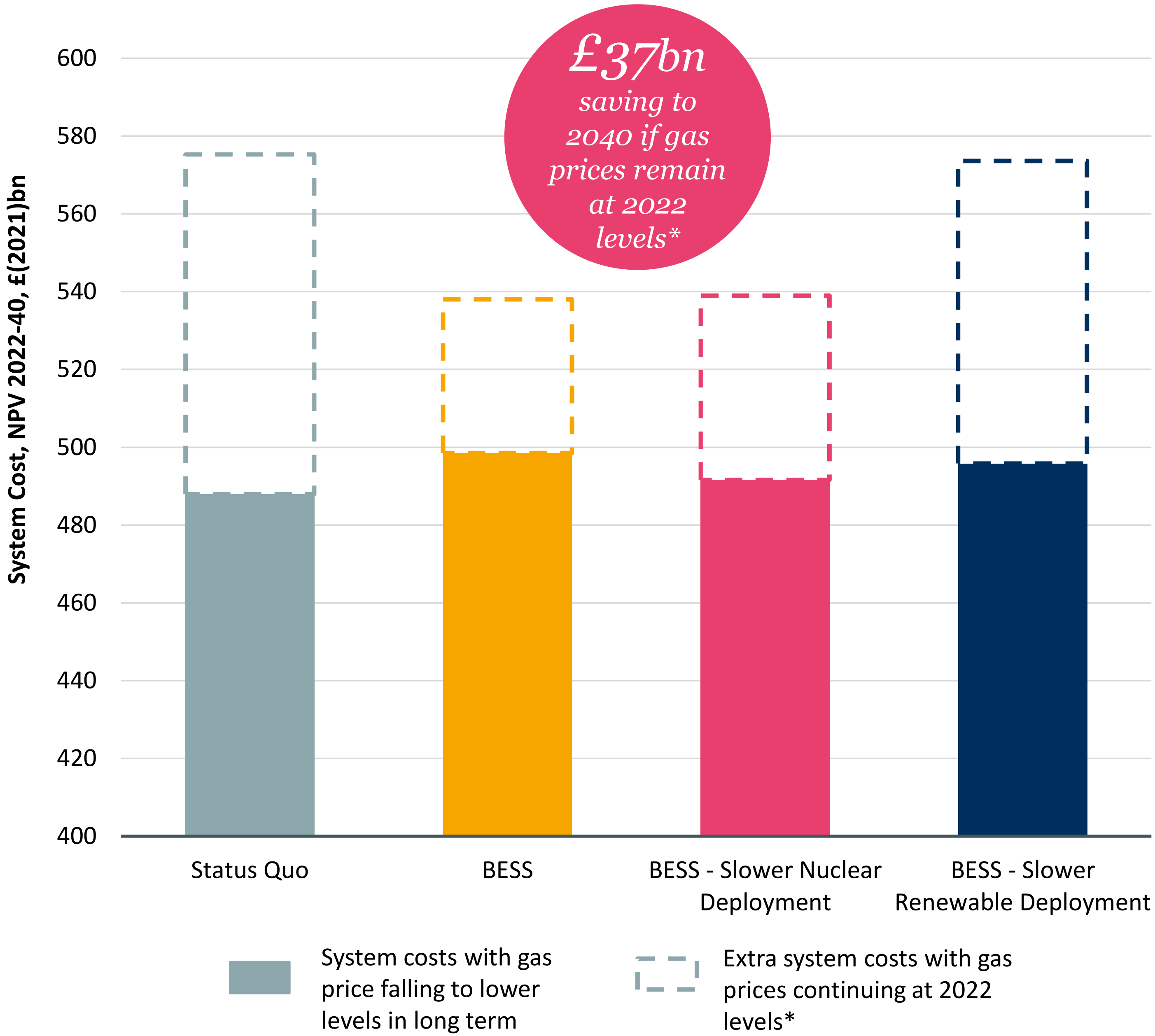
Renewable energy deployment has a much bigger impact on emissions reduction than nuclear due to earlier deployment meaning it replaces unabated gas

New nuclear has long build times, meaning it only has an impact on emissions from 2039. This leads to higher cumulative emissions in Slower Renewable Deployment scenario

Gross power sector emissions intensity reaches 38gCO2/kWh by 2030 (14Mt), with further efforts only slightly reducing residual emissions by 2040. To avoid diminishing returns, there is merit in defining 'clean power' as <30gCO2/kWh

BESS Impact – Power sector costs

Reduced exposure to volatile prices



If gas prices return to lower levels, BESS scenario results in additional £11bn in system costs compared to Status Quo. This additional cost reduces to £4bn without new nuclear

But **BESS acts an insurance against very high gas prices** keeping total system costs £37bn lower if high gas prices remain

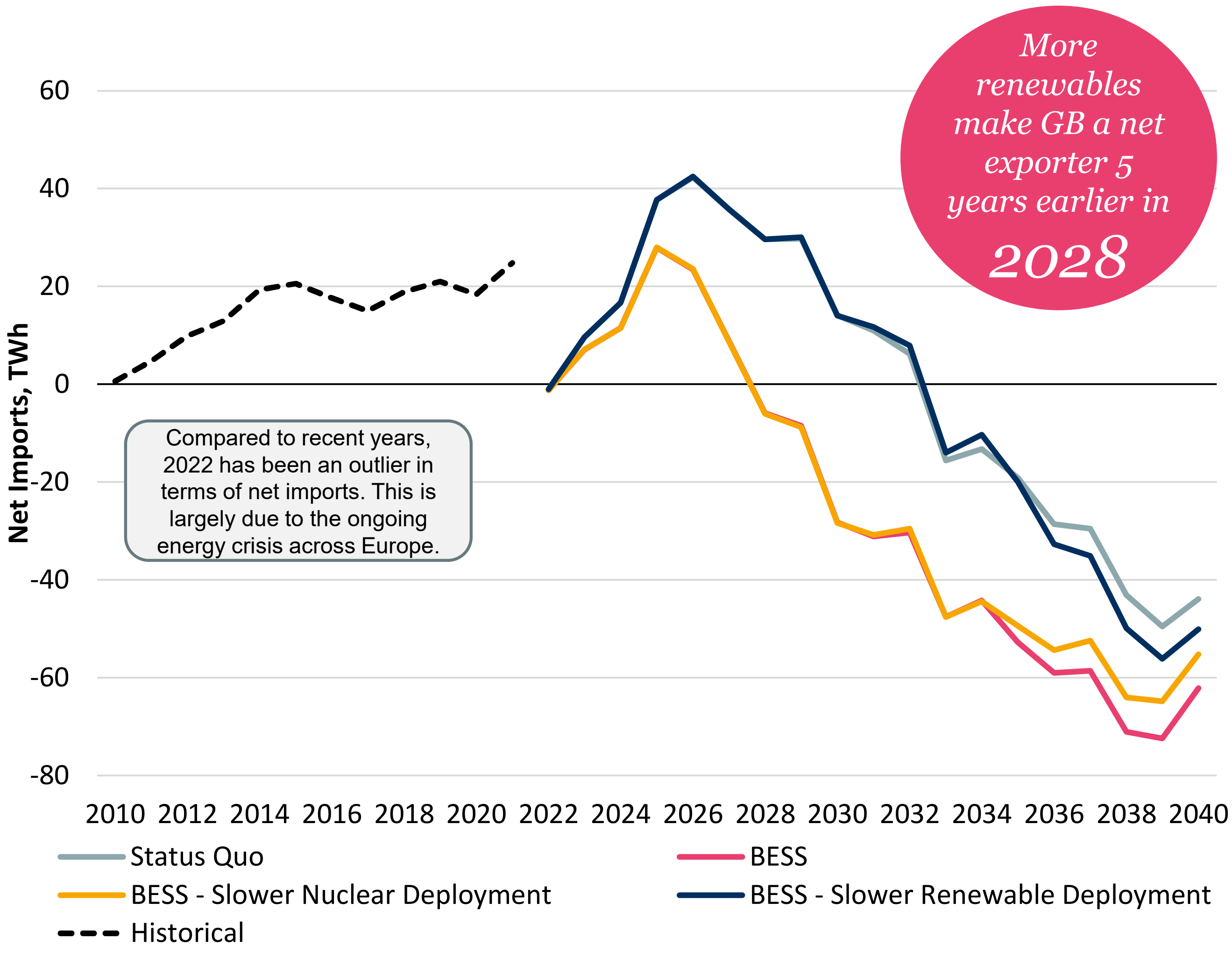
Faster renewables deployment has a bigger impact on reducing system costs than increased Nuclear deployment

Policymakers should consider our REMA and technology implications from BESS to minimise system cost increases whilst reducing reliance on gas

*2022 levels reflected GB forward prices from May 2022, which were at an average of 225p(2021)/therm for the year. Central gas price assumptions included in Annex

BESS Impact – GB becomes a net exporter of electricity

Increased 2030 renewables ambition to make GB a net electricity exporter by 2028



With the increases in renewable capacity and increased interconnector capacity, **GB is likely to become a net exporter of electricity before 2040**. This will be a significant contribution to the government aim of being a net energy exporter by 2040.

The Government is aiming to have 18GW of interconnector capacity with other countries to by 2030, up from 7.4GW today. Whilst interconnectors face questions over their impact during concurrent capacity issues as seen this winter, they certainly **help integrate large levels of renewable capacity** onto the system allowing GB to export excess wind and solar energy to Europe during high renewable low demand periods.

The measures in the BESS to increase renewable capacity mean that GB becomes a net exporter in the late 2020s rather than the early 2030s. In 2021, GB was a net imported from Europe with net electricity imports of 24TWh. This changes significantly by 2040 with GB becoming a net exporter and net exports being up to 70TWh, which would be **worth £1bn/year in net exports to UK plc**.

BESS Implications:

Importance of REMA

Review of Electricity Market Arrangements (REMA)

REMA will be vital in delivering BESS but the right changes to the GB electricity market will be required to ensure delivery at lowest cost

- As announced in BESS, then UK Government recently launched its **Review of Electricity Market Arrangements (REMA) consultation** to ensure that the market is fit for the purpose for the future.
- The core objective of the REMA programme is to **reform electricity market arrangements to facilitate the full decarbonisation of the electricity system by 2035, subject to security of supply, whilst being cost effective for consumers**.
- **The areas under review are split into different areas**, including changing locational granularity of the wholesale market through to a complete split in the wholesale market into low carbon and high carbon. REMA also looks at evolving existing subsidy mechanisms for low-carbon power and improvements to ensure security of supply.
- REMA will be vital in delivering the measures outlined in BESS and to deliver Net Zero but **changes to the market need to be made in the right way and the right time to facilitate decarbonisation at the lowest cost**. Within the REMA programme, the government must consider:

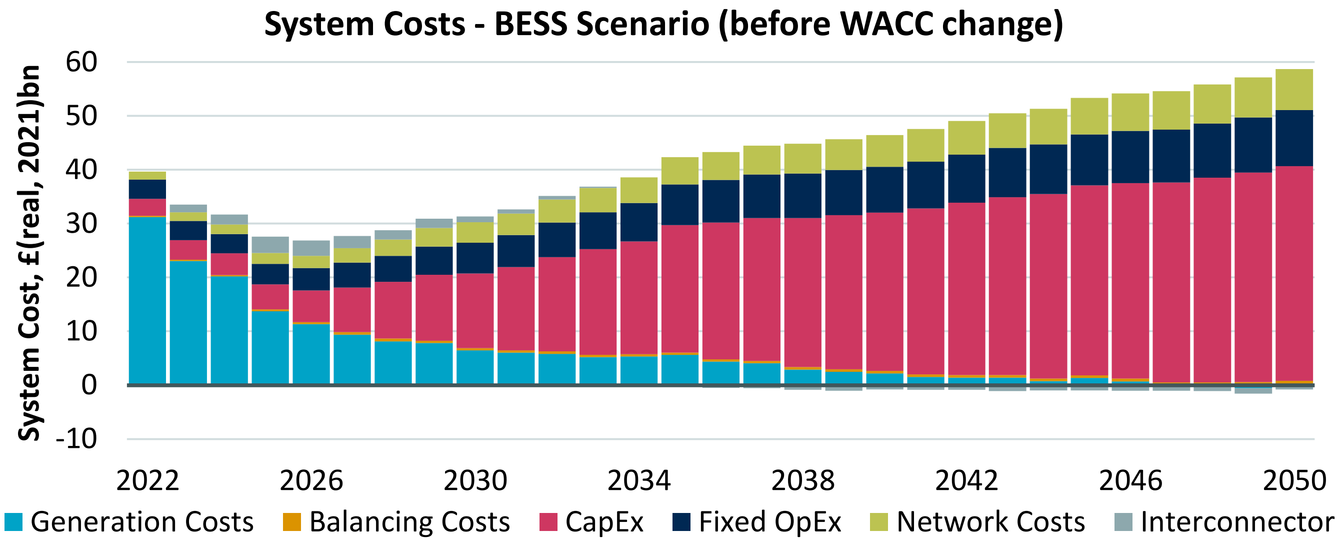
1. **Finance costs** – With capital costs making up half of total system costs, keeping capital costs low should be a key consideration of REMA. **Increasing the Weighted Average Cost of Capital (WACC) for new projects by 1pp (percentage point) could increase capex costs by £45bn and a 2-3pp increase by £92-142bn to 2050**

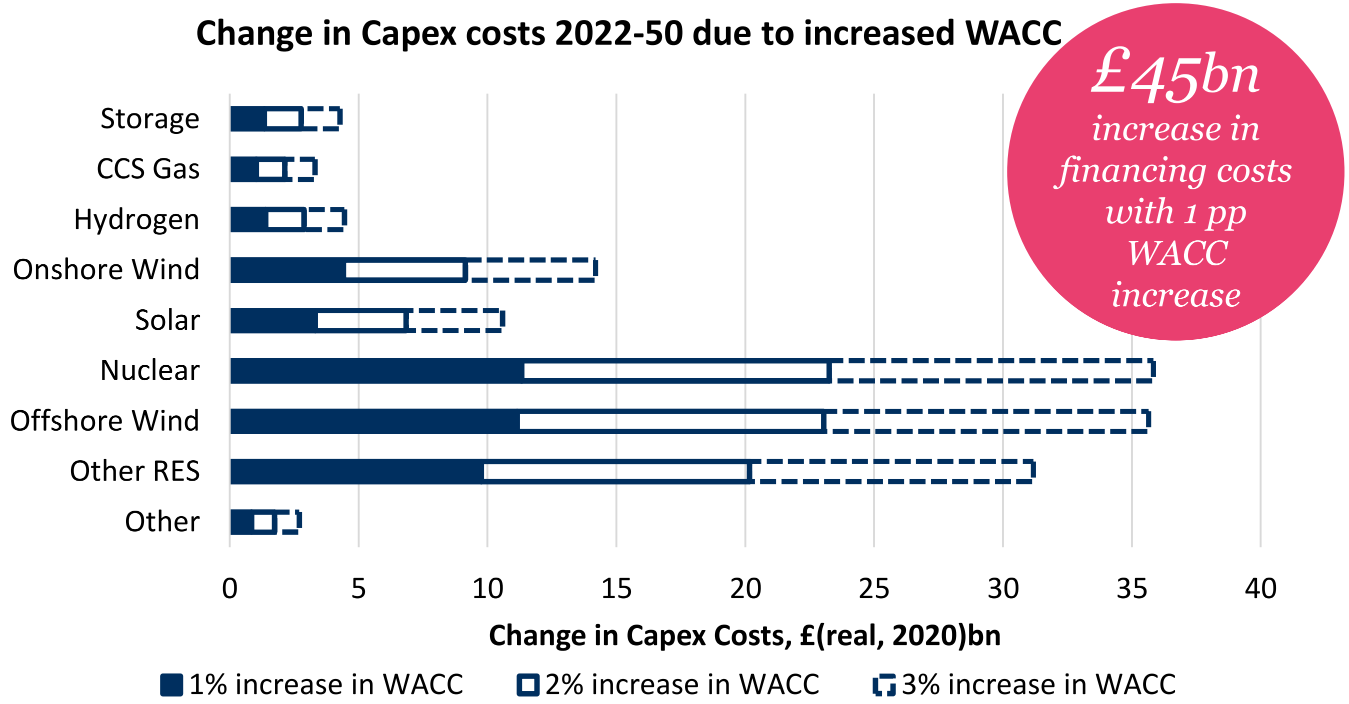
2. **Market design** – Valuing all low carbon equally is likely biggest potential saving from REMA. **Supporting life extensions, refurbishments and/or repowering of existing assets inline with new generation assets could save £48bn from now to 2050**. The higher BESS ambition has increased this impact form £20bn last year

3. **Optionality** – Retaining **optionality to modify power sector strategy to reflect changes in technology costs, commodity markets and consumer demand** will be vital in ensuring optimal outcomes and keeping costs down for consumers

1. Importance of finance costs

Keeping capital costs low should be a main focus of REMA





Within REMA, significant changes to electricity market design should be considered in the context of the significant levels of new investment that are required over the next decade.

Reforms that increase **volatility or uncertainty for investors will raise the cost of financing new projects** needed to achieve Net Zero.

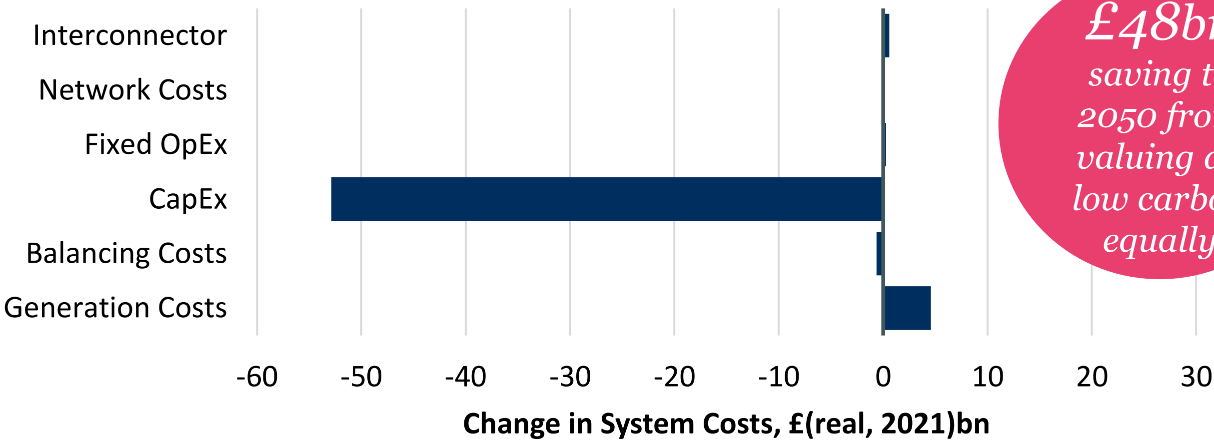
Capital costs (CapEx) making up the bulk of system costs in future years, with £350bn of the £710bn of the system costs out to 2050. **An increased cost of capital would ultimately increase costs for consumers** as this would increase CfD strike prices and clearing prices in the Capacity Market.

Our analysis highlights that an increase in the Weighted Average Cost of Capital (WACC) for new projects of 1 percentage point (pp) could increase capex costs by £45bn, a 2 pp increase by £92bn, and 3 pp increase by £142bn to 2050 in the Full BESS scenario.

2. Evolution of market design

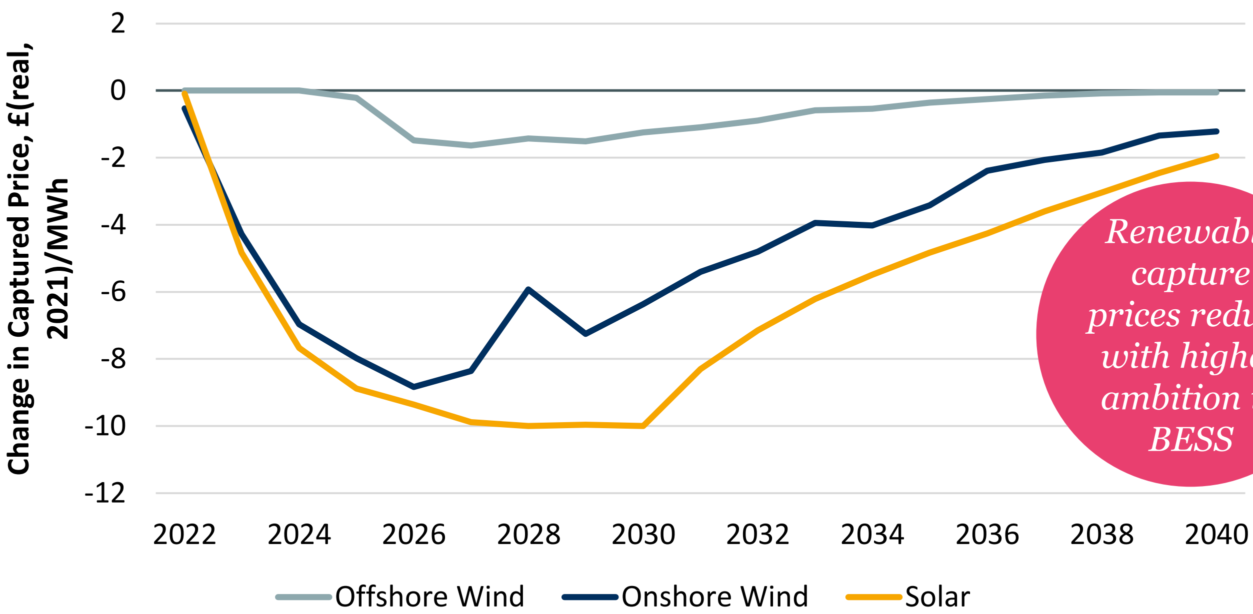
Valuing all low carbon equally is likely biggest potential saving from REMA

Change in system costs due to low carbon support reforms



£48bn saving to 2050 from valuing all low carbon equally

Change in capture between Status Quo and BESS scenario



Renewable capture prices reduce with higher ambition in BESS

A rapid build out of CfD supported generation could create perverse incentives in market signals and lead to higher costs for consumers in the long term.

An immediate issue is that investment costs in the coming years **could increase as new zero marginal-cost generation seek to recoup their full capital costs over their initial CfD period.**

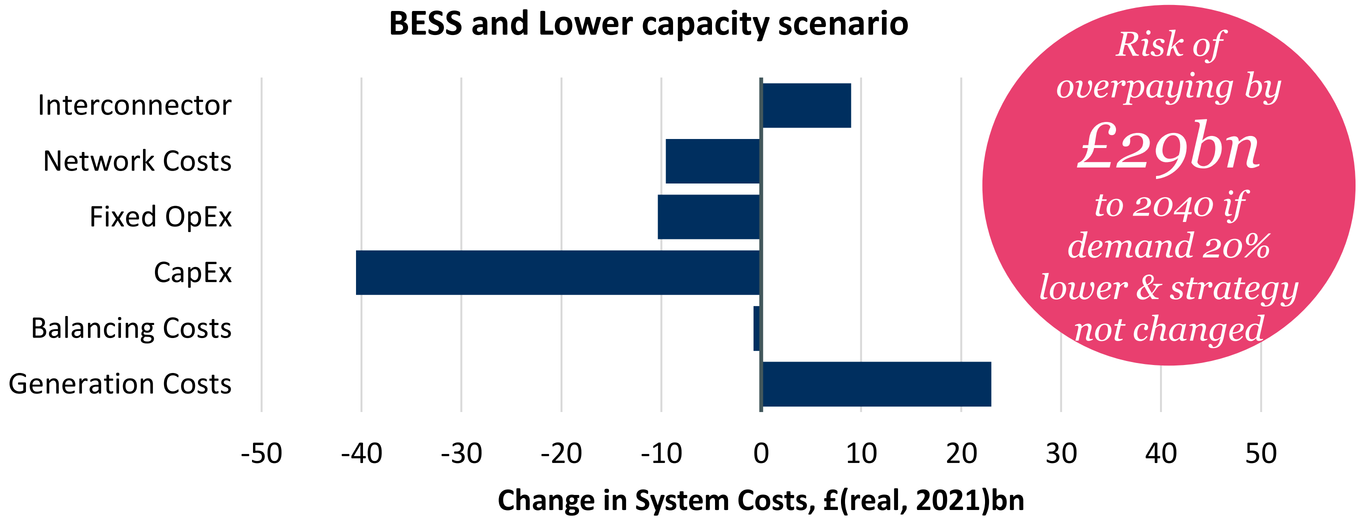
Longer term, maintaining the CfD in its current form would mean **new supported generation would displace existing unsupported low carbon generation who rely on market signals to cover their ongoing costs.** This would mean new generation is supported at the expense of life extensions, refurbishments or repowering of existing assets.

BESS has accelerated this issue. In July 2021, the addressing the split market for new and existing low carbon generation would have saved £20bn. With the increased renewables ambition within BESS, **valuing all low carbon generation equally could save £48bn in system costs up to 2050, and is likely to be the biggest potential saving from the REMA programme.**

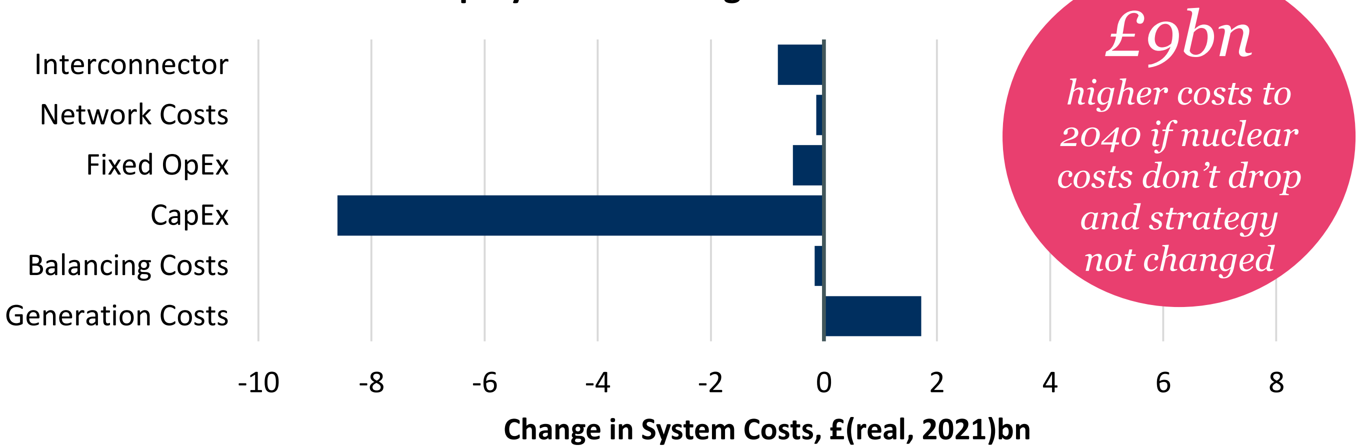
3. Optimal pathway will develop over time

Retaining optionality will help keep costs down as technology costs, commodity prices and consumer demand changes

Change in system cost in lower demand scenarios between Full BESS and Lower capacity scenario



Change in System costs between Full BESS and BESS with Slower Nuclear Deployment with higher Nuclear Costs



Retaining optionality to modify power sector strategy will be vital in ensuring optimal outcomes and keeping costs down for consumers. This also needs to be considered in any reform to the markets, for example to avoid market reforms that benefit one technology over another or solve problems that exist now which may be eased later.

For example, lower energy demand than used in these scenarios will mean less renewable and nuclear capacity is needed to achieve the same level of emissions reduction. **If we retain the same level of build but demand is 20% lower then we could be overbuilding capacity in the power sector and increasing system costs by £29bn** to reach the same level emissions as Full BESS with higher demand**.**

Similarly, as technology advances costs will likely change in ways that are difficult to predict at present. For example, if Nuclear costs do not decline from todays levels as more capacity is deployed then this could mean Gas CCS is a cheaper option. If Nuclear costs stay at BEIS FOAK levels then deploying Gas CCS over Nuclear could reduce costs by £9bn.

BESS Implications:

Technology insights

Technology considerations for delivering BESS

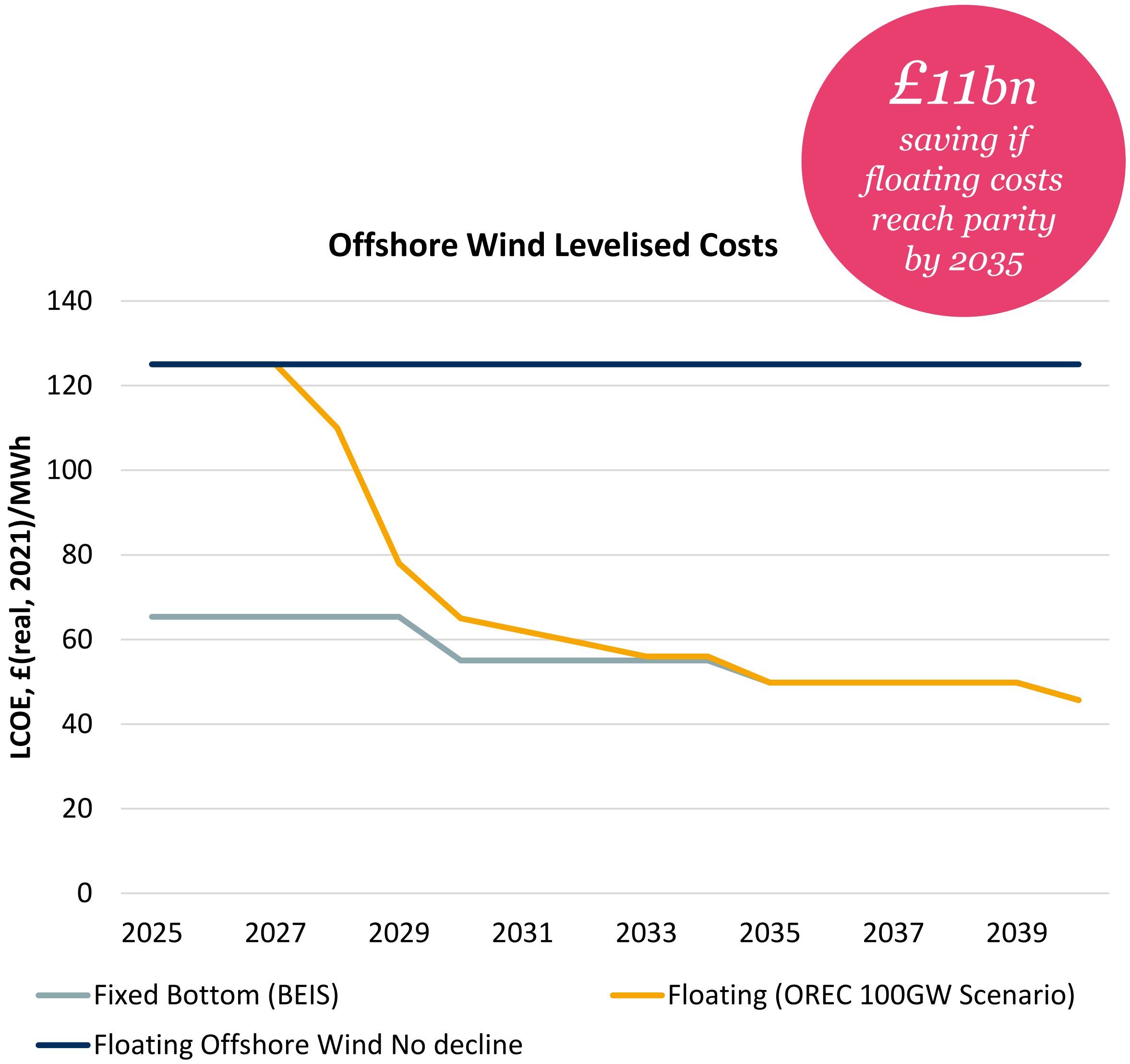
Our recommendations highlight key areas and actions that government will need to consider on different technologies to successfully deliver BESS at low cost

- The BESS highlighted the different role various technologies can play in meeting the fully decarbonised by 2035, subject to security of supply, target for the power sector and moving the system away from gas use.
- To maximise these benefits, the **following considerations for different technologies should be considered** by the policymakers when implementing and delivering power sector strategy:

1. **Floating offshore wind** – While BESS goes big on offshore wind, **wider support for floating offshore wind can help it reach cost parity with fixed bottom by 2035, potentially saving £11bn by 2040**
2. **Electricity storage** – **Deploying flexible assets, such as battery storage, long duration storage and hydrogen electrolysis could save £2bn by 2040** by helping to balance a renewables-led system
3. **Power CCS** – **Deploying 5GW gas CCS by 2030 is a no regrets option** reducing carbon emissions and system cost, without increasing gas use
4. **Hydrogen power** – Increased levels of peaking capacity will be needed as demand increases. **Hydrogen power stations can displace unabated gas plants in this role** as this will save 15Mt in emissions over the 2030s.
5. **Offshore grid** – Significant upgrades need to be made to electricity transmission network before 2030 to connect 50GW of offshore wind. **Coordinated networks this decade could save £6bn in system costs by 2040.**

1. Floating offshore wind cost reductions

Floating offshore wind has enormous potential if costs follow same trajectory as fixed-bottom offshore wind



As per our first step to achieving Net Zero power in our previous report, with increased offshore wind targets, the government is already going big on offshore wind.

However, reaching up to 100GW of offshore wind by 2050 will be challenging with fixed-bottom offshore wind alone. This means **floating offshore wind has a key role to play**. **Floating offers advantages over fixed-bottom as it can be deployed at a greater sea depth** meaning it can use a greater proportion of the seabed.

However, **floating currently costs around twice as much as fixed-bottom**. For it to be deployed at scale, costs need to reduce from current levels. **The new target for up to 5GW of floating by 2030 could speed up this cost reduction by providing a clear pipeline.**

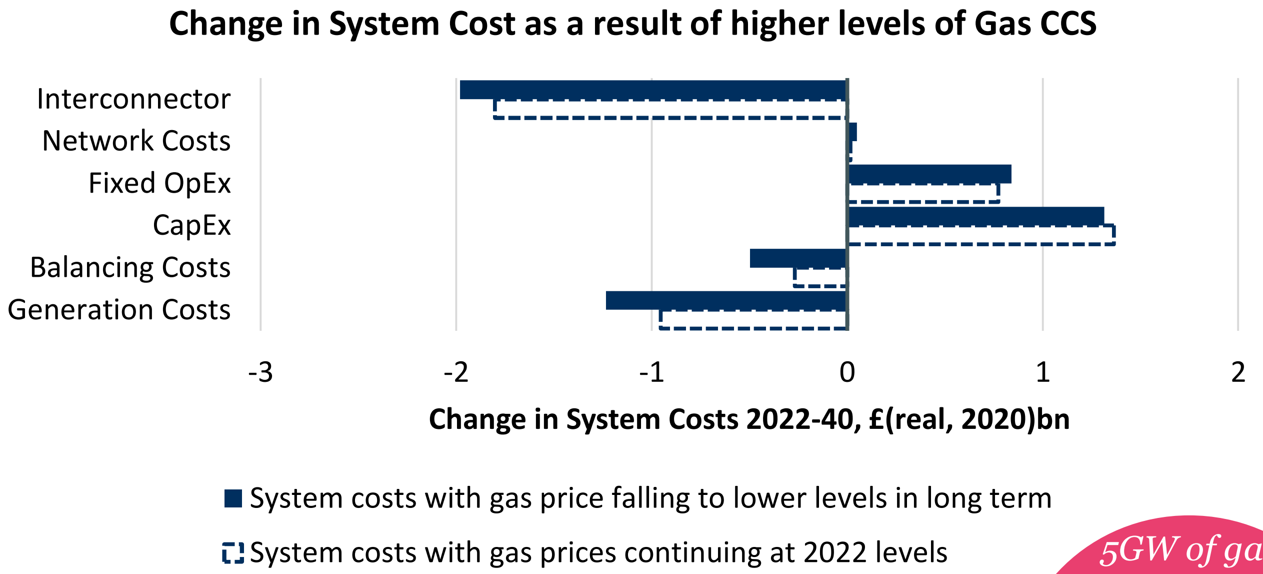
Early indications are that substantial cost reductions are possible given the latest CfD auction results included a project at 30% lower than the admin strike price but **further targeted innovation and supply chain support will likely be needed to fully realise potential cost decreases**.

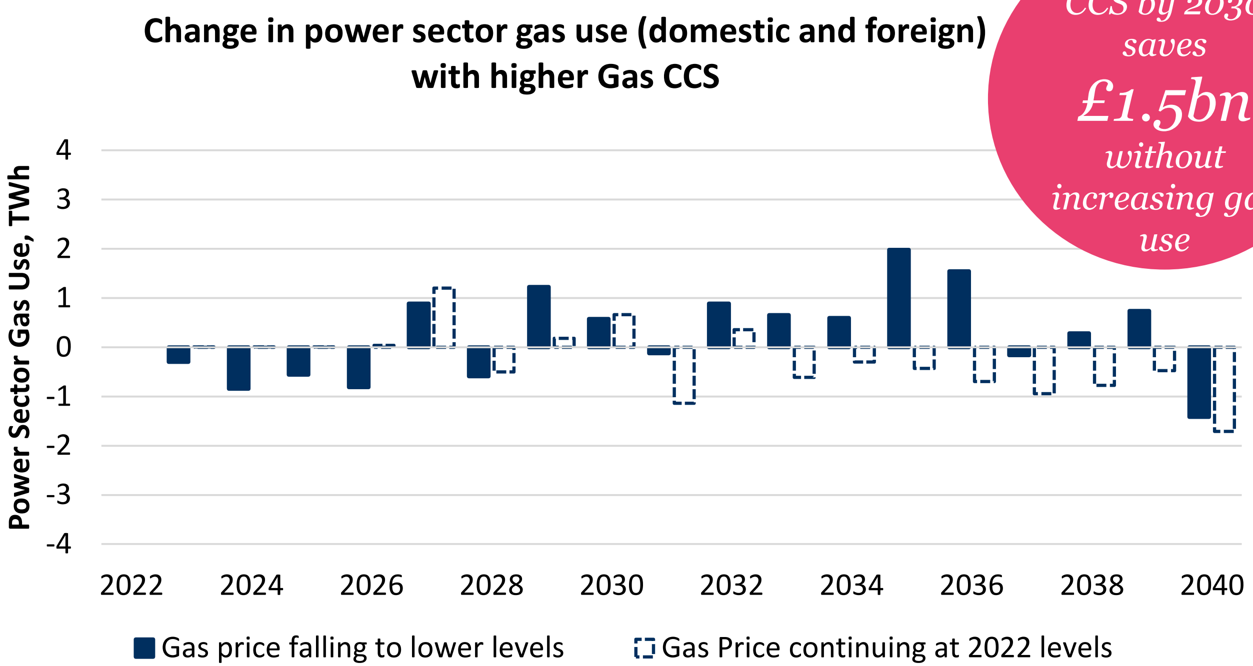
If floating offshore wind costs can drop to the same level as fixed-bottom by 2035 in line with industry expectations* then this can save £11bn in system costs to 2040.

*https://ore.catapult.org.uk/wp-content/uploads/2021/01/FOW-Cost-Reduction-Pathways-to-Subsidy-Free-report-.pdf

2. The role of power CCS

Deploying 5GW gas CCS by 2030 saves on carbon and cost, while using similar levels of gas





*5GW of gas CCS by 2030 saves **£1.5bn** without increasing gas use*

Deploying 5GW Gas CCS capacity by 2030 rather than 1GW by 2030 would reduce emissions by 10Mt and system costs by £1.5bn by 2040 compared to a scenario with 1GW by 2030. Benefits are similar even with gas prices continuing at 2022 levels with £1bn cost saving.

Counterintuitively, **a scenario with 5GW gas CCS uses a similar level of gas compared to 1GW gas CCS due to the efficiency gains of newer turbines displacing older existing gas generation in GB and importing over the interconnectors***, even including the energy used to capture its carbon emissions.

Under a 5GW gas CCS scenario gas consumption is on average 0.1-0.2TWh/year higher between 2025-30 depending on gas prices, and between 0.5TWh/year higher or 0.7TWh/year lower over the 2030s. For comparison, UK gas consumption was 861TWh in 2021.

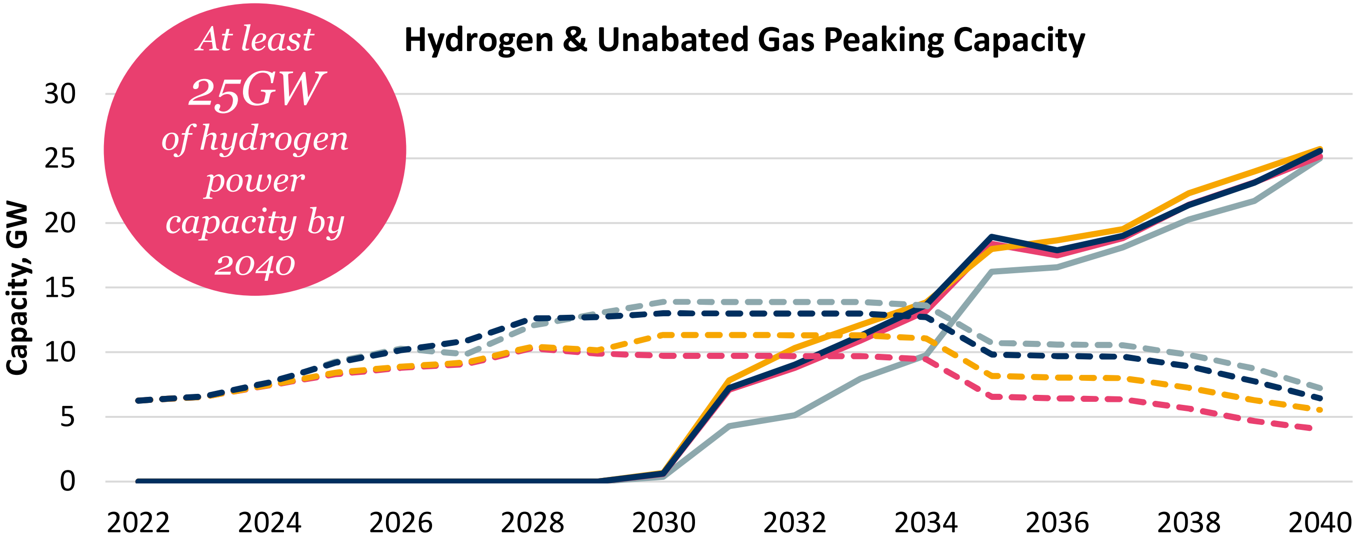
As such building at least 5GW Gas CCS by 2030 is likely to be low regrets and can support the deployment of carbon and hydrogen in industrial cluster around ports.

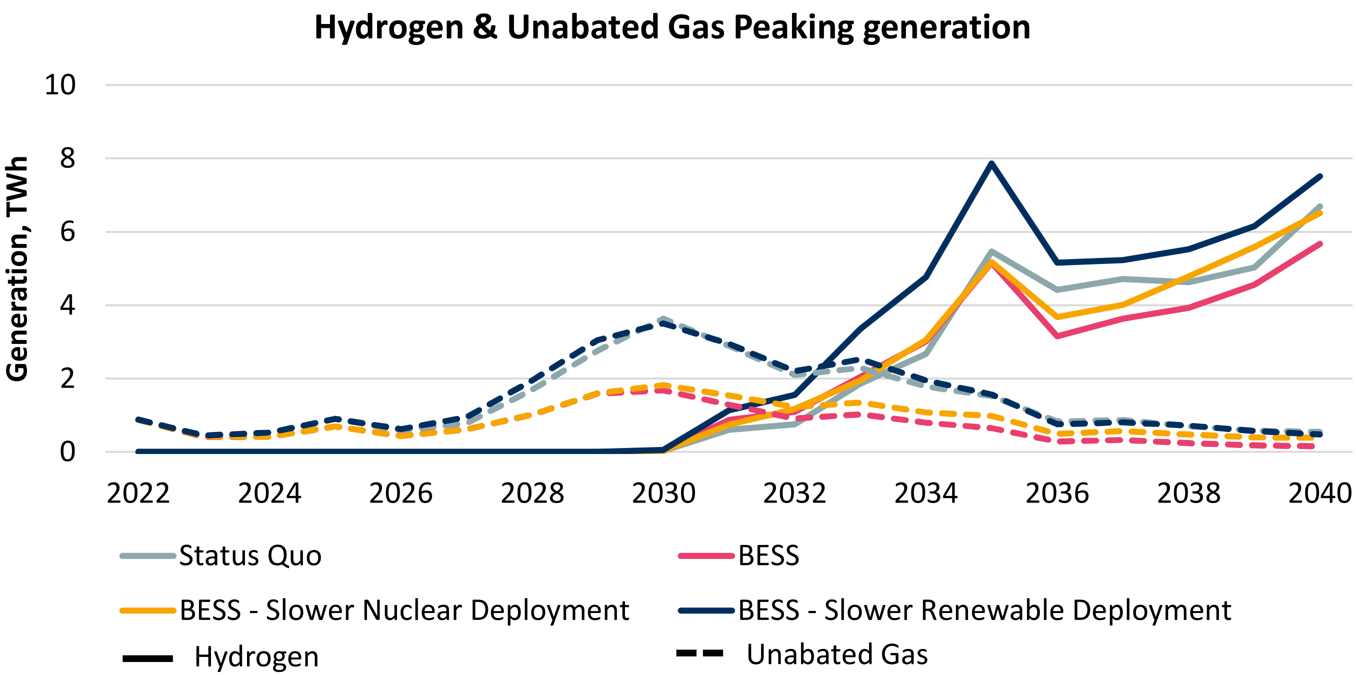
*Assumes inefficient gas-fired generation being imported as marginal generator

3. The emergence of hydrogen power stations

Hydrogen power generation can displace unabated gas capacity and output

At least 25GW of hydrogen power capacity by 2040





With electricity sector demand set to double between now and 2050 and different types of demand being added to the system, **increased levels of peaking capacity operating at low load factors will likely be needed to ensure security of supply.**

In our BESS scenarios, this **peaking capacity* reaches up to 30GW in 2040 generating up from 6GW today.** This capacity generates less than 10TWh per year.

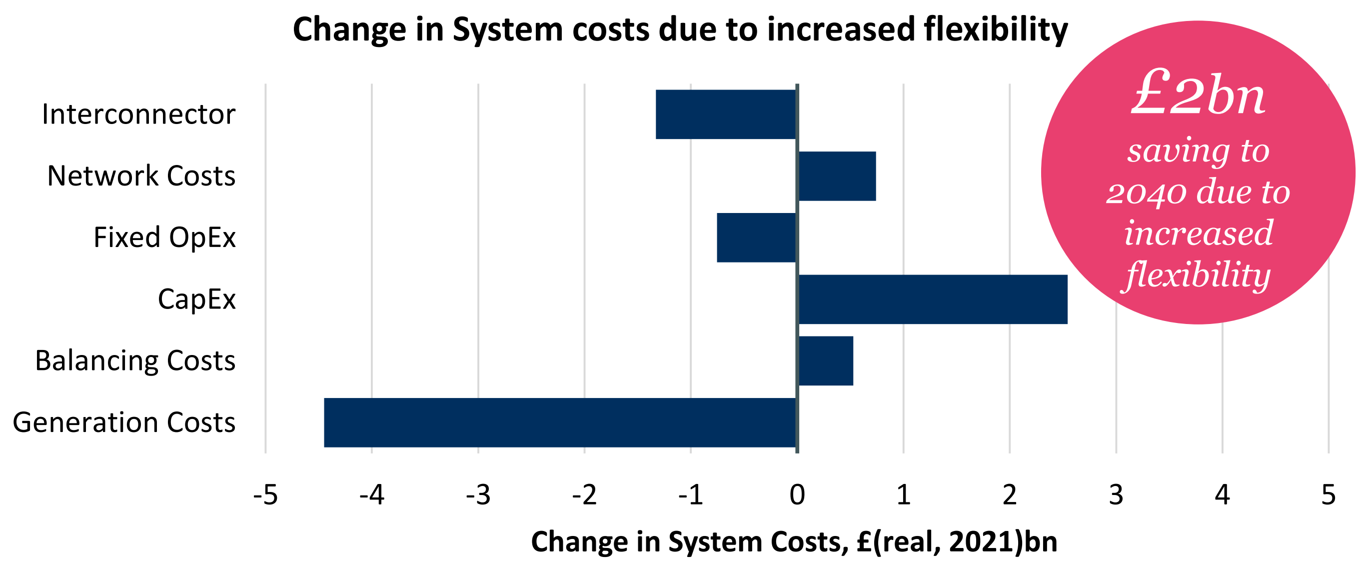
To decarbonise the electricity system cost effectively **new peaking gas generation should be able to utilise 100% hydrogen** and be located within industrial clusters with emerging hydrogen network and storage infrastructure.

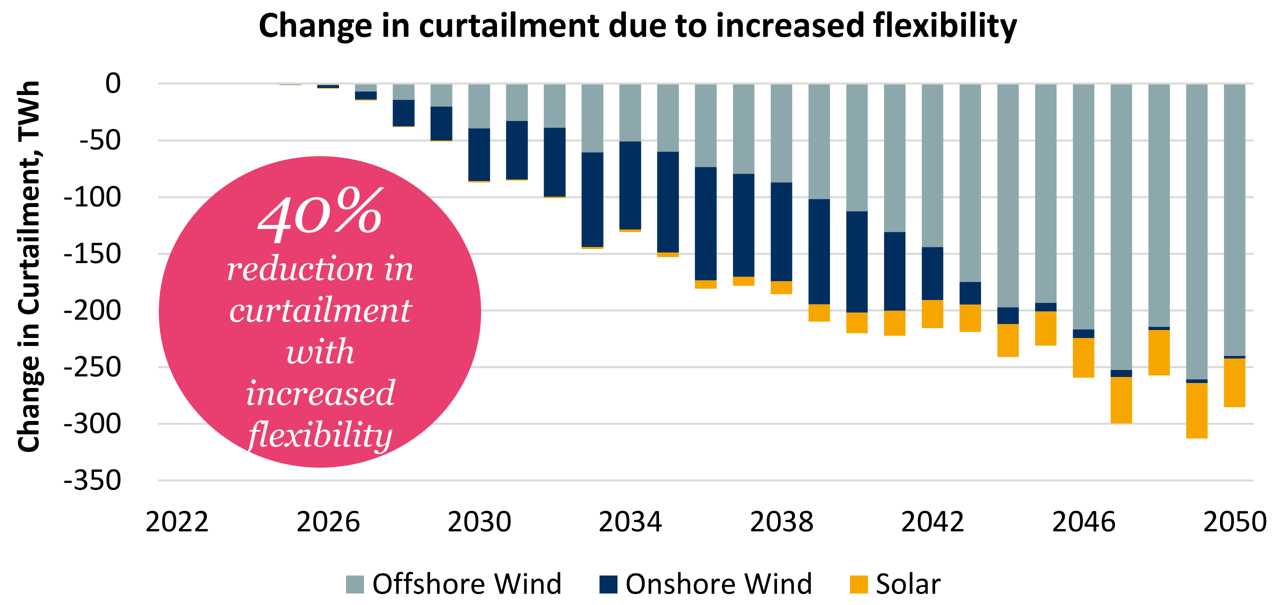
This hydrogen power generation capacity could save up to 15MtCO2 over the 2030s compared to this generation coming from unabated gas, **and would reduce the need for 4GW of unabated gas peakers by 2030 to meet security of supply** if there was no restriction in the capacity mechanism by the 2029-30 Delivery Year.

*Peaking capacity includes Open cycle Gas/Hydrogen Turbines (OCGT/OCHT) and below

4. The value of electricity storage

Batteries, long duration storage and green hydrogen can help cost effectively integrate renewable energy





Increased flexible assets can successfully integrate large amounts of renewables onto the system. **Batteries, longer duration storage and green hydrogen need to be deployed at scale.** The higher renewables also creates increased opportunities for batteries to reduce system costs.

With pumped storage increased to 5GW (from 2.8GW), batteries to 21GW (from 18GW) and electrolysis to 40GW (from 15GW), **curtailment decreases by 40% (75TWh) and system costs decrease by £2bn to 2040.** Targeting the siting of this capacity through TNUoS or investment mechanisms could present an alternative to locational marginal pricing.

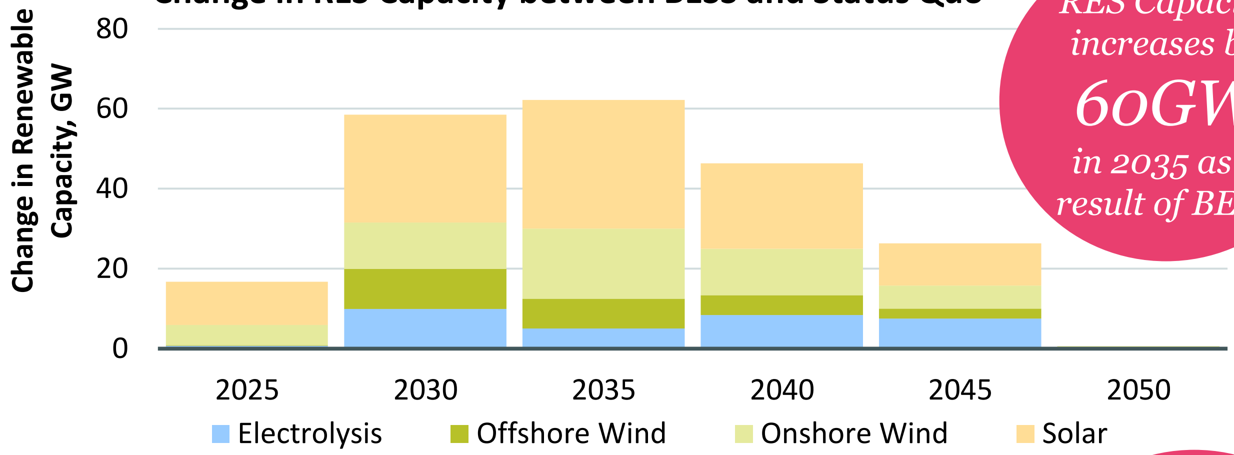
Savings are primarily in generation costs and fixed opex due to the need for more peaking generation to meet peak demand. In addition, residual emissions from the production of blue hydrogen are displaced, reducing overall carbon emissions in the economy.

Savings could be even greater as these technologies could also displace renewable capacity (to achieve same overall level of renewable generation) rather than just peaking capacity.

5. The developing offshore grid

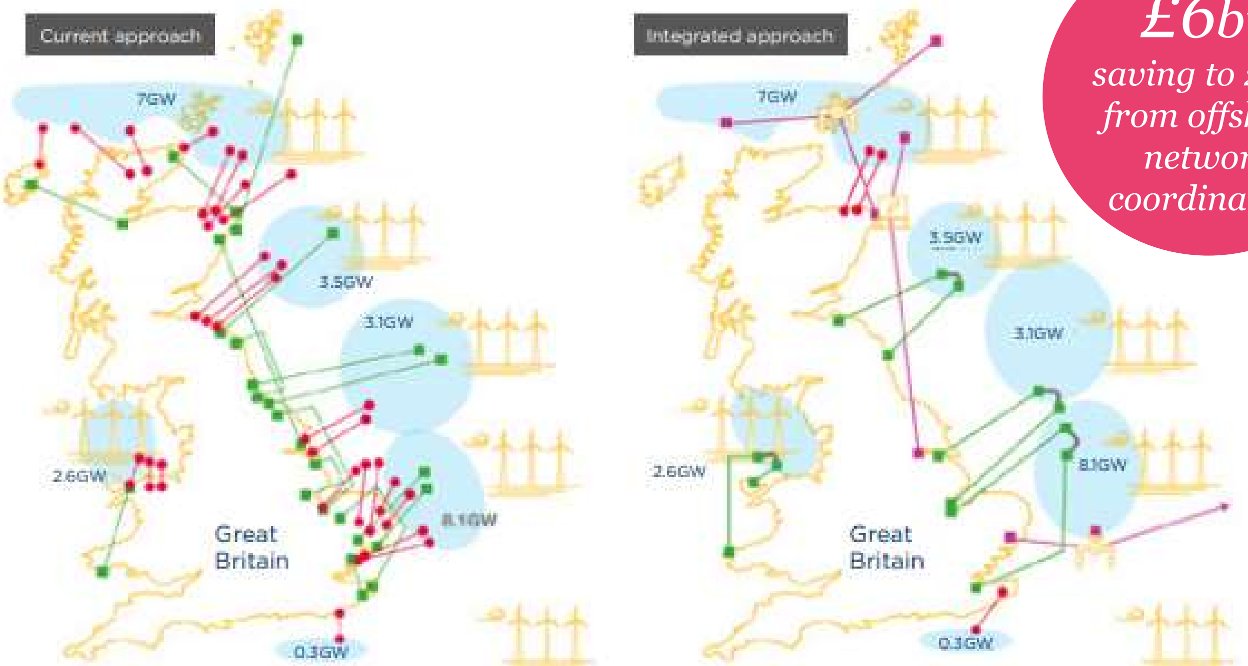
The Offshore Transmission Network Review (OTNR) will reduce costs and local impacts

Change in RES Capacity between BESS and Status Quo



RES Capacity increases by **60GW** *in 2035 as a result of BESS*

Current and Integrated GB Network Designs for 2030



Source: National Grid ESO

£6bn *saving to 2040 from offshore network coordination*

BESS commits to significantly higher levels of renewable capacity with around 60GW more capacity from these technologies in 2030 and 2035. As renewable generators are less likely to be built near demand centres, **this will require a significant upgrading of the transmission network.**

Without faster build out of networks, renewable generation will be constrained and not be able to get from where it is generated to where the demand is. This will mean gas generation increasing to fill the gap and significantly reducing the benefits of deploying more renewable capacity.

In addition, the **higher offshore wind capacity means taking a co-ordinated approach to offshore transmission becomes even more important** and provides higher savings than estimated previously. The **co-ordinated offshore approach contained within the Holistic Network Design (HND) under the Offshore Transmission Network Review (OTNR) could save £6bn in system costs from now to 2040.**

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BESS Impacts and Implications:

Conclusions

Conclusions

BESS Impacts – Cutting gas, carbon and costs

The impacts of BESS on the power sector show it will likely achieve its aims of reducing gas use and emissions whilst acting as an insurance against volatile gas prices.

BESS results in a **significant reduction in gas usage.**

850TWh saved through to 2040 in the power sector alone.

BESS **accelerates emissions reductions.**

BESS scenario reduces carbon emissions by 75MtCO2 by 2040.

BESS is an **£11bn insurance against very high gas prices.**

If prices stay at current levels then BESS scenario reduces costs by £35bn by 2040.

BESS makes **GB a net exporter of electricity by late 2020s.**

Net exports could reach up to 70TWh in 2030s, worth £1bn/year in exports to UK plc.

BESS implications – Importance of REMA

The REMA programme will be vital to enable the cost effective delivery of the ambitions to fully decarbonise the power sector by 2035.

50% of energy system costs will be capex from now to 2050. Increasing cost of capital by just 1-3 percentage points would increase system costs by £45-142bn

Reforming the electricity market to **value all low carbon generation equally is biggest REMA saving** with BESS increasing the potential saving from £20bn to £48bn by 2050.

Future market design should be able to fit with a variety of future real world scenarios and **enable optionality within power sector strategy** so it can adapt where needed.

BESS implications – Technology insights

To help deliver on the BESS objectives, policy and regulation should focus in support emerging technology developments

£11bn saving by 2040 if **floating offshore wind** costs can be reduced to fixed-bottom levels

Electricity storage and electrolysers can avoid 95TWh/ year of curtailed renewables by 2030

5GW of **gas CCS by 2030** can reduce costs and carbon without increasing gas use

A coordinated approach to **offshore grids** can save £6bn by 2040

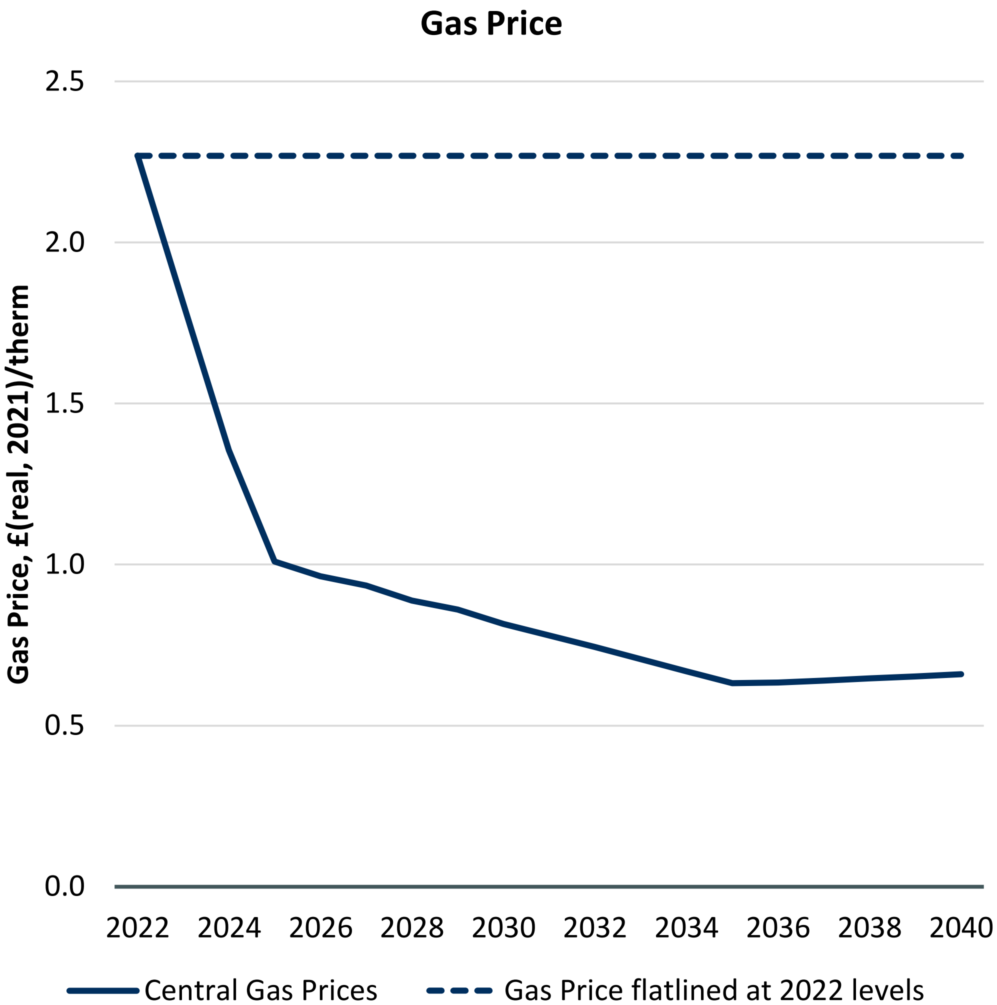
At least **25GW hydrogen power capacity** required by 2040

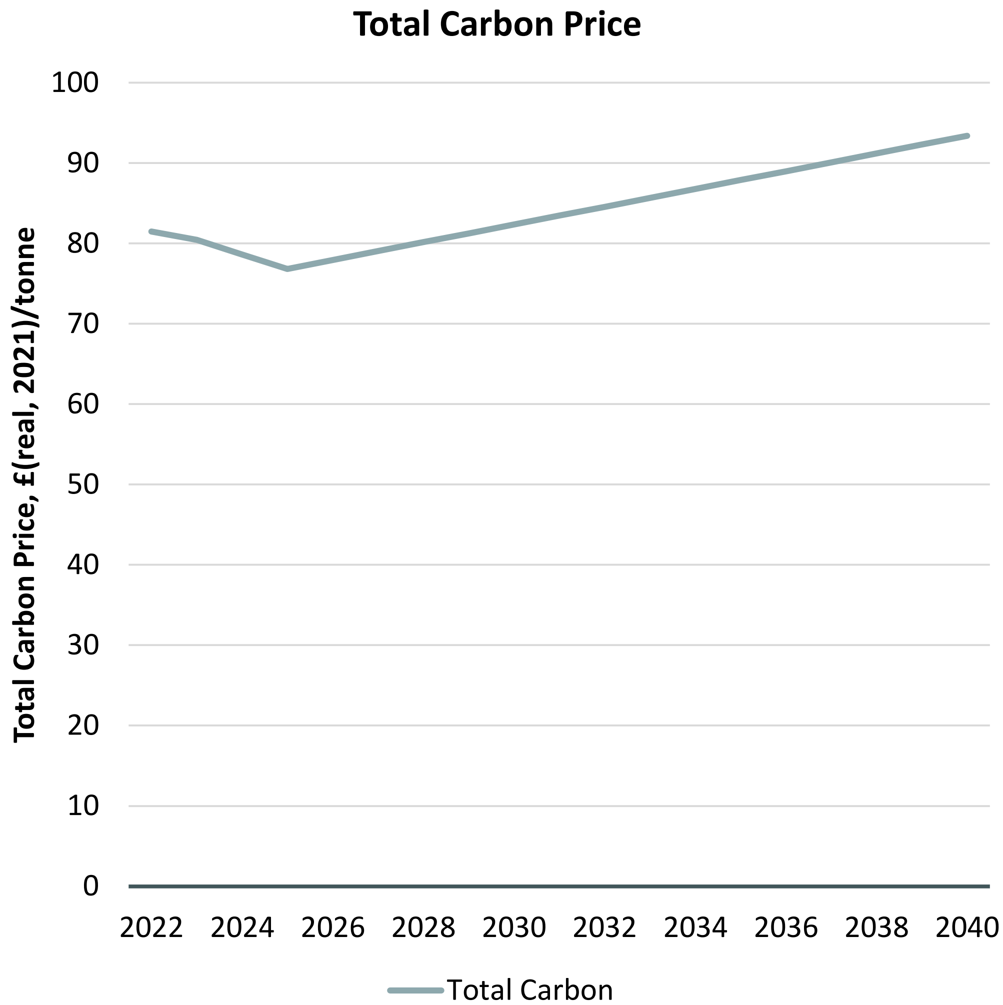
BESS Impacts and Implications:

Annex

Annex: Assumptions

Commodity prices





Gas and Carbon Prices are based off forward look curves of gas price for 2025 from May 2022.

Prices are then interpolated from this point to reach FES2021 levels in 2035 in central gas price and carbon price.

Annex: Assumptions

Other assumptions

Assumption	Status Quo	BESS	BESS – Slower Nuclear Deployment	BESS – Slower Renewables Deployment
Demand	Demand aligns with BEIS Net Zero Lower Demand scenario rising from 305TWh in 2022 to 460TWh in 2035 and 490TWh in 2040			
Peak demand	Peak demand is scaled from FES Consumer Transformation scenario to be consistent with total demand. Peak demand rises from 58GW in 2022 to 95GW in 2040.			
Coal retirements	All retired by 2024			
Nuclear	Hinkley Point C and Sizewell C live by 2028 and 2034. No further Nuclear capacity added	Hinkley Point C and Sizewell C live by 2028 and 2034. Further 6GW added to reach 15GW by 2040 on the way to reaching 24GW ambition in 2050	Hinkley Point C and Sizewell C live by 2028 and 2034. No further Nuclear capacity added	Hinkley Point C and Sizewell C live by 2028 and 2034. Further 6GW added to reach 15GW by 2040 on the way to reaching 24GW ambition in 2050
Solar	Rising from 15GW in 2022 to 40GW in 2035.	Rising from 15GW in 2022 to 70GW by 2035 in line with BESS ambition.	Rising from 15GW in 2022 to 70GW by 2035 in line with BESS ambition.	Rising from 15GW in 2022 to 40GW in 2035.
Onshore wind	Rising from 13GW in 2022 to 19GW by 2030 and 36GW by 2040	Rising from 13GW in 2022 to 30GW by 2030 and 48GW by 2040	Rising from 13GW in 2022 to 30GW by 2030 and 48GW by 2040	Rising from 13GW in 2022 to 19GW by 2030 and 36GW by 2040
Offshore wind	Rising from 13GW in 2022 to meet previous 40GW target in 2030 and 75GW in 2040. 5GW of floating offshore wind in 2030	Rising from 13GW in 2022 to meet previous 40GW target in 2030 and 75GW in 2040. 5GW of floating offshore wind in 2030	Rising from 13GW in 2022 to meet previous 40GW target in 2030 and 75GW in 2040. 5GW of floating offshore wind in 2030	Rising from 13GW in 2022 to meet previous 40GW target in 2030 and 75GW in 2040. 5GW of floating offshore wind in 2030
CCS new build	Rising to 5GW in 2030 and reaching 15GW by 2040	Rising to 5GW in 2030 and reaching 8,5W by 2040	Rising to 5GW in 2030 and reaching 15GW by 2040	Rising to 5GW in 2030 and reaching 8,5W by 2040
Electrolysis Capacity	Rising to 0.5GW by 2030 and then reaches 40GW by 2040	Rising to 10GW by 2030 and then reaches 50GW by 2040		
Biomass CCS Capacity	0.5GW in 2030 rising to 2.5GW by 2040			
Peaking Capacity	Additional peaking capacity built as required to meet security of supply. This role is fulfilled by Gas Recips pre-2030 with Hydrogen peakers being built after this point			
Technology Costs	All technology costs (opex and capex) taken from BEIS Generation Costs report 2020 with exception of Storage costs taken from Mott Mcdonald report on storage. Floating offshore wind costs based on OREC floating offshore wind report.			