Ofgem TCR and Embedded Benefits Reforms

Wider system modelling: Renewable sensitivities

July 2019

Introduction

Wider system modelling: Renewable sensitivities

In our analysis of the wider system and consumer impacts of Ofgem's network charging reforms 'minded to' decision, renewable deployment is a fixed exogenous assumption based on National Grid's FES18 scenarios. Effectively this assumes that renewable deployment is unaffected by the reforms. This approach was based on the following rationale:

- Although we identified some potential for an impact on BTMG (behind the meter generation) solar PV from the ***TCR reform of residual charging,*** given the analysis did not necessarily suggest a consistent nationwide impact and that consumers may not directly see the change in cost or respond solely on the basis of price, we did not explicitly model the impact of a change in solar PV take-up on the results between the counterfactual and factual.
- Although we recognised that the **reform of other embedded benefits (TGR and BSUoS)** would directly impact revenues of grid connected distributed generation, we assumed that the level of new renewable deployment would be unaffected on the basis that CfD support payments would adjust to maintain the same level of new renewable capacity in the factual and counterfactual.

Ofgem has now asked us to analyse the impact on system and consumer benefits of the reforms assuming that:

- consistent with an overall policy to decarbonise progressively the electricity sector, total renewable generation is not reduced as a result of the reform
- that the reforms lead to a lower level of unsupported grid connected renewable deployment. This fits with a view that grid connected generation such as solar PV and onshore wind would remain unsupported by CfDs throughout our modelling horizon i.e. from the perspective of our modelling we should consider them 'subsidy-free' which is in turn consistent with recent policy announcements which have indicated that "Pot 1" will not be supported in AR3. This modelling assumes this policy continues going forward.

For consistency with our previous analysis, this new modelling examines sensitivities with significantly reduced Onshore Wind and Solar deployment in the following factual scenarios:

1. TGR & Full BSUoS reforms (Steady Progression (SP) background)
2. Alternative FES18 background: TGR & Full BSUoS reforms (Community Renewables (CR) background)

Overview and key assumptions

Wider system modelling: Renewable sensitivities

Assumed impact on subsidy free renewables (drop-out rate)

- The actual drop-out rate for renewables is a key input for the analysis and cannot be predicted with any certainty. We do not attempt to predict the drop out rate as part of this analysis. Our previous analysis assumed a 0% drop-out rate (based on the assumption that these technologies would be supported).
- Oxera's recent analysis[1] adopted the assumption that relative to CR and SP backgrounds used in our analysis, there is no new investment in unsupported onshore wind and solar PV as a result of the reforms (a 100% drop-out rate). We consider this to be a highly unlikely scenario.
- Analysis by Aurora[2] estimated a more modest, though still significant impact, that investment in subsidy free renewables could be set back by 2-5 years
- For this new analysis we test the benefits case previously published (based on a 0% drop-out rate) against a relatively large reduction in onshore wind and solar PV investment. Whilst this should not be considered a prediction of the potential impact of the reforms on onshore wind and solar PV investment, it does illustrate how the benefits case changes in response to a relatively extreme assumption. For this purpose we have assumed a **50%** drop-out of new onshore wind and solar build. We feel that this broad assumption is more realistic than Oxera's assumption and roughly aligns to the upper end of the expected impact on subsidy free renewables identified by Aurora i.e. a 5 year delay to deployment.

1 https://www.oxera.com/wp-content/uploads/2018/01/Ofgem%E2%80%99s-Targeted-Charging-Review-A-review-by-Oxera.pdf

2 https://www.auroraer.com/wp-content/uploads/2019/05/Aurora-TCR-Public-Report-May-2019.pdf

Wider system modelling: Renewable sensitivities

Assumed government response to reduced subsidy free renewables deployment (which technologies fill the generation gap)

- A reduction in the overall level of renewables deployment would not be consistent with the overall direction of government climate policy. Recent government policy announcements have indicated that Pot 1 technologies will not be supported in AR3. This modelling assumes this policy continues going forward.
- In response to the reduction in subsidy-free renewables, we therefore make the assumption that the government would maintain the level of output from renewables assumed in the relevant FES18 scenarios by supporting the next cheapest alternative technology i.e. offshore wind. This means that the reduction of onshore wind and solar are replaced with the equivalent amount (in energy terms) of offshore wind. However, we assume drop-outs from new solar and onshore wind from 2021, and the timing of the CfD auctions mean there is no mechanism in place to replace the drop-outs until 2025/26 at the earliest.
- The approach we have taken is to maintain the same level of renewable generation in 2030 (and beyond), meaning that higher amounts of replacement offshore wind capacity will come online over the 2026-2030 period to "catch-up" with the solar PV and onshore wind reduction over the 2021-2025 period. This means there is a net decrease in renewable generation in the 2021-2029 period, which has knock-on impacts for the consumer and system cost analysis.

Implications for interpretation of results

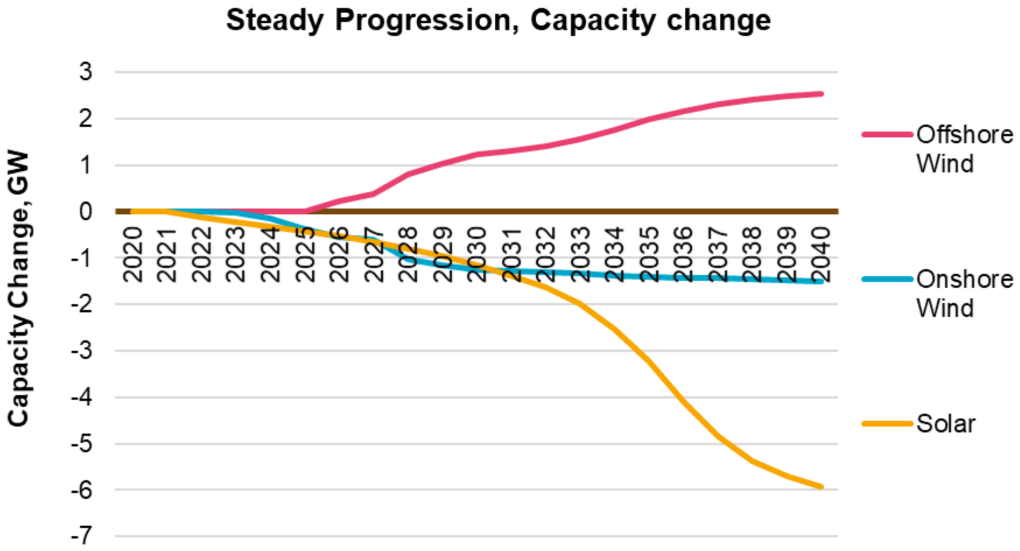
- The assumption that onshore wind and solar PV are replaced by (supported) offshore wind means that the analysis assesses the impact on the system and consumer benefits of replacing cheaper renewable technologies with technologies, which have a higher strike price in this analysis. Therefore we expect changes in consumer and system costs relative to our previous analysis to be closely linked to the difference in levelised costs between the relevant renewable technologies.

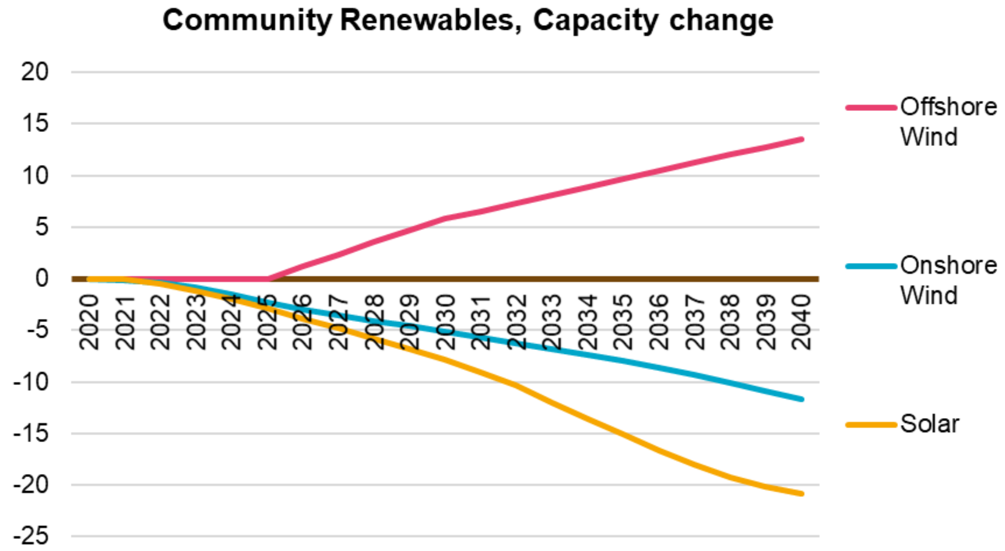
Overview and key assumptions

Wider system modelling: Renewable sensitivities

Renewable capacity change vs previous analysis

- The 50% reduction assumption for the purpose of this sensitivity implies a reduction of around 7.5GW of onshore wind and solar PV deployment by 2040 in the Steady Progression scenario. This is replaced by 2.5GW of offshore wind.
- In the Community Renewables scenario the 50% drop out assumption implies a reduction of around 33GW of onshore wind and solar PV. We assume this is replaced by 13.5GW of offshore window.





* Offshore wind replaces the generation from onshore wind and solar with a lower installed capacity. This is because offshore wind has a higher load factor than onshore wind or solar.

Overview and key assumptions

Wider system modelling: Renewable sensitivities

Hurdle rates used for renewable technologies

- Levelised costs depend, among other things, on the hurdle rate assumed. Our hurdle rate assumptions are based on BEIS generation costs report (2016). These apply to technologies supported under the CfD regime.
- There could be an increase in the hurdle rates for unsupported RES because plant revenues (merchant market only) are less certain than for supported plants (a mix of merchant market and support payments)
- We have not increased these hurdle rates for the unsupported onshore wind and solar. With this adjustment, the levelised cost of energy (LCOE) for the capacity dropping out would increase. Adjusting for this factor would have a positive impact on the overall benefits case for the reforms. Therefore, our analysis is conservative in this respect.

Technology	Hurdle rate (pre-tax real)	Capex, £/kW*	LCOE: 2023 strike price required, 2012 £/MWh
Offshore Wind	8.9%	1000	57.5
Onshore Wind	6.7%	800	45.0
Solar	6.5%	450	45.0

Inclusion of OFTO costs

- We have included OFTO (Offshore Transmission Owner) TNUoS charges in the capex component of system costs.
- This represents the costs of the infrastructure (including cable and substation) for connecting the offshore wind asset to the onshore network. Note that we do not include an estimate of other (onshore) network costs for any technology. These are difficult to forecast with any certainty.

* Set to align with CfD strike prices for Offshore Wind from AR2, and with required strike prices for Onshore Wind and Solar in line with recent publications (such as https://bvgassociates.com/download/6985/) and stakeholder feedback. There is inherent uncertainty in this assumption.

Treatment of subsidy costs in the counterfactual and factual scenarios

- To ensure the internal consistency of the scenarios that we model, we maintain the support levels assumed in the counterfactual of our previous analysis for onshore wind and solar, and compare this to the higher support costs that would be implied as a result of the replacement offshore wind capacity in the factual.
- We note that this is inconsistent with the idea that in the counterfactual onshore wind and solar PV are subsidy free. However, given our focus is on the incremental impact of the switch from onshore wind and solar PV to more expensive offshore wind we consider that this approach is appropriate. In practice, our approach is capturing the impact of the difference in levelised cost between the different technologies.
- Alternatively, if we were to model subsidy free investment consistent with the Community Renewables and Steady Progression backgrounds we would need to adjust onshore wind and solar PV capital costs and hurdle rates to ensure they are consistent with zero subsidy while still delivering up to the level assumed in the FES scenario (e.g. an additional 66GW in the Community Renewables scenario).
- This is feasible in theory, though in turn we would also need to identify a suitable adjustment to the cost of offshore wind, given similarities in drivers of onshore and offshore wind costs.
- The net result would leave the incremental impact of the change in investment very similar to that which we are modelling.

Results & comparison to prior TCR analysis

Consumer and system cost impacts (1/2)

Recap of previous analysis

In our previous analysis of the TGR and BSUoS reforms, the results did not show a significant impact on system costs, with the results showing a reduction in some scenarios and an increase in others all of which are very small given the uncertainties inherent in the analysis. In relation to system costs in particular, it is not obvious that they provide a clear reading in either direction.

In contrast to system costs, consumer benefits were significant under all scenarios. These were largely driven by:

- lower TDR payments, as a result of removing the negative TGR payments which were previously paid for through TDR; and
- the removal of the supplier BSUoS avoidance payments.

Descriptive results from new analysis

- **System costs** are increased as a result of the reduction in onshore wind and solar, and are now higher relative to the counterfactual without the policy intervention. However, the increase in system costs is not reflective of an inefficiency introduced directly by this policy. Instead, it is a reflection of the assumed policy choice imposed on this analysis that renewable energy production levels should be maintained, but that this is achieved via the replacement of onshore wind and solar PV with more expensive offshore wind. Were support to onshore wind and PV technologies to increase or different assumptions made about the extent of reduction in renewable deployment or capex assumptions were lower, system costs would be materially lower.
- For a similar reason, **Consumer costs** increase relative to our previous analysis but remain lower relative to the counterfactual. In other words, consumer costs are reduced as a result of the policies even if we were to assume a significant reduction in subsidy free renewables.

Results & comparison to prior TCR analysis

Consumer and system cost impacts (2/2)

Quantitative results from new analysis

- Our results show that under the renewable sensitivities the reforms still reduce consumer costs by £3.5bn under Steady Progression background and £1.9bn under Community Renewables.
- There is an increase in the system cost which is driven by the higher levelised cost of offshore wind relative to onshore wind and solar PV.

Counterfactual	Factual	System Cost Impact (£bn) NPV to 2040	Consumer Cost Impact (£bn) NPV to 2040
Previous analysis*			
Baseline (Steady progression)	TGR & Full BSUoS Reform	-0.02	-4.52
Alt FES: Baseline (Community renewables)	Alt FES: TGR & Full BSUoS Reform	+0.33	-5.99
New analysis – Renewable sensitivities*			
Baseline (Steady progression)	Renewable sensitivity – TGR & Full BSUoS Reform	+1.04	-3.52
Alt FES: Baseline (Community renewables)	Renewable sensitivity – Alt FES: TGR & BSUoS	+4.06	-1.92

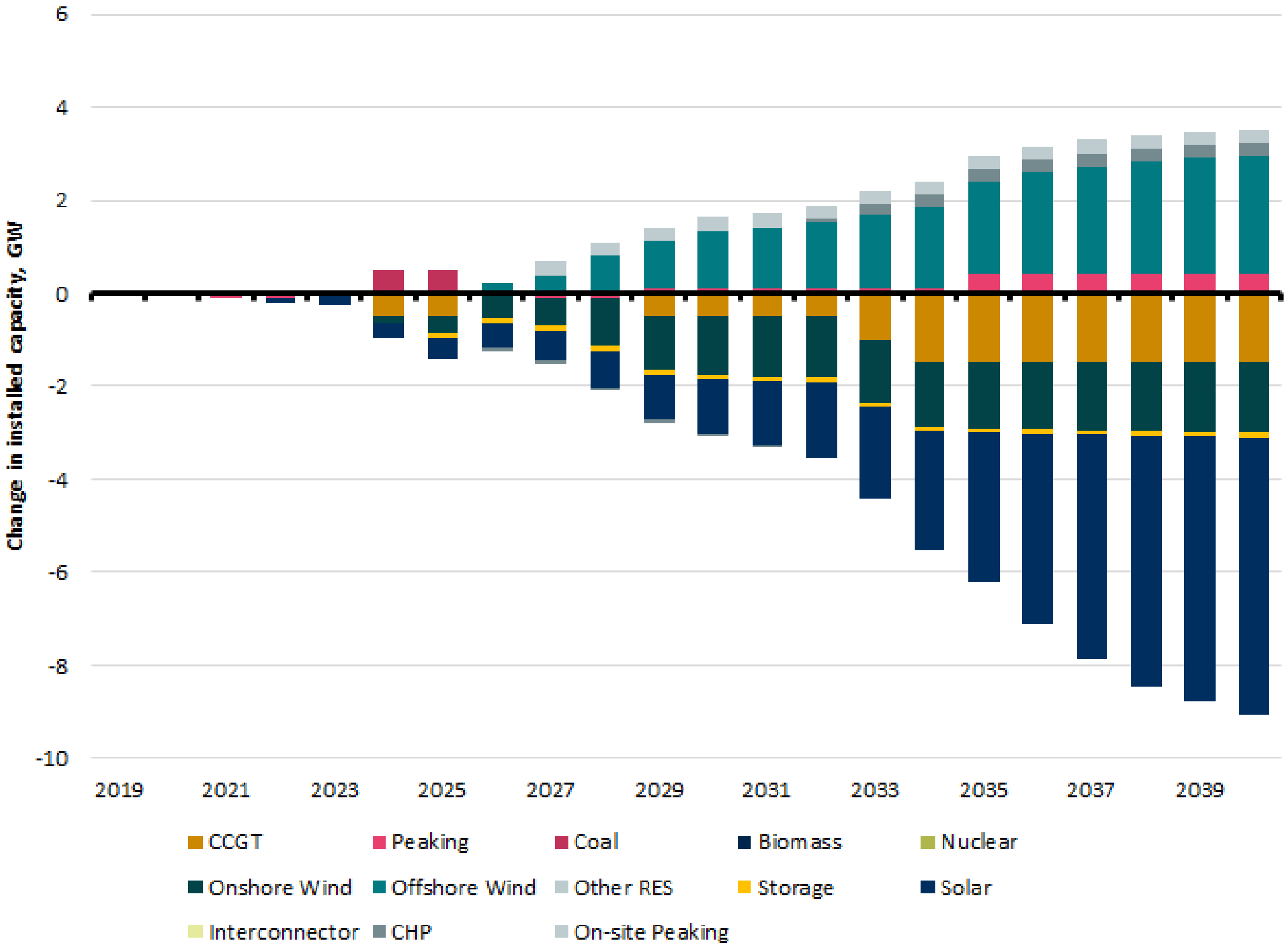
- The results from the previous analysis are shown for comparison, though it should be noted that these were based on implementation of the reforms in 2020 rather than in 2021.
- ** these are the results for one sensitivity with relatively extreme assumption regarding a reduction in renewable deployment. Other sensitivities could yield materially different outcomes

Wider system modelling results:

Counterfactual:	*TCR residual*
Factual:	*Renewable drop-out sensitivity, TCR residual, TGR & Full BSUoS reforms*
Background:	*Steady Progression*

Installed Capacity (GW)

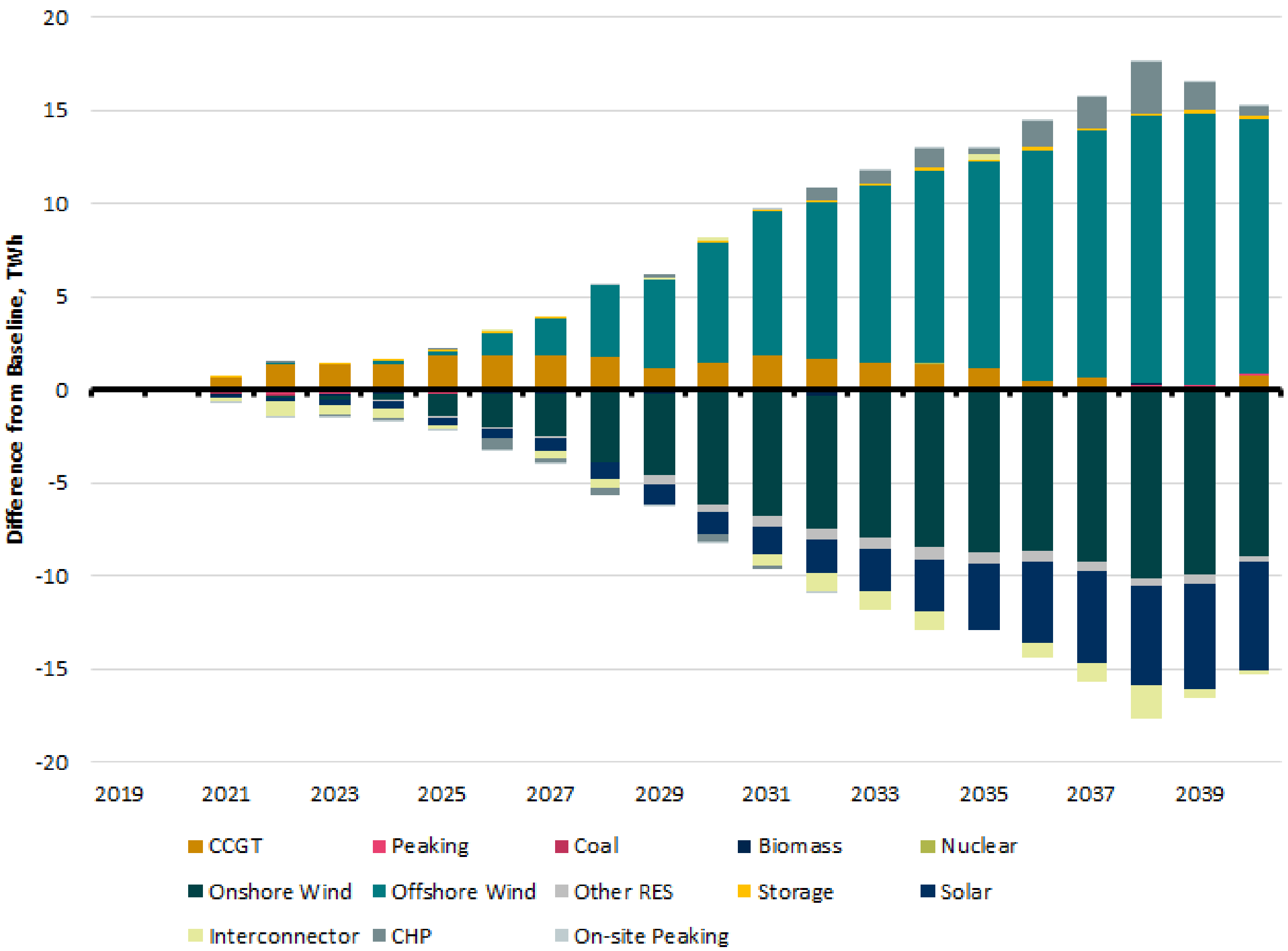
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Steady Progression background)



- Significant amounts of Onshore Wind and Solar capacity are removed under the 50% drop-out assumption, replaced by Offshore Wind.
- The total amount of capacity is reduced, due to the higher load factors of Offshore Wind which means that the installed capacity to replace the equivalent amount of Onshore Wind and Solar in energy terms is lower.
- CCGT capacity is also reduced, primarily due to the increase in TGR. There is an increase in distribution-connected peaking capacity to replace the CCGT. This is consistent with our previous TGR & BSUoS reforms analysis.

Generation (TWh)

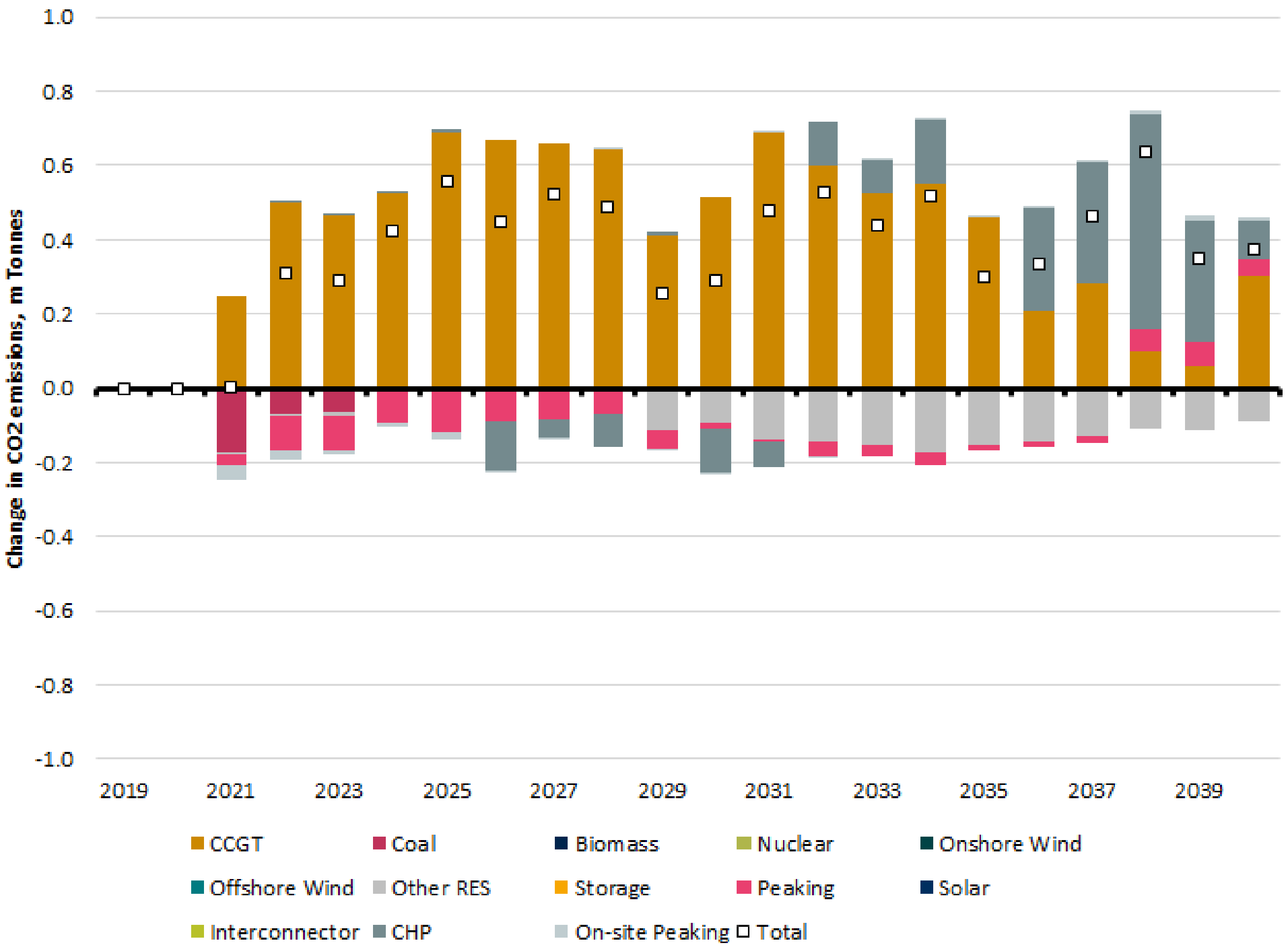
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Steady Progression background)



- The decrease in generation from Onshore Wind and Solar is fully replaced by Offshore Wind generation from 2030 onwards, as we assume the government will maintain consistent levels of renewable generation.
- In the 2020s, the lag in deployment in Offshore Wind (due to timelines for CfD auctions) leads to some of the decreases in Onshore/Solar generation being replaced by thermal generation.
- There is an increase in CCGT generation due to the lower BSUoS charges (due to a larger charging base), displacing Interconnection imports (that do not pay BSUoS charges).

CO_2 emissions (m Tonnes)

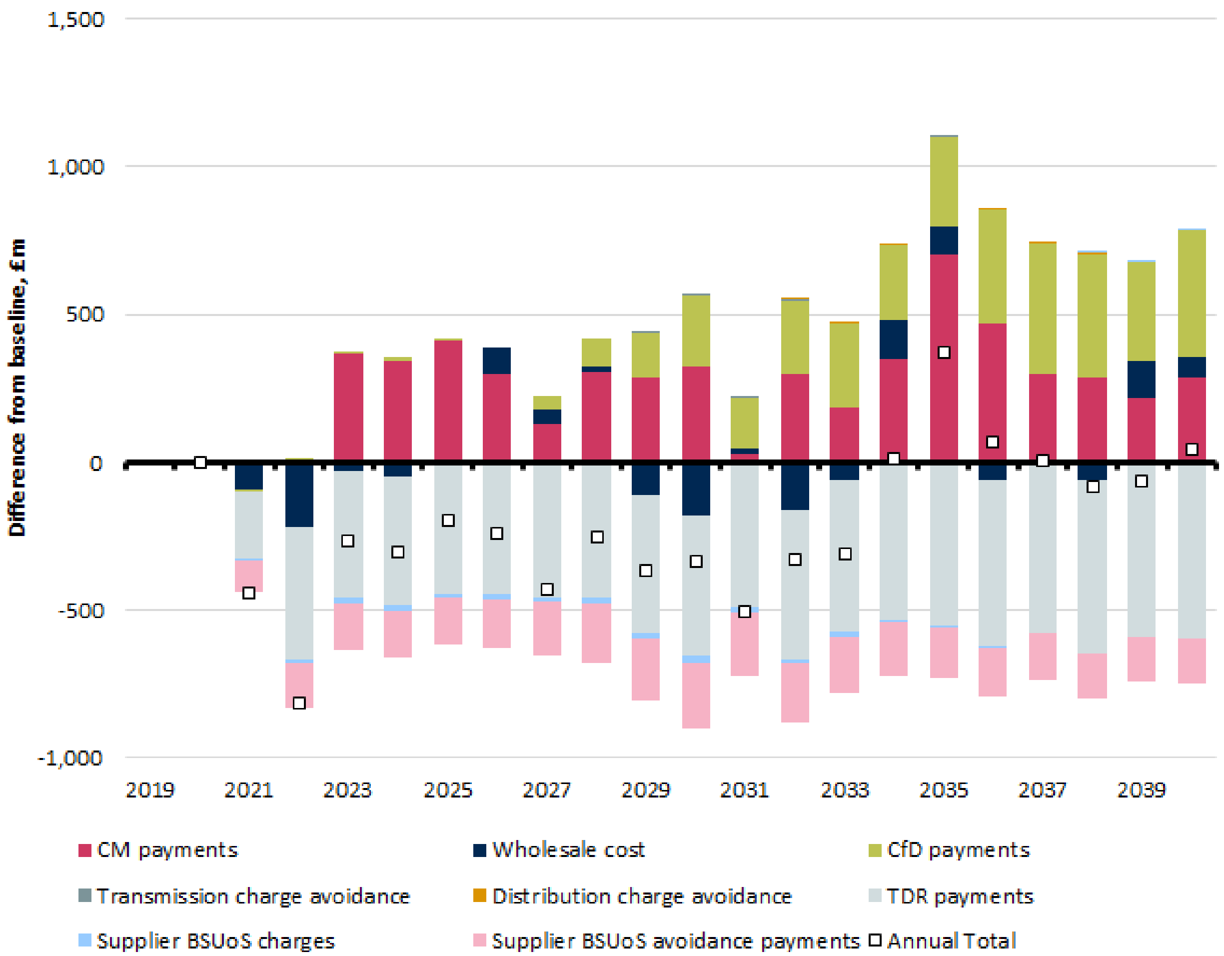
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Steady Progression background)



- The changes in renewable generation have a minimal direct impact on CO_2 emissions in the long term (relative to our previous TGR & BSUoS analysis), though emissions are increased in the 2020s as Offshore Wind deployment lags the assumed Solar/Onshore drop outs.
- The increases in CO_2 emissions in the longer term are primarily driven by domestic generation displacing Interconnection imports (as a result of lower BSUoS charges).
- Increases in CO_2 emissions in the longer term are marginally larger than in our previous analysis. Total annual renewable generation is the same but the time profile is different. Solar generation is lost which was generating during the day and displacing mainly CCGT generation. Some of the additional Offshore Wind generation is produced overnight (surplus generation overnight is exported) which means it does not displace as much CCGT generation as Solar.

Consumer Costs (£m)

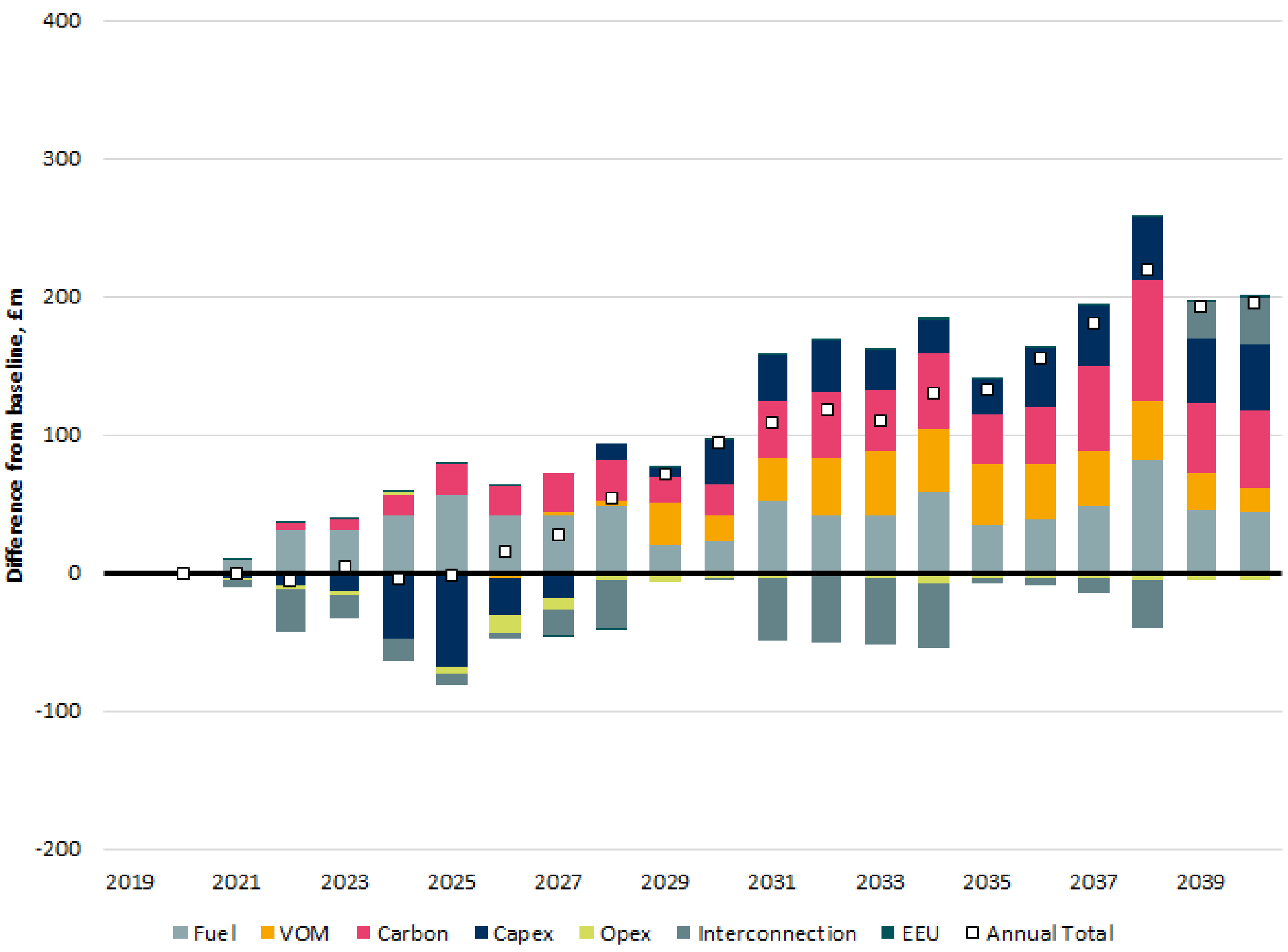
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Steady Progression background)



- Overall, the results show that consumer costs are reduced by **£3.52bn** (NPV to 2040)
- Consumers benefit from savings due to lower TDR payments, lower supplier BSUoS avoidance payments, and lower wholesale costs. These are broadly similar to the benefits seen in our previous analysis.
- The offsetting costs to consumers primarily come through higher CfD and Capacity Market payments.
- The main difference from our previous analysis is that CfD costs are higher, due to the increased amount of CfD-supported Offshore Wind required to replace the unsupported Onshore Wind and Solar capacities.
- Capacity Market payments are slightly lower than in the previous analysis, as Offshore Wind provides more system security (on a per MWh basis) than the Solar it replaces.

System Costs (£m)

Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Steady Progression background)



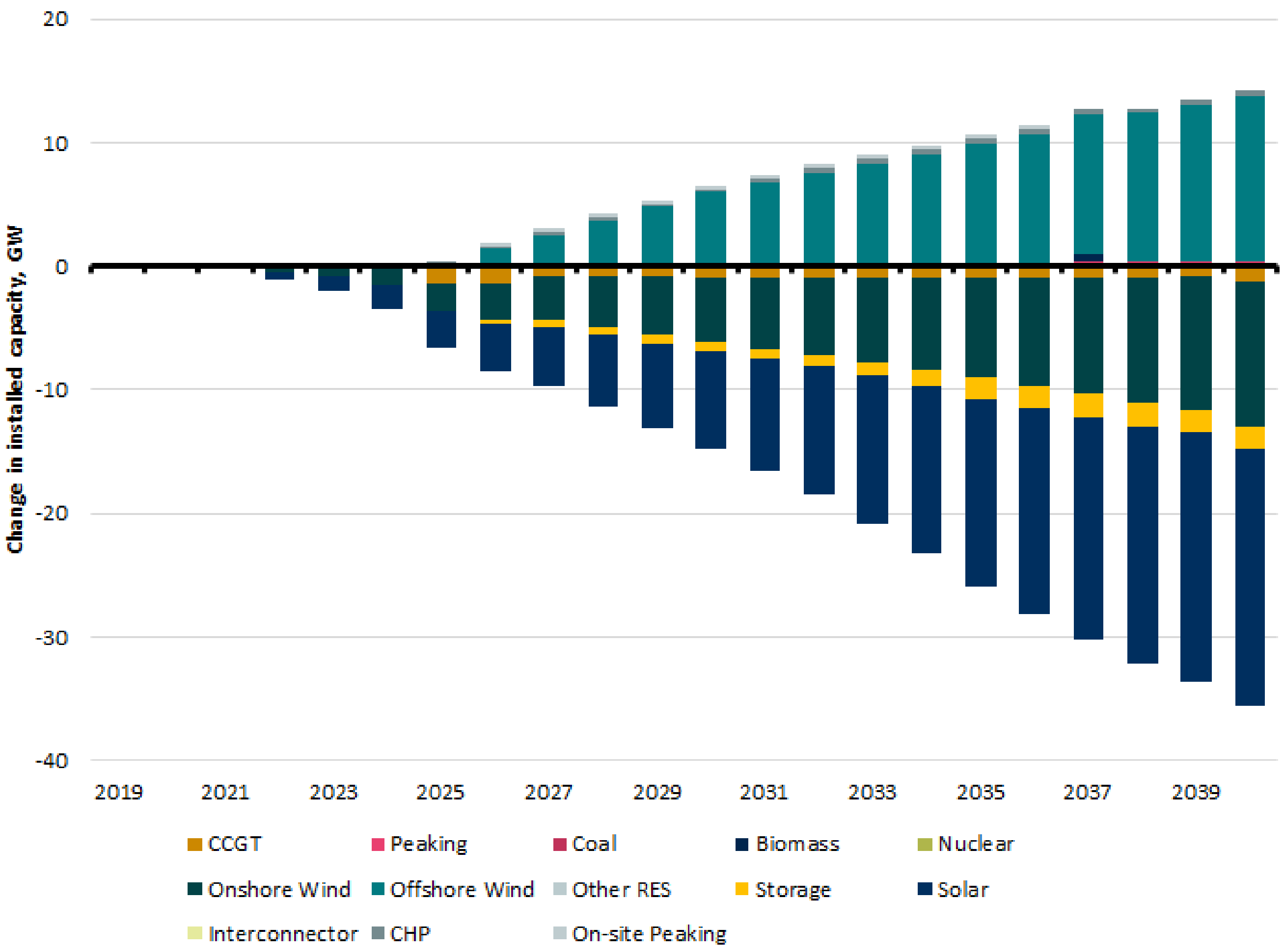
- Overall, the results show that system costs are increased by **£1.04bn** (NPV to 2040) due to the reforms.
- The higher VOM (variable operating and maintenance costs) and Capex costs are due to the higher cost of Offshore Wind relative to Onshore Wind and Solar. Note that the Offshore Wind capex costs include OFTO TNUoS charges.
- The higher carbon and fuel costs (partly offset by decreased Interconnection costs) are a result of domestic generation (mainly CCGT) displacing Interconnection imports. This is due to the BSUoS reforms, and broadly in line with the previous analysis.
- This result might be taken to imply the reforms lead to a less efficient system – however the inefficiency in this result is driven by the assumption that the government will maintain levels of renewable deployment through the support of higher cost technologies.

Wider system modelling results:

Counterfactual:	*TCR residual*
Factual:	*Renewable drop-out sensitivity, TCR residual, TGR & Full BSUoS reforms*
Background:	*Community Renewables*

Installed Capacity (GW)

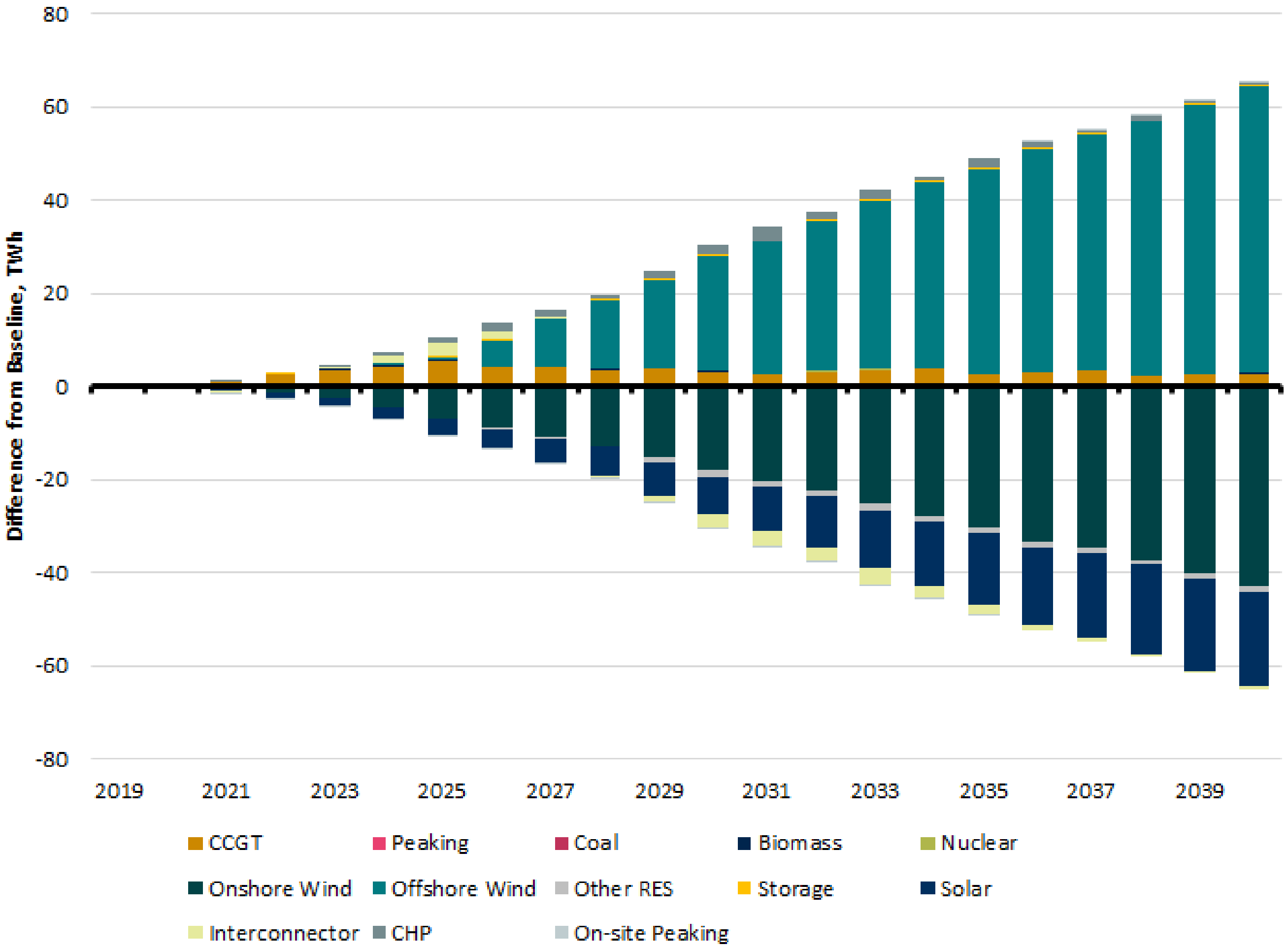
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Community Renewables background)



- Due to the large amounts of Solar and Onshore Wind in the Community Renewables scenario there are correspondingly larger changes in installed capacity under the 50% drop-out assumption.
- Similar to the previous scenario the total amount of capacity is reduced, due to the higher load factors of Offshore Wind meaning that the installed capacity required to replace the equivalent amount of Onshore Wind and Solar in energy terms is lower.
- We also observe reductions in CCGT (primarily due to the increase in TGR) and Storage capacity (due to impact of BSUoS reforms). These reductions are generally consistent with what was observed in our previous analysis, thought the reductions in storage capacity are more significant – which has reduced opportunities due to the loss of Solar and Onshore Wind capacity.

Generation (TWh)

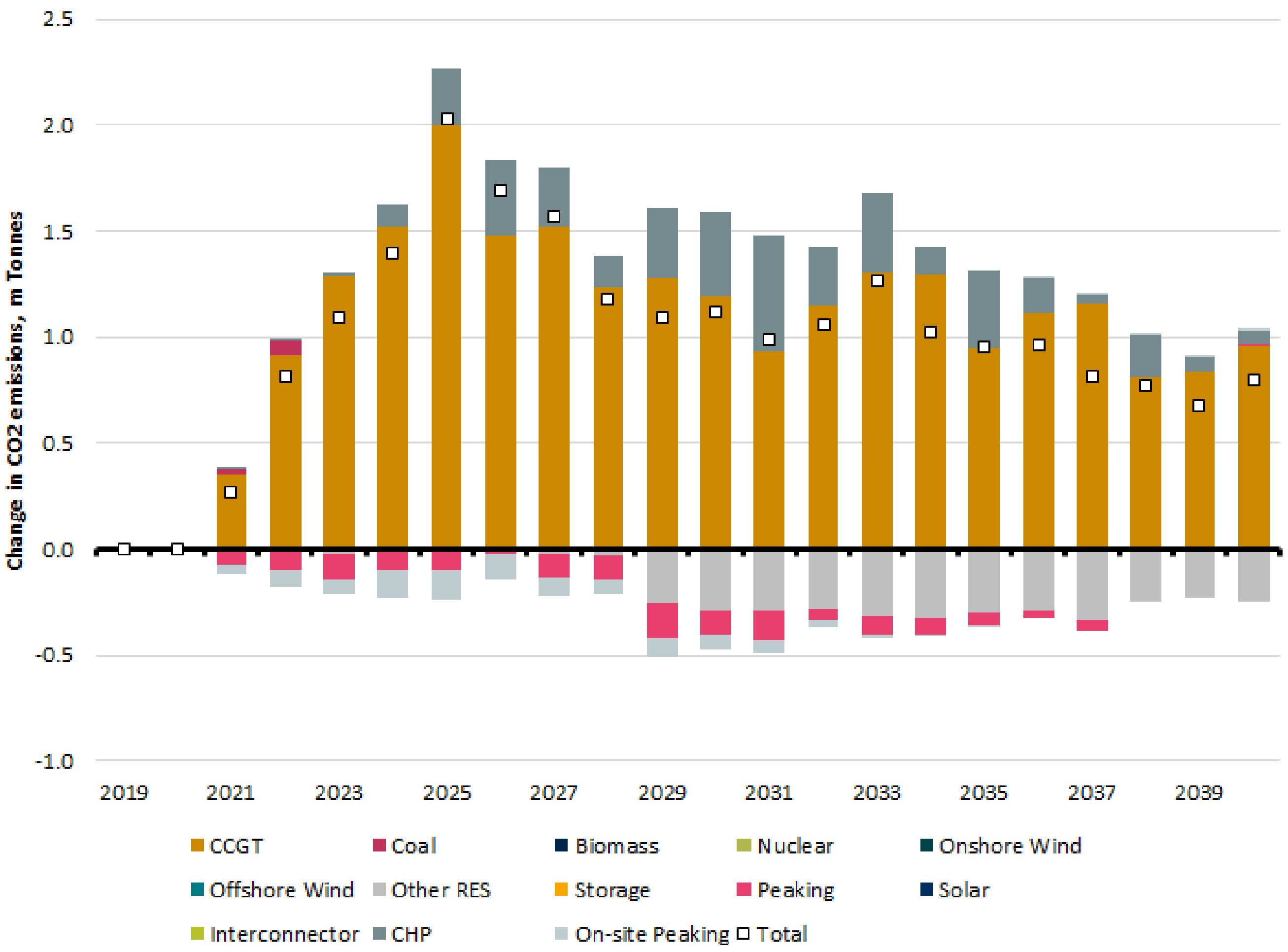
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Community Renewables background)



- Changes are much more significant than in the SP scenario, due to the much large amounts of Onshore Wind and Solar in the baseline.
- As in the SP scenario, the decrease in generation from Onshore Wind and Solar is fully replaced by Offshore Wind generation from 2030 onwards, as we assume the government will maintain consistent levels of renewable generation. In the 2020s, the lag in deployment in Offshore Wind (due to timelines for CfD auctions) leads to some of the decreases in Onshore/Solar generation being replaced by thermal generation.
- There is an increase in CCGT generation due to the lower BSUoS charges, displacing Interconnection imports (that do not pay BSUoS charges).

CO_2 emissions (m Tonnes)

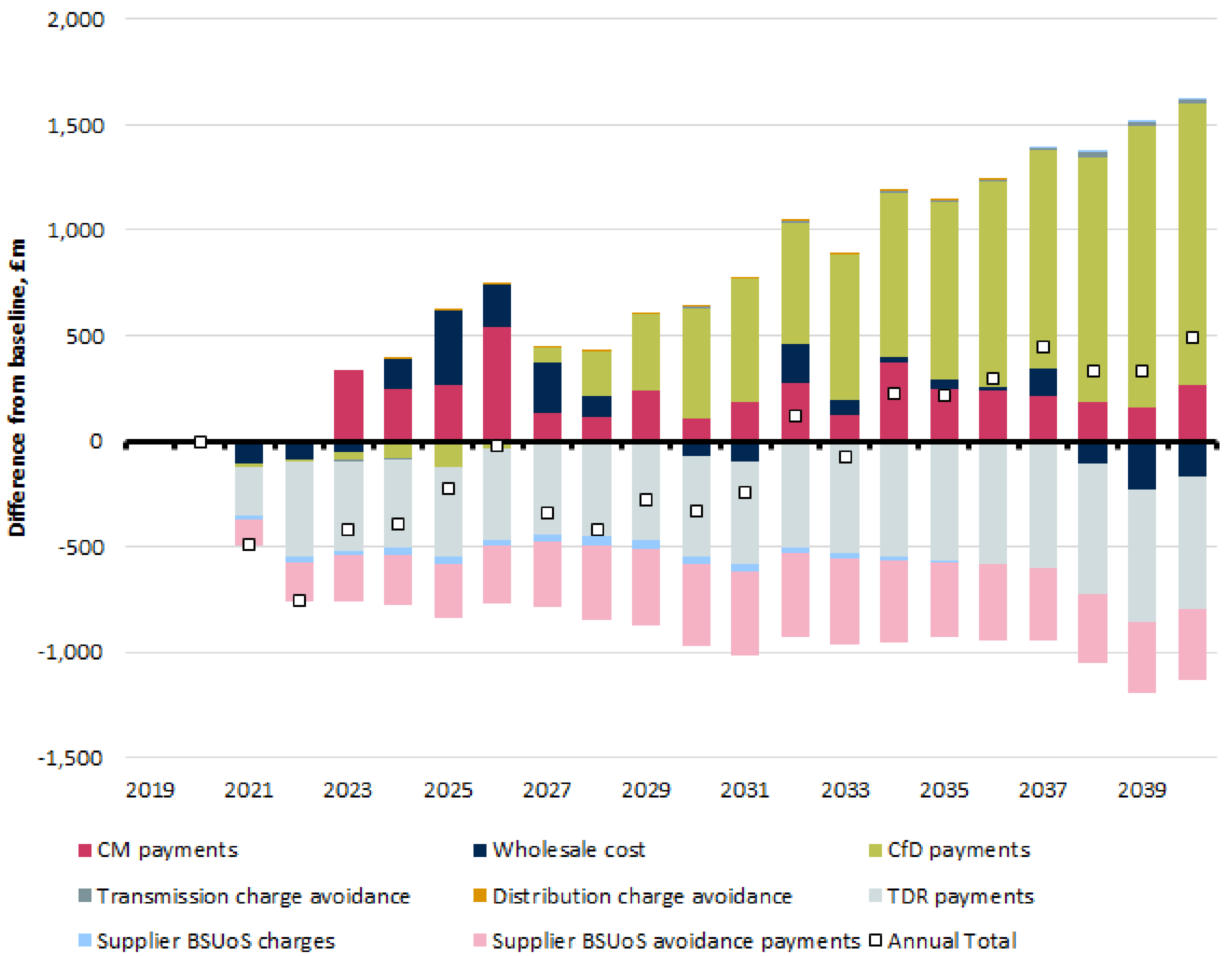
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Community Renewables background)



- CO_2 emissions in the 2020s increase by more than in our previous analysis due to the Offshore Wind deployment lagging the Solar/Onshore drop outs.
- The increases in CO_2 emissions in the longer term (2030+) are primarily driven by domestic generation displacing Interconnection imports (as a result of lower BSUoS charges).
- Increases in CO_2 emissions in the longer term are slightly higher than in our previous analysis. Total annual renewable generation is the same but the time profile is different. Solar generation is lost which was generating during the day and displacing mainly CCGT generation. Some of the additional Offshore Wind generation is produced overnight (surplus generation overnight is exported) which means it does not displace as much CCGT generation as Solar.

Consumer Costs (£m)

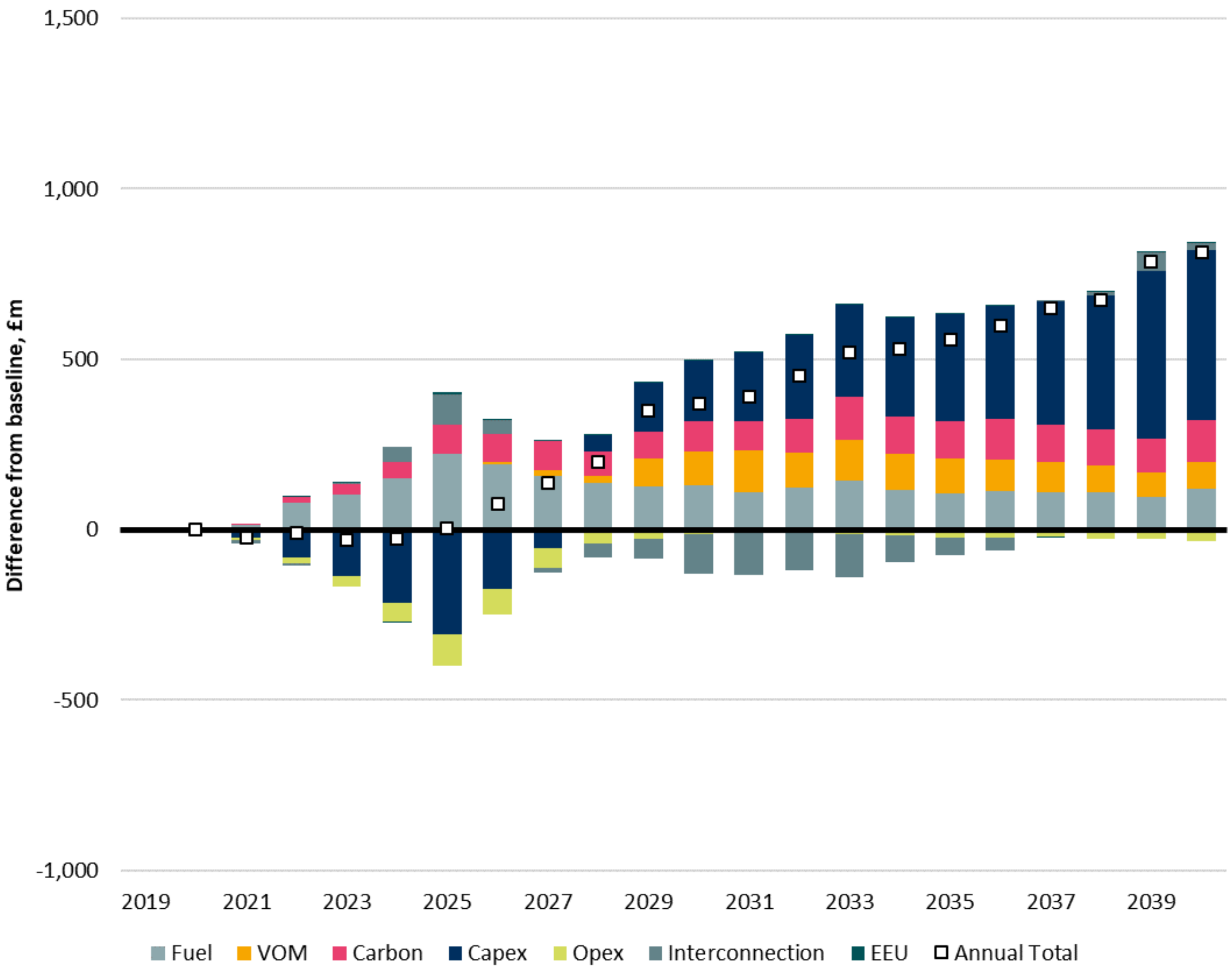
Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Community Renewables background)



- Overall, the results show that consumer costs are reduced by **£1.92bn** (NPV to 2040).
- Consumers benefit from savings due to lower TDR payments, lower supplier BSUoS avoidance payments, and lower wholesale costs. These are broadly similar to the benefits seen in our previous results.
- The offsetting costs to consumers primarily come through higher CfD and Capacity Market payments.
- The main difference in this sensitivity from our previous analysis is that CfD costs are significantly higher, due to the increased amount of CfD-supported Offshore Wind required to replace the unsupported Onshore Wind and Solar capacities.
- Capacity Market payments are slightly lower than in the previous analysis, as Offshore Wind provides more system security (on a per MWh basis) than the Solar it replaces.

System Costs (£m)

Difference between Renewable drop-out sensitivity with TGR & BSUoS reforms and Baseline (Community Renewables background)



- Overall, the results show that system costs are increased by **£4.06bn** (NPV to 2040) due to the reforms.
- Significantly higher VOM (variable operating and maintenance costs) and Capex costs in the longer term are due to the higher cost of Offshore Wind relative to Onshore Wind and Solar. Note that the Offshore Wind capex costs include OFTO TNUoS charges.
- The higher carbon and fuel costs (partly offset by decreased Interconnection costs) are a result of domestic generation (mainly CCGT) displacing Interconnection imports. This is due to the BSUoS reforms, and broadly in line with the previous analysis.
- This result might be taken to imply the reforms lead to a less efficient system – however the inefficiency in this result is driven by the assumption that the levels of renewable deployment is maintained through the support of higher cost technologies.

Use of our work

Interpretation and Limitations

The results presented in this slide pack are dependent on the assumptions used and the modelling methodology applied. In particular, long term forecasts are subject to significant uncertainty and actual market outcomes may differ materially from the forecasts presented. Frontier Economics and LCP can therefore accept no liability for losses suffered, direct or consequential, arising out of any reliance on the results presented.

In particular:

- The scenarios presented do not take into account all changes that could potentially occur in the power market. More extreme market outcomes than those presetned are therefore possible.
- The relationship between the cost of generation and prevailing market prices has been assessed based on historical data, market fundamentals and current forward power prices. To the extent that this relationship changes over time results could vary.
- The modelling results are based on all market participants having a common view on future market outcomes. To the extent that views vary between market participants the results could be considerably different to those presented in this report.
- The modelling makes use of a power plant database maintained by LCP. Assumptions on individual plant characteristics have been estimated where required.

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