Sensitivity scenarios for triad benefit analysis

16 June 2017

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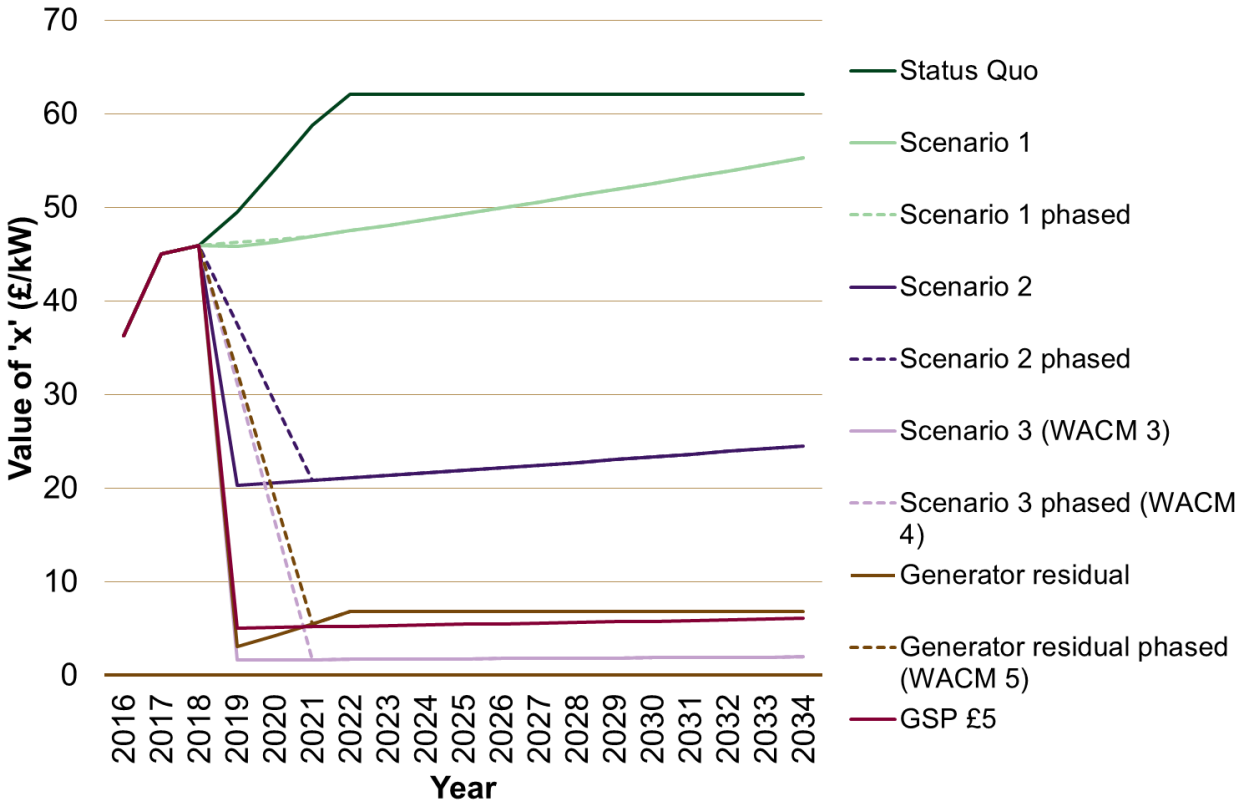
Limitations of this analysis

- This presentation has been provided by LCP. The results contained in this workbook are produced by LCP's dispatch model of the GB power market. The workbook contains projections from 2016 to 2035 under assumptions provided by publically available sources and the client (e.g. tariff levels).
- The results presented 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. We 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 presented are therefore possible.
  - The relationship between the cost of generation and prevailing market prices has been assessed based on historical data 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 which is based on publically available information where possible. Assumptions on individual plant characteristics have been estimated where required.
  - We do not take into account the effect that future changes to the market structure may have on the behaviour of market participants.

Scenarios overview

Tariff levels

- The tariff levels in each Scenario have been updated to reflect the latest National Grid forecasts (April 2017) of the demand and generator residuals.



Scenarios overview

Other changes to assumptions

Alongside changes to the tariff assumptions, there have been further changes to the baseline assumptions.

- Updates to existing/commissioned reciprocating gas and diesel engines to reflect the most recent CM auctions, as opposed to National Grid's FES assumptions.
- This includes changes to the split between gas and diesel engines – the proportion of gas engines has increased.

The counterfactuals (Status Quo) for the capex and efficiency sensitivities contain the same assumption changes.

- For example, if the efficiency of a reciprocating gas engine is assumed to be +10% in Scenario 3, then it is also assumed to be +10% under Status Quo.
- This does not apply to the drop-out sensitivity, for which the counterfactual assumes no drop-out.

- Cost savings
- Capex sensitivity
- Efficiency sensitivities
- Drop-out sensitivities

System and consumer cost savings

Scenario 1

	Phasing	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
	Capex	Low	Medium	Medium	Medium	Low	Low	Low	Medium	Medium	Medium	Low	Low
	Efficiency of Gas Recip	+0%	+0%	+5%	+10%	+0%	+0%	+0%	+0%	+5%	+10%	+0%	+0%
	Drop out	None	None	None	None	Low	High	None	None	None	None	Low	High
Grandfathering	**Scenario**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
None	System cost saving (£m)	304	252	189	325	125	85	304	252	189	325	125	85
None	Consumer cost saving (£m)	1,621	1,411	1,438	1,242	1,183	1,144	1,617	1,408	1,434	1,238	1,179	1,141
Option A	System cost saving (£m)	304	252	189	325	125	85	304	252	189	325	125	85
Option A	Consumer cost saving (£m)	1,621	1,411	1,438	1,242	1,183	1,144	1,618	1,408	1,434	1,239	1,180	1,142
Option B	System cost saving (£m)	304	252	189	325	125	85	304	252	189	325	125	85
Option B	Consumer cost saving (£m)	1,621	1,411	1,438	1,242	1,183	1,144	1,620	1,411	1,437	1,241	1,182	1,144
Option C (both)	System cost saving (£m)	304	252	189	325	125	85	304	252	189	325	125	85
Option C (both)	Consumer cost saving (£m)	1,621	1,411	1,438	1,242	1,183	1,144	1,621	1,411	1,437	1,242	1,183	1,145

System and consumer cost savings

Scenario 2

	Phasing	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
	Capex	Low	Medium	Medium	Medium	Low	Low	Low	Medium	Medium	Medium	Low	Low
	Efficiency of Gas Recip	+0%	+0%	+5%	+10%	+0%	+0%	+0%	+0%	+5%	+10%	+0%	+0%
	Drop out	None	None	None	None	Low	High	None	None	None	None	Low	High
Grandfathering	**Scenario**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
None	System cost saving (£m)	1,379	1,707	1,499	1,398	1,126	985	1,375	1,703	1,495	1,396	1,124	982
None	Consumer cost saving (£m)	5,421	5,347	4,997	4,935	4,963	4,917	5,284	5,210	4,857	4,811	4,831	4,790
Option A	System cost saving (£m)	1,379	1,707	1,499	1,398	1,126	985	1,375	1,703	1,495	1,396	1,124	982
Option A	Consumer cost saving (£m)	4,927	4,853	4,502	4,441	4,469	4,422	4,814	4,739	4,386	4,340	4,360	4,320
Option B	System cost saving (£m)	1,379	1,707	1,499	1,398	1,126	985	1,375	1,703	1,495	1,396	1,124	982
Option B	Consumer cost saving (£m)	3,921	3,843	3,493	3,431	3,463	3,415	3,896	3,818	3,464	3,418	3,442	3,400
Option C (both)	System cost saving (£m)	1,379	1,707	1,499	1,398	1,126	985	1,375	1,703	1,495	1,396	1,124	982
Option C (both)	Consumer cost saving (£m)	3,427	3,349	2,999	2,937	2,968	2,921	3,426	3,347	2,994	2,948	2,971	2,930

System and consumer cost savings

Scenario 3

	Phasing	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
	Capex	Low	Medium	Medium	Medium	Low	Low	Low	Medium	Medium	Medium	Low	Low
	Efficiency of Gas Recip	+0%	+0%	+5%	+10%	+0%	+0%	+0%	+0%	+5%	+10%	+0%	+0%
	Drop out	None	None	None	None	Low	High	None	None	None	None	Low	High
Grandfathering	**Scenario**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
None	System cost saving (£m)	1,892	2,457	2,387	2,336	1,770	1,645	1,869	2,434	2,368	2,322	1,754	1,632
None	Consumer cost saving (£m)	7,740	7,756	7,685	8,079	7,473	7,088	7,542	7,558	7,483	7,847	7,284	6,917
Option A	System cost saving (£m)	1,892	2,457	2,387	2,336	1,770	1,645	1,869	2,434	2,368	2,322	1,754	1,632
Option A	Consumer cost saving (£m)	6,883	6,899	6,827	7,222	6,616	6,230	6,725	6,741	6,666	7,030	6,468	6,101
Option B	System cost saving (£m)	1,892	2,457	2,387	2,336	1,770	1,645	1,869	2,434	2,368	2,322	1,754	1,632
Option B	Consumer cost saving (£m)	5,136	5,149	5,077	5,472	4,872	4,484	5,129	5,142	5,066	5,430	4,874	4,505
Option C (both)	System cost saving (£m)	1,892	2,457	2,387	2,336	1,770	1,645	1,869	2,434	2,368	2,322	1,754	1,632
Option C (both)	Consumer cost saving (£m)	4,279	4,292	4,220	4,614	4,014	3,626	4,312	4,325	4,250	4,614	4,057	3,688

System and consumer cost savings

Generator Residual Scenario

	Phasing	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
	Capex	Low	Medium	Medium	Medium	Low	Low	Low	Medium	Medium	Medium	Low	Low
	Efficiency of Gas Recip	+0%	+0%	+5%	+10%	+0%	+0%	+0%	+0%	+5%	+10%	+0%	+0%
	Drop out	None	None	None	None	Low	High	None	None	None	None	Low	High
Grandfathering	**Scenario**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**	**GR**
None	System cost saving (£m)	1,800	2,459	2,306	2,141	1,646	982	1,762	2,438	2,291	2,128	1,633	1,496
None	Consumer cost saving (£m)	6,531	7,374	6,877	7,479	6,378	6,543	6,434	7,153	6,622	7,228	6,064	6,046
Option A	System cost saving (£m)	1,800	2,459	2,306	2,141	1,646	982	1,762	2,438	2,291	2,128	1,633	1,496
Option A	Consumer cost saving (£m)	5,755	6,598	6,101	6,703	5,603	5,767	5,699	6,417	5,887	6,493	5,329	5,310
Option B	System cost saving (£m)	1,800	2,459	2,306	2,141	1,646	982	1,762	2,438	2,291	2,128	1,633	1,496
Option B	Consumer cost saving (£m)	4,171	5,007	4,510	5,113	4,017	4,180	4,264	4,976	4,446	5,052	3,893	3,872
Option C (both)	System cost saving (£m)	1,800	2,459	2,306	2,141	1,646	982	1,762	2,438	2,291	2,128	1,633	1,496
Option C (both)	Consumer cost saving (£m)	3,395	4,231	3,734	4,337	3,241	3,404	3,529	4,241	3,710	4,316	3,158	3,137

System and consumer cost savings

GSP £5 Sensitivity

	Phasing	FALSE	FALSE
	Capex	Low	Low
	Efficiency of Gas Recip	+0%	+0%
	Drop out	None	None
Grandfathering	**Scenario**	**3**	**GSP £5**
None	System cost saving (£m)	1,892	1,801
None	Consumer cost saving (£m)	7,740	6,961
Option A	System cost saving (£m)	1,892	1,801
Option A	Consumer cost saving (£m)	6,883	6,170
Option B	System cost saving (£m)	1,892	1,801
Option B	Consumer cost saving (£m)	5,136	4,562
Option C (both)	System cost saving (£m)	1,892	1,801
Option C (both)	Consumer cost saving (£m)	4,279	3,771

- Cost savings
- Capex sensitivity
- Efficiency sensitivities
- Drop-out sensitivities

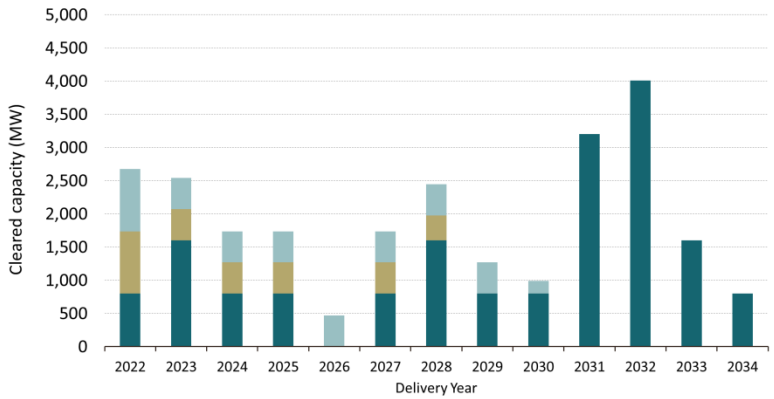
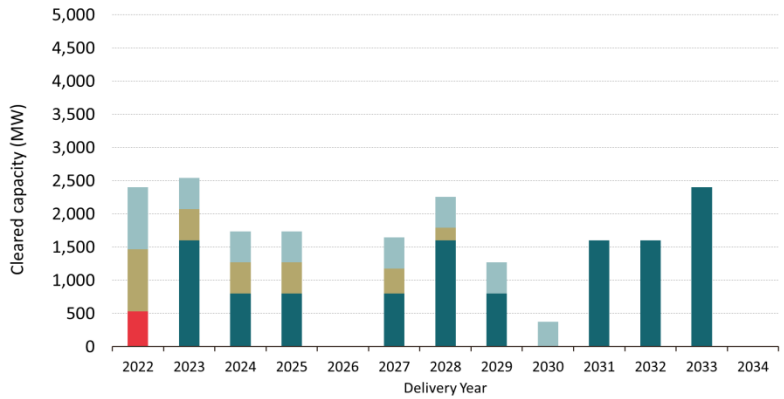
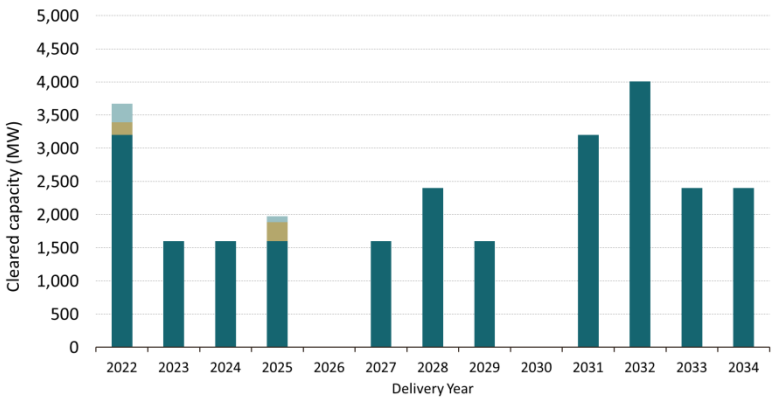
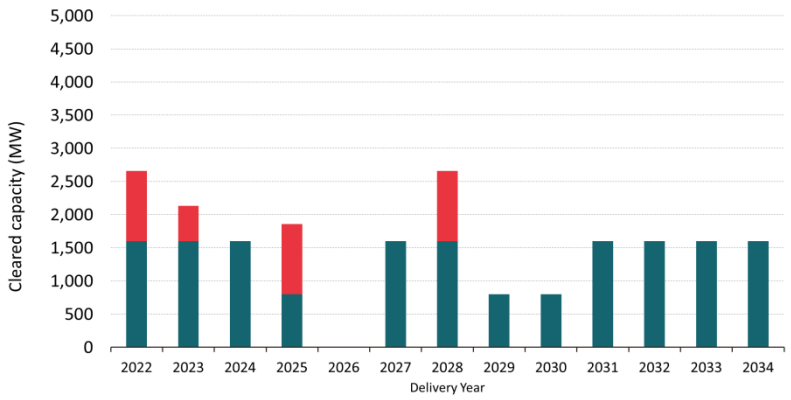
Capex sensitivity overview

- The main effect of changing the capex assumptions from BEIS Low to BEIS Medium is to increase the system cost saving. The capex changes for each technology are summarised in the table below.
- The increases in capex do not significantly alter the amount of reciprocating engines built under Status Quo.
- The proportional increase in the capex of reciprocating engines is higher than that of CCGTs and OCGTs.
- The effect of this change is to amplify the saving when moving from building reciprocating engines in the Status Quo to CCGTs and OCGTs at lower tariff levels.

Capex incl. infrastructure cost	BEIS Low (£/kW)	BEIS Medium (£/kW)
CCGT	416	523
OCGT	339	368
Reciprocating diesel	255	420
Reciprocating gas	345	480

CM new build

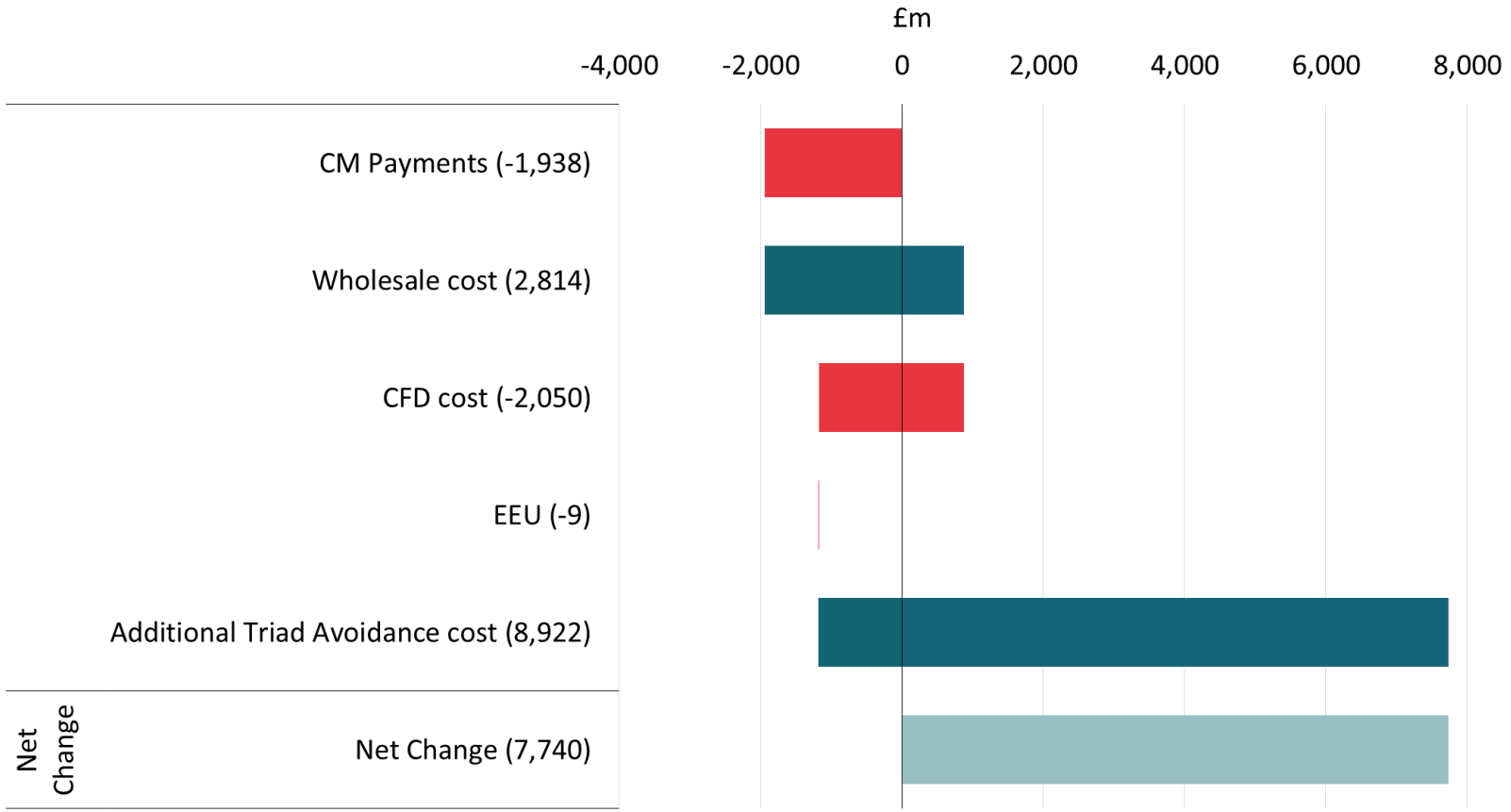
Effects of changing capex

	BEIS Low	BEIS Medium
SQ		
S3		

CCGT OCGT Reciprocating Engine Diesel Reciprocating Engine Gas

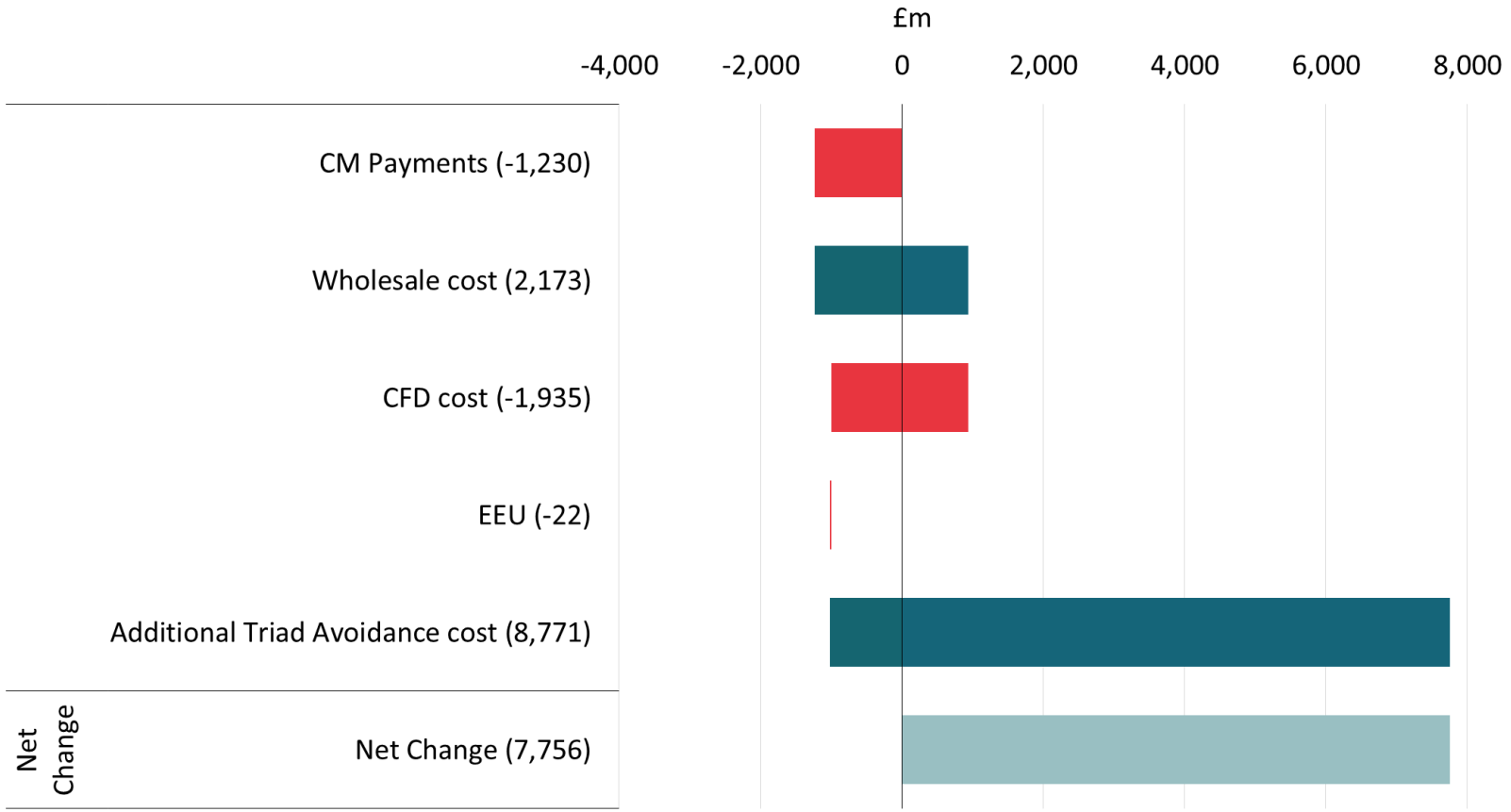
Consumer cost savings (SQ vs Scenario 3)

BEIS Low capex



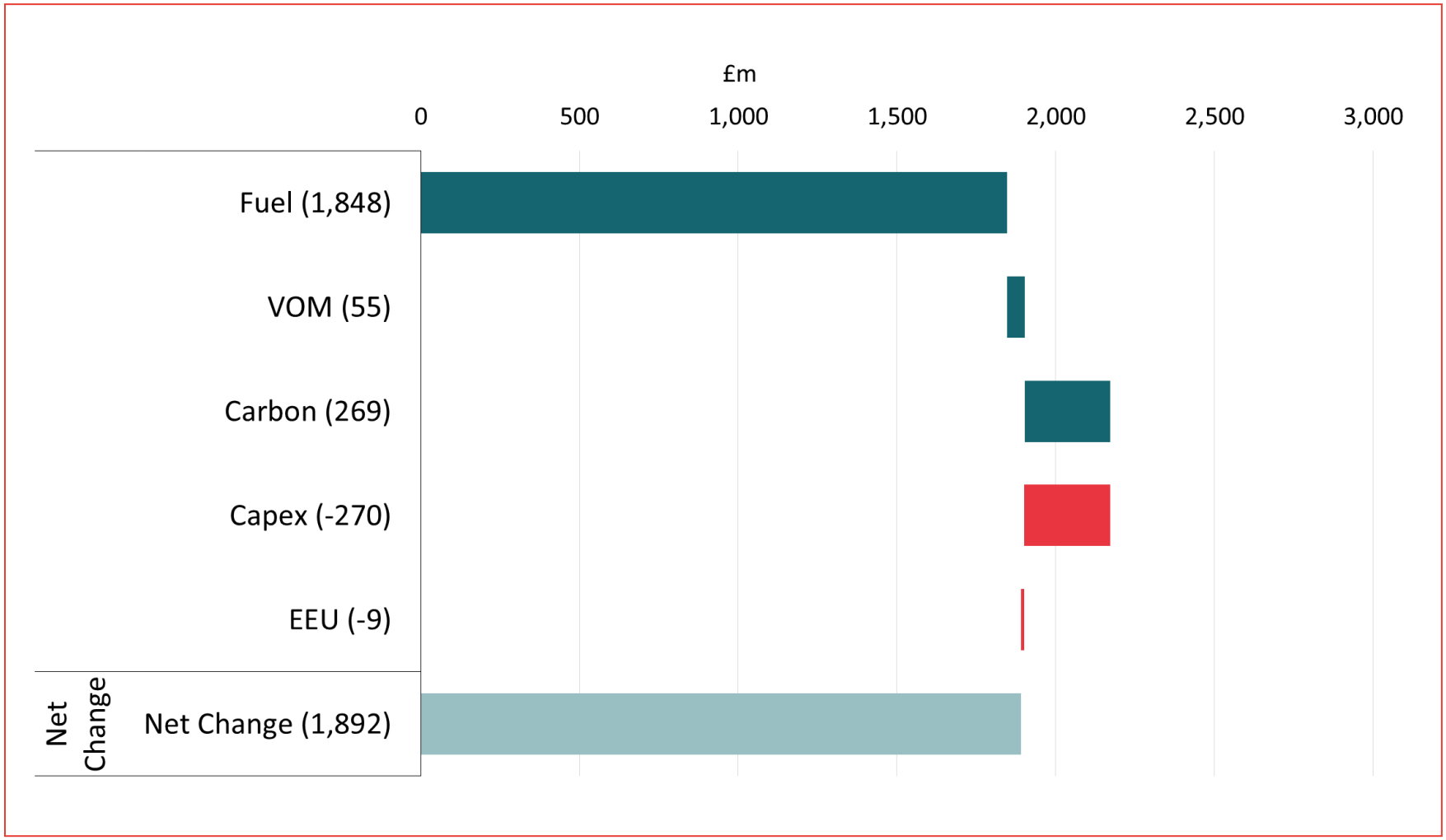
Consumer cost savings (SQ vs Scenario 3)

BEIS Medium capex



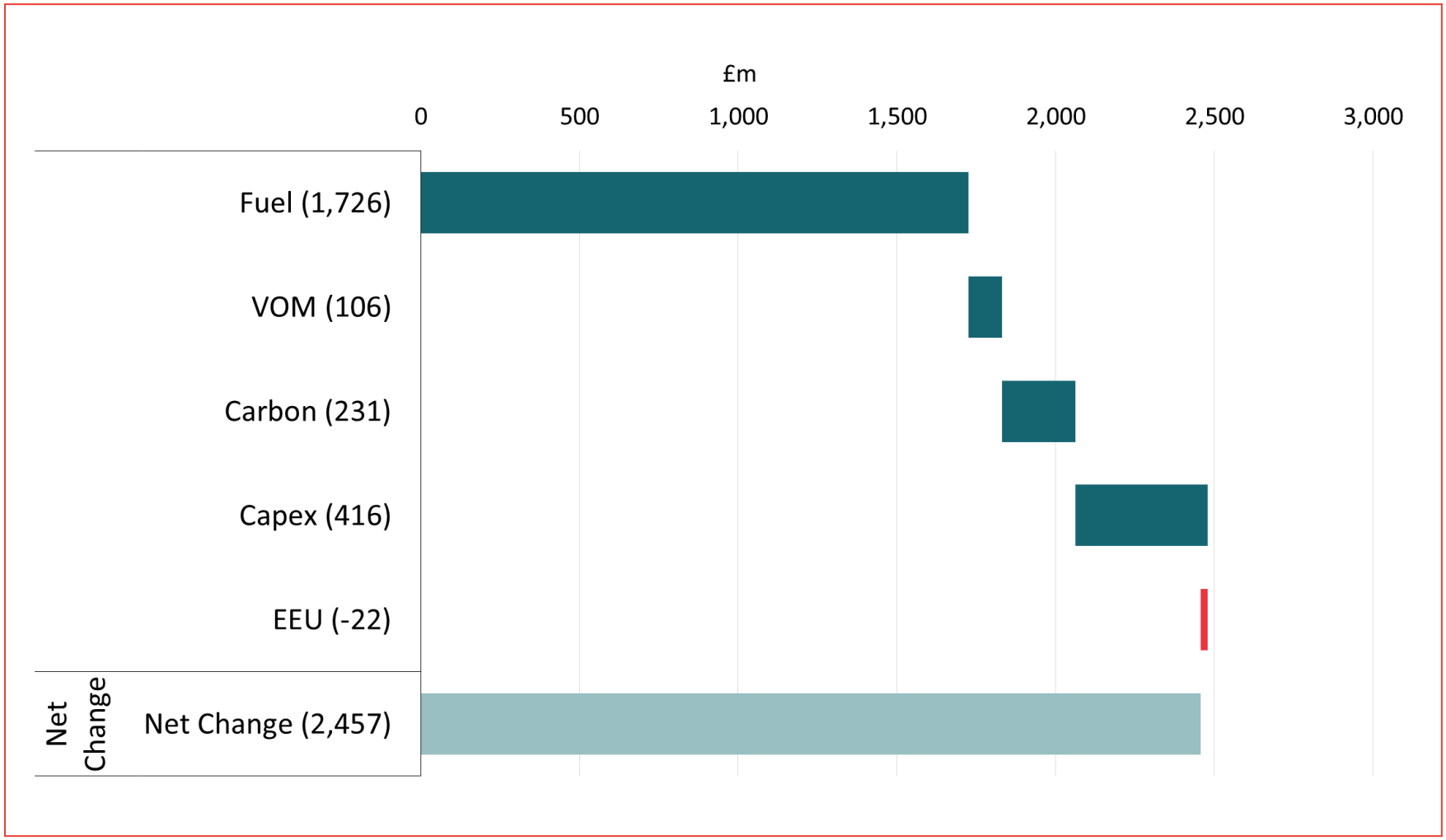
System cost savings (SQ vs Scenario 3)

BEIS Low capex



System cost savings (SQ vs Scenario 3)

BEIS Medium capex



- Cost savings
- Capex sensitivity
- Efficiency sensitivities
- Drop-out sensitivities

Efficiency sensitivity overview

System costs

- Increasing the efficiencies of reciprocating engines whilst assuming higher capex does not lead to a significant change in reciprocating engine build.
- Under Status Quo, reciprocating engines continue to build at their maximum build limits. Under Scenario 3, there is no reciprocating engine build for any of the efficiency sensitivities.
- The reduction in the triad benefit and the BEIS medium capex assumption result in the procurement of OCGTs instead.
- Subsequently, the increase in efficiencies only leads to a small reduction in system cost savings. This reduction is due to the reduced fuel costs of reciprocating engines under Status Quo.

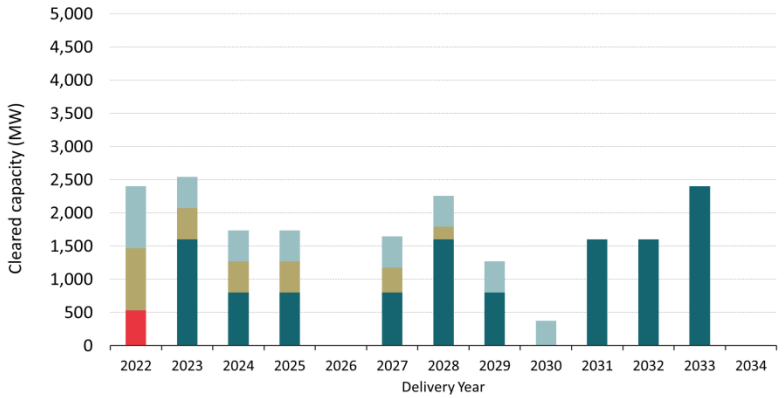
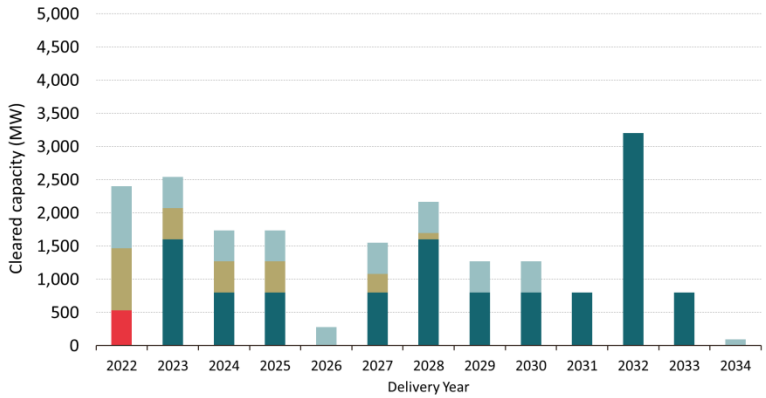
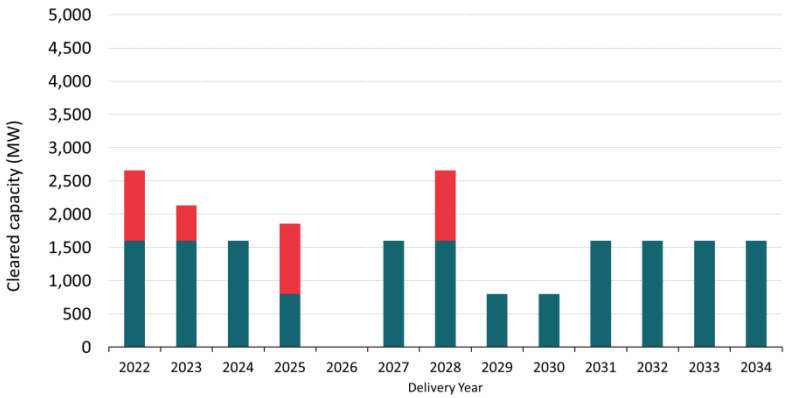
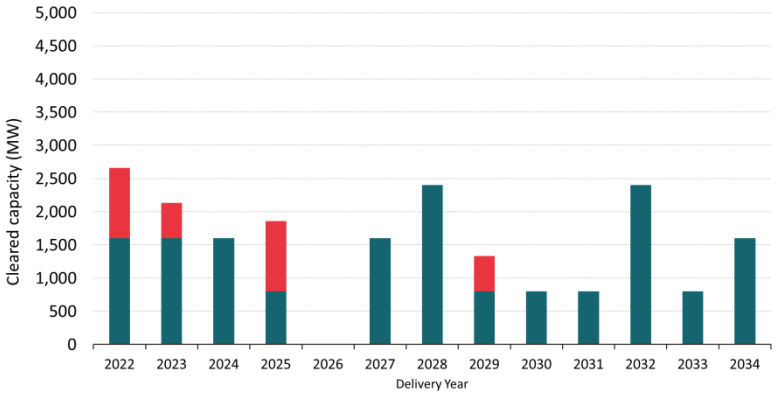
Efficiency sensitivity overview

Consumer costs

- Meanwhile, the consumer cost saving does not have such a simple relationship with the choice of efficiency.
- Increasing the efficiency of reciprocating engines deflates the wholesale price that new CCGT units expect in the future, and so CCGTs increase their bids in the CM.
- Deciding whether or not to clear a new 800MW CCGT unit on the margin in the CM auction can significantly alter the costs of the CM. Therefore, the model is sensitive to changes in the bids of new CCGT units.
- In some Scenarios, higher efficiency increases the consumer cost saving whilst reducing the saving in others.

CM new build (SQ vs Scenario 3)

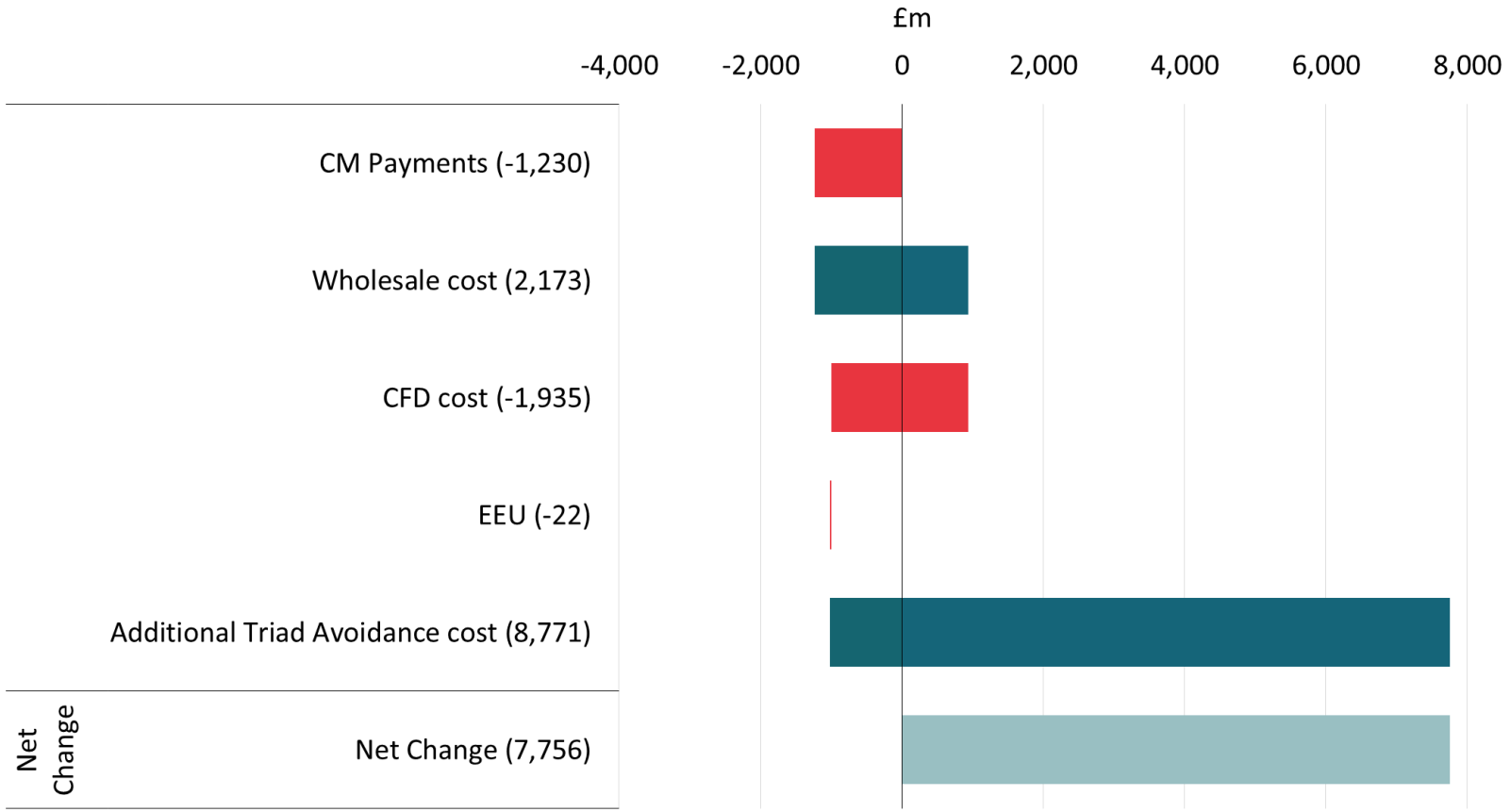
Effects of changing efficiencies

	+0% efficiency (BEIS Medium capex)	+10% efficiency (BEIS Medium capex)
SQ		
S3		

CCGT OCGT Reciprocating Engine Diesel Reciprocating Engine Gas

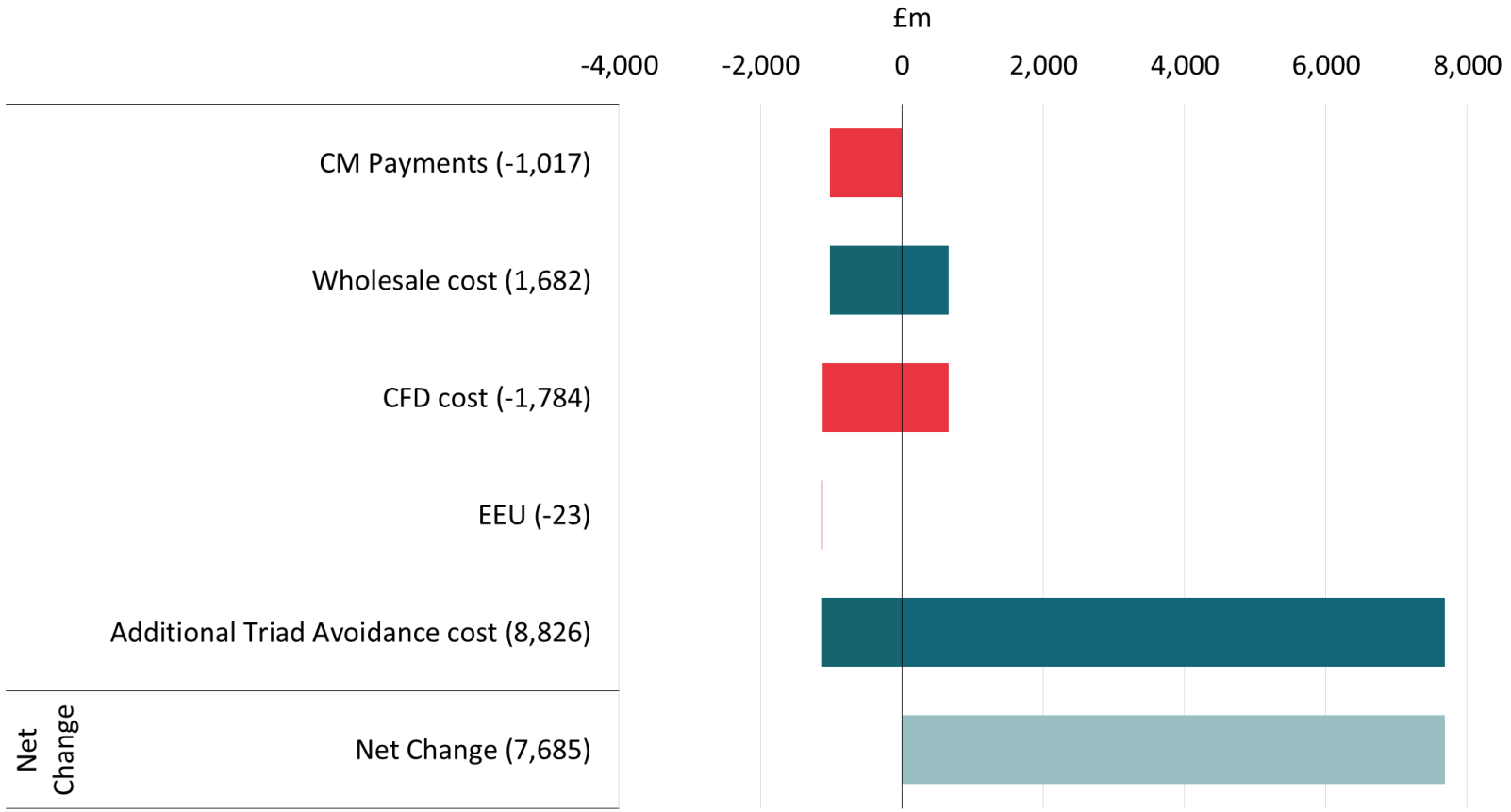
Consumer cost savings (SQ vs Scenario 3)

+0% efficiency (BEIS Medium capex)



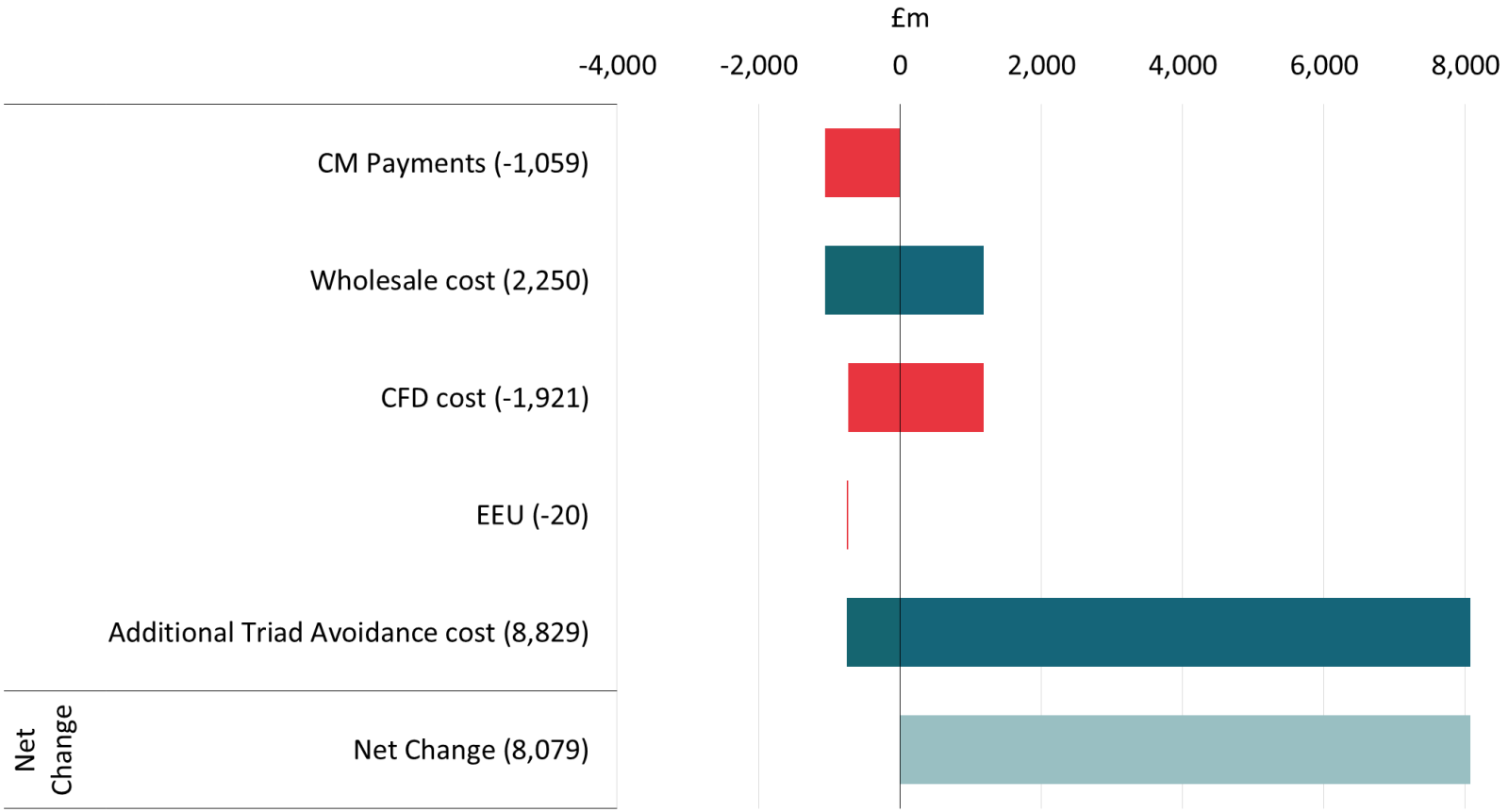
Consumer cost savings (SQ vs Scenario 3)

+5% efficiency (BEIS Medium capex)



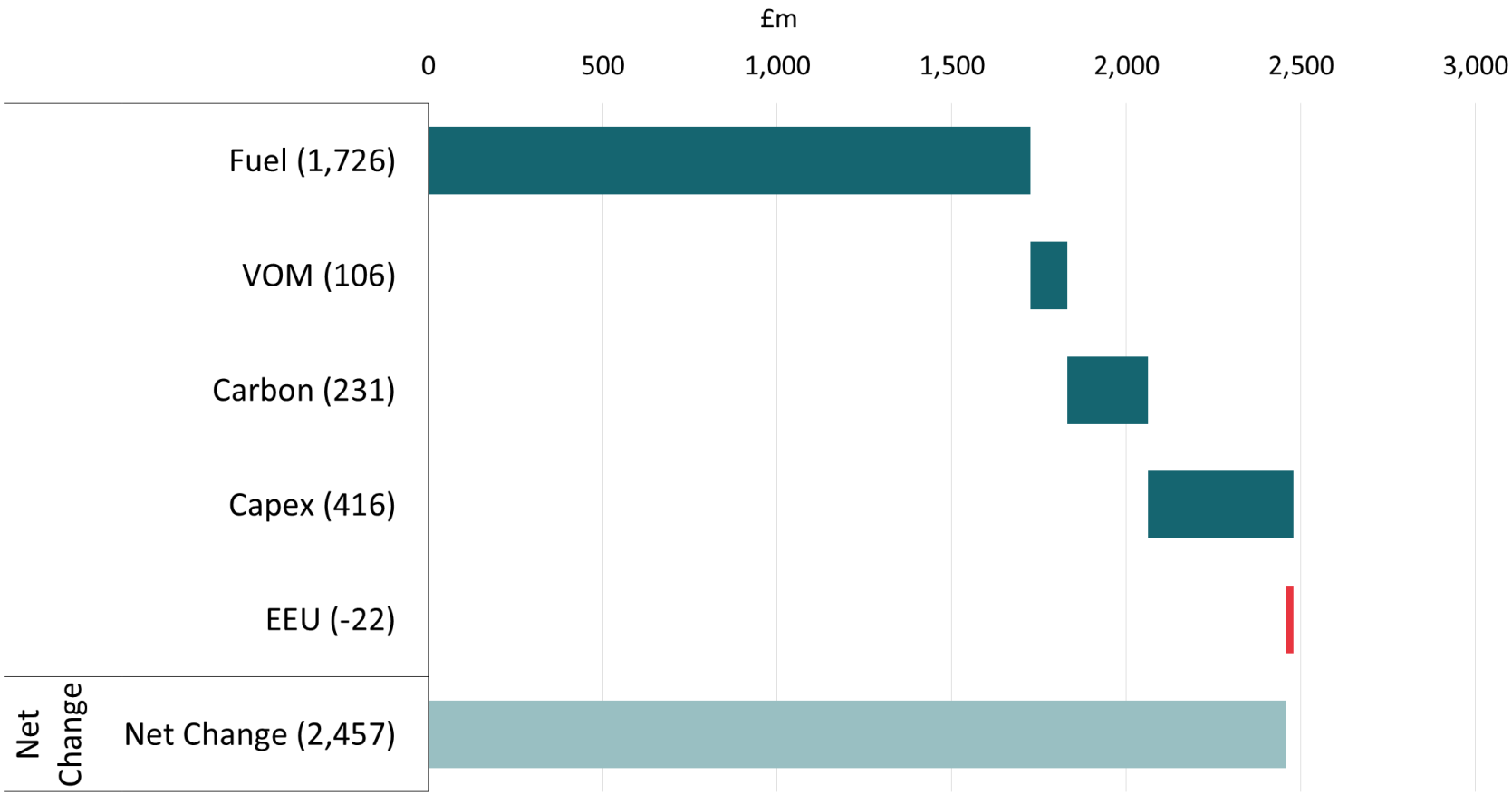
Consumer cost savings (SQ vs Scenario 3)

+10% efficiency (BEIS Medium capex)



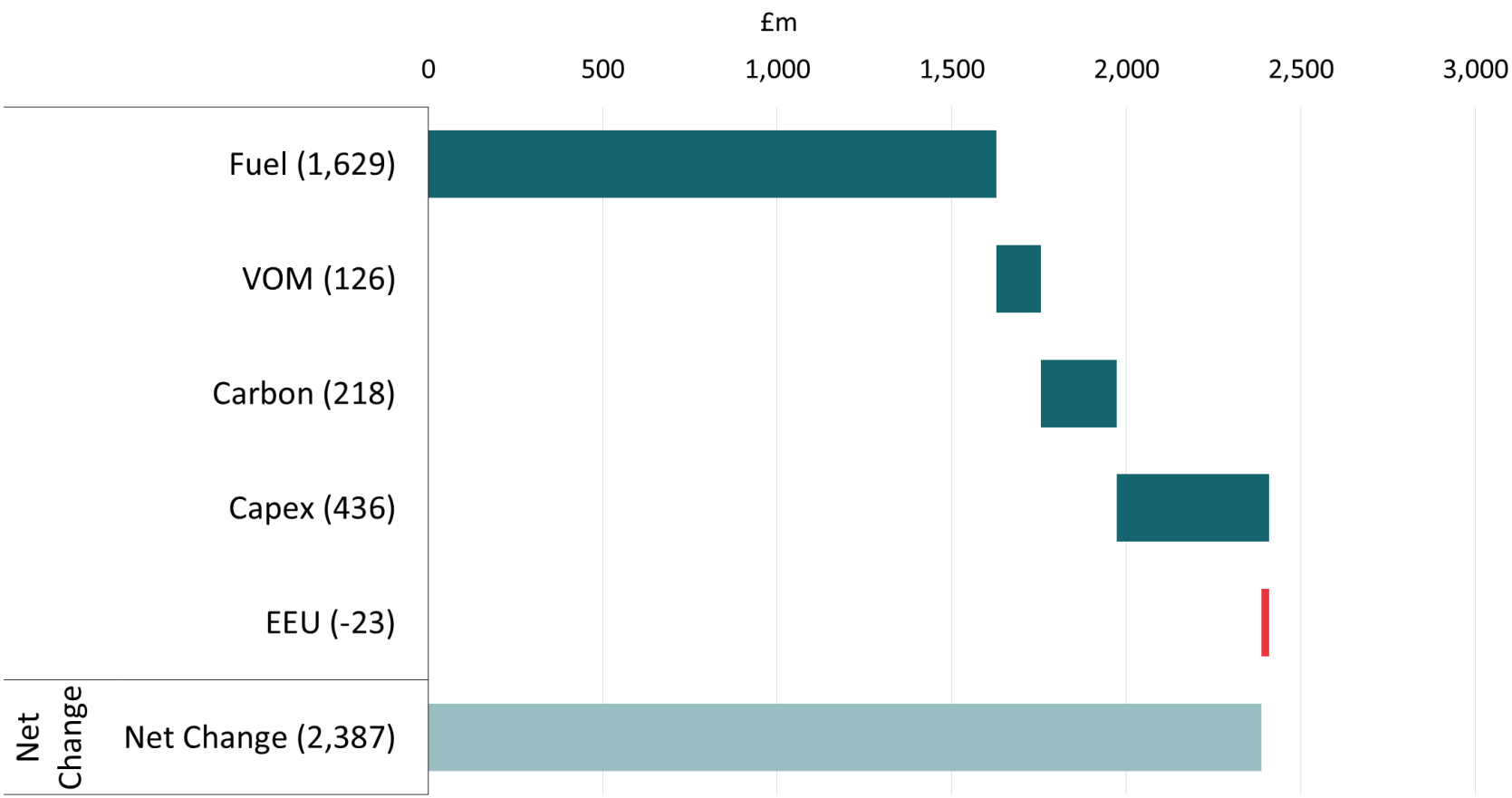
System cost savings (SQ vs Scenario 3)

+0% efficiency (BEIS Medium capex)



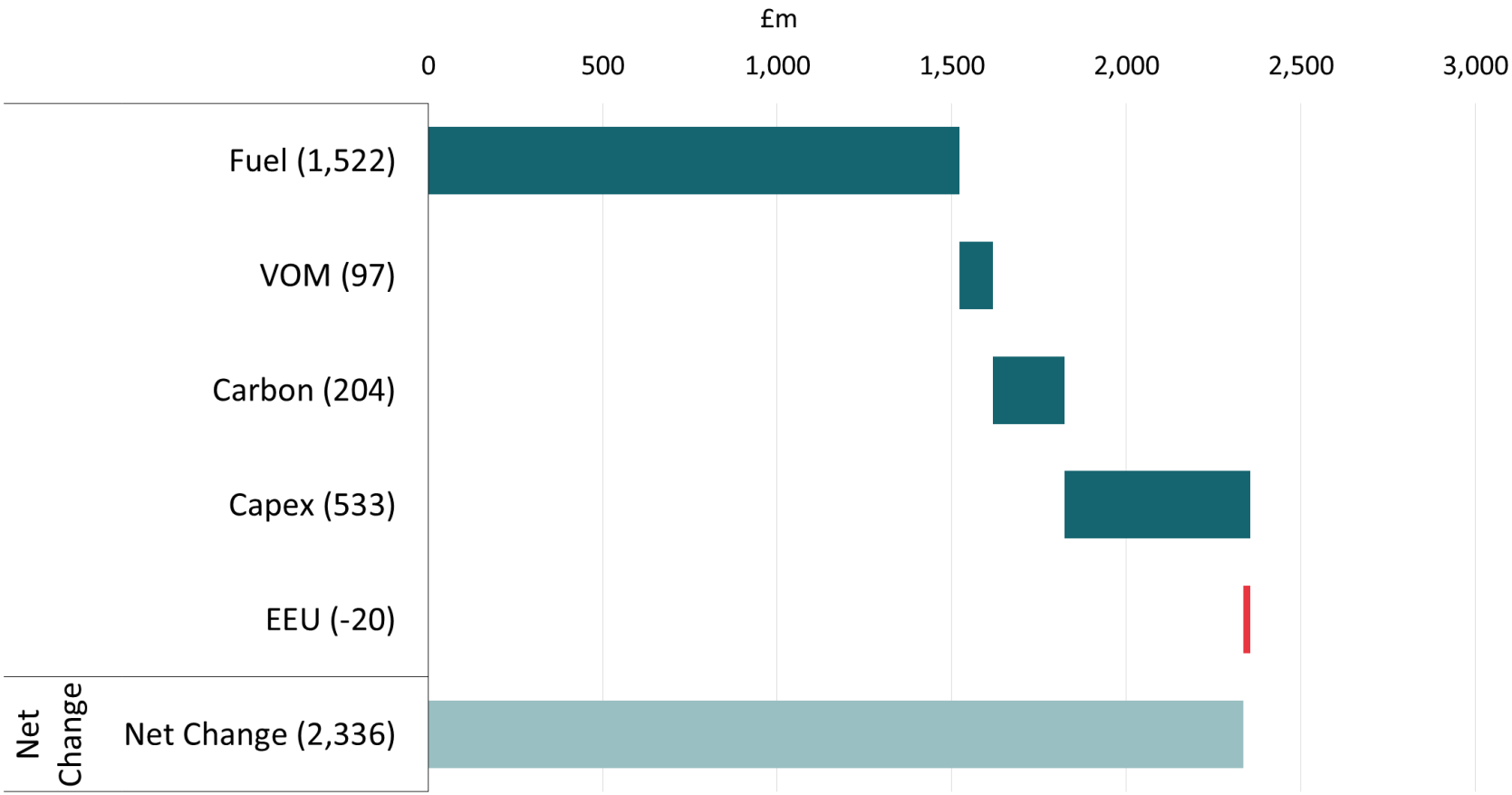
System cost savings (SQ vs Scenario 3)

+5% efficiency (BEIS Medium capex)



System cost savings (SQ vs Scenario 3)

+10% efficiency (BEIS Medium capex)



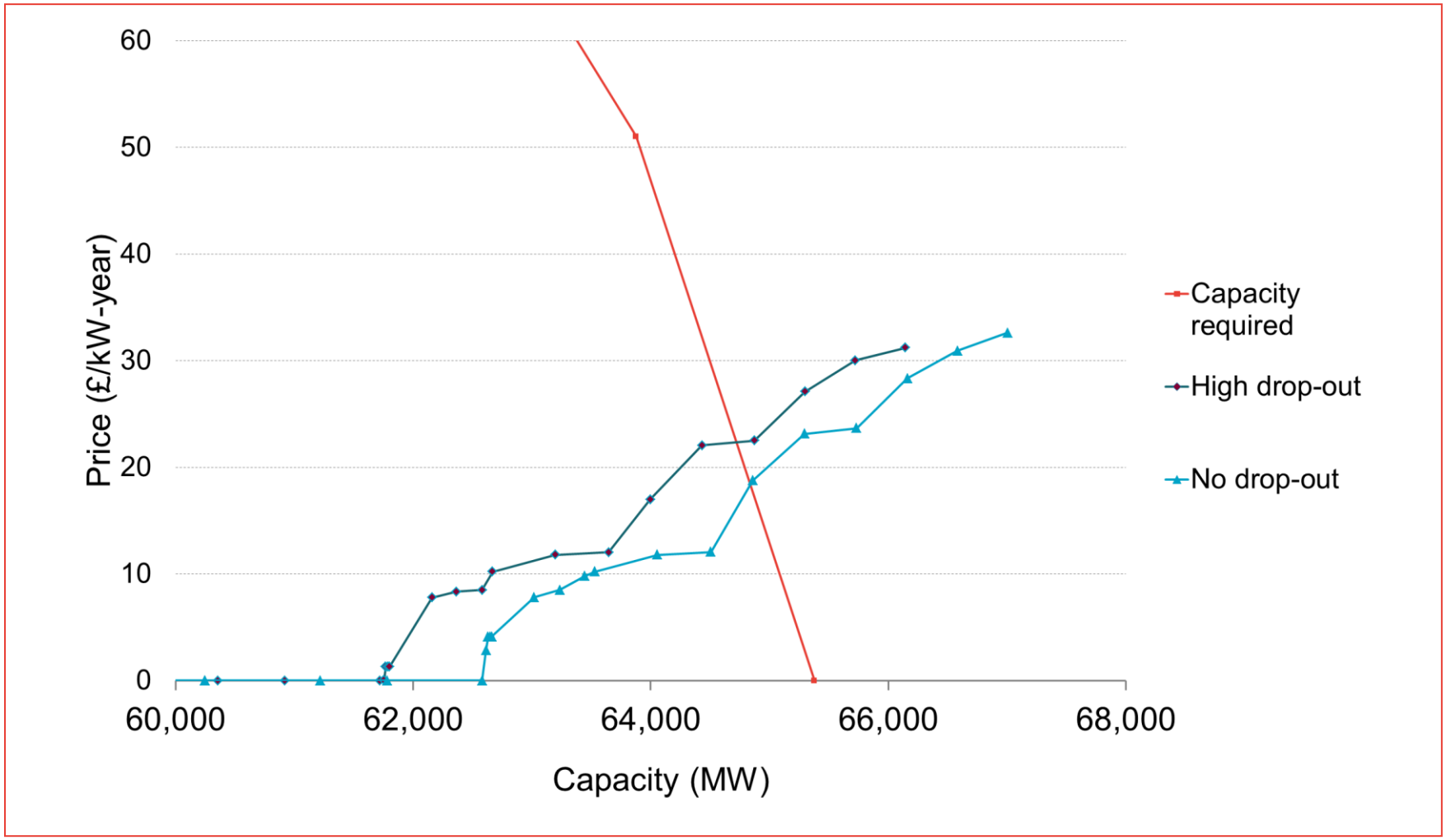
- Cost savings
- Capex sensitivity
- Efficiency sensitivities
- Drop-out sensitivities

Drop-out sensitivity overview

- Assuming a higher drop-out rate increases the amount of capacity procured in the first T-1 auction and increases the clearing price.
- The combination of these two changes reduces the consumer cost saving by increasing CM payments in Scenario 3.
- Higher drop-out rates among renewable plants increases the amount of gas procurement in CM auctions.
- This decreases the wholesale cost savings seen in consumer costs as more expensive gas plant dispatch more regularly.
- The replacement of renewables with gas also causes an overall decrease in system cost savings. The reduction in fuel savings outweighs the increase in VOM savings.

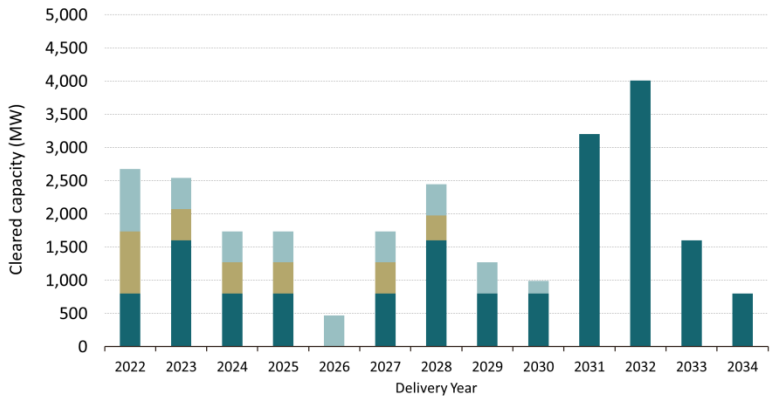
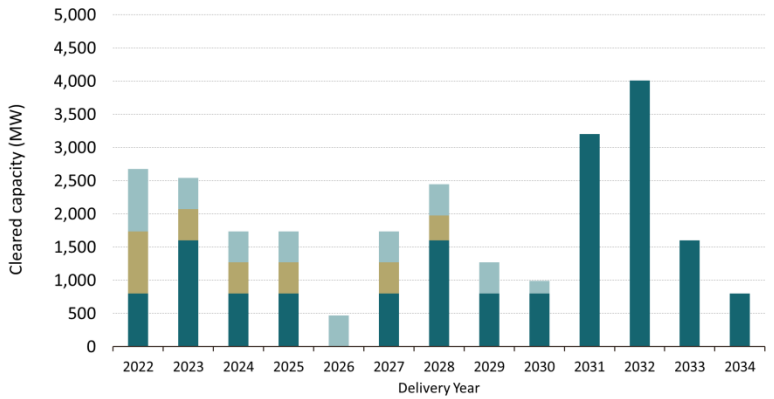
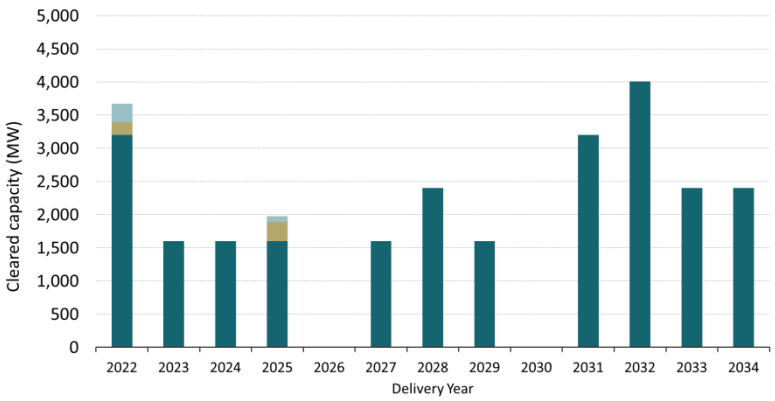
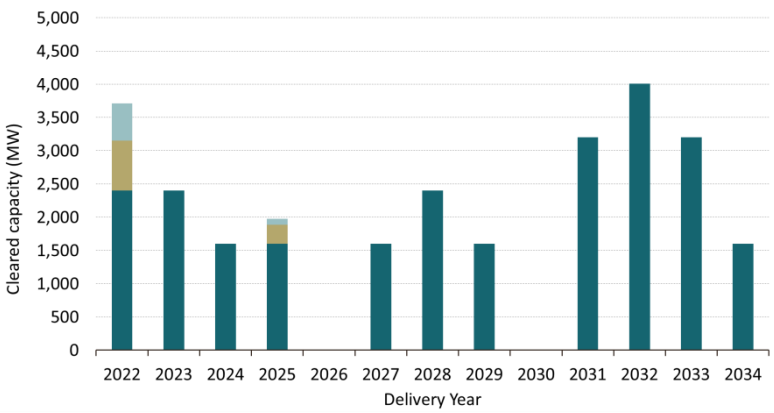
2019 T-1 Auction (Scenario 3)

Effect of high drop-outs



CM new build (SQ vs Scenario 3)

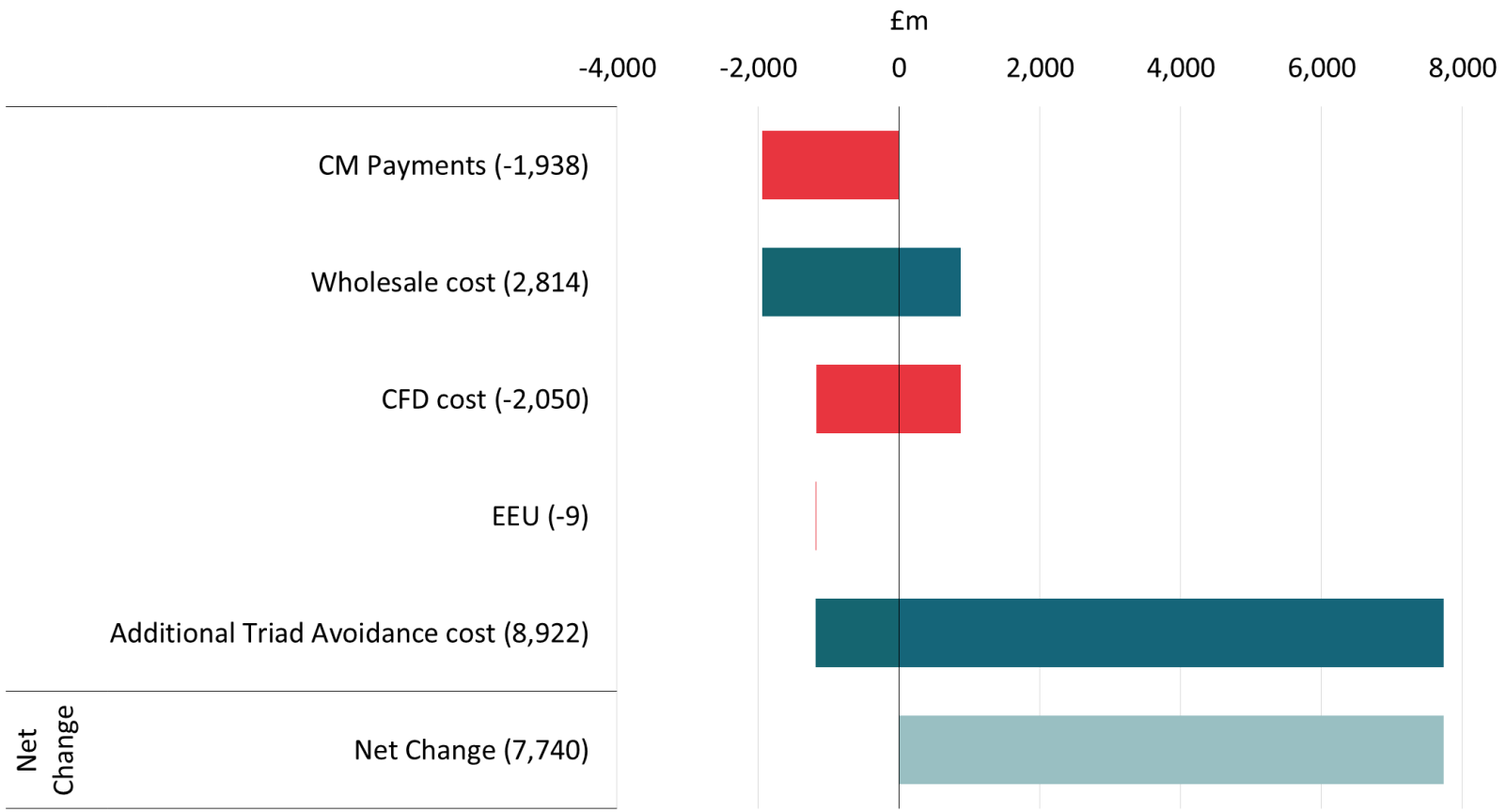
Effects of drop-outs

	Baseline (no drop-outs)	High drop-out
SQ		
S3		

CCGT OCGT Reciprocating Engine Diesel Reciprocating Engine Gas

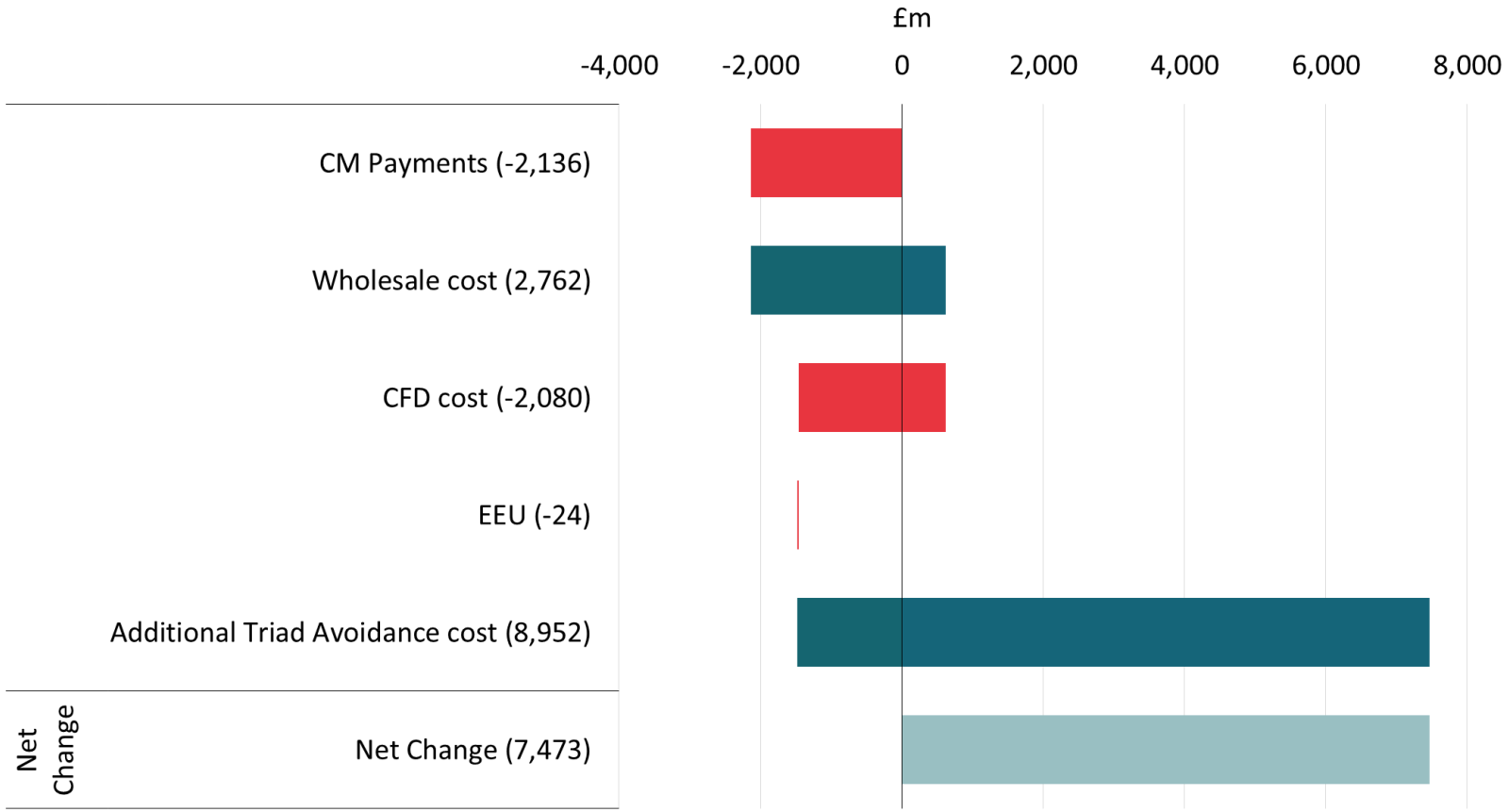
Consumer cost savings (SQ vs Scenario 3)

Baseline (no drop-outs)



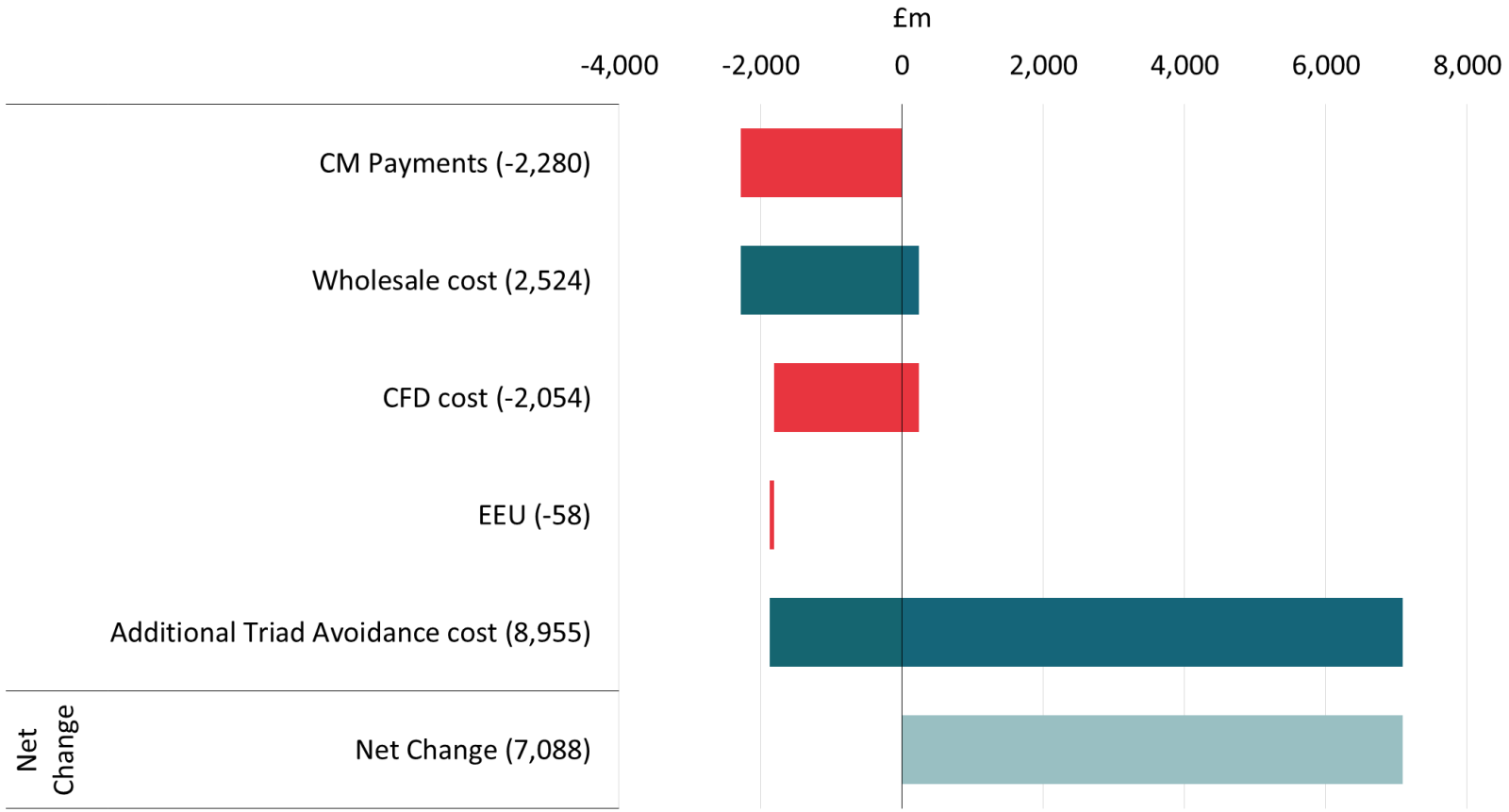
Consumer cost savings (SQ vs Scenario 3)

Low drop-outs



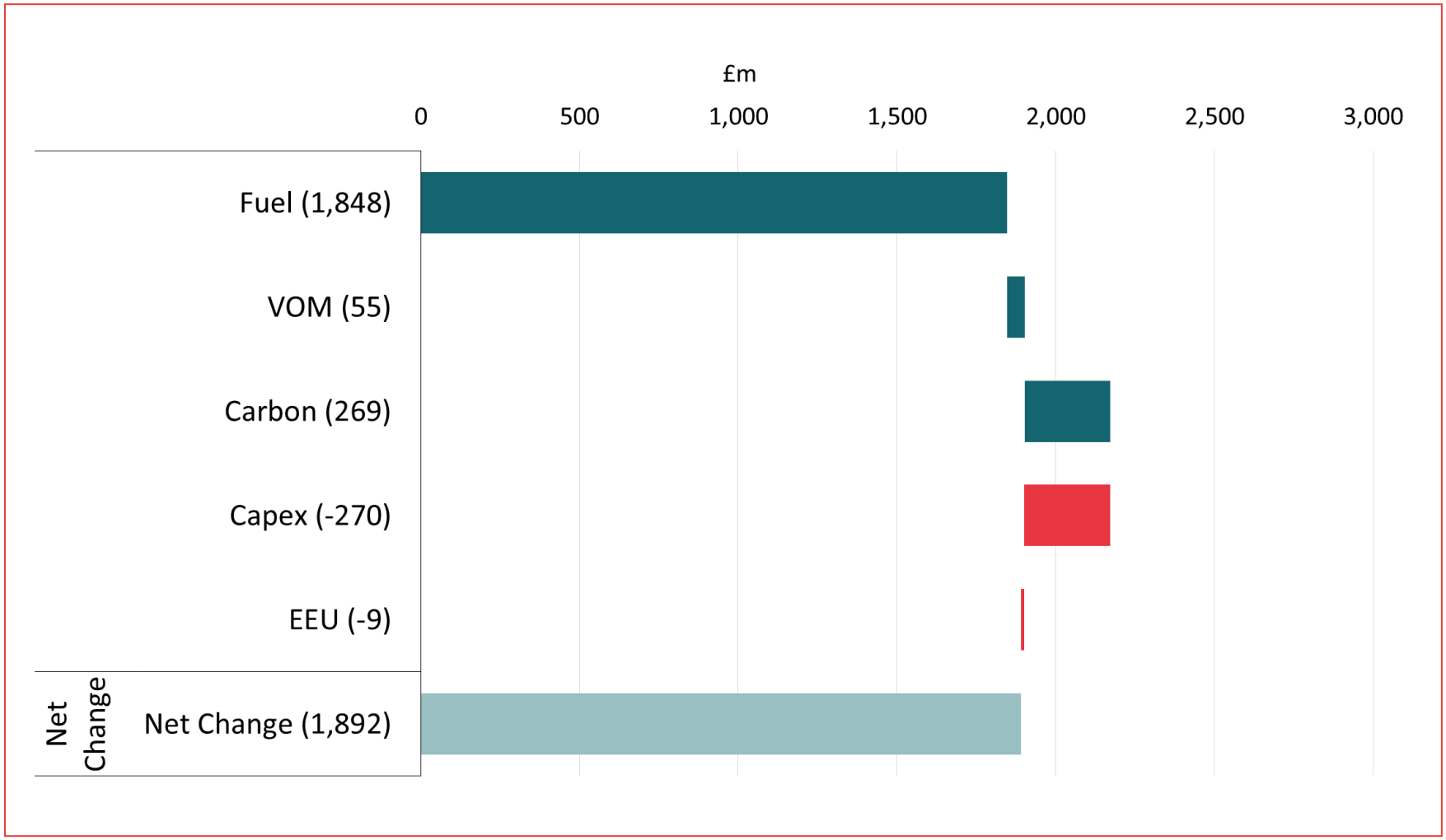
Consumer cost savings (SQ vs Scenario 3)

High drop-outs



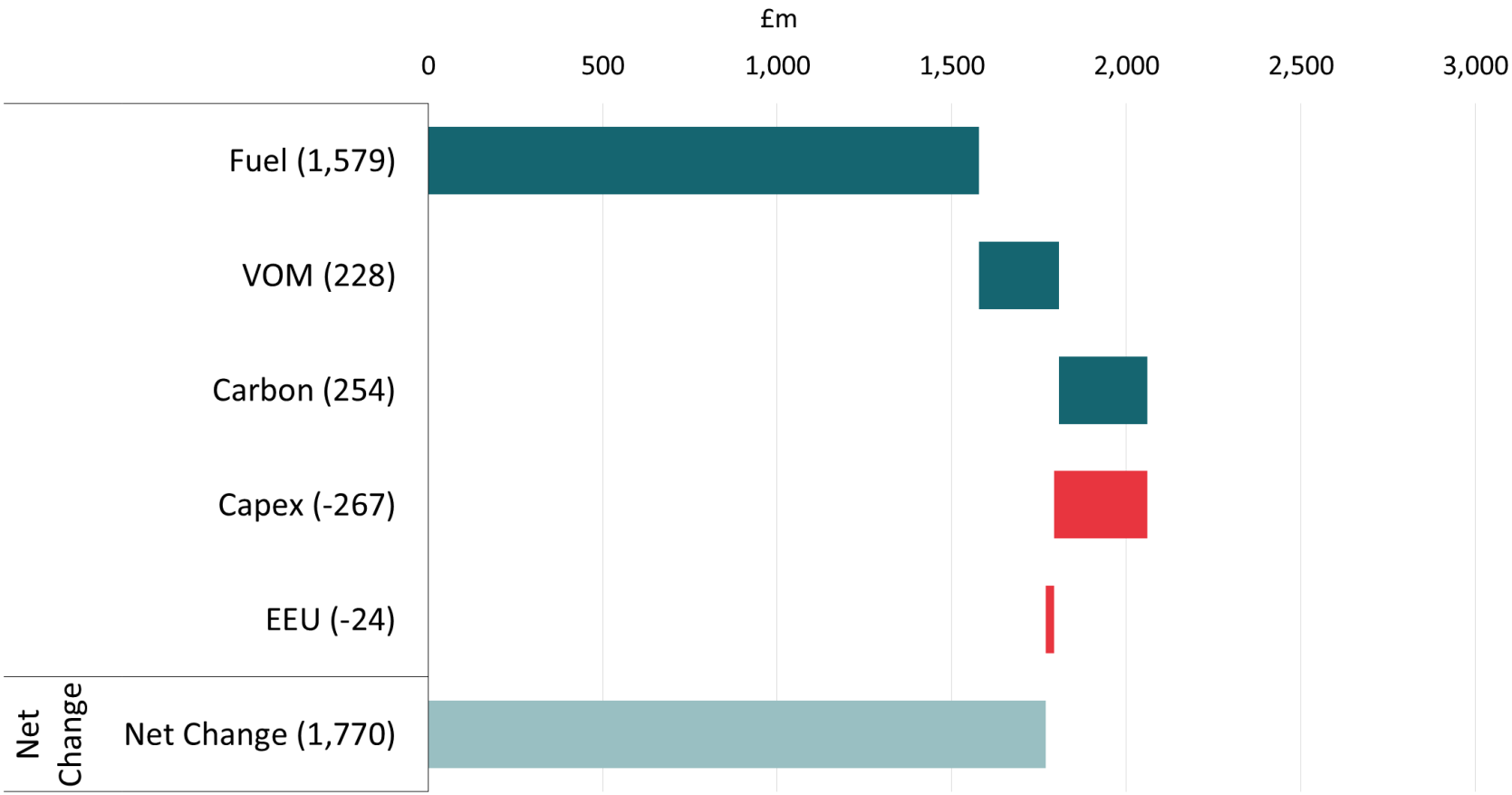
System cost savings (SQ vs Scenario 3)

Baseline (no drop-outs)



System cost savings (SQ vs Scenario 3)

Low drop-outs



System cost savings (SQ vs Scenario 3)

High drop-outs