Net Zero Market Reform – Phase 4

External Stakeholder Sessions

Workshop Pre-read - Review of Draft Report

NG ESO

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Introduction

The ESO's Phase 2 work on Net Zero Market Reform concluded that the current market design requires reform to achieve a secure Net Zero power system at lowest whole system cost. Phase 3 focused on the challenges arising in operational timescales and found that the existing market arrangements, established for a different type of electricity system, are increasingly incompatible from what is needed to achieve a cost-effective and secure decarbonised power system by 2035 and a Net Zero economy by 2050. As part of the Phase 3 assessment, options for the locational and dispatch design elements of system were assessed against a range of criteria. The assessment concluded that a nodal pricing system and a centralised dispatch mechanism is the ESO's recommended approach.

Phase 4 continues the programme and intends to support BEIS and Ofgem in their respective market reform work. Phase 4 builds on Phase 3 by focusing on challenges that arise in the investment timescale, and considers the full range of options covered in BEIS's Review of Electricity Market Arrangements (REMA) consultation. The objective of Phase 4 is to identify and assess credible packages of options that can adequately address the challenges identified and give the best chance of achieving timely, cost-effective decarbonisation and wider policy objectives.

Context of GB status quo and REMA

Many aspects of the current system were established at a time when generator location and output was not dependent on weather resource, and flexible demand was minimal. In this context, the creation of near real-time locational signals was not prioritised. The role of the ESO was envisaged to be that of a 'residual balancer': maintaining a continuous energy balance by fine-tuning the dispatch of generation and for protecting the limits of the system, but not intervening in a major way. Over the last 10 years, Electricity Market Reform has delivered substantial investment in low carbon technologies and reduced the carbon intensity of power generation, however it has also substantially altered the operational challenge. Market arrangements will need to be updated to meet this challenge and achieve Net Zero ambitions. BEIS' REMA programme has been launched to establish the enduring market arrangements needed to deliver a fully decarbonised and cost-effective electricity system by 2035 and a Net Zero economy by 2050 , while ensuring security of supply.

Net Zero implications for low carbon investment, capacity adequacy and operability

The 2022 ESO FES Leading the Way scenario suggests that intermittent renewable technologies could potentially provide more than 80% of generation by 2035. A large proportion of this resource will be in more peripheral regions of the network (for example, wind in North Scotland, distribution-connected solar) which may be far from demand locations. As weather-driven assets which generate when available rather than on demand, these create significant challenges for balancing the system, and result in congestion on the transmission system.

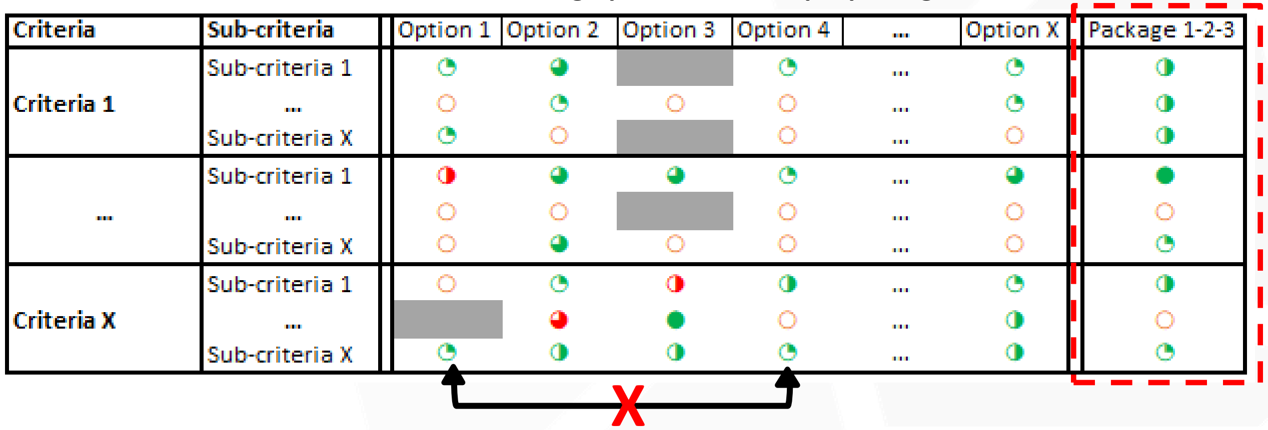
Greater flexibility, the ability to adjust supply and demand to balance the system, is needed to manage intermittency so that low carbon electricity can be better utilised when available, and demand can be met when renewables output is low. Ensuring incentives are in place to optimise location of assets and make best use of excess generation, through improved options for storage or demand side response, for example, can help to reduce the cost and challenge of maintaining a low carbon secure and operable system.

Approach to package design

We have taken a six-stage approach for assessing policy options and packages of options

1. Develop sub-criteria (under 10 criteria from Phase 3)
2. Assess long-list of options against sub-criteria, with Status Quo as the counterfactual (unless stated)
3. Combine options to design packages for National, Zonal and Nodal pricing market designs reflecting least change. Results in 3 'Baseline' packages
4. Build on top of 'baseline' packages to design more optimal alternatives. Results in 3 'Build' packages
5. Assess the 3 Baseline packages against each other, using the criteria, which can be weighted depending on priorities
6. Assess each Build package against each other and relative to their corresponding Baseline

Process of combining options to develop a package



Option 4 incompatible with Option 1 - not combined in example package

Combining options 1, 2 and 3 results in a package that scores consistently better than the options on their own

'Baseline' packages

*For a given pricing mechanism (national, zonal or nodal), what is a cohesive set of policies **entailing minimal deviation from existing policies**, which address, to some extent, the key areas in the case for change. Implicit in this is the prioritisation of implementation.*

'Build' packages

For a given pricing mechanism, what cohesive set of policies would increase the confidence in achieving the REMA objectives (i.e. score more strongly against the assessment criteria).

The 6 packages

National	Baseline	Build	National Baseline vs National Build
Zonal	Baseline	Build	Zonal Baseline vs Zonal Build
Nodal	Baseline	Build	Nodal Baseline vs Nodal Build
	National Baseline vs Zonal Baseline vs Nodal Baseline	National Build vs Zonal Build vs Nodal Build	

Proposed Packages and Assessment

List of options considered under baseline and build packages

System dimension	Policy option	Considered for 'Baseline'			Rationale	Considered for 'Build'			Rationale	
		National	Zonal	Nodal		National	Zonal	Nodal		
Mass Low Carbon	Evolved CfD	✗	✓	✓	Changes required to accommodate zonal/nodal pricing	✗	✗	✗	Would be insufficient to remove market distortions as volumes of CfDs increase	
	CfD with Deemed Output	✗	✗	✗	Significant change	✓	✓	✓	Would remove dispatch distortions	
	CfD with Price Cap and Floor	✗	✗	✗	Significant change	✓	✓	✓	Would provide stronger indication of the value of electricity at different times and locations	
	Revenue Cap and Floor	✗	✗	✗	Significant change	✓	✓	✓	Would reduce dispatch distortions	
	Elective Participation	✓	✓	✓	Would allow greater role of market in determining generation mix	✓	✓	✓	As for Baseline	New option
	Supplier Obligation	✗	✗	✗	Incompatible with coordinated delivery of large scale infrastructure	✗	✗	✗	As for Baseline	
Capacity Adequacy	Evolved CM	✓	✓	✓	Changes required to promote low carbon flex	✓	✓	✓	As for Baseline	
	Optimised CM	✗	✗	✗	Significant change	✓	✓	✓	Include combination of flex, carbon and locational dimensions in auction algorithm to strengthen market signals	
	Centralised Reliability Option	✗	✗	✗	Significant change	✓	✓	✓	As above, but replacing with financial option that aligns better with centralised dispatch	
	Decentralised Reliability Option	✗	✗	✗	Significant change	✓	✓	✓	As above, but replacing with decentralised financial option	
	Reverse Reliability Option	✗	✗	✗	New mechanism	✓	✓	✓	Create stronger investment signals for long duration storage/demand turn up to reduce curtailment risk	New option
	Strategic Reserve	✗	✗	✗	Option to bolster security of supply	✓	✓	✓	Option to bolster security of supply	

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List of options considered under baseline and build packages

System dimension	Policy option	Considered for 'Baseline'			Rationale	Considered for 'Build'			Rationale
		National	Zonal	Nodal		National	Zonal	Nodal	
Dispatch	Centralised dispatch	✗	✗	✓	Pre-requisite for nodal pricing	✓	✓	✓	Reduces the need for de-dispatch
	Self dispatch	✓	✓	✗	Least change option for national and zonal pricing	✗	✗	✗	Centralised dispatch likely to lead to better efficient operational outcomes
Operability	BAU	✗	✗	✗	Insufficient to promote low carbon flex	✗	✗	✗	As Baseline
	BAU+	✓	✓	✗	Necessary to promote low carbon flex	✗	✗	✗	Assumed co-optimisation with centralised dispatch
	Co-optimisation	✗	✗	✓	Integral to nodal pricing/centralised dispatch	✓	✓	✓	As Baseline
Other	Split Market	✗	✗	✗	Assuming gas/electricity price de-coupling can be achieved more easily through expansion of CfDs	✗	✗	✗	As Baseline
	Carbon Intensity reporting	✗	✗	✗	Improving carbon disclosure	✓	✓	✓	Could be used in conjunction with CfD opt out to ensure large consumers are meeting required decarbonization trajectory
	PTR/FTR	✗	✓	✓	Necessary for managing locational basis risk/grandfathering existing rights	✗	✓	✓	As Baseline
	Network Access and Charging Reform	✓	✗	✗	Considered as an alternative or transitional step to locational pricing	✓	✗	✗	As Baseline
	Settlement Period Reform	✗	✗	✓	Integral to nodal pricing/centralised dispatch	✓	✓	✓	Implementable with centralised dispatch
	Scarcity Adder	✗	✗	✗	Significant change	✗	✗	✓	In conjunction with wholesale price cap, could help limit market power under locational pricing whilst maintaining strong dispatch signal

New options

Baseline packages

The 'Baseline' packages represent, for a given pricing mechanism, a cohesive set of policies entailing minimal deviation from existing policies. Implicit in this is the prioritisation of implementation.

	National Baseline	Zonal Baseline	Nodal Baseline
Pricing	National	Zonal	Nodal
Dispatch	Self	Self	Central
Mass Low C	Evolved CfD; Elective Participation	Evolved CfD; Elective Participation	Evolved CfD; Elective Participation
Cap Adequacy	Evolved CM	Existing CM	Existing CM
Operability	BAU+	BAU+	Co-optimisation
Other	Network Access and Charging Reform	PTRs/FTRs	FTRs; 5 min settlement

- The National Baseline package can be characterised as an evolution of the current arrangements.
- The main instrument for promoting investment in mass low carbon would be the CfD, with some evolutions. For example, **some locational differentiation in allocation rounds** might be introduced to better align with the Holistic Network Design.
  - Larger consumers (and their suppliers) could elect to opt out of the central CfD scheme and demonstrate how they are achieving required decarbonised obligation, which may include bidding into CfD tenders for bilateral agreements giving them access to larger offshore wind projects, for example. (This would also be a feature of the Zonal and Nodal Baseline packages).
- Likewise, **locational de-rating factors could be introduced in the Capacity Market** to improve locational signalling, together with changes to Network Access and Charging to provide stronger short-term locational signals through a combination of differentiated access rights and more system responsive pricing - a simple proxy for locational wholesale markets – which may be combined with more locational targeting in BSUoS cost recovery.
- **Balancing Services** would continue to evolve to stimulate new products (using Pathfinders where needed), with low carbon providers prioritised either through explicit procurement of low carbon services or minimum Emission Performance Standards.
- **Local Markets** would continue to evolve, with the ESO able to access ancillary services from Distributed Energy Resources through co-ordinated procurement on emerging distribution level market platforms.

- The Zonal Baseline package would retain self-dispatch and a bilateral trading model, but with the introduction of a number of zones aligned to the main constrained transmission boundaries.
- Market participants would be balance responsible in each zone with transmission capacity between zones either allocated explicitly through PTR auctions, or more likely using implicit market coupling at the day-ahead stage, and potentially intra-day. Under the latter approach, FTRs would be the main instrument to allow participants to manage locational basis risk. The locational element of TNUoS may be reduced or removed.
- **The CfD would be retained but would need to be adjusted to deal with locational pricing.**
  - For existing CfD generators the most likely outcome would be to make the Market Reference Price each generator's respective zonal market price, thus preserving their current rights.
  - For new CfDs it is assumed that the reference price would be a national price, thus sending a strong locational signal since the generator would be exposed to the difference between the zonal and national price. These generators would need access to (bespoke) FTRs to manage this risk. Likewise, other generators and storage would want access to FTRs, with the possibility of some grandfathering for existing assets to preserve access rights.
- **Zonal pricing should introduce locational incentives into the Capacity Market** although a locational CM could be considered.
- **Evolution of Balancing Services and Local Markets** would be similar to the National Build package.

- The Nodal Baseline package would replace the existing bilateral national market with a market based around central dispatch and several hundred nodes, probably at the GSP level, with 5 min settlement.
- Market participants could either bid into and be scheduled through the centralised market (day-ahead and intra-day balancing markets) or self-dispatch and be a price taker. Reserve and response requirements would be co-optimised through the central dispatch algorithm. New interfaces with interconnectors and Local Markets would need to be designed to align scheduling across markets as efficiently as possible, noting that these assets may not be participating directly in the centralised dispatch. Markets in FTRs would allow participants to manage locational price risk, but if these are at zonal hubs rather than individual nodes there could be residual basis risk between individual nodes and hubs. Markets in 'virtuals' could allow participants to manage day-ahead to intra day price risk. Demand may be settled for certain customer types at zonal or national level to limit adverse distributional effects across the country.
- **Changes to CfDs needed to accommodate locational pricing would be similar to Zonal Build**, but with nodal rather than zonal reference prices where applicable for existing CfD generators. Depending on the availability of bespoke FTR products, new CfD generators may not be able to perfectly hedge their locational risk.
- As with Zonal Build, it is **assumed that locational granularity in wholesale market is sufficient to provide locational investment signals**, but a zonal CM could be considered if not.

Build packages

The ‘Build’ packages represent, for a given pricing mechanism, what cohesive set of policies would increase the confidence in achieving the REMA objectives (i.e. score more strongly against the assessment criteria).

	National Build	Zonal Build	Nodal Build
Pricing	National	Zonal	Nodal
Dispatch	Central	Central	Central
Mass Low C	Revenue C+F; Elective Participation	Revenue C+F; Elective Participation	Revenue C+F; Elective Participation
Cap Adequacy	Optimised CM: Zonal, Min C, Flex	Optimised CM: Min C, Flex	CRO; RRO; Scarcity Adder; Strat Reserve
Operability	Co-optimisation	Co-optimisation	Co-optimisation
Other	Network Access and Charging Reform; 5 min settlement; Carbon Rep	FTRs; 5-min settlement, Carbon Intensity Rep	FTRs; 5-min settlement, Carbon intensity rep

National Build

- The National Build package would involve a **move to central dispatch**, similar to as described for the Nodal Baseline package but with a single national price, and therefore the costs of managing transmission constraints still being socialised – albeit reduced by Network Access and Charging Reform to provide stronger short-term locational signals through a combination of differentiated access rights and more system responsive pricing.
- It is assumed that the current **CfD would be replaced with a mechanism based on a cap and floor** to provide stronger signals for low carbon generators to respond to market/system signals.
  - A revenue cap and floor is marginally favoured over a price cap and floor given the lower risk of dispatch distortions (noting there is a spectrum of options for settling a price cap and floor which increasingly resemble a revenue cap and floor the longer the settlement period).
  - As in the Baseline package larger consumers (and their suppliers) could elect to opt out of the central scheme and demonstrate how they are achieving required decarbonised obligation, which may include bidding into organised tenders.
- The **CM would include zonal, minimum low carbon and flexibility dimensions** – either through explicit volume constraints or price scalars – in order to promote the more rapid decarbonisation of peaking and flexible capacity in the right locations.
- The replacement of the physical CM with a financial **Centralised Reliability Option, and the introduction of a Reverse Reliability Option, is a possible addition** to this package.

Zonal Build

- The Zonal Build package has many of the same options as National Build with central dispatch, but with a zonal rather than national price model. As with the Zonal Baseline package the **locational element of TNUoS would likely be reduced or removed**, and market participants would have access to PTRs or FTRs to manage locational risk.
- **CfDs would be replaced with Revenue Cap and Floor** for new low carbon generation, with the difference being the generator would be exposed to the zonal rather than national price.
- The Optimised CM would include minimum low carbon and flexibility dimensions, but unlike tor the National Build may not need to be zonal if signals from wholesale market are sufficiently strong.
- The **Centralised Reliability Option and Reverse Reliability Option are also a possible addition** to this package.

Nodal Build

- The Nodal Build package is an extension of the Nodal Baseline package which already includes central dispatch and nodal pricing.
- As with the other two Build packages the existing **CfD would be replaced with a Revenue Cap and Floor**, with Elective Participation for larger customers.
- There is a **stronger rationale for replacing the CM with a Centralised Reliability Option** under Nodal pricing to ensure good alignment of price signals with availability incentives, whilst combining with a solution to limit exploitation of market power, which is a particular risk under nodal pricing. One possible formulation would be to set the CRO strike price at the same level as a wholesale price cap, with an administered Scarcity Adder above the wholesale price cap. This would provide strong incentives for CRO holders to deliver in addition to stimulating any further demand side response not participating in the CRO. A strategic reserve is included here to provide further confidence in the physical availability of capacity given the shift from a physical to financial capacity adequacy mechanism.
- The **Reverse Reliability Option** also sits well with the Nodal Build package since its primary objective would be to send signals to reduce the level of curtailment, which by its nature is very locational.
- The Nodal Build package also creates **the opportunity to extend co-optimisation to Local Markets** and this could be a feature of this package.

National Pricing – Status Quo

Stylised representation of current electricity markets

Investment timeframes | Hedging timeframes | Operational timeframes | Settlement

CfDs

CM

Forward OTC market
Physical

DA exchanges

WD OTC market

Balancing Mechanism

Half-hourly settlement

Balancing Services markets (pathfinders to DA Markets)

TNUoS

BSUoS
Generators will no longer pay BSUoS from April 2023

Transmission Loss Factors

National Pricing – Baseline

Evolution of CfDs and CM, with stronger short term locational signals through Access and Charging Reform

Investment timeframes

Evolved CfDs

Evolved CM
Locational de-rating factors
Tightening EPS

Hedging timeframes

Forward OTC market
Physical

Operational timeframes

DA exchanges

WD OTC market

Balancing Mechanism

Settlement

Half-hourly settlement

Enhanced Balancing Services markets (BAU+)

Network Access and Charging
Stronger short-term locational signals through a combination of differentiated access rights and more system responsive pricing

Transmission Loss Factors

Reduced role for BM in resolving transmission constraints

National Pricing – Build

Revenue Cap/Floor and optimised CM, co-optimised centralised dispatch and stronger locational signal

Investment timeframes

Revenue Cap/Floor
Minimum annual revenue and (soft) annual cap

Optimised CM
Minimum low carbon requirement
(Zonal)
(Flex scalars)

Hedging timeframes

Forward OTC market
Financial

Operational timeframes

Co-optimised centralised dispatch

Day-ahead market

Real-time market
(Balancing)

Option for self commitment

Settlement

5 min settlement

Other residual Balancing Services procurement (e.g. pathfinders)

Generators have option to self-commit or self-schedule generation

Network Access and Charging
Stronger short-term locational signals through a combination of differentiated access rights and more system responsive pricing

Transmission Loss Factors

Assessment of National Pricing Packages

Baseline

- Incremental improvement relative to Status Quo across most criteria, but stronger outcome for value for money mainly on account of increased system flexibility and less need to redispatch coming from better locational signals in CM, stronger short term signals through changes to Network Access and Charging and Operability BAU+ options in Balancing Services.
- Neutral on consumer fairness.
- Implementation not too challenging.

Build

- Scores more strongly than Baseline option on all criteria other than challenge to implement.
- This is mainly the result of having a better Optimised CM, greater price exposure for low carbon generation (through Revenue Cap/Floor) reducing the need for self-dispatch, and operational efficiency from Central dispatch.
- The inclusion of Carbon Intensity Reporting, helps to enhance the scoring across the competition, whole system, consumer fairness and decarbonisation criteria.
- The greatest deliverability challenge comes from the inclusion of Central dispatch and Co-optimisation in this package.

Baseline

Criteria	*Evolved CfD*	*Evolved CM*	*Operability BAU+*	*Access and Charging Reforms*	*Elective Participation*	*National*	*Self*	*Package score*
Value for Money	○	◔	◔	◔	○	○	○	◑
Competition	◔	○	◔	○	○	○	○	◔
Investor Confidence	○	○	◔	○	◔	○	○	◔
Full chain flexibility	○	○	◑	◔	○	○	○	◔
Whole system	○	○	◔	◔	◑	○	○	◔
Adaptability	○	◔	◔	○	◔	○	○	◔
Consumer fairness	○	○	○	○	◔	○	○	○
Energy security and system operability	○	◔	◔	◔	○	○	○	◔
Decarbonisation	○	○	◑	○	◔	○	○	◔
Challenge to implement	○	○	○	◔	◑	○	○	◔
Total	◔	◔	◑	◑	◔	○	○	◔

Build

Criteria	*Revenue Cap/Floor*	*Optimised CM - Zonal*	*Co-optimisation*	*Carbon Intensity Reporting*	*CM + Enhanced Flex*	*Optimised CM - Minimum Carbon*	*Access and Charging Reforms*	*Elective Participation*	*National*	*Central*	*Package score*
Value for Money	◑	◔	◔	○	◑	◔	◔	○	○	◔	◕
Competition	◔	○	◑	◔	◑	◔	○	○	○	◑	◕
Investor Confidence	◔	○	◔	○	◔	○	○	◔	○	◔	◑
Full chain flexibility	◑	○	◑	○	◑	○	◔	○	○	◑	◑
Whole system	◑	○	◔	◔	◔	◔	◔	◑	○	◑	◑
Adaptability	◔	◔	◔	○	◑	◑	○	◔	○	○	◑
Consumer fairness	○	○	◔	◔	○	○	○	◔	○	○	◔
Energy security and system operability	○	◔	○	○	◑	○	◔	○	○	○	◑
Decarbonisation	◔	○	◔	◔	◔	◑	○	◔	○	◔	◑
Challenge to implement	◑	◔	◕	◔	◔	◔	◔	◑	○	◑	◑
Total	◑	◔	◑	◑	◑	◑	◑	◔	○	◕	◑

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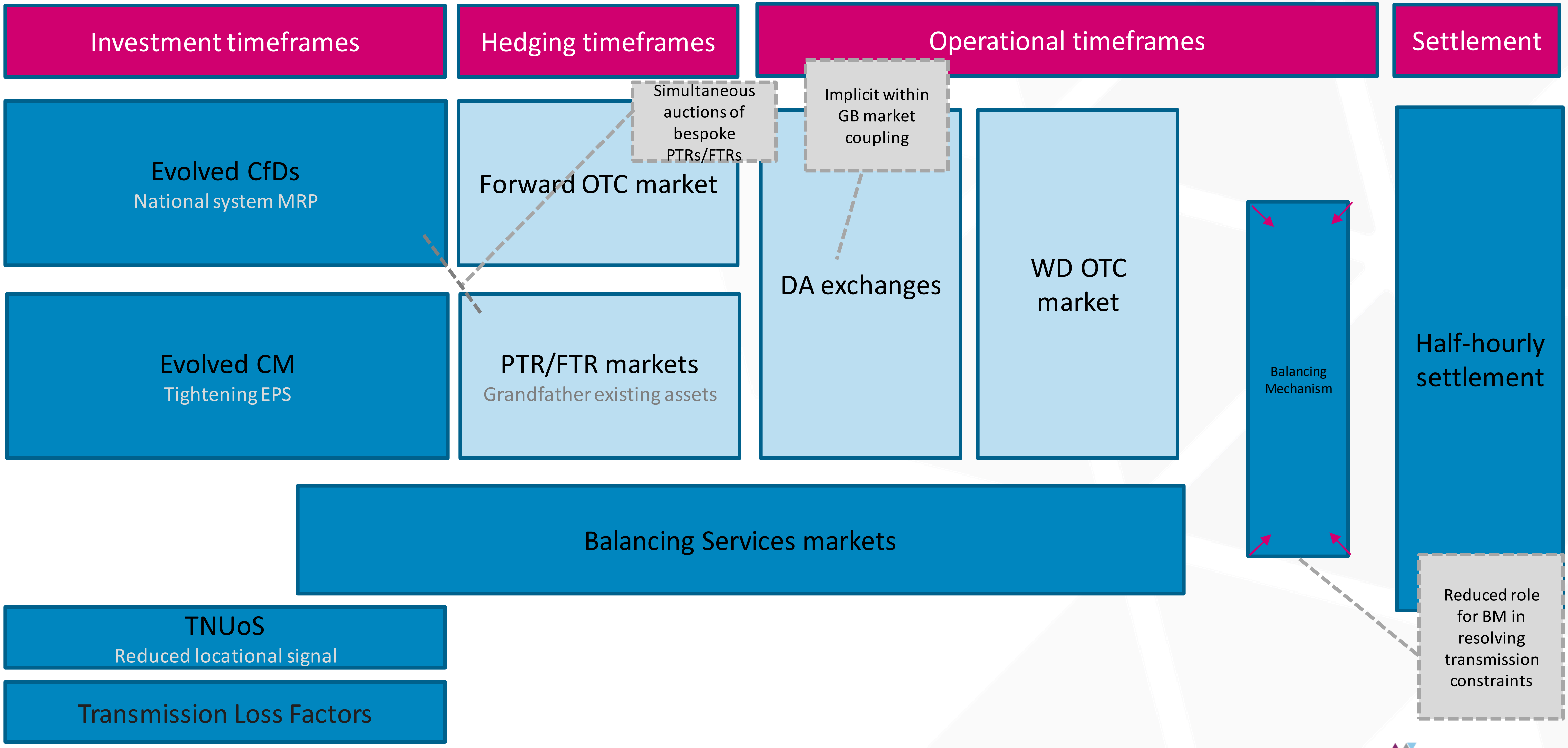
Zonal Pricing – Baseline

Wholesale market split into 10-12 zones; self-dispatch retained; evolution of CfD/CM for zonal pricing



Zonal Pricing – Build

Wholesale market split with centralised dispatch; Revenue Cap/Floor and optimised CM

Investment timeframes

Revenue Cap/Floor
National system MRP
Mix/max price
Bi-lateral option

Optimised CM
Minimum low carbon requirement
Flex scalars

TNUoS
Reduced locational signal

Transmission Loss Factors

Hedging timeframes

Forward OTC market
Financial

PTR/FTR markets
Grandfather existing assets

Operational timeframes

Co-optimised centralised dispatch

Day-ahead market

Real-time market
(Balancing)

Self commitment

Other residual Balancing Services procurement (e.g. pathfinders)

Settlement

5 min settlement

Central dispatch market creates (zonal) reference prices for CfDs and PTR/FTRs

Role of forward Balancing Services markets could become very limited

Generators have option to self-commit or self-schedule generation

Assessment of Zonal Pricing Packages

Baseline

- Scores significantly better than Status Quo across value for money, competition, full chain flexibility and whole system.
- This is mainly resulting from the reduction in re-dispatch and improvement in system operability.
- PTRs/FTRs counter the potential negative impacts of Zonal pricing on investor confidence and consumer fairness.
- Implementation is more of a challenge than the National Baseline package given the need for participants to be balance responsible in multiple locations, plus possible issues surrounding the need to re-zone.

Build

- The inclusion of Revenue Cap/Floor, Optimised CM and Central dispatch with Co-optimisation helps improve the outcomes relative to the Baseline package across most criteria.
- Assumed that zonal dimension is not required in Optimised CM, although this may be required if investors in new capacity do not have sufficient confidence in forward signals created by Zonal pricing.
- Implementation is more challenging that the Baseline given inclusion of Central dispatch.

Baseline

Criteria	*Existing CfD*	*Existing CM*	*Operability BAU+*	*FTR / PTR*	*Elective Participation*	*Zonal*	*Self*	*Package score*
Value for Money	○	○	◔	◔	○	◑	○	◑
Competition	○	○	◔	◔	○	◑	○	◑
Investor Confidence	○	○	◔	◔	◔	◑	○	○
Full chain flexibility	○	○	◑	○	○	◑	○	◑
Whole system	○	○	◔	○	◑	◑	○	◑
Adaptability	○	○	◔	○	◔	◔	○	◔
Consumer fairness	○	○	○	◑	◔	◔	○	○
Energy security and system operability	○	○	◔	○	○	◔	○	◔
Decarbonisation	○	○	◑	○	◔	◔	○	◔
Challenge to implement	○	○	○	◑	◑	◕	○	◑
Total	○	○	◑	◑	◔	◑	○	◑

Build

Criteria	*Revenue Cap/Floor*	*Co-optimisation*	*Carbon Intensity Reporting*	*CM + Enhanced Flex*	*Optimised CM - Minimum Carbon*	*FTR / PTR*	*Settlement Period Reform*	*Elective Participation*	*Zonal*	*Central*	*Package score*
Value for Money	◑	◔	○	◑	◔	◔	◔	○	◑	◔	◕
Competition	◔	◑	◔	◑	◔	◔	◔	○	◑	◑	◕
Investor Confidence	◔	◔	○	◔	○	◔	○	◔	◑	◔	◔
Full chain flexibility	◑	◑	○	◑	○	○	◑	○	◑	◑	◕
Whole system	◑	◔	◔	◔	◔	○	◔	◑	◑	◑	◑
Adaptability	◔	◔	○	◑	◑	○	◔	◔	◔	○	◑
Consumer fairness	○	◔	◔	○	○	◑	○	◔	◔	○	○
Energy security and system operability	○	○	○	◑	○	○	○	○	◔	○	◑
Decarbonisation	◔	◔	◔	◔	◑	○	○	◔	◔	◔	◕
Challenge to implement	◑	◕	◔	◔	◔	◑	◑	◑	◕	◑	◕
Total	◑	◑	◑	◑	◑	◑	◑	◔	◑	◕	◑

Nodal Pricing - Baseline

Nodal pricing with centralised dispatch; evolution of CfD/CM to accommodate nodal pricing

Investment timeframes

Evolved CfDs
National system MRP

Evolved CM
Tightening EPS

TNUoS
Remove locational signal

Transmission Loss Factors

Hedging timeframes

Forward OTC market
Financial

FTR markets
Grandfather existing assets

Operational timeframes

Simultaneous auctions of bespoke FTRs

Day-ahead market

Real-time market
(Balancing)

Co-optimised centralised dispatch

Self commitment

Virtuals trading

Other residual Balancing Services procurement (e.g. pathfinders)

Generators have option to self-commit or self-schedule generation

Role of forward Balancing Services markets could become very limited

Settlement

5 min settlement

Nodal Pricing – Build

Nodal pricing with centralised dispatch and scarcity price function; optimised CRO for nodal pricing

Investment timeframes

Revenue Cap/Floor
National system MRP
Mix/max price
Bi-lateral option

Centralised Reliability Option
Minimum low carbon requirement
Flex scalars
(Zonal)

Reverse Reliability Option
(Zonal)

TNUoS
Remove locational signal

Transmission Loss Factors

Hedging timeframes

Forward OTC market
Financial

FTR markets
Grandfather existing assets

Price capped at CRO strike price

Operational timeframes

Co-optimised centralised dispatch

Day-ahead market

Real-time market
(Balancing)

Scarcity price function

Scarcity price kicks in when market price hits price cap

Self commitment

Virtuals trading

Other residual Balancing Services procurement (e.g. pathfinders)

Central dispatch market creates (nodal) reference prices for CfDs, CROs, FTRs

Role of forward Balancing Services markets could become very limited

Generators have option to self-commit or self-schedule generation

Settlement

5 min settlement

Assessment of Nodal Pricing Packages

Baseline

- Scores significantly better than Status Quo across value for money, competition, full chain flexibility, whole system and decarbonisation.
- This is mainly resulting from the reduction in re-dispatch, Co-optimisation and improvement in system operability.
- It is assumed that FTRs effectively hedge and counter the price volatility impacts of Nodal pricing on investor confidence and consumer fairness.
- Deliverability is a challenge given the significant change for market participants as well as the system operator.

Build

- The inclusion of further options in this package such a Centralised and Reverse Reliability Options further strengthen scores.
- Scarcity Adder included in order to maintain strong locational dispatch signal whilst reducing possibility of exploiting market power.
- Strategic reserve strengthens energy security and provides physical back-up to financial Centralised Reliability Option.
- Implementation of Nodal pricing on critical path and hence inclusion of other options does not materially increase implementation challenge.

Baseline

Criteria	*Evolved CfD*	*Existing CM*	*Co-optimisation*	*FTR / PTR*	*Settlement Period Reform*	*Elective Participation*	*Nodal*	*Central*	*Package score*
Value for Money	○	○	◔	◔	◔	○	◕	◔	◕
Competition	◔	○	◑	◔	◔	○	◔	◑	◕
Investor Confidence	○	○	◔	◔	○	◔	◑	◔	○
Full chain flexibility	○	○	◑	○	◑	○	◕	◑	◕
Whole system	○	○	◔	○	◔	◑	◕	◑	◑
Adaptability	○	○	◔	○	◔	◔	◑	○	◑
Consumer fairness	○	○	◔	◑	○	◔	◔	○	○
Energy security and system operability	○	○	○	○	○	○	◔	○	◔
Decarbonisation	○	○	◔	○	○	◔	◑	◔	◑
Challenge to implement	○	○	◕	◑	◑	◑	●	◑	●
Total	◔	○	◑	◑	◑	◔	◕	◕	◑

Build

Criteria	*Revenue Cap/Floor*	*Elective Participation*	*CRO*	*Strategic Reserve*	*Co-optimisation*	*FTR / PTR*	*Settlement Period Reform*	*Scarcity Adder*	*RRO*	*CM + Enhanced Flex*	*Optimised CM - Minimum carbon*	*Elective Participation*	*Nodal*	*Central*	*Package score*
Value for Money	◑	○	◔	○	◔	◔	◔	◔	◑	◑	◔	○	◕	◔	●
Competition	◔	○	◔	◔	◑	◔	◔	◑	◑	◑	◔	○	◔	◑	●
Investor Confidence	◔	◔	◔	○	◔	◔	○	◔	◔	◔	○	◔	◑	◔	◔
Full chain flexibility	◑	○	○	○	◑	○	◑	◑	◑	◑	○	○	◕	◑	●
Whole system	◑	◑	◑	○	◔	○	◔	○	◔	◔	◔	◑	◕	◑	◕
Adaptability	◔	◔	◔	◔	◔	○	◔	◔	○	◑	◑	◔	◑	○	◕
Consumer fairness	○	◔	◔	○	◔	◑	○	○	○	○	○	◔	◔	○	◔
Energy security and system operability	○	○	◔	◑	○	○	○	◔	○	◑	○	○	◔	○	◕
Decarbonisation	◔	◔	○	○	◔	○	○	○	◑	◔	◑	◔	◑	◔	◕
Challenge to implement	◑	◑	◑	◔	◕	◑	◑	◔	◕	◔	◔	◑	●	◑	●
Total	◑	◔	◑	◔	◑	◑	◑	◑	◑	◑	◑	◔	◕	◕	◕

Full package scoring

		National Baseline	National Build	Zonal Baseline	Zonal Build	Nodal Baseline	Nodal Build	National Baseline	National Build	Zonal Baseline	Zonal Build	Nodal Baseline	Nodal Build
Value for Money	Reduce relative proportion of redispatch	◑	◑	◑	◕	●	●	◑	◕	◑	◕	◕	●
	Improve operational efficiency of interconnectors	◔	◔	◑	◑	◑	◑						
	Ensure appropriate risk allocation for generation and demand	◔	◔	◔	◔	◔	◑						
	Increase system flexibility	◑	◑	◕	◕	◕	●						
	Reduce inefficient inframarginal rent	○	◑	◔	◕	◑	●						
Competition	Align markets/avoid distortions	◔	◔	◑	◕	◕	◕	◔	◕	◑	◕	◕	●
	Better target system costs through market signals	◔	◔	◑	●	◕	◕						
	Promote greater inter-technology competition	◑	◑	◔	◕	◑	●						
	Promote greater market transparency	◔	◔	◕	◕	●	●						
	Reduce barriers to entry	◔	◔	◔	◔	○	◑						
	Reduce risk of gaming or exploitation of market power	○	◔	○	○	○	◔						
Investor confidence	Respect existing legal framework and rights	○	○	○	◑	◔	◑	◔	◑	○	◔	○	◔
	Provide assurance for debt holders	○	○	◔	◔	◔	◔						
	Provide suitable incentives for equity	◔	◑	◑	◕	◔	◔						
	Promote market liquidity	○	◔	◔	◑	◔	◑						
	Minimise ongoing regulatory risk	○	○	◑	◔	◔	○						
Full chain flexibility	Optimise investment in flexibility	◔	◑	◕	◕	◕	●	◔	◑	◑	◕	◕	●
	Optimise dispatch of flexibility	◔	◕	◕	●	●	●						
	Manage large and extended mismatches between supply and demand	◔	◑	◑	◑	◔	◕						
	Promote demand side participation	◔	◑	◑	◕	◕	●						
Whole system	Align investment incentives for cross-vector assets	○	◑	◔	◑	◑	◕	◔	◑	◑	◑	◑	◕
	Align dispatch incentives for cross-vector assets	◔	◑	◑	◕	◕	◕						
Adaptability	Facilitate new and evolving business models	◔	◑	◑	◑	◑	◕	◔	◑	◔	◑	◑	◕
	Reduce risk of lock-in or asset stranding	◔	◕	◔	◕	◑	◕						
	Adapt to changing technology trends	◔	◑	◑	◕	◑	◕						
Consumer fairness	Limit adverse distributional impacts for consumers	○	○	○	○	◔	◔	○	◔	○	○	○	◔
	Allow greater consumer choice	○	○	◔	◔	◑	◑						
	Facilitate fair allocation of costs, based on cost-reflectivity	○	◔	◔	◔	◑	◔						
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	◔	◑	◔	◑	◔	◑	◔	◑	◔	◑	◔	◕
	Ensure sufficient available energy and demand response to manage extended low renewable output	◔	◑	◔	◑	◔	◕						
	Ensure sufficient responsive capacity to maintain system operability	◔	◑	◔	◔	◔	◕						
	Manage external shocks and unintended consequences	○	◑	○	◑	◑	◑						
Decarbonisation	Increase probability of achieving decarbonisation objective	◔	◕	◔	◕	◑	◕	◔	◑	◔	◕	◑	◕
Challenge to implement	Minimise policy complexity/interdependencies	○	◔	◔	○	◔	◑	◔	◑	◑	◕	●	●
	Minimise market disruption	○	◑	◑	◕	◕	●						
	Reduce implementation cost	◔	◑	◑	◕	◕	●						
	Reduce risk of unproven solutions	○	◔	○	◑	◑	◕						
	Expedite implementation	◔	◑	◑	◕	●	●						
Total		◔	◑	◑	◑	◑	◕	◔	◑	◑	◑	◑	◕

Appendix

Criteria and Sub-criteria

Reviewing Assessment Criteria

Following BEIS' REMA consultation we reviewed and mapped criteria to ensure compatibility

REMA Assessment Criteria

- **Least cost**. Least cost to consumers and sub-groups of consumers, with ongoing incentives to keep costs low and drive innovation (through competition where appropriate). Markets should be open to all relevant participants.
- **Deliverability**. Changes to market design should be achievable within designated timeframes and seek to minimise disruption during the transition
- **Investor confidence**. Market design must drive the significant investment in low carbon technologies needed to deliver our objectives.
- **Whole-system flexibility**. Market design should incentivise market participants of all sizes (both supply and demand side) to act flexibly where it is efficient to do so. Market design should promote greater coordination across traditional energy system boundaries, including between electricity and other vectors like heat and hydrogen.
- **Adaptability**. Market design should be adaptive and responsive to change. It should help ensure delivery of our objectives in a wide range of scenarios and should be robust to uncertainty, for instance regarding commodity prices and technology costs.

REMA Vision

Future market arrangements will:

- Deliver a step change in the rate of deployment of low carbon technologies, and reduces our dependence on fossil fuelled generation
- Provide the right signals for flexibility across the system
- Facilitate consumers to take greater control of their electricity use by rewarding them through improved price signals, whilst ensuring fair outcomes
- Optimise assets operating at local, regional, and national levels
- Ensure that the security of the system can be maintained at all times

NG ESO Criteria

- Value for money
- Competition
- Challenge to implement
- Investor confidence
- Full chain flexibility
- Whole system
- Adaptability
- Consumer fairness
- Energy security
- Decarbonisation

Criteria mapping to Least Cost and Deliverability

Separate criterion but potential component of BEIS Least Cost

Component of BEIS Full Chain Flexibility

Link to REMA vision point of consumer control with fair outcomes

Additional REMA objective (i.e. trilemma) criteria included explicitly

Evaluation Criteria - 1

For Phase 4 it was decided that the criteria needed to be broken down into sub-criteria in order to give more transparency to the assessment, and expose trade offs more clearly

Value for Money is supported by increased efficiency of the market design and more effective utilisation of energy generation. Appropriate risk allocation may vary based on, for example, technology maturity.

Whilst competition, all else equal, is generally deemed a good thing for driving customer value, it was felt it was necessary to be more specific how different policy options could impact on different aspects of competition.

There are some factors which can support investor confidence across all investor types. Other design choices may infer a trade-off between investors with different risk appetites or expectations for investment duration.

Criteria	Sub-criteria
Value for money	Reduce relative proportion of redispatch
	Improve operational efficiency of interconnectors
	Ensure appropriate risk allocation between generation and demand
	Increase system flexibility
	Reduce inefficient inframarginal rent
Competition	Align markets/avoid distortions
	Better target system costs through market signals
	Promote greater inter-technology competition
	Promote greater market transparency
	Reduce barriers to entry
	Reduce risk of gaming or exploitation of market power
Challenge to implement	Minimise policy complexity/interdependencies
	Minimise market disruption
	Reduce implementation cost
	Reduce risk of unproven solutions
	Expedite implementation
Investor confidence	Respect existing legal framework and rights
	Provide assurance for debt holders
	Provide suitable incentives for equity
	Promote market liquidity
	Minimise ongoing regulatory risk

Evaluation Criteria - 2

The overall assessment for each criteria is based on the average across the sub-criteria; being able to see the underlying sub-criteria assessments helps in the justification in the overall criteria assessment

The distinction between incentives for investment and dispatch of technologies is relevant for several criteria. Additionally, for flexibility, the duration over which flexibility can help to balance supply and demand is crucial.

In establishing a new long-term market design, adaptability to new technologies may be assumed the primary concern, but ability to accommodate new and evolving business models is also key.

The consumer fairness assessment is split into considerations of consumer choice as well as distributional impacts for things like regional price variation.

For Phase 4 – previous *Security of supply* criteria in previous phases has been changed to *Energy security and system operability*.

Criteria	Sub-criteria
Full chain flexibility	Optimise investment in flexibility
	Optimise dispatch of flexibility
	Manage large and extended mismatches between supply and demand
	Promote demand side participation
Whole system	Align investment incentives for cross-vector assets
	Align dispatch incentives for cross-vector assets
Adaptability	Facilitate new and evolving business models
	Reduce risk of lock-in or asset stranding
	Adapt to changing technology trends
Consumer fairness	Limit adverse distributional impacts for consumers
	Allow greater consumer choice
	Ensure fair allocation of costs, based on cost-reflectivity
Energy security and system operability	Ensure sufficient capacity to meet peak system needs
	Ensure sufficient available energy and demand response to manage extended low renewable output
	Ensure sufficient responsive capacity to maintain system operability
	Manage external shocks and unintended consequences
Decarbonisation	Increase probability of achieving decarbonisation objective

A set of Options

A set of options considered

We have considered a range of options – those included in the REMA consultation (light blue), and additional options developed with NGESO (pink)

Pricing System	National	Zonal	Nodal		
Dispatch	Centralised	Self			
Mass Low Carbon	Existing CfD	Evolved CfD	CfD with Price Cap and Floor	CfD with Revenue Cap and Floor	Deemed Output CfD
	Elective participation	Supplier Obligation			
Capacity Adequacy	Existing Capacity Market	Evolved Capacity Market	Optimised Capacity Market - Zonal	Optimised Capacity Market – Minimum Low Carbon Requirement	Capacity Market + Enhanced Flexibility
	Centralised Reliability Option	Decentralised Reliability Option	Reverse Reliability Option	Supplier Obligation	Strategic Reserve
Operability	BAU	BAU+	Co-optimisation	Local Markets	
Additional Options	Physical Transmission Rights / Financial Transmission Rights	Scarcity Adder	Network Access and Charging Reform	Settlement Period Reform	Carbon Intensity Reporting
	Split Market				

We have focused on options that are plausible and realistic considerations for the GB system. While some options are well established in other systems, others are more novel or less tested. There is uncertainty around all options in how they might be devised and applied in GB context in combination with other market design elements.

To support consideration and assessment of options, in some cases we have had to make choices and define aspects of them in more detail. We have intended to define options in a manner which best supports their potential role in a future market or system design.

For several options which are more novel or complex we have provided more detailed exposition or worked examples.

A set of options considered – (1)

Reforms to wholesale pricing granularity, dispatch and operability arrangements are key areas to improve the efficiency of operating a decarbonising power system

Pricing System	The Pricing System considers the considers the locational granularity of the wholesale price
National	The current market design. Parties are balance responsible at a national level and hence all electricity is traded based at a single national price, with the costs of operating the system, including managing transmission constraints, socialised via use of system charges.
Zonal	In a zonal (or regional) wholesale market, the transmission system is divided into several zones and parties would be balance responsible at the zonal level. Hence, markets trade based on zonal pricing, with capacity on the transmission system between zones most likely allocated on an implicit basis based on day-ahead market clearing.
Nodal	System divided into many "nodes" e.g. at GSP, with individual prices which reflect the full cost of supplying an incremental unit of consumption at each node. Every transmission system injection point, offtake and transmission line intersections at transmission substations, are typically defined as nodes. Parties' positions settled based on nodal prices.

Dispatch	The extent to which market participants self-dispatch versus the system operator assuming responsibility for scheduling, committing and dispatching units.
Centralised	A central clearing algorithm, administered by the system operator is used to dispatch units to minimise system costs subject to security needs. May also include centralised unit commitment.
Self	The current market design. Market participants self-schedule by submitting intended position, capacity available and bids/offers to the market. The system operator utilises the Balancing Mechanism and pre-contracted Balancing Services to redispatch the system to ensure real-time balance, and that transmission constraints resolved.

Operability	Ensuring operability through the procurement of balancing services is crucial for the efficient and safe functioning of the electricity system. The system operator considers operability challenges in the five key areas of Frequency, Stability, Voltage, Thermal and Restoration.
BAU	Retain and implement policies already in place to help ensure that balancing services meet the challenges posed by the transition to a decarbonised electricity system. This includes implementing a single day-ahead market for response and reserve, facilitating greater participation of renewables and pursuing a more active role for DNOs.
BAU+	In addition to BAU, giving the system operator the ability (or an obligation) to prioritise zero/low carbon procurement or give carbon reductions equal weighting to cost effectiveness in procurement principles, allowing it greater flexibility to accelerate decarbonisation.
Co-optimisation	Scheduling of energy, reserve (and in some markets additionally other ancillary services) are undertaken within the same process, so that the two markets are 'co-optimised'. The co-optimisation process automatically determines whether the asset provides energy and/or ancillary services, based on what would provide most system value.
Local Markets	Various alternative models to increase access to system services from distribution connected assets, including coordinating/integrating distribution market platforms.

A set of options considered – (2)

A number of potential reforms to the current Contracts for Difference approach for promoting investment in mass low carbon power are being considered

Mass Low Carbon	Options for supporting the investment in largely non-dispatchable low carbon technologies needed to produce the majority of low carbon electricity. Meeting 2035 commitment to decarbonise the electricity sector means delivering significant investment in new low carbon electricity capacity.
Existing CfD	The existing CfD scheme provides certainty to investors in low carbon projects, by guaranteeing a pre-determined 'strike price' for every MWh generated. If the reference market price is below this, they receive a top-up. If it is above, they must pay back into the scheme. In each round the strike price is set through a competitive auction and contracts are awarded for 15 years. Under latest rules, generators will not receive payments under a CfD when the reference price is negative.
Evolved CfD	Under a zonal or nodal pricing system, the 'Evolved CfD' is an option where the top-up payment is calculated by the difference between the 'strike price' and the national system Market Reference Price – the average price across the system rather than the price at a specific zone or node which a generator receives. This maintains a locational signal through the CfD and provides an incentive for generators to locate in higher value locations. For national pricing may entail differentiation of allocation rounds by location.
CfD with Price Cap and Floor	Instead of a single strike price, generators are guaranteed a maximum and minimum price per MWh output, with market exposure within that range.
Revenue Cap and Floor	Under this option, which follows the precedent of the interconnector cap and floor, generators would be guaranteed a minimum revenue in each period. They would compete in the full range of markets (capacity, wholesale, balancing, ancillary services), and if they do not meet their minimum revenue, then they would be topped up at the end of the period. If their revenue was above the cap, a proportion of the excess would be paid back. There would be no transfer if their revenue was between the floor and the cap.
Deemed Output CfD	Generators are paid based on their potential to generate in a particular period, rather than their actual generation output. Generators would not have to export energy to receive their CfD top-up payment, as they do currently. This removes dispatch distortions by incentivising generators to sell their output in the highest value market.
Elective Participation	This option allows certain customers (e.g. large I&C customers) to opt-out of the levy payments under the centralised CfD mechanism and source low carbon power independently, or bid their demand for low carbon power into the auctions and enter directly into a bilateral agreement with a generator.
Supplier Obligation	An obligation on electricity suppliers to procure low carbon electricity directly on behalf of their consumers. The government would set a trajectory of maximum carbon intensity of electricity that electricity suppliers can sell to their customers, aligned with decarbonisation targets, and suppliers would contract either directly with generators, or through an intermediary.

A set of options considered – (3)

Evolutions or alternatives to the existing Capacity Market are under consideration to ensure system security in a system with a much higher proportion of intermittent renewables

Capacity Adequacy	Market arrangements to ensure there is sufficient available capacity to meet peak demand and available energy across an extended period of low renewables output.
Existing Capacity Market	Assets participate in auctions for capacity agreements of differing lengths to be available during periods of system stress when called upon by the system operator. The capacity requirement is determined by the EMR Delivery Body. Auctions are settled on a pay as clear basis at a price per unit of capacity. Asset capacity is "de-rated" according to expectations about the technologies' availability at times of system stress.
Evolved Capacity Market	Evolution of the existing Capacity Market design to incentivise capacity which has more value to the system, for example using locational de-rating factors to send a locational signal not to site new generation behind transmission constraints, or including scalars on clearing price to reward more flexible capacity.
Optimised Capacity Market - Zonal	Creating a zonal version of the Capacity Market by including major transmission boundaries and ensuring that the capacity adequacy requirement could be met in each zone. This would create multiple zonal clearing prices from the auction algorithm.
Optimised Capacity Market – Minimum Low Carbon Requirement	A single auction, as at present, but with a minimum requirement for low carbon capacity (that increases over time). This would create two separate clearing prices in the auction, one for low carbon and one for other technologies.
Capacity Market + Enhanced Flexibility	A single auction, as at present, but with minimum volumes requirements for more responsive technologies creating multiple clearing prices with more flexible technologies receiving a higher price.
Centralised Reliability Option	A financial alternative to the Capacity Market. The mechanism is based on the concept of a 'call option contract', which gives the buyer of the contract the right to buy a commodity at a predefined strike price. The delivery body determines the amount of reliability options (capacity) to be procured and pays a reliability premium, determined through the auction process. The strike price is set based on an expectation of marginal costs of peaking generator. When the reference price exceeds the strike price the Reliability Option holder must pay the difference to the delivery body.
Decentralised Reliability Option	The DRO model works similarly to CRO above, however, the role of the Transmission System Operator is stripped out, and suppliers are required to secure reliability options to meet their peak demand by contracting directly with capacity providers. If they fail to procure enough capacity to ensure security of supply, or a generator overestimates its performance during a certain period, penalties apply.
Reverse Reliability Option	The Reverse Reliability Option model is a mirror of the CRO. The mechanism is based on the concept of a 'put option contract', which gives the buyer of the contract the right to sell a commodity at a predefined price. Its objective would be to create more revenue certainty for demand turn up including long duration storage. The holder of the RRO would need to pay back the delivery body the difference between very low prices and the strike price in return for the option fee.
Supplier Obligation	An obligation on electricity suppliers to demonstrate that they have secured sufficient electricity in advance to meet a reliability standard on behalf of their customers.
Strategic Reserve	Procurement of a certain volume of back-up capacity that is only used if the market has failed to meet demand. Successful providers receive a payment for being available and a separate activation payment. So as not to distort market incentives, strategic reserve would likely be priced at the value of lost load (VoLL)

A set of options considered – (4)

There are a number of additional policy options that we have included in our assessment

Additional Options	A range of other policy options that are being considered alongside the options outlined in the REMA consultation
Physical Transmission Rights / Financial Transmission Rights	Financial Transmission Rights are instruments that allow market participants to hedge their exposure to locational price by giving the holder the right to receive the price difference between two nodes or zones. Physical Transmission Rights offer the holder the right to sell and dispatch their electricity across zones and receive the relevant zonal prices.
Scarcity Adder	Under the Scarcity Adder, the wholesale market is capped at a level reflective of the cost of the marginal generator but with an administered price premium added on which may vary according to a measure of system tightness. This maintains a strong dispatch signal, but at the same time avoids the risk of exploitation of market power, which is a potential concern, particularly under a nodal pricing approach
Network Access and Charging Reform	Changes to Network Access and Charging to provide stronger short term locational signals through a combination of differentiated access rights and more system responsive pricing (down to zonal level).
Settlement Period Reform	While electricity is produced and consumed continuously, the market is divided into discrete windows known as 'settlement periods', to facilitate its functioning. In GB the settlement period is 30 minutes; there are 48 settlement periods per day. Shortening the settlement period would allow prices to be more reflective of actual market conditions, incentivising generation and demand to respond to the state of the system more frequently.
Carbon Intensity Reporting	A Carbon Intensity Reporting obligation could aid transparency and underpin other policy options such as low carbon supplier obligations.
Split Market	This option would entail separate markets for variable and firm power. Prices in the variable, 'as available' market would be set on the basis of the long-run marginal cost of renewables through auctions. Prices in the firm, 'on demand' market would continue to be set by short-run marginal cost. The main objective of this approach is to decouple revenues for low carbon generators from prices set up marginal gas-fired plant.

Counterfactual

For most options the counterfactual is the Status Quo market design, but for those options which are ‘built’ on others the counterfactual is the relevant related policy option to show the incremental cost/benefit

Pricing System	National	Zonal	Nodal		
Dispatch	Centralised	Self			
Mass Low Carbon	Existing CfD	Evolved CfD	CfD with Price Cap and Floor	CfD with Revenue Cap and Floor	Deemed Output CfD
	Elective Participation	Supplier Obligation			
Capacity Adequacy	Existing Capacity Market	Evolved Capacity Market	Optimised Capacity Market - Zonal	Optimised Capacity Market – Minimum Low Carbon Requirement	Capacity Market + Enhanced Flexibility
	Centralised Reliability Option	Decentralised Reliability Option	Reverse Reliability Option	Supplier Obligation	Strategic Reserve
Operability	BAU	BAU+	Co-optimisation	Local Markets	
Additional Options	Physical Transmission Rights / Financial Transmission Rights	Scarcity Adder	Network Access and Charging Reform	Settlement Period Reform	Carbon Intensity Reporting
	Split Market				

Counterfactual for analysis is range of the low carbon power options, all are adaptable to elective model, not only existing CfD

Counterfactual for analysis is range of CM options, all are adaptable to CRO and DRO. RRO counterfactual is CRO

Counterfactual for analysis is the zonal/nodal system without PTR/FTRs

We have scored individual options against a counterfactual of the status quo market design:

Status Quo counterfactual

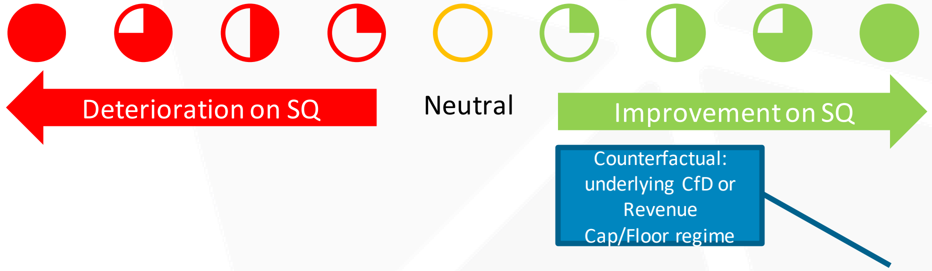
For a small number of more specific options, the chosen counterfactual differs:

Alternative counterfactual specified in pink boxes

Option Assessment

Mass Low Carbon Power

Key conclusions



Greater exposure to market prices/system conditions should improve the flexibility of the system and deliver greater value for money

- Generators should have greater incentive to self-curtail reducing the need to re-dispatch, and it would reduce distortions in the BM and Balancing Services markets.
- This could be achieved through the Revenue Cap/Floor, CfD + Price Cap/Floor, Deemed CfD and Supplier Obligation.

Increase in revenue risk need not necessarily lead to lower investor confidence

- Floors in the Revenue Cap/Floor and CfD + Price Cap/Floor would continue to provide a good degree of assurance to debt; whereas there would also be greater upside for equity.
- An increase in forward liquidity could also be beneficial for investor confidence.

Revenue Cap/Floor or CfD + Price Cap/Floor are preferred

- The assessment is close but these two options score slightly better than Deemed CfD given this is less adaptable and relies on benchmarking rather than true market alignment, which may be problematic when the system is largely decarbonised. Revenue Cap/Floor could address distortions more effectively than the CfD + Price Cap/Floor.
- The Supplier Obligation scores well but there are significant questions about implementation, and concerns about the financial capacity of suppliers in the current climate, and the challenge to coordinate investment in new infrastructure.

The Elective Participation option should be considered in addition

- This scores positively in terms of investor confidence, whole system and adaptability by allowing customers who can, to source their own low carbon power, either independently or by bidding into centralised auctions (either for CfDs or their replacements).
- Given that a lot of large corporates are ambitious this could accelerate decarbonisation; the current exposure to CfD settlement is actually a disincentive to procure forward. Elective participation could also be combined with the Revenue Cap/Floor option.

Criteria	Existing CfD	Evolved CfD	CfD + Price Cap/Floor	Revenue Cap/Floor	Deemed CfD	Elective Participation	Supplier Obligation
Value for Money	○	○	◔	◑	◔	○	◔
Competition	○	◔	◔	◔	◔	○	◔
Investor Confidence	○	○	◔	◔	○	◔	◔
Full chain flexibility	○	○	◔	◑	◑	○	◑
Whole system	○	○	◑	◑	◑	◑	◕
Adaptability	○	○	◔	◔	○	◔	◕
Consumer fairness	○	○	○	○	○	◔	◑
Energy security and system operability	○	○	○	○	○	○	○
Decarbonisation	○	○	◔	◔	◔	◔	◑
Challenge to implement	○	○	◔	◑	◑	◑	◕
Total	○	◔	◑	◑	◔	◔	◑

Option design open questions

- The Deemed CfD cannot be fully discounted given the closeness of the scoring, but further details are required to understand how it would operate particularly with a large proportion of generation being settled based on deemed output rather than actual output in a fully decarbonised market.
- For the CfD + Price Cap/Floor and Revenue Cap/Floor consideration needs to be given whether it should include sharing factors outside the caps and floors in order to maintain incentives to continue to engage in the market.
- For customers 'opting out' under the Elective Participation option, additional monitoring would be required to ensure their carbon intensity reductions were at least tracking, with sufficient granularity, the national average. A possible variant of this option, rather than it being voluntary, would be to concentrate the existing centralised mass low carbon regime only on residential and small business customers, with all larger customers operating under a supplier obligation with the option of bidding into the centralised auctions for bilateral agreements.

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Mass Low Carbon Power

Sub-criteria assessment

Counterfactual: underlying CfD or Revenue Cap/Floor regime

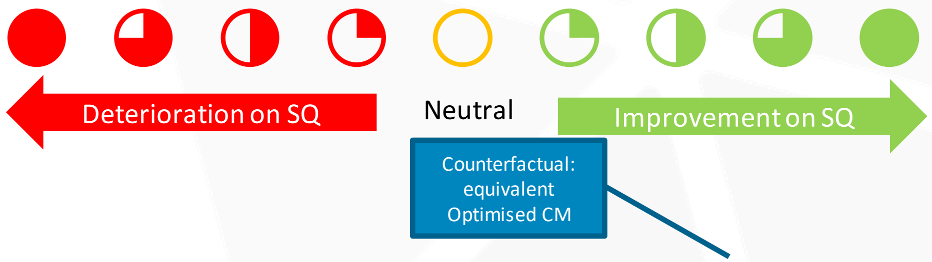
−● −◕ −◑ −◔ ○ +◔ +◑ +◕ +●

Deterioration on SQ | Neutral | Improvement on SQ

Criteria	Sub-criteria	Existing CfD	Evolved CfD	CfD + Price Cap/Floor	Revenue Cap/Floor	Deemed CfD	Elective Participation	Supplier Obligation
Value for Money	Reduce relative proportion of redispatch	○	+◔	+◔	+◑	+◔	○	+◑
	Improve operational efficiency of interconnectors	○	+◔	+◔	+◔	+◔	○	+◔
	Ensure appropriate risk allocation for generation and demand	○	○	+◔	+◑	○	+◔	+◑
	Increase system flexibility	○	○	+◑	+◕	+◕	○	+◕
	Reduce inefficient inframarginal rent	○	○	○	○	○	○	−◑
Competition	Align markets/avoid distortions	○	+◔	+◑	+◕	+◕	+◑	+●
	Better target system costs through market signals	○	+◔	+◕	+◕	+●	○	+●
	Promote greater inter-technology competition	○	+◔	+◑	+◑	+◔	+◑	+●
	Promote greater market transparency	○	○	○	−◔	○	−◔	−◑
	Reduce barriers to entry	○	○	−◔	−◔	○	−◔	−◑
	Reduce risk of gaming or exploitation of market power	○	○	○	−◔	−◑	○	○
Investor confidence	Respect existing legal framework and rights	○	○	○	○	○	○	○
	Provide assurance for debt holders	○	○	−◔	−◔	+◔	○	−◕
	Provide suitable incentives for equity	○	○	+◑	+◑	○	+◔	+◕
	Promote market liquidity	○	○	+◑	+◑	○	+◑	+◕
	Minimise ongoing regulatory risk	○	○	○	○	−◔	+◔	○
Full chain flexibility	Optimise investment in flexibility	○	○	+◔	+◔	+◔	○	+◔
	Optimise dispatch of flexibility	○	○	+◑	+◕	+◕	+◔	+●
	Manage large and extended mismatches between supply and demand	○	○	+◔	+◑	+◑	○	+◑
	Promote demand side participation	○	○	○	○	○	○	+◔
Whole system	Align investment incentives for cross-vector assets	○	○	+◔	+◔	+◔	+◔	+◕
	Align dispatch incentives for cross-vector assets	○	○	+◑	+◑	+◑	+◑	+◕
Adaptability	Facilitate new and evolving business models	○	○	○	○	○	+◔	+●
	Reduce risk of lock-in or asset stranding	○	○	+◔	+◔	○	+◑	+◑
	Adapt to changing technology trends	○	○	+◔	+◔	○	+◔	+●
Consumer fairness	Limit adverse distributional impacts for consumers	○	○	○	○	○	○	−◔
	Allow greater consumer choice	○	○	○	○	○	+◑	+●
	Facilitate fair allocation of costs, based on cost-reflectivity	○	+◔	+◑	+◑	+◔	○	+◑
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	○	○	○	○	○	○
	Ensure sufficient available energy and demand response to manage extended low renewable output	○	○	○	○	○	○	○
	Ensure sufficient responsive capacity to maintain system operability	○	○	+◔	+◔	+◔	○	+◔
	Manage external shocks and unintended consequences	○	○	○	○	○	○	○
Decarbonisation	Increase probability of achieving decarbonisation objective	○	○	+◔	+◔	+◔	+◔	+◑
Challenge to implement	Minimise policy complexity/interdependencies	○	○	○	○	−◔	−◔	−◑
	Minimise market disruption	○	○	−◔	−◑	−◑	−◑	−◕
	Reduce implementation cost	○	○	−◔	−◑	−◑	−◑	−◕
	Reduce risk of unproven solutions	○	○	○	−◔	−◑	−◔	○
	Expedite implementation	○	○	○	−◑	−◑	−◑	−◕

Capacity Adequacy

Key conclusions



Criteria	Existing CM	Evolved CM	Optimised CM - Zonal	CM - Minimum Carbon	CM + Enhanced Flex	CRO	DRO	RRO	Supplier Obligation_CA	Strategic Reserve
Value for Money	○	◔	◔	◔	◑	◔	○	◑	◔	○
Competition	○	○	○	◔	◑	◔	◔	◑	◔	◔
Investor Confidence	○	○	○	○	◔	◔	◔	◔	○	○
Full chain flexibility	○	○	○	○	◑	○	○	◑	○	○
Whole system	○	○	○	◔	◔	◑	◑	◔	◔	○
Adaptability	○	◔	◔	◑	◑	◔	◑	○	◑	◔
Consumer fairness	○	○	○	○	○	◔	◔	○	◔	○
Energy security and system operability	○	◔	◔	○	◑	◔	○	○	◔	◑
Decarbonisation	○	○	○	◑	◔	○	○	◑	○	○
Challenge to implement	○	○	◔	◔	◔	◑	◕	◕	◑	◔
Total	○	◔	◔	◑	◑	◑	◔	◑	◑	◔

Centralised Reliability Options would be preferred solution but there are deliverability challenges

- Centralised Reliability Options score well on value for money, competition and full chain flexibility, since as a financial overlay on the markets they are less distortive than CM if implemented effectively.
- CRO could be decentralised over time, although the prospect for improved outcomes under a Decentralised Reliability Option appear limited.

A Reverse Reliability Option should be considered as one option to support investment in long duration storage

- This option scores well in terms of value for money and decarbonisation since the challenge of excess generation will be as great as insufficient generation in a decarbonised power system.

The Capacity Market should be reformed to better optimise investment

- Incentivising low carbon in the CM would help to accelerate decarbonisation of peaking and flexible capacity.
- Rewarding flexibility in the CM could deliver greater value for money by reducing costs of Balancing Services.
- The case for a zonal signal in the CM hinges on the effectiveness of other locational signals, either locational wholesale prices (zonal or nodal) or stronger signalling through access and charging.

Supplier Obligation is not demonstrably better than Optimised CM and would be disruptive to implement

Strategic Reserve could be considered as an extra insurance policy

- It may be most applicable as a physical backup to a financial approach such as Centralised Reliability Options, helping to manage exit of capacity.
- It could also reduce the cost of the Capacity Market by socialising the cost of the absolute peaking capacity rather than setting a high clearing price with potential for large inframarginal gains.

Option design open questions

- The different dimensions of an Optimised CM (zonal, low carbon, flexibility) could be implemented using minimum requirements within a single algorithm producing multiple clearing prices. The dimensions would compound which creates additional complexity and risks illiquidity (market power exploitation) – using scalar or de-rating factors for some dimensions would address this problem (but would produce less accurate market signals).
- It is assumed that how these different dimensions are treated would apply equally under Centralised Reliability Options.
- The additional value of including the flexibility dimension in the CM will depend on the future design of Balancing Services markets; pathways that eventually lead to the full integration of capacity and Balancing Services markets could be considered.
- With future expectation of significant increase in demand side response, there is an open question how this participates in a capacity market – either bidding in directly (requiring baselining) or assumed to respond to (sharpened) market signals and excluded from the volume requirement. There are similar questions for interconnector capacity.

Capacity Adequacy

Sub-criteria assessment

Counterfactual: equivalent Optimised CM

−● −◕ −◑ −◔ ○ +◔ +◑ +◕ +●

Deterioration on SQ | Neutral | Improvement on SQ

Criteria	Sub-criteria	Existing CM	Evolved CM	Optimised CM - Zonal	Optimised CM - Minimum Carbon	CM + Enhanced Flex	CRO	DRO	RRO	Supplier Obligation_CA	Strategic Reserve
Value for Money	Reduce relative proportion of redispatch	○	+◔	+◔	○	+◔	○	○	+◔	○	○
	Improve operational efficiency of interconnectors	○	+◔	+◔	○	+◔	○	○	○	○	○
	Ensure appropriate risk allocation for generation and demand	○	○	○	○	○	+◔	+◔	+◔	+◔	○
	Increase system flexibility	○	○	○	○	+◕	○	○	+◕	+◔	○
	Reduce inefficient inframarginal rent	○	+◔	+◑	+◑	+◑	+◑	+◑	+◑	○	+◔
Competition	Align markets/avoid distortions	○	○	○	○	○	+◑	+◕	+◑	+◑	−◔
	Better target system costs through market signals	○	○	+◔	○	+◑	○	+◔	○	+◑	○
	Promote greater inter-technology competition	○	○	○	+◑	+◑	+◔	+◑	+◑	+◑	○
	Promote greater market transparency	○	○	○	○	+◑	+◑	+◔	+◑	+◔	−◔
	Reduce barriers to entry	○	○	○	+◕	+◕	+◔	−◔	+◕	−◔	○
	Reduce risk of gaming or exploitation of market power	○	○	−◔	○	○	+◔	○	+◔	○	−◑
Investor confidence	Respect existing legal framework and rights	○	○	○	○	○	○	−◔	○	○	○
	Provide assurance for debt holders	○	○	○	○	+◔	○	−◔	+◑	−◑	○
	Provide suitable incentives for equity	○	○	○	+◔	+◑	○	○	○	+◑	○
	Promote market liquidity	○	○	○	○	+◔	+◑	+◑	+◑	+◔	○
	Minimise ongoing regulatory risk	○	○	−◔	○	○	−◔	−◑	−◔	−◔	○
Full chain flexibility	Optimise investment in flexibility	○	○	○	○	+◕	+◔	+◔	+◑	○	○
	Optimise dispatch of flexibility	○	○	○	○	+◑	+◔	+◔	+◔	−◔	○
	Manage large and extended mismatches between supply and demand	○	○	○	○	+◑	+◑	+◑	+◑	−◔	+◔
	Promote demand side participation	○	○	○	○	+◑	+◑	+◑	+◑	+◔	○
Whole system	Align investment incentives for cross-vector assets	○	○	○	+◔	+◔	+◔	+◔	+◔	+◔	○
	Align dispatch incentives for cross-vector assets	○	○	○	○	○	+◔	+◔	+◔	+◔	○
Adaptability	Facilitate new and evolving business models	○	○	○	+◔	+◑	+◔	+◑	+◑	+◑	○
	Reduce risk of lock-in or asset stranding	○	+◔	+◑	+◑	+◔	○	○	−◔	+◔	+◔
	Adapt to changing technology trends	○	+◔	○	+◑	+◑	+◔	+◑	○	+◑	+◔
Consumer fairness	Limit adverse distributional impacts for consumers	○	○	○	○	○	○	−◔	○	○	○
	Allow greater consumer choice	○	○	○	○	○	+◔	+◑	○	+◔	○
	Facilitate fair allocation of costs, based on cost-reflectivity	○	○	○	○	○	+◔	+◔	+◔	+◑	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	+◔	+◑	○	+◔	○	−◔	○	−◔	+◑
	Ensure sufficient available energy and demand response to manage extended low renewable output	○	+◔	+◔	○	+◕	+◑	+◔	○	+◑	+◔
	Ensure sufficient responsive capacity to maintain system operability	○	+◔	+◔	○	+◑	○	○	+◔	+◔	+◔
	Manage external shocks and unintended consequences	○	○	○	○	+◔	○	○	○	+◑	+◕
Decarbonisation	Increase probability of achieving decarbonisation objective	○	○	○	+◑	+◔	○	○	+◑	○	○
Challenge to implement	Minimise policy complexity/interdependencies	○	○	○	○	○	+◔	+◔	−◑	+◑	−◔
	Minimise market disruption	○	○	−◔	−◔	−◔	−◑	−◕	−◔	○	○
	Reduce implementation cost	○	○	−◔	−◔	−◔	−◑	−◑	−◑	−◑	−◔
	Reduce risk of unproven solutions	○	○	○	−◔	−◔	−◔	−◑	−◕	○	○
	Expedite implementation	○	○	−◔	−◔	−◔	−◑	−◑	−◕	−◑	○

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Operability

Key conclusions

Deterioration on SQ | Neutral | Improvement on SQ

Stronger incentives for low carbon could be included in Balancing Services design

- Incentives for low carbon flexibility provision could be strengthened by explicit procurement of zero carbon services or including a tightening Emissions Performance Standard for providers.

Co-optimisation of energy and Balancing Services should lead to more efficient operation and help promote decarbonisation

- Providers of Balancing Services are already stacking multiple revenue streams.
- Co-optimisation would make this easier, provide greater transparency and ultimately improve investor confidence and provide greater value for money.
- It could also help reduce barriers to entry for new technologies and business models, helping to support more rapid decarbonisation.

Developing Local Markets will be essential for accessing flexibility from Distributed Energy Resources

- Local Markets can help the coordination and optimisation of flexible assets connected to the distribution networks.
- This will provide benefits across a wide range of criteria; the challenge is one of deliverability given it will require quite fundamental changes to the way that distribution networks are operated.
- Local Markets also require efficient coordination between transmission and distribution systems at different levels of readiness.
- Local Markets are not currently scored due to the range and uncertainty of potential option designs.

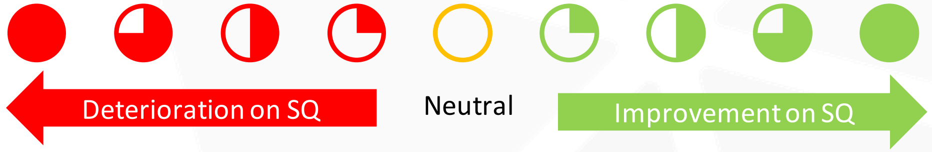
Criteria	BAU	Operability BAU+	Co-optimisation	Local Markets
Value for Money	○	◔	◔	◔
Competition	○	◔	◑	◑
Investor confidence	○	◔	◔	◔
Full chain flexibility	○	◑	◑	◕
Whole system	○	◔	◔	◔
Adaptability	○	◔	◔	◔
Consumer fairness	○	○	◔	◔
Energy security and system operability	○	◔	○	◔
Decarbonisation	○	◑	◔	◑
Challenge to implement	○	○	◕	◕
Total	○	◑	◑	◕

Option design open questions

- The ongoing evolution of Balancing Services will need to be considered in conjunction with any changes to the Capacity Market that optimises for location, low carbon or flexibility.
- The scope for Co-optimisation will depend on wider changes to the wholesale market, for example to introduce Centralised dispatch.
- The are a number of ways that Local Markets could be implemented that vary the primacy of the ESO or local market operator (DSO or third party) for DER dispatch, and the extent of contemporaneous co-optimisation versus sequencing, or hybrid approaches based on greater co-ordination.

Operability

Sub-criteria assessment



Criteria	Sub-criteria	BAU	Operability BAU+	Co-optimisation	Local Markets
Value for Money	Reduce relative proportion of redispatch	○	○	◑	◑
	Improve operational efficiency of interconnectors	○	○	○	◔
	Ensure appropriate risk allocation for generation and demand	○	○	○	○
	Increase system flexibility	○	◑	◑	◕
	Reduce inefficient inframarginal rent	○	○	○	○
Competition	Align markets/avoid distortions	○	◔	◑	◑
	Better target system costs through market signals	○	◔	◑	◕
	Promote greater inter-technology competition	○	◑	◔	◑
	Promote greater market transparency	○	◑	◕	◑
	Reduce barriers to entry	○	◔	◑	◑
	Reduce risk of gaming or exploitation of market power	○	○	◔	○
Investor confidence	Respect existing legal framework and rights	○	○	○	○
	Provide assurance for debt holders	○	◔	○	○
	Provide suitable incentives for equity	○	◑	◔	◑
	Promote market liquidity	○	○	◑	◕
	Minimise ongoing regulatory risk	○	○	○	◔
Full chain flexibility	Optimise investment in flexibility	○	◑	◑	◑
	Optimise dispatch of flexibility	○	◑	◕	●
	Manage large and extended mismatches between supply and demand	○	◔	○	◔
	Promote demand side participation	○	◑	◔	●
Whole system	Align investment incentives for cross-vector assets	○	○	○	○
	Align dispatch incentives for cross-vector assets	○	◔	◔	◑
Adaptability	Facilitate new and evolving business models	○	◑	◔	◑
	Reduce risk of lock-in or asset stranding	○	◔	◔	○
	Adapt to changing technology trends	○	◔	◔	◑
Consumer fairness	Limit adverse distributional impacts for consumers	○	○	○	○
	Allow greater consumer choice	○	○	◔	◔
	Facilitate fair allocation of costs, based on cost-reflectivity	○	○	○	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	◔	○	◑
	Ensure sufficient available energy and demand response to manage extended low renewable output	○	◔	○	○
	Ensure sufficient responsive capacity to maintain system operability	○	◑	◑	◑
	Manage external shocks and unintended consequences	○	◔	◔	○
Decarbonisation	Increase probability of achieving decarbonisation objective	○	◑	◔	◑
Challenge to implement	Minimise policy complexity/interdependencies	○	◔	◕	○
	Minimise market disruption	○	○	◑ (red)	◔ (red)
	Reduce implementation cost	○	◔ (red)	◕ (red)	◑ (red)
	Reduce risk of unproven solutions	○	○	◔ (red)	◕ (red)
	Expedite implementation	○	○	◕ (red)	◕ (red)

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Wholesale Pricing and Dispatch

● ◕ ◑ ◔ ○ ◔ ◑ ◕ ●

Deterioration on SQ | Neutral | Improvement on SQ

Key conclusions

Greater locational signalling in the wholesale market has significant benefits

- It would significantly reduce the volumes of re-dispatch required, incentivise much greater response from flexible demand side assets and support cross-vector optimisation.
- It would improve operability, and would reduce the need for additional network capacity promoting value for money, and helping to accelerate decarbonisation (all else equal).
- Further, it should reduce the scope for infra-marginal excess profit with gas not being the price setting technology nationwide.
- Overall the benefits are greater under Nodal versus Zonal pricing, with the exception of competition since forward market liquidity is further split across multiple locations.

The impact of nodal/ zonal pricing on investment would need to be carefully addressed via complementary investment design policy (see Packages):

- The impact of reforming the wholesale market to Nodal or Zonal pricing could expose some market participants to greater price volatility, although this would depend significantly on how other policies (e.g CfDs, FTRs) are combined with wholesale market reform . Investor impact would not be uniform across technologies; e.g flexible assets would benefit from more granular locational signals.

The extent to which consumers are exposed to regional price variation is a key question for policymakers

- Although consumers would benefit overall by reduced congestion and balancing costs, depending on policy decisions around consumer exposure to locational prices, there could be regional variation in the wholesale energy prices faced by consumers. Other measures or policy options such as FTR/PTR could lessen this impact (see Other options discussion).

Central dispatch has a number of benefits when operating a rapidly decarbonising power system

- NGESO is already taking steps to better optimise its balancing actions. Central dispatch would allow it to schedule resources further ahead of gate closure, and optimise across a range of needs
- This should be more efficient, promote transparency and competition and ultimately improve the operability of the system and facilitate decarbonisation.

There are questions regarding the implementation complexity of wholesale market reform

- Zonal and Nodal pricing, and to a lesser extent Central dispatch, would represent a major change to the current market arrangement. In the event this is pursued, rigorous consideration of clear transitional arrangements would be needed to ensure delivery of the 2035 decarbonisation targets.

Criteria	National	Zonal	Nodal	Self	Central	FTR / PTR
Value for Money	○	green ◑	green ◕	○	green ◔	○
Competition	○	green ◑	green ◔	○	green ◑	green ◔
Investor confidence	○	red ◑	red ◑	○	green ◔	green ◔
Full chain flexibility	○	green ◑	green ◕	○	green ◑	○
Whole system	○	green ◑	green ◕	○	green ◑	○
Adaptability	○	green ◔	green ◑	○	○	○
Consumer fairness	○	red ◔	red ◔	○	○	green ◑
Energy security and system operability	○	green ◔	green ◔	○	○	○
Decarbonisation	○	green ◔	green ◑	○	green ◔	○
Challenge to implement	○	red ◕	red ●	○	red ◑	red ◑
Total	○	green ◑	green ◕	○	green ◕	green ◑

Option design open questions

- Nodal pricing would need to be implemented with Central dispatch; it is possible to implement Zonal pricing under either Central or Self dispatch.
- Equally, Central Dispatch could be implemented with the current National pricing approach
- Central dispatch could be implemented with or without central unit commitment, and Central dispatch can accommodate a degree of self-commitment. The timing and frequency of the auctions to best facilitate flexibility are among many open questions.
- A market in virtuals trading (financial contracts) could be established to help participants manage price risk between day-ahead and real-time market outcomes.
- The timing, frequency and look-ahead of the Central dispatch optimisation to best facilitate flexibility are key technical design questions.
- Measures to reduce the risk of market power exploitation (as have been deployed in markets elsewhere with Nodal pricing) are assumed to be included in the market design.

Pricing and Dispatch

Sub-criteria assessment

−● −◕ −◑ −◔ ○ +◔ +◑ +◕ +●

Deterioration on SQ | Neutral | Improvement on SQ

Criteria	Sub-criteria	National	Zonal	Nodal	Self	Central	FTR / PTR
Value for Money	Reduce relative proportion of redispatch	○	+◕	+●	○	+◑	○
	Improve operational efficiency of interconnectors	○	+◑	+◕	○	○	○
	Ensure appropriate risk allocation for generation and demand	○	+◔	+◑	○	○	○
	Increase system flexibility	○	+◕	+●	○	+◔	○
	Reduce inefficient inframarginal rent	○	+◔	+◑	○	○	○
Competition	Align markets/avoid distortions	○	+◕	+●	○	+◑	○
	Better target system costs through market signals	○	+◕	+●	○	+◑	○
	Promote greater inter-technology competition	○	○	○	○	+◔	○
	Promote greater market transparency	○	+◑	+●	○	+◕	+◑
	Reduce barriers to entry	○	−◑	−◕	○	+◔	+◑
	Reduce risk of gaming or exploitation of market power	○	−◑	−◔	○	○	○
Investor confidence	Respect existing legal framework and rights	○	−◕	−●	○	○	+◕
	Provide assurance for debt holders	○	−◑	−◕	○	○	+◑
	Provide suitable incentives for equity	○	+◑	+◕	○	○	−◔
	Promote market liquidity	○	−◑	−◕	○	+◑	+◔
	Minimise ongoing regulatory risk	○	−◕	+◔	○	+◔	○
Full chain flexibility	Optimise investment in flexibility	○	+◑	+◕	○	+◔	○
	Optimise dispatch of flexibility	○	+◕	+●	○	+◕	○
	Manage large and extended mismatches between supply and demand	○	+◔	+◑	○	○	○
	Promote demand side participation	○	+◔	+◕	○	+◑	○
Whole system	Align investment incentives for cross-vector assets	○	+◔	+◑	○	○	○
	Align dispatch incentives for cross-vector assets	○	+◑	+◕	○	+◔	○
Adaptability	Facilitate new and evolving business models	○	+◔	+◑	○	○	○
	Reduce risk of lock-in or asset stranding	○	+◔	+◑	○	○	○
	Adapt to changing technology trends	○	+◔	+◑	○	○	○
Consumer fairness	Limit adverse distributional impacts for consumers	○	−◕	−●	○	○	+◕
	Allow greater consumer choice	○	+◔	+◑	○	○	○
	Facilitate fair allocation of costs, based on cost-reflectivity	○	+◔	+◑	○	○	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	+◔	+◔	○	○	○
	Ensure sufficient available energy and demand response to manage extended low renewable output	○	+◔	+◔	○	○	○
	Ensure sufficient responsive capacity to maintain system operability	○	○	○	○	+◑	○
	Manage external shocks and unintended consequences	○	○	+◔	○	+◔	○
Decarbonisation	Increase probability of achieving decarbonisation objective	○	+◔	+◑	○	+◔	○
Challenge to implement	Minimise policy complexity/interdependencies	○	−◑	−●	○	+◔	−◑
	Minimise market disruption	○	−◕	−●	○	−◑	+◔
	Reduce implementation cost	○	−◕	−●	○	−◕	−◑
	Reduce risk of unproven solutions	○	−◔	−◑	○	−◔	○
	Expedite implementation	○	−◑	−●	○	−◕	−◑

Other options

Key conclusions

FTRs/PTRs will be required under Zonal or Nodal pricing to help market participants manage their locational risk, and may be awarded to existing participants to protect legacy access rights

- FTRs/PTRs would help manage the additional price exposure for market participants, and thus increase investor confidence facilitating greater competition and ultimately value for money for consumers.
- They could be used to address unintended distributional effects, for example to ensure that generators connected under Connect and Manage principles are not unduly disadvantaged, and to offset locational variations in wholesale prices for consumers.

Network Access and Charging Reform could deliver some of the benefits of locational wholesale markets

- The assessment considers stronger short term signals through differentiated access rights or more system responsive pricing (down to zonal level); these may be easier to implement than locational wholesale markets, and could be considered as an alternative or transitional step.
- Stronger long term signals (through deeper connection charging or stronger locational elements) are possible but not considered as part of this assessment.

The assessment suggests that any potential benefits of a Split Market are likely outweighed by the delivery risk

- Assessment shows no incremental benefit of Split Market in terms of value for money given that CfDs can provide the same benefit in terms of decoupling gas and power prices.
- Potential benefit to decarbonisation by further protecting renewables from system costs but at the expense of creating distortions between markets.
- Combined with the deliverability risk this option is not favoured.

Settlement Period Reform would be beneficial and likely go hand in hand with move to Central dispatch

Carbon Intensity Reporting is a low regrets intervention that could support the implementation of other policy options

● ◕ ◑ ◔ ○ ◔ ◑ ◕ ●

Deterioration on SQ — Neutral — Improvement on SQ

Counterfactual: locational wholesale market

Criteria	FTR / PTR	Scarcity Adder	Access and Charging Reforms	Split Market	Settlement Period Reform	Carbon Intensity Reporting
Value for Money	◔	◔	◔	○	◔	○
Competition	◔	◑	○	○	◔	◔
Investor confidence	◔	◔	○	○	○	○
Full chain flexibility	○	◑	◔	○	◑	○
Whole system	○	○	◔	○	◔	◔
Adaptability	○	◔	○	○	◔	○
Consumer fairness	◑	○	○	○	○	◔
Energy security and system operability	○	◔	◔	○	○	○
Decarbonisation	○	○	○	◑	○	◔
Challenge to implement	◑	◔	◔	◕	◑	◔
Total	◑	◑	◑	○	◑	◑

Option design open questions

- If FTRs/PTRs were only available in standard product shapes then they would provide an imperfect basis risk hedge for variable renewables; possible that bespoke products for renewables could be considered.
- FTRs/PTRs are one method for reducing the distributional impacts on consumers; another would be simply to settle load on a zonal or national basis. The risk with this is it dampens locational signals for demand side response. Various permutations are possible such as opt in to locational pricing, or social tariffs that allow consumption below a threshold at a national pricing with demand above that (e.g. driven by EVs) exposed to the locational price.
- Assessment of Split Market is based on what we know today; it is possible that it may score better when further details become clearer.
- Scarcity Adder could be implemented alongside price cap to control market power, particularly in Nodal pricing approaches.

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Other Options

Sub-criteria assessment

Counterfactual: locational wholesale market

● ◕ ◑ ◔ (red) ← Deterioration on SQ | ○ Neutral | ◔ ◑ ◕ ● (green) → Improvement on SQ

Criteria	Sub-criteria	FTR / PTR	Scarcity Adder	Access and Charging Reforms	Split Market	Settlement Period Reform	Carbon Intensity Reporting
Value for Money	Reduce relative proportion of redispatch	○	○	◔ (green)	◔ (red)	◔ (green)	○
	Improve operational efficiency of interconnectors	○	◔ (green)	○	○	○	○
	Ensure appropriate risk allocation for generation and demand	◑ (green)	◔ (green)	◔ (green)	◔ (red)	◔ (green)	○
	Increase system flexibility	○	◔ (green)	◔ (green)	○	◑ (green)	○
	Reduce inefficient inframarginal rent	○	◔ (green)	○	◔ (green)	○	○
Competition	Align markets/avoid distortions	○	◔ (green)	○	◑ (red)	○	○
	Better target system costs through market signals	○	○	◔ (green)	○	◔ (green)	○
	Promote greater inter-technology competition	○	◑ (green)	○	○	◔ (green)	○
	Promote greater market transparency	◑ (green)	◑ (green)	◔ (green)	◑ (green)	◕ (green)	◕ (green)
	Reduce barriers to entry	◑ (green)	○	○	○	○	○
	Reduce risk of gaming or exploitation of market power	○	● (green)	○	○	◔ (green)	○
Investor confidence	Respect existing legal framework and rights	◕ (green)	○	○	○	○	○
	Provide assurance for debt holders	◑ (green)	○	○	◔ (green)	○	○
	Provide suitable incentives for equity	◔ (red)	◔ (green)	○	○	○	○
	Promote market liquidity	◔ (green)	○	○	◔ (red)	○	○
	Minimise ongoing regulatory risk	○	◔ (green)	○	○	○	○
Full chain flexibility	Optimise investment in flexibility	○	◑ (green)	◔ (green)	○	◑ (green)	○
	Optimise dispatch of flexibility	○	◕ (green)	◔ (green)	○	◕ (green)	○
	Manage large and extended mismatches between supply and demand	○	◔ (green)	○	○	○	○
	Promote demand side participation	○	◕ (green)	◔ (green)	○	◔ (green)	○
Whole system	Align investment incentives for cross-vector assets	○	○	○	○	○	◔ (green)
	Align dispatch incentives for cross-vector assets	○	○	◔ (green)	○	◔ (green)	◔ (green)
Adaptability	Facilitate new and evolving business models	○	◔ (green)	○	○	◔ (green)	○
	Reduce risk of lock-in or asset stranding	○	◔ (green)	◔ (green)	○	◔ (green)	○
	Adapt to changing technology trends	○	◔ (green)	○	○	◔ (green)	○
Consumer fairness	Limit adverse distributional impacts for consumers	◕ (green)	○	◔ (red)	○	○	○
	Allow greater consumer choice	○	○	○	○	○	◑ (green)
	Facilitate fair allocation of costs, based on cost-reflectivity	○	○	○	○	○	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	◕ (green)	◔ (green)	○	○	○
	Ensure sufficient available energy and demand response to manage extended low renewable output	○	◔ (green)	○	○	○	○
	Ensure sufficient responsive capacity to maintain system operability	○	○	○	○	◔ (green)	○
	Manage external shocks and unintended consequences	○	○	○	○	○	○
Decarbonisation	Increase probability of achieving decarbonisation objective	○	○	○	◑ (green)	○	◔ (green)
Challenge to implement	Minimise policy complexity/interdependencies	◑ (red)	◔ (red)	◔ (red)	◕ (red)	◑ (red)	○
	Minimise market disruption	◔ (green)	○	○	◑ (red)	◑ (red)	○
	Reduce implementation cost	◑ (red)	◔ (red)	◔ (red)	◕ (red)	◔ (red)	◔ (red)
	Reduce risk of unproven solutions	○	◔ (green)	◔ (red)	◑ (red)	◔ (red)	○
	Expedite implementation	◑ (red)	◔ (red)	◔ (red)	◕ (red)	◑ (red)	◔ (red)

Baringa