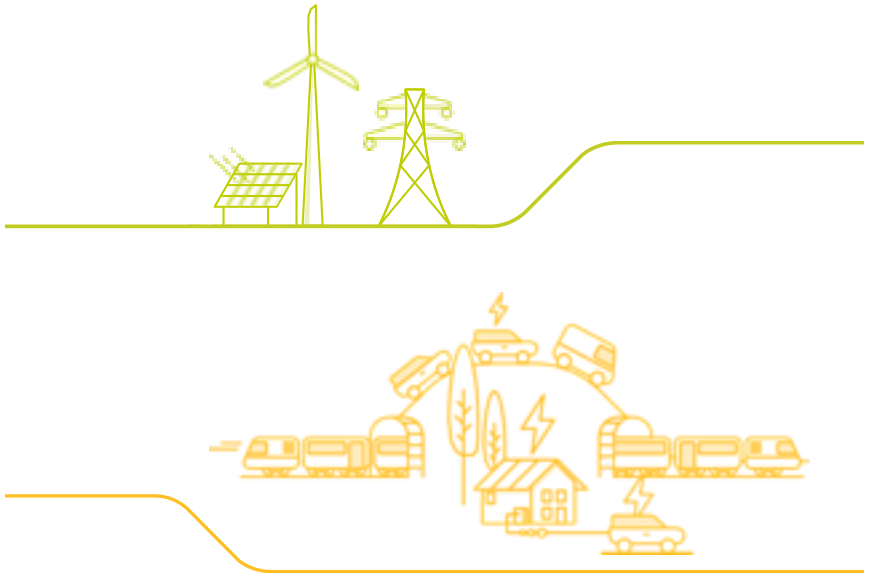
Assessment of Investment Policy and Market Design Packages

27 February 2023

ESO

Contents



Foreword by ESO

As part of the current fourth phase of our Net Zero Market Reform (NZMR) programme, and to support the debate around market reform driven by DESNZ's Review of Electricity Market Arrangements (REMA), we commissioned Baringa to assess policy options and policy / market design packages. REMA is GB's opportunity to get market and policy arrangements right for net zero. There is general consensus that current arrangements need reform; however, taking the wrong decisions on reform now could jeopardise our net zero ambitions, cause security/reliability issues and/or result in unnecessarily high costs for consumers. It is therefore crucial that stakeholders work together to gather the evidence and analysis needed to map out the right net zero market design in the best interests of current and future consumers.

NZMR – how have we reached this point?

We launched our NZMR programme in early 2021, to examine holistically the changes to GB electricity market design that would be required to achieve the power sector's 2035 decarbonisation targets cost-efficiently and securely, while laying the foundation for a net zero economy by 2050.

Our early Case for Change analysis in Phases 1 and 2 concluded with three key challenges:

1. **Investment:** there is a need to invest at unprecedented scale and pace;
2. **Location:** assets must locate and dispatch where they can minimise whole system costs; and
3. **Flexibility/Operation:** dramatic energy imbalances must be managed with flexible and firm technologies across both supply and demand.

In Phase 3 we dove deep into the location and flexibility/operation challenges and found evidence that the status quo market design results in inefficient investment and dispatch outcomes: rapidly rising congestion costs and greater volumes of redispatch; a lack of incentives for distributed flexibility and demand-side response; and inefficient signals for storage and interconnector flows. We concluded that the combination of locational wholesale energy pricing with centralised scheduling – as a complement to significant strategic transmission network build – could deliver efficiencies

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for a net zero system, coordinating an increasingly complex system dominated by renewable and flexible assets of all sizes. However, there is much more analysis to be done and evidence to be gathered before a decision can be made on GB's future wholesale market design.

We are currently in Phase 4 of our work, where we are assessing how policies could evolve to better complement the wholesale market, such that emerging inefficiencies are addressed while ensuring efficient investment at the needed scale and pace. This policy evolution element is critical if bills are to be kept affordable and the system operable and secure while investment accelerates, especially during a period of considerable market and regulatory change. Our Phase 4 work involves assessing individual policy options and designing coherent market design and policy packages that can be efficient and effective in meeting REMA's objectives. From this, efficient pathways can be mapped out, helping policymakers to sequence and stage complementary reforms in the most efficient way to optimise investment, operation and value for consumers.

Why did we commission this independent assessment from Baringa?

As other markets introduce or strengthen ambitious investment support policies, such as the Inflation Reduction Act in the US, it is vital that the UK swiftly renews and strengthens its commitments on investment policy, alongside market reforms, to compete for this global finance. Investment and innovation must be driven across low carbon generation, capacity adequacy and system flexibility, particularly on the demand side.

The current investment policy framework, delivered through the Electricity Market Reform programme of 2013, has been successful in delivering some 30GW of low carbon capacity (by 2030) and has enough capacity margin to keep the lights on. Since then, however, the power system, markets and technologies have developed considerably. As the system continues to transition to net zero, there are growing inefficiencies that prevent the market from delivering an optimal resource mix, invested in the right place and dispatching efficiently, because:

a) there exists inconsistency and asymmetry in magnitude and targeting of signals through policy and markets particularly between the supply side and the demand side

b) policy sometimes shields assets from system value signals, distorts signals or inappropriately allocates risk between producers and consumers.

We asked Baringa to evaluate coherent investment policy packages for market design based on national and zonal pricing as well as nodal pricing (with centralised scheduling). As any fundamental market reform may take some years to implement, and given the growing inefficiencies, careful thought must also be given to the need for interim measures and their coordination with reforms for enduring arrangements such that net social benefit is maximised through the transition as well as under a new equilibrium.

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What are our key reflections from Baringa's assessment?

1. Baringa's qualitative assessment finds that locational energy pricing and centralised scheduling could provide the most efficient foundation for GB net zero market design, but highlights implementation complexity and cost as a key risk of nodal pricing and centralised scheduling. This is an important challenge we are exploring further via our NZMR programme (see next steps). To be effective, this market design would need to be combined with well-designed investment policy, timely transmission network investment and complementary, coherent short-term measures. Baringa's analysis suggests that the following coherent investment policy packages – compatible with all wholesale pricing options (i.e. national, zonal, nodal) – could drive investment at needed scale and pace while ensuring assets respond accurately to all price signals, and rebalancing risk more appropriately across producers and consumers:

   a) *Drive investment and low-cost financing for low-carbon resources*

      - Some price exposure could be introduced through e.g. an Annual Revenue Soft Cap / Floor design, which could more effectively mitigate risks of distortions and gaming compared to alternatives. A soft cap (i.e. producer-consumer revenue sharing above a cap or below a floor) would incentivise greater market participation and system integration. All high-capex low-carbon assets should be eligible and policy design should ensure an optimal ratio of weather dependent to flexible resource.
      - By allowing opt-in/out of the support scheme through Elective Participation, as part of establishing a Government-facilitated Low-Carbon Futures market, volume requirements could be determined around consumer demand for low carbon power, strengthening the role of the PPA/futures and retail markets in matching low-carbon supply and demand.

   b) *Focus capacity renumeration on reliability performance*

      - With growth in the share of weather-dependent renewables in the power mix, the nature of what is needed for energy and system security is changing. Sustained, two-way response for extreme demand/supply imbalances, ramping and other capabilities are increasingly needed for system security but are not appropriately rewarded in the current market arrangements. A reliability mechanism for a system largely based on weather-dependent renewables will need to complement the wholesale energy market, respecting the integrity of its price signals, to provide stronger and more accurate incentives for resources with the right capabilities needed by the system in times of system stress.

2. This is not included in Baringa's assessment, but we believe it is important that while wholesale market reform is being decided and potentially implemented, tackling market inefficiencies in the short term will need intervention:

      - We do not believe that short-run locational signals can be efficiently addressed through transmission charging. In the short-term we are trying to address rising transmission constraints through our 5-point

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plan and introducing a Local Constraints Market. At distribution level, all options (including network charging) should be explored.

- Several options should be assessed for improving long-run locational siting efficiency (e.g. locational CfDs or CM, reformed transmission charging, or network access reform) but would need to be carefully designed.
- Setting out a well-defined holistic vision for net zero market design, and a clear pathway to getting there, will result in investors and developers responding immediately, unlocking the benefits of longer-term reforms well before full implementation.

What next from our NZMR programme?

Baringa's qualitative assessment adds to the body of work previously conducted under ESO's NZMR programme. In coming months we will complete our own assessment of the investment policy options and packages, building on Baringa's evidence and analysis, taking account of stakeholders' feedback and input.

In parallel, we are also conducting:

1. Further work on reforms to wholesale and balancing markets:
    a) further assessment on zonal pricing based on self-dispatch versus nodal pricing based on centralised scheduling with self-commitment
    b) disaggregating the benefits of locational pricing and centralised scheduling (including co-optimisation)
    c) assessment of options for shorter-term improvements to dispatch efficiency (including Balancing Mechanism Review analysis and outcomes) and locational siting
2. Further work on broader, relevant strategic programmes and reform (e.g. network/system planning; network access; allocation/design of network, system and policy costs).

We will bring together the above, along with stakeholder feedback and input, to form our conclusions on holistic market design for net zero GB, including our proposal for potential pathways with phasing of short-, medium- and long-term measures towards a clear, long-term vision. **These conclusions will be published in our Phase 4 report in summer of 2023.**

To keep up to date with the latest from the NZMR programme, do subscribe to our mailing list. If you have any questions, please email box.Market.Strategy@nationalgrideso.com

Net Zero Market Reform – Phase 4

Final Report – options and packages assessment for market design and policy reform

Updated May 2023, v1.1

NG ESO

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Table of contents

Executive Summary - 1

The ESO launched its Net Zero Market Reform programme in early 2021, with the objective of examining the changes to current GB electricity market design required to achieve net zero. Phases 1 and 2 of the programme set out a strong case for change, highlighting issues in both operational and investment timeframes.

Phase 3 focused on the challenges arising in operational timescales and concluded that a market based on nodal pricing and centralised dispatch would best further the objectives of achieving a cost-effective and secure decarbonised power system by 2035 and a Net Zero economy by 2050.

Phase 4 builds on Phase 3 by focusing on the investment challenges and considers the full range of options covered in BEIS's Review of Electricity Market Arrangements (REMA) consultation, which was published in July 2022.

To support Phase 4, Baringa:

1. Assessed individual options for reform of market design and policy based on their ability to meet our assessment criteria (expanded from Phases 2 and 3)
2. Combined options into packages, including each of the alternative locational pricing models (national, zonal and nodal pricing) as well as elements intended to bring forward investment in new low carbon capacity, ensure capacity adequacy and improve system operability.

Methodology

National Grid ESO previously defined assessment criteria. Following the publication of BEIS' REMA consultation with its objectives and case for change, we reviewed the ESO's high-level criteria and defined a number of sub-criteria to support a more detailed and transparent assessment of the various reform options being considered, under these headings:

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

Building on the options set out in the REMA consultation, we created a set of policy options for consideration across categories of low carbon investment, capacity adequacy and system operability. We also undertook our own independent assessment of the options for locational pricing and dispatch mechanisms from Phase 3. Informed by the options scoring and consideration of how effectively alternative options could be combined in operation, we created a number of reform packages. For each of the national, zonal and nodal pricing mechanisms we developed two packages, a 'Baseline' and 'Build' package, i.e. six in total.

The Baseline packages represent a cohesive least change set of policies, but which have potential to address, to an extent, key areas of the case for change. Implicitly, this prioritises minimising implementation risks and optimising costs/benefits in the shorter term. The Build packages consider more fundamental reform and should increase the confidence in achieving the REMA objectives over the longer term. The design of some of the constituent policy options is formative, and hence the Build packages in particular, and their assessment, should be regarded as indicative at this stage.

Executive Summary - 2

Option scoring conclusions

Across options to support low carbon investment, the Revenue Cap/Floor or Contract for Difference CfD with a Price Cap/Floor scored strongly. Our assessment is close but these two options score slightly better than the Deemed CfD given the latter is less adaptable and relies on benchmarking. The Revenue Cap/Floor may address distortions more effectively than the CfD with Price Cap/Floor, and could be extended to flexible low carbon technologies as well as variable renewables.

For options to ensure capacity adequacy, there is a strong case to differentiate the Capacity Market by low and high carbon, and potentially by degrees of flexibility – the Optimised CM. Centralised Reliability Options (CRO) could further improve outcomes for value for money, competition and full chain flexibility, since as a financial overlay on the markets they are less distortive than the CM. A Reverse Reliability Option, combined with CRO, should be considered as an option to support investment on the demand-side, particularly long duration storage.

To improve system operability, 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.

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. The impact of nodal/ zonal pricing on investment, and customer fairness, would need to be carefully addressed via complementary policy design.

Centralised dispatch has a number of benefits when operating a rapidly decarbonising power system. This should be more efficient, promote transparency, competition, liquidity and ultimately improve the operability of the system.

Summary of policy options

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/Low Carbon Futures Market	Supplier Obligation	Financial Wind CfD		
Capacity Adequacy	Existing Capacity Market	Evolved Capacity Market	Optimised Capacity Market - Zonal	Optimised Capacity Market – Low Carbon Requirement	Capacity Market + Enhanced Flexibility
	Centralised Reliability Option	Centralised Reliability Option	Optimised CRO - Zonal	Optimised CRO - Low Carbon Requirement	CRO + Enhanced Flexibility
	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				

Executive Summary - 3

Summary of baseline packages

	National Baseline	Zonal Baseline	Nodal Baseline
Pricing	National	Zonal	Nodal
Dispatch	Self	Self	Centralised
Mass Low Carbon	Evolved CfD (locational auctions); Elective Participation	Revenue Cap and Floor; Elective Participation	Revenue Cap and Floor; Elective Participation
Capacity Adequacy	Evolved CM	Optimised CM: Min C, Flex	Optimised CM: Min C, Flex
Operability	BAU+; Revenue Cap and Floor for low carbon flexibility	BAU+; Revenue Cap and Floor for low carbon flexibility	Co-optimisation; Revenue Cap and Floor for low carbon flexibility
Other	Network Access and Charging Reform	PTRs/FTRs	FTRs; 5 min settlement

Summary of build packages

	National Build	Zonal Build	Nodal Build
Pricing	National	Zonal	Nodal
Dispatch	Centralised	Centralised	Centralised
Mass Low Carbon	Revenue C+F (locational auctions); Elective Participation	Revenue C+F; Elective Participation	Revenue C+F; Elective Participation
Capacity Adequacy	Optimised CM: Zonal, Minimum Carbon, Flexibility	CRO and RRO (locational auctions); Scarcity Adder; Strategic Reserve	CRO and RRO (locational auctions); Scarcity Adder; Strategic Reserve
Operability	Co-optimisation; Revenue Cap and Floor for low carbon flexibility	Co-optimisation; Revenue Cap and Floor for low carbon flexibility	Co-optimisation; Revenue Cap and Floor for low carbon flexibility
Other	Network Access and Charging Reform; 5 min settlement; Carbon Intensity Reporting	FTRs; 5-min settlement, Carbon Intensity Reporting	FTRs; 5-min settlement, Carbon Intensity Reporting

Executive Summary - 4

Package scoring conclusions

All packages show an improvement on the Status Quo, with the Nodal Build package scoring most strongly overall but with considerable challenges to implement. The choice of accompanying policy options could mitigate some of the challenges of nodal pricing, particularly around investor confidence and consumer fairness. Given the greatest delivery challenge is in implementing Centralised Dispatch and Nodal Pricing, there is an advantage in targeting the Build version of this option to unlock greater benefits.

The Zonal Build and National Build packages score respectively less well and are less adaptable, but with easier transition paths. Zonal Build scores as strongly as Nodal Build if value for money, energy security and decarbonisation are prioritized in the assessment. The Zonal Baseline would further reduce delivery risk, but scores less favourably for criteria including decarbonisation and energy security.

The National Baseline is the easiest package to implement and might be considered a low regrets option as a transitional step to one of the Build packages. The Zonal and Nodal Build packages include options such as Centralised Reliability Options and Reverse Reliability Options which could be implemented with the National Build package, although we have found the incremental value of these options is greatest with locational pricing in the wholesale market.

The tradeoff between the challenge to implement and realising potential benefits is potentially the biggest swing factor in the assessment, with its importance heightened by the 2035 decarbonisation objective; a detailed assessment of the pathway to implement each package would be needed ahead of firm recommendations. Design of potential pathways must consider the trade off between optimal market design and confidence in achieving 2035 and 2050 targets.

Summary of package assessment

Criteria	*National Baseline*	*National Build*	*Zonal Baseline*	*Zonal Build*	*Nodal Baseline*	*Nodal Build*
Value for Money	◑	◕	◑	◕	◕	●
Energy security and system operability	◔	◑	◔	◑	◔	◕
Decarbonisation	◔	◑	◔	◕	◑	◕
Competition	◔	◕	◑	◕	◕	●
Challenge to implement	◔	◑	◑	◕	●	●
Investor confidence	◔	◑	○	◔	○	◔
Full chain flexibility	◔	◑	◑	◕	◕	●
Whole system	◔	◑	◑	◑	◑	◕
Adaptability	◔	◑	◔	◑	◑	◕
Consumer fairness	○	◔	○	○	○	◔
Total	◔	◑	◑	◑	◑	◕
Total - prioritise VfM, security and decarb	◔	◑	◔	◕	◑	◕

Introduction and approach

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 (for the 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
6. Assess each Build package against each other and relative to their corresponding Baseline

Process of combining options to develop a package

Criteria	Sub-criteria	Option 1	Option 2	Option 3	Option 4	...	Option X	Package 1-2-3
Criteria 1	Sub-criteria 1					...		
	...					...		
	Sub-criteria X					...		
...	Sub-criteria 1					...		
	...					...		
	Sub-criteria X					...		
Criteria X	Sub-criteria 1					...		
	...					...		
	Sub-criteria X					...		

X

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 least change but cohesive set of policies, which address, to some extent, the key areas in the case for change.

Build packages

For a given pricing mechanism, and a longer implementation time, what comprehensive 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
Zonal	Baseline	Build
Nodal	Baseline	Build

National Baseline vs National Build

Zonal Baseline vs Zonal Build

Nodal Baseline vs Nodal Build

National Baseline vs Zonal Baseline vs Nodal Baseline

National Build vs Zonal Build vs Nodal Build

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	Rationale
Value for money	Criteria mapping to Least Cost
Energy security and system operability	Additional REMA objective (i.e. trilemma) criteria included explicitly
Decarbonisation	
Competition	Separate criterion for component of BEIS Least Cost
Challenge to implement	Criteria mapping to Deliverability
Investor confidence	REMA criterion
Full chain flexibility	Component of BEIS Whole-system Flexibility
Whole system	
Adaptability	REMA criterion
Consumer fairness	Link to REMA vision - consumer control with fair outcomes

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 resources. Appropriate risk allocation between generation and demand may vary based on, for example, technology maturity.

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

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.

Minimising market disruption interpreted to cover both initial disruption and risk of further disruption if measure do not have longevity.

Criteria	Sub-criteria
Value for money	Reduce relative proportion of redispatch
	Improve operational efficiency of interconnectors
	Ensure appropriate risk allocation and efficient cost of capital
	Increase system flexibility
	Reduce inefficient inframarginal rent
Energy security and system operability	Ensure sufficient capacity to meet peak system needs
	Ensure sufficient available capacity 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
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

Evaluation Criteria - 2

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

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

The distinction between incentives for investment and dispatch of technologies is relevant for several criteria. Additionally, 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 issues like regional price variation.

Criteria	Sub-criteria
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
	Ensure fair allocation of costs, based on cost-reflectivity

Policy options

A set of options considered

We 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/Low Carbon Futures Market	Supplier Obligation	Financial CfD		
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	Optimised CRO - Zonal	Optimised CRO - Low Carbon Requirement	CRO + Enhanced Flexibility	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 designed 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 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 wholesale market the Market Reference Price would need to be changed to either the respective locational index or a national system price. For the purposes of the assessment we assume the former, but that would remove the locational signal. Therefore it is assumed that some degree of locational differentiation in allocation rounds may be included in the Evolved CfD approach, for example to align with the Holistic Network Design.
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. For our assessment we assume a 'hard' cap and floor, but a 'soft' cap and floor would be introduced (based on gain/loss sharing) to maintain incentives to participate in the market.
Revenue 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. Above the cap, excess revenues would be paid back. There would be no transfer if revenue was between the floor and the cap. In addition to supporting mass low carbon power this option could be available for certain forms of low carbon flexibility.
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 aims to remove dispatch distortions by decoupling support from output.
Elective Participation/Low Carbon Futures Market	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 into an agreement with a generator. This could evolve into a more liquid futures market for low carbon hedges, with a range of contract tenors that allow low carbon generators (not operating under a fixed price CfD) to manage their revenue risk.
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.
Financial CfD	Under this model, the CfD counterparty makes a fixed monthly payment to the asset. In turn, the low carbon generator pays the counterparty the spot market revenue of that month. These revenues are not the actual revenues of any given asset, but the revenues of a reference asset – benchmark revenues.

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. A capacity requirement is recommended 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.
Optimised CRO - Zonal	Creating a zonal version of Centralised Reliability Options 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 for the reliability premium from the auction process, for the right to buy a commodity at a predefined strike price .
Optimised CRO - Low Carbon Requirement	A Centralised Reliability Option 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.
CRO + Enhanced Flexibility	A single auction CRO with minimum volume requirements for more responsive technologies, creating multiple clearing prices with more flexible technologies receiving a higher reliability premium.

A set of options considered – (4)

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.
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 – (5)

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 by marginal gas-fired plant.

A set of options considered – (6)

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
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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/Low Carbon Futures Market	Supplier Obligation	Financial CfD		
Capacity Adequacy	Existing Capacity Market	Evolved Capacity Market	Optimised Capacity Market – Zonal	Optimised Capacity Market – Minimum Low Carbon Requirement	Capacity Market + Enhanced Flexibility
	Decentralised Reliability Option	Centralised Reliability Option	Optimised CRO - Zonal	Optimised CRO - Low Carbon Requirement	CRO + Enhanced Flexibility
	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

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

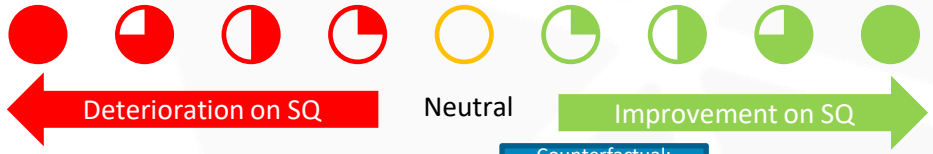
- Generators should have greater incentive to self-curtail reducing the need to re-dispatch, and it would reduce distortions in the BM and Balancing Services markets.
- This could be achieved through the Revenue Cap/Floor, CfD + Price Cap/Floor, Deemed CfD, Supplier Obligation and Financial Wind CfD.

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

- Floors in the Revenue Cap/Floor, 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 is preferred

- The assessment is relatively close but the Revenue Cap/Floor scores better than CfD + Price Cap/Floor, Deemed CfD and the Financial CfD. The CfD + Price Cap/Floor could still lead to dispatch distortions, whereas the Deemed CfD and Financial CfD are less adaptable and rely 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 (which we assume is calculated per settlement period), although may still require a soft cap and/or floor to retain incentives if revenues hit the cap or floor. The Financial CfD would introduce basis risk and could reduce investor confidence.
- 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.



Counterfactual: underlying CfD or Revenue Cap/Floor regime

New option

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

Option design open questions

- The Deemed CfD and Financial Wind 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. This is particularly the case for the CfD + Price Cap/Floor given the greater chance of the cap or floor being reached more frequently.
- 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.
- Elective Participation could evolve into a more liquid futures market for low carbon hedges, with a range of contract tenors, allowing low carbon generators to manage their revenue risk. See Appendix for further discussion.

Note: cells highlighted in grey reflect updated scores relative to v1.0 based on further research

Mass Low Carbon Power

Sub-criteria assessment

Criteria	Sub-criteria	Existing CfD	Evolved CfD	CfD + Price Cap/Floor	Revenue Cap/Floor	Deemed CfD	Elective Participation	Supplier Obligation	Financial CfD
Value for Money	Reduce relative proportion of redispatch	○	◔	◔	◑	◔	○	◑	◔
	Improve operational efficiency of interconnectors	○	◔	◔	◔	◔	○	◔	◔
	Ensure appropriate risk allocation and efficient cost of capital	○	○	◔	◑	○	◔	◑	○
	Increase system flexibility	○	○	◑	◕	◕	○	◕	◕
	Reduce inefficient inframarginal rent	○	○	○	○	○	○	◑	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	○	○	○	○	○	○	◔
	Ensure sufficient available capacity 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	○	○	◔	◔	◔	◔	◑	◔
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	○	○	○	○	◔	◔	○	◔
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	○	◔	◑	◑	◔	○	◑	◔

Note: cells highlighted in grey reflect updated scores relative to v1.0 based on further research

Capacity Adequacy

Key conclusions

Centralised Reliability Options could offer a strong solution as part of a package including complementary elements but there are implementation challenges

- Centralised Reliability Options could be segmented by asset type, such as high or low carbon, in the same way as the Optimised CM.
- Relative to the CM, Centralised Reliability Options improve outcomes for value for money, competition and full chain flexibility, since as a financial overlay on the markets they are less distortive than a CM, if implemented effectively, as they do not distort the wholesale price in the event of a scarcity event.
- The Centralised Reliability Option model could be combined with dimensions of an Optimised CM. Similar choices and challenges for addressing these dimensions would apply. A flex dimension could reduce the need to forward contract Balancing Services if additional value can be secured via CROs for more flexible capacity.
- CRO could be decentralised over time, although the prospect for improved outcomes under a Decentralised Reliability Option currently appear limited.

A Reverse Reliability Option, combined with CRO, 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.

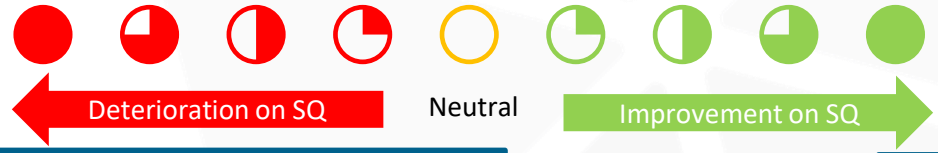
The Capacity Market, if retained, should be reformed to better optimise investment

- 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 high carbon, uneconomic capacity occasionally needed by the system.
- 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.



Counterfactual for CRO is the respective CM or Optimised CM. For the three Optimised CRO options the counterfactual is the Status Quo

RRO counterfactual is CRO

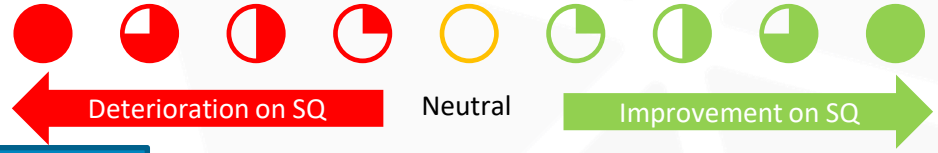
Criteria	Evolved CM	Optimised CM - Zonal	CM - Minimum Carbon	CM + Enhanced Flex	CRO	Optimised CRO - Zonal	CRO - Minimum Carbon	CRO + Enhanced Flex	DRO	RRO	Supplier Obligation_ CA	Strategic Reserve
Value for Money	◔	◔	◔	◑	◔	◑	◔	◕	○	◑	◔	○
Energy security and system operability	◔	◔	○	◑	◔	◑	◔	◕	○	○	◔	◑
Decarbonisation	○	○	◑	◔	○	○	◑	◔	○	◑	○	○
Competition	○	○	◔	◑	◔	◔	◑	◕	◔	◑	◔	◔
Challenge to implement	○	◔	◔	◔	◑	◑	◕	◑	◕	◕	◑	◔
Investor confidence	○	○	○	◔	◔	○	◔	◔	◔	◔	○	○
Full chain flexibility	○	○	○	◑	◑	◑	◔	◕	○	◑	○	○
Whole system	○	○	◔	◔	◑	◔	◑	◑	◑	◔	◔	○
Adaptability	◔	◔	◑	◑	◔	◑	◕	◕	◑	○	◑	◔
Consumer fairness	○	○	○	○	◔	◔	◔	◔	◔	○	◔	○
Total	◔	◔	◑	◑	◑	◑	◑	◕	◔	◑	◑	◔
Total - prioritise VfM, Security and Decarb	◔	◑	◑	◕	◑	◑	◑	◕	◔	◑	◑	◔

Option design open questions

- The different dimensions of an Optimised CM of CRO (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).
- The additional value of including the flexibility dimension in the CM (or CRO) 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. The value also depends on the design of the wholesale market and potential role of scarcity pricing.
- 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

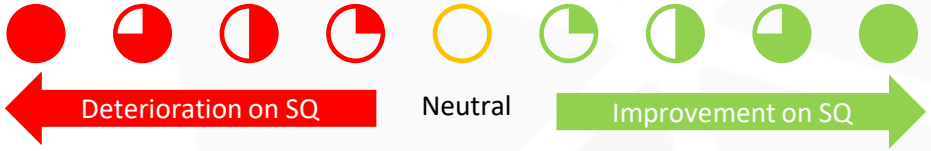


Counterfactual for CRO is the respective CM or Optimised CM. For the three Optimised CRO options the counterfactual is the Status Quo

Criteria	Sub-criteria	Existing CM	Evolved CM	Optimised CM - Zonal	Optimised CM - Minimum Carbon	CM + Enhanced Flex	CRO	Optimised CRO - Zonal	Optimised CRO - Minimum Carbon	CRO + Enhanced Flex	DRO	RRO	Supplier Obligation_CA	Strategic Reserve
Value for Money	Reduce relative proportion of redispatch	○	◔	◔	○	◔	○	◔	○	◔	○	◔	○	○
	Improve operational efficiency of interconnectors	○	◔	◔	○	◔	○	◔	○	◔	○	○	○	○
	Ensure appropriate risk allocation and efficient cost of capital	○	○	○	○	○	◔	◔	◔	◔	◔	◔	◔	○
	Increase system flexibility	○	○	○	○	◕	○	○	○	◕	○	◕	◔	○
	Reduce inefficient inframarginal rent	○	◔	◑	◑	◑	◑	◕	◕	◕	◑	◑	○	◔
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	◔	◑	○	◔	○	◑	○	◔	◔	○	◔	◑
	Ensure sufficient available capacity 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	○	○	○	◑	◔	○	○	◑	◔	○	◑	○	○
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	○	○	◔	○	○	◔	◑	◔	◔	◑	◔	◔	○
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	○	○	○	○	○	◔	◔	◔	◔	◔	◔	◑	○

Operability

Key conclusions



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

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

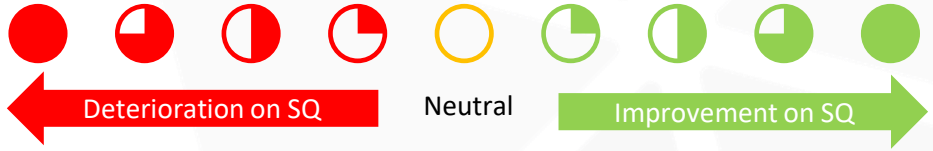
- Local Markets can help the coordination and optimisation of flexible assets connected to the distribution networks.
- This will provide benefits across a wide range of criteria; the challenge is one of delivery given it will require quite fundamental changes to the way that distribution networks are 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.

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	Operability BAU+	Co-optimisation	Local Markets
Value for Money	Reduce relative proportion of redispatch	○	◑	◑
	Improve operational efficiency of interconnectors	○	○	◔
	Ensure appropriate risk allocation and efficient cost of capital	○	○	○
	Increase system flexibility	◑	◑	◕
	Reduce inefficient inframarginal rent	○	○	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	◔	○	◑
	Ensure sufficient available capacity 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	◑	◔	◑
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	○	○	◔
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	○	○	○

Wholesale Pricing and Dispatch

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 benefit from more granular locational signals.

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

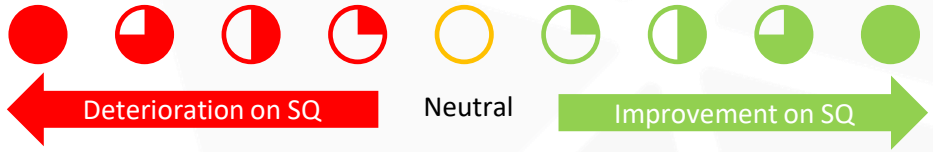
- Although consumers would benefit overall by reduced congestion and balancing costs, and consumer response can help reduce costs, there could be regional variation in the wholesale energy prices faced by consumers. Other measures or policy options such as FTR/PTR could lessen this impact (see Other options discussion).

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

- NGESO is already taking steps to better optimise its balancing actions. Centralised 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, competition, liquidity 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 Centralised dispatch, would represent a major change to the current market arrangements including cross-border. Rigorous consideration of clear transitional arrangements would be needed to ensure delivery of the 2035 decarbonisation targets.



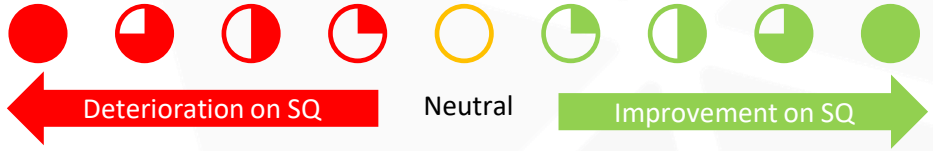
Criteria	Pricing system			Dispatch		Additional
	National	Zonal	Nodal	Self	Central	FTR / PTR
Value for Money	○	◑	◕	○	◔	○
Energy security and system operability	○	◔	◔	○	○	○
Decarbonisation	○	◔	◑	○	◔	○
Competition	○	◑	◔	○	◑	◔
Challenge to implement	○	◕	●	○	◑	◑
Investor confidence	○	◑	◑	○	◔	◔
Full chain flexibility	○	◑	◕	○	◑	○
Whole system	○	◑	◕	○	◑	○
Adaptability	○	◔	◑	○	○	○
Consumer fairness	○	◔	◔	○	○	◑
Total	○	◑	◕	○	◕	◑
Total - prioritise VfM, Security and Decarb	○	◑	◕	○	◕	◑

Option design open questions

- Nodal pricing would need to be implemented with Centralised dispatch; it is possible to implement Zonal pricing under either Centralised or Self dispatch; equally, Centralised Dispatch could be implemented with the current National pricing approach
- Centralised dispatch could be implemented with or without central unit commitment, and Centralised 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 Centralised dispatch optimisation are key technical design questions, particularly in respect to dispatching flows across interconnectors, and optimising whole system flexibility.
- 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



		Pricing system			Dispatch		Additional
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 and efficient cost of capital	○	◔	◑	○	○	○
	Increase system flexibility	○	◕	●	○	◔	○
	Reduce inefficient inframarginal rent	○	◔	◑	○	○	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	◔	◔	○	○	○
	Ensure sufficient available capacity 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	○	◔	◑	○	◔	○
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	○	◕	◔	○	◔	○
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	○	◔	◑	○	○	○

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.

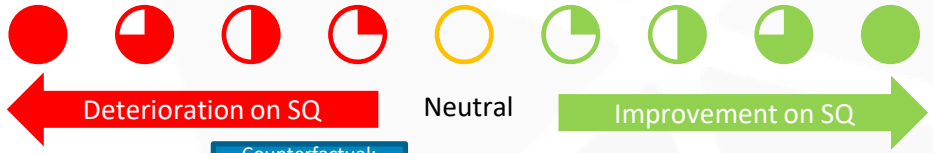
Network Access and Charging Reform could deliver some of the benefits of locational wholesale markets

- 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.
- There is a potential benefit to decarbonisation by further protecting renewables from system costs but at the expense of creating distortions between markets.
- The alternative option for Elective Participation and potential development of a Low Carbon Futures Market would expand the options that consumers have for sourcing low carbon power.

Settlement Period Reform would be beneficial and likely go hand in hand with move to Centralised dispatch. Carbon Intensity Reporting is a low regrets intervention that could support the implementation of other policy options



Counterfactual: locational wholesale market

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

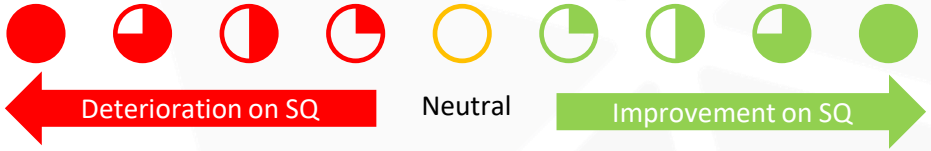
Option design open questions

- We assume a principles-based approach to provision of FTRs/PTRs for existing participants to protect rights – with timing of allocations aligned with other support mechanisms and allocations reducing over time.
- 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.
- Provision of FTRs/PTRs is also 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.

Other Options

Sub-criteria assessment

Counterfactual: locational wholesale market



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	○	○	◔	◔	◔	○
	Improve operational efficiency of interconnectors	○	◔	○	○	○	○
	Ensure appropriate risk allocation and efficient cost of capital	◑	◔	◔	◔	◔	○
	Increase system flexibility	○	◔	◔	○	◑	○
	Reduce inefficient inframarginal rent	○	◔	○	◕	○	○
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	○	◕	◔	○	○	○
	Ensure sufficient available capacity 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	○	○	○	◔	○	◔
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	○	◔	○	○	○	○
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	○	○	○	○	○	○

Proposed packages and assessment

Baseline packages

The Baseline packages represent, for a given pricing mechanism, a least change but cohesive set of policies

	National Baseline	Zonal Baseline	Nodal Baseline
Pricing	National	Zonal	Nodal
Dispatch	Self	Self	Centralised
Mass Low C	Evolved CfD (locational auctions); Elective Participation	Revenue Cap and Floor; Elective Participation	Revenue Cap and Floor; Elective Participation
Cap Adequacy	Evolved CM	Optimised CM: Min C, Flex	Optimised CM: Min C, Flex
Operability	BAU+; Revenue Cap and Floor for low carbon flexibility	BAU+; Revenue Cap and Floor for low carbon flexibility	Co-optimisation; Revenue Cap and Floor for low carbon flexibility
Other	Network Access and Charging Reform	PTRs/FTRs	FTRs; 5 min settlement

- The main instrument for promoting investment in mass low carbon would be the CfD, with some changes. For example, **locational 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 auctions or tenders for bilateral agreements giving them access to larger 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 signaling, 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 basic 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. Revenue Cap and Floor would be available for certain forms of low carbon flexibility.
- **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 replaced with a Revenue Cap and Floor to support investment and improve dispatch incentives.**
  - For new generators, the Cap and Floor can effectively address dispatch distortions and will send 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.
  - 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.
  - Other existing generators would want access to FTRs, with the possibility of some grandfathering for existing assets to preserve access rights.
- **An Optimised CM can bolster low-carbon and flex incentives in the Capacity Market**, building on improved incentives due to zonal pricing.
- **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 centralised 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 centralised 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 existing 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.
- For new generators, including low carbon flexibility providers, the Cap and Floor will send strong locational signal since the generator would be exposed to the difference between the nodal and national price.
- As with Zonal Baseline, an **Optimised CM** can bolster benefits of **locational granularity in wholesale market to bolster investment** signals.
- A **Revenue Cap and Floor** would be included for some low carbon flexibility options

Build packages

For a given pricing mechanism, the Build package represents a comprehensive set of policies that would increase confidence in achieving the REMA objectives

	National Build	Zonal Build	Nodal Build
Pricing	National	Zonal	Nodal
Dispatch	Centralised	Centralised	Centralised
Mass Low C	Revenue C+F (locational auctions); Elective Participation	Revenue C+F; Elective Participation	Revenue C+F; Elective Participation
Cap Adequacy	Optimised CM: Zonal, Min C, Flex	CRO and RRO (locational auctions); Scarcity Adder; Strat Reserve	CRO and RRO (locational auctions); Scarcity Adder; Strat Reserve
Operability	Co-optimisation; Revenue Cap and Floor for low carbon flexibility	Co-optimisation; Revenue Cap and Floor for low carbon flexibility	Co-optimisation; Revenue Cap and Floor for low carbon flexibility
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

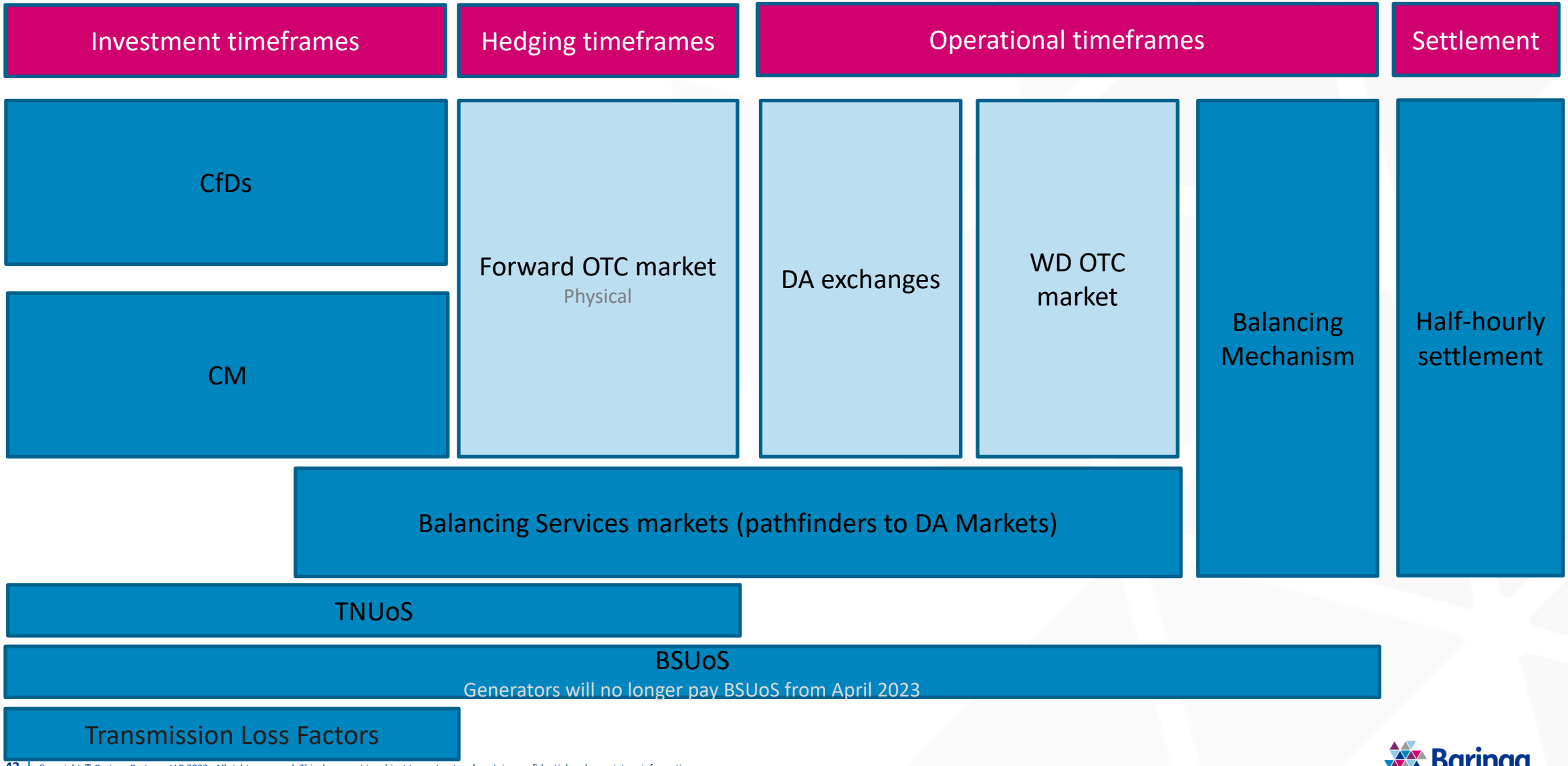
- The National Build package would involve a **move to Centralised dispatch**, similar to as described for the Nodal Baseline package but with a single national price, and therefore the costs of managing transmission constraints still being socialised – albeit reduced by Network Access and Charging Reform 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 revenue cap and floor**.
- 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).
  - In the absence of investment incentives provided under locational pricing, C+F auctions can be locational.
  - As in the Baseline package larger consumers (and their suppliers) could elect to opt out of the central scheme.
- 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. Revenue Cap and Floor would be available for certain forms of low carbon flexibility.
- The replacement of the physical CM with a financial **Centralised Reliability Option, and the introduction of a Reverse Reliability Option, is a possible variant** for this package.

- The Zonal Build package has many of the same options as National Build with Centralised 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.
- There is a stronger rationale for replacing the CM with a **Centralised Reliability Option** under zonal pricing to ensure good alignment of price signals with availability incentives.
- The **Reverse Reliability Option** also sits well with the Zonal 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 **Revenue Cap and Floor** for some forms of low carbon flexibility may be retained, but could be phased out as revenue streams from CRO and RRO become more bankable.

- The Nodal Build package is an extension of the Nodal Baseline package which already includes Centralised 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 **strong 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 focus 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 Nodal Build package also creates **the opportunity to extend co-optimisation to the distribution level** and this could be a feature of this package.
- The **Reverse Reliability Option is also included in this package** with locational auctions.
- As for Zonal Build, the **Revenue Cap and Floor** for some forms of low carbon flexibility may be retained as a transitional measure.

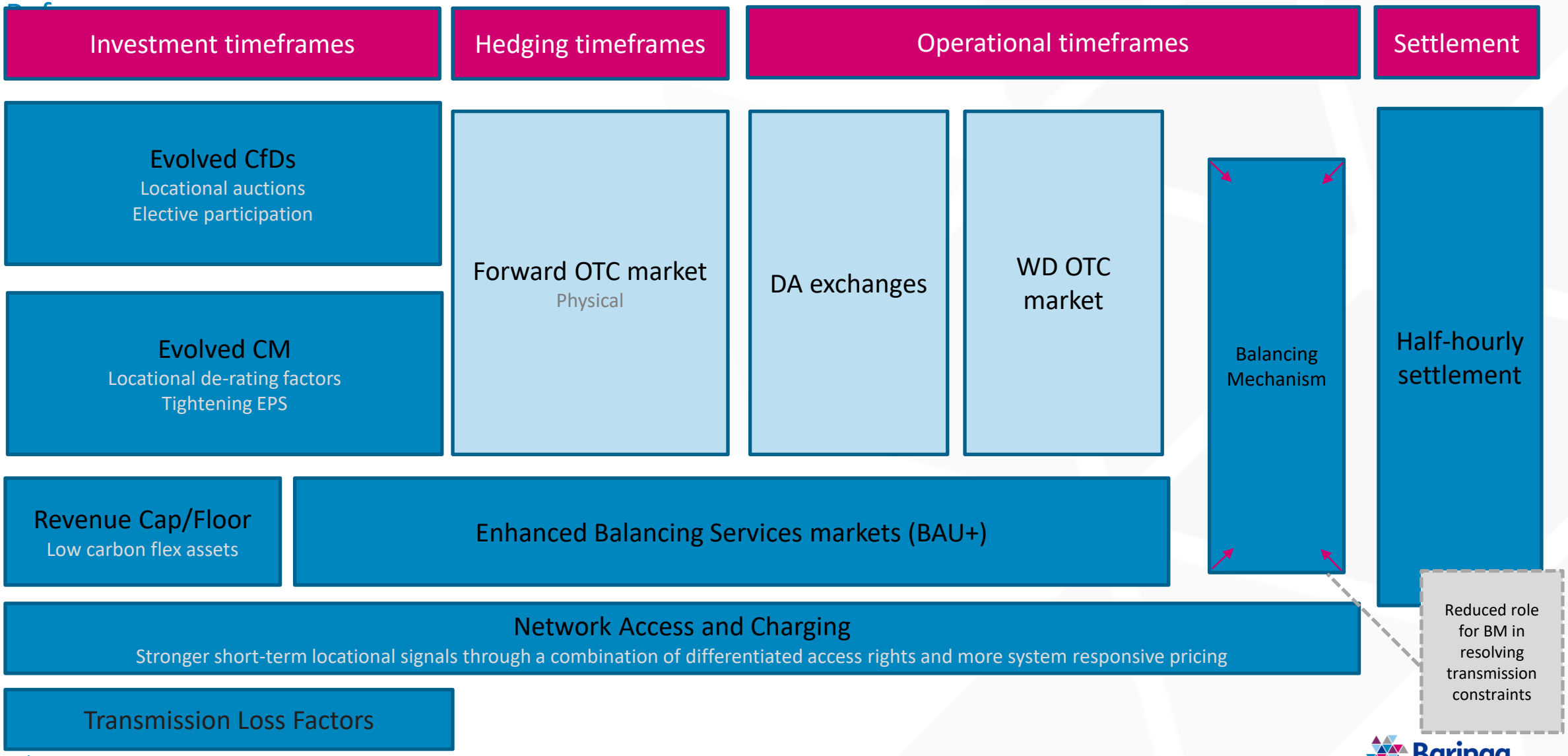
National Pricing – Status Quo

Stylised representation of current electricity markets



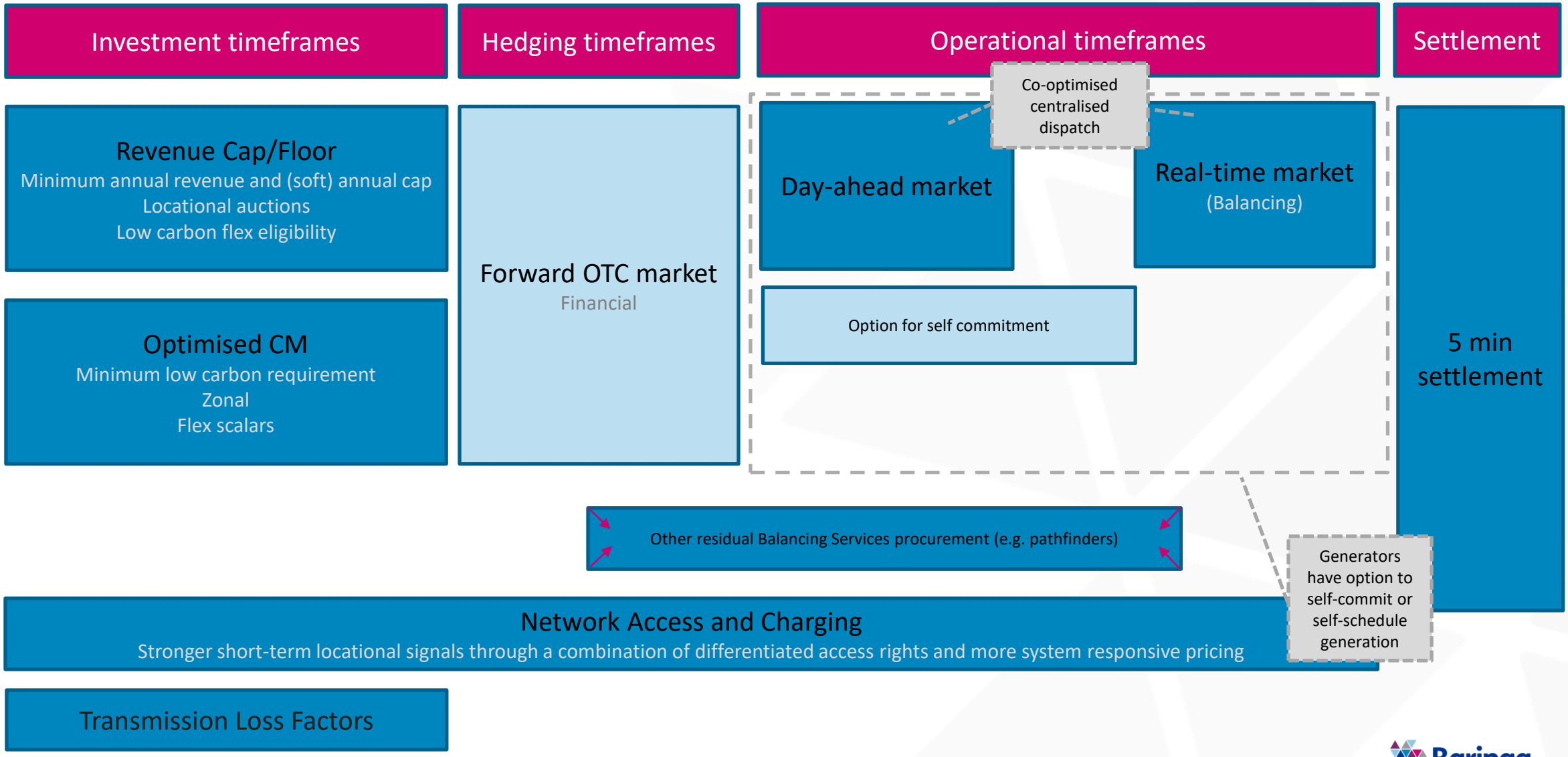
National Pricing – Baseline

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



National Pricing – Build

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



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 implementation
- 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 Centralised 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 Centralised dispatch and Co-optimisation in this package.

Baseline

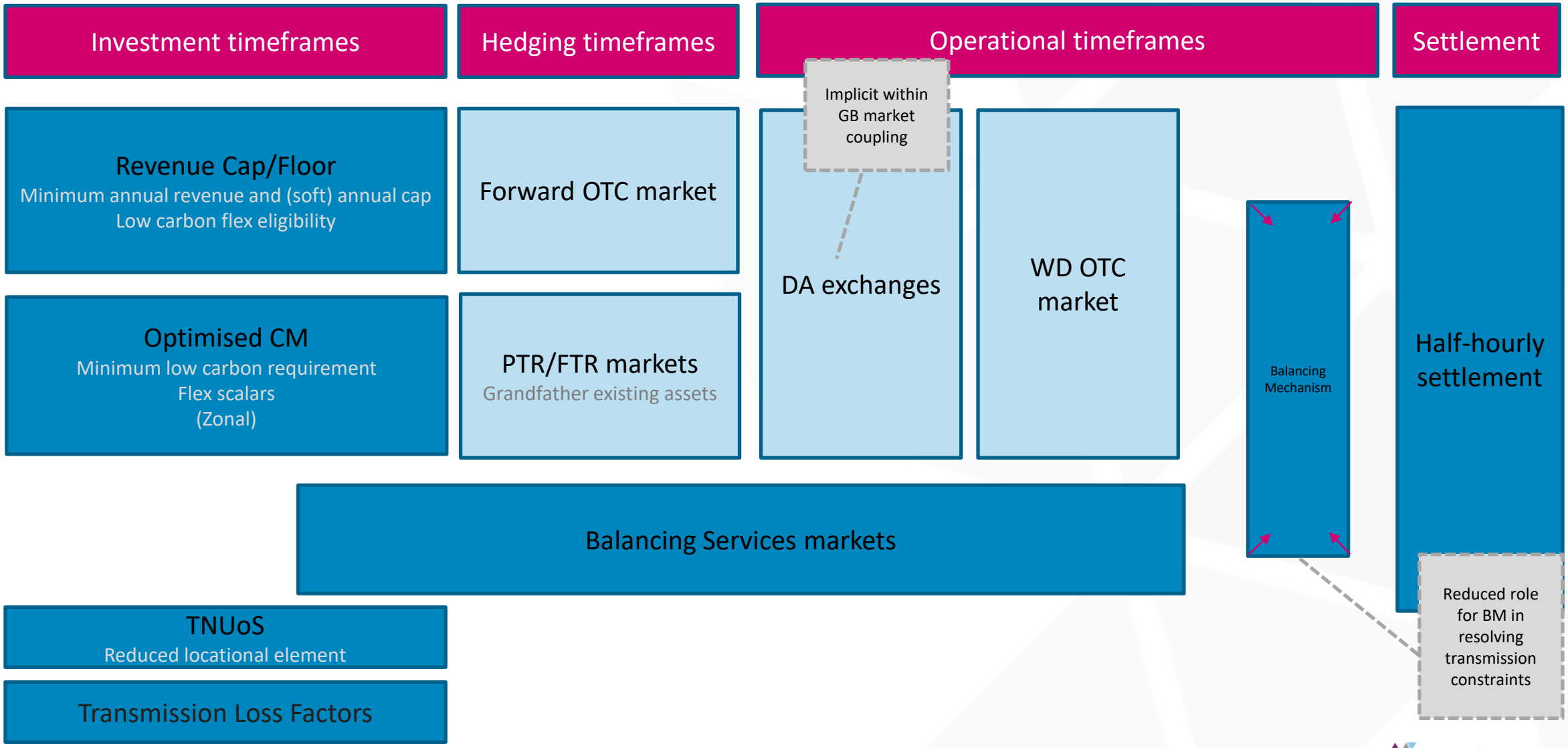
Criteria	*Evolved CfD*	*Evolved CM*	*Operability BAU+*	*Access and Charging Reforms*	*Elective Participation*	*Revenue Cap/Floor*	*National*	*Self*	*Package score*
Value for Money	○	◔	◔	◔	○	◑	○	○	◑
Energy security and system operability	○	◔	◔	◔	○	○	○	○	◔
Decarbonisation	○	○	◑	○	◔	◔	○	○	◔
Competition	◔	○	◔	○	○	◔	○	○	◔
Challenge to implement	○	○	○	◔	◑	◑	○	○	◔
Investor confidence	○	○	◔	○	◔	◔	○	○	◔
Full chain flexibility	○	○	◑	◔	○	◑	○	○	◔
Whole system	○	○	◔	◔	◑	◑	○	○	◔
Adaptability	○	◔	◔	○	◔	◔	○	○	◔
Consumer fairness	○	○	○	○	◔	○	○	○	○
Total	◔	◔	◑	◑	◔	◑	○	○	◔
Total - prioritise VfM, security and decarb	◔	◔	◑	◑	◔	◕	○	○	◔

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	◑	◔	◔	○	◑	◔	◔	○	○	◔	◕
Energy security and system operability	○	◔	○	○	◑	○	◔	○	○	○	◑
Decarbonisation	◔	○	◔	◔	◔	◑	○	◔	○	◔	◑
Competition	◔	○	◑	◔	◑	◔	○	○	○	◑	◕
Challenge to implement	◑	◔	◕	◔	◔	◔	◔	◑	○	◑	◑
Investor confidence	◔	○	◔	○	◔	○	○	◔	○	◔	◑
Full chain flexibility	◑	○	◑	○	◑	○	◔	○	○	◑	◑
Whole system	◑	○	◔	◔	◔	◔	◔	◑	○	◑	◑
Adaptability	◔	◔	◔	○	◑	◑	○	◔	○	○	◑
Consumer fairness	○	○	◔	◔	○	○	○	◔	○	○	◔
Total	◑	◔	◑	◑	◑	◑	◑	◔	○	◕	◑
Total - prioritise VfM, security and decarb	◕	◑	◑	◑	◕	◑	◑	◔	○	◕	◑

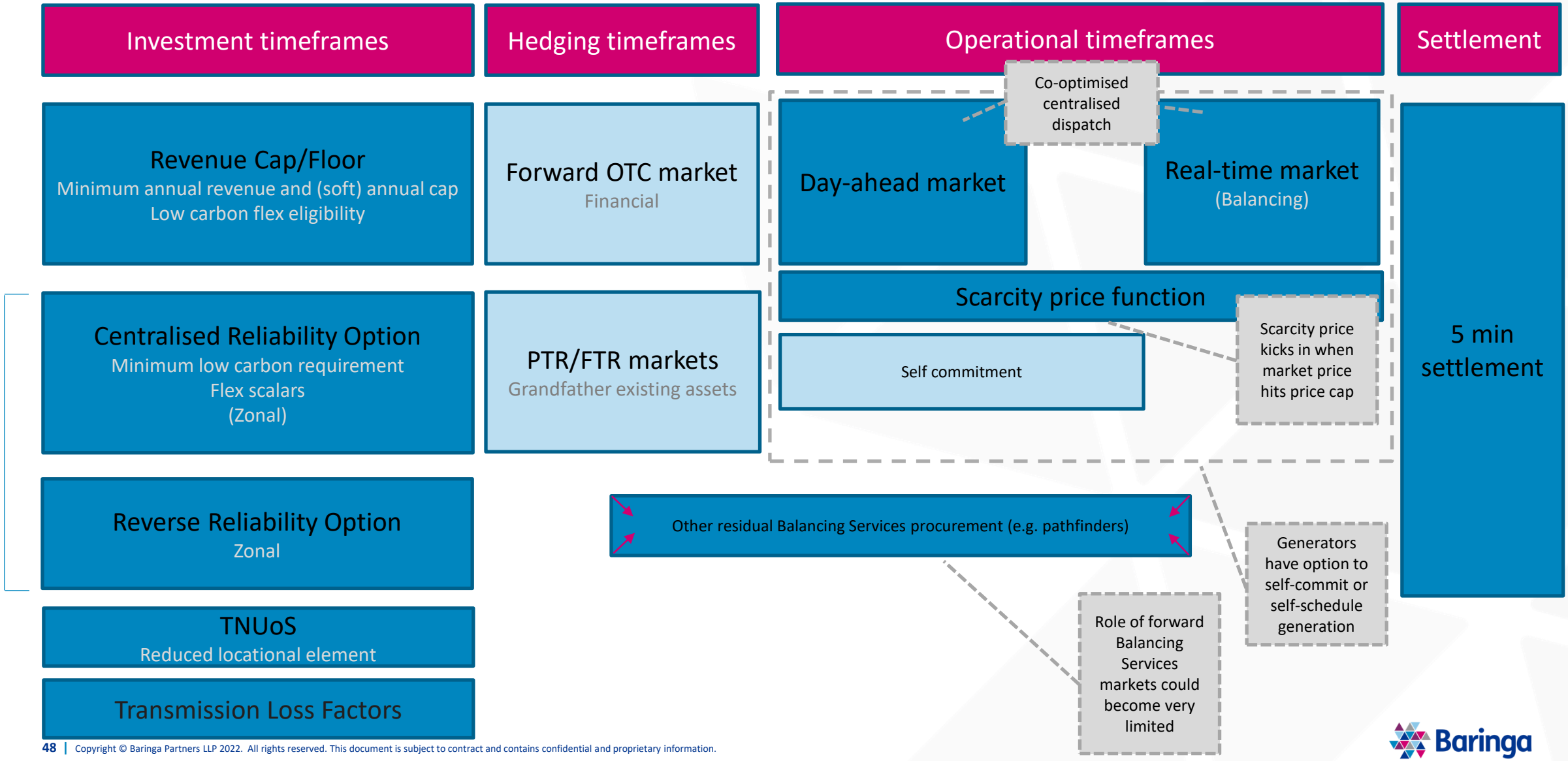
Zonal Pricing – Baseline

Wholesale market split into 10-12 zones; self-dispatch retained; Revenue Cap/Floor and Optimised CM



Zonal Pricing – Build

Wholesale market split with centralised dispatch; Revenue Cap/Floor and Centralised Reliability Option



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 help to 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 Centralised and Reverse Reliability Options and Centralised dispatch with Co-optimisation helps improve the outcomes relative to the Baseline package across most criteria.
- Low carbon and flexibility dimensions are retained in the CRO mechanism building on the baseline Optimised CM.
- Implementation is more challenging than the Baseline given inclusion of Centralised dispatch.

Baseline

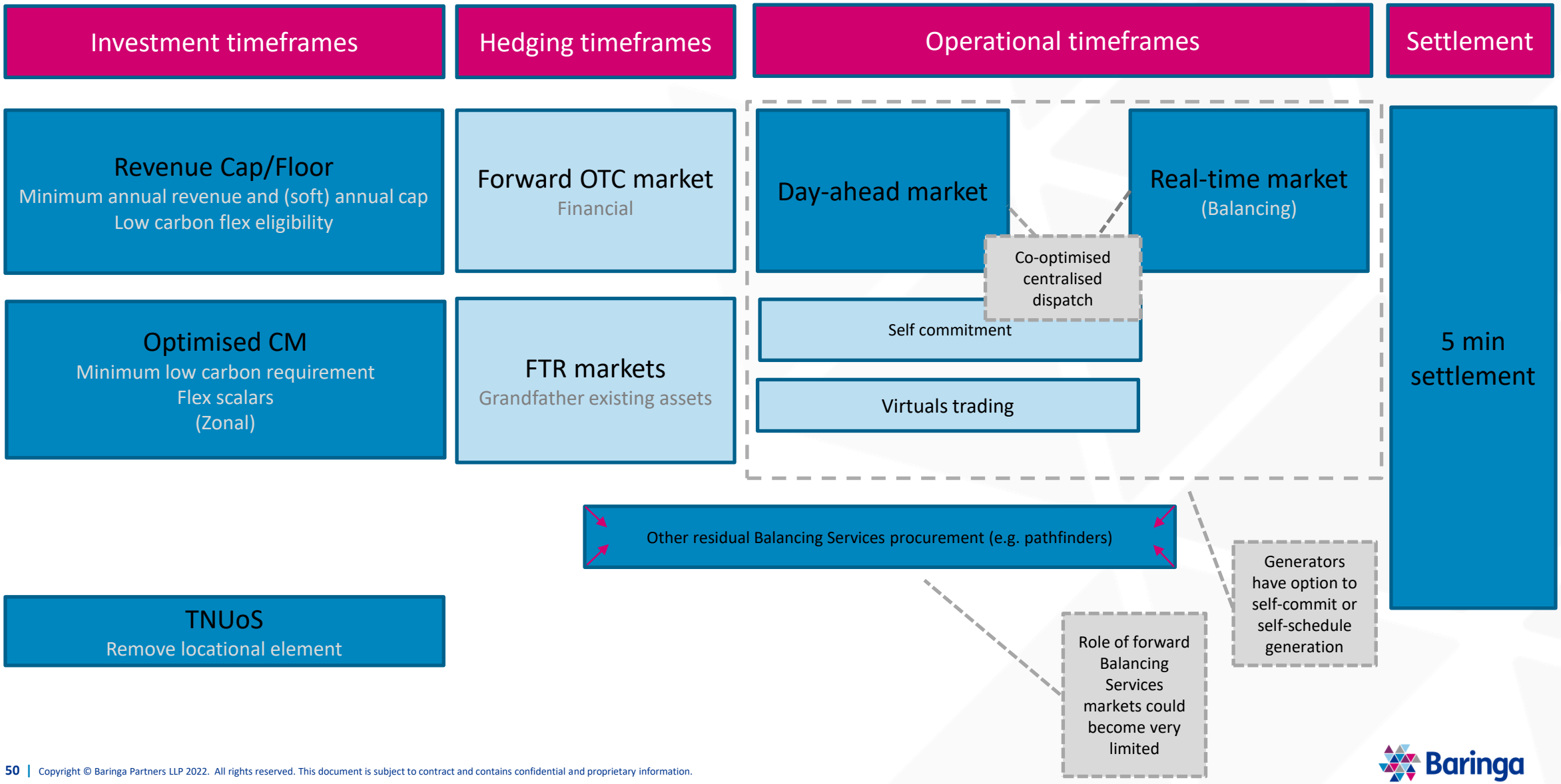
Criteria	*Revenue Cap/Floor*	*CM + Enhanced Flex*	*Operability BAU+*	*FTR / PTR*	*Elective Participation*	*Optimised CM - Minimum Carbon*	*Zonal*	*Self*	*Package score*
Value for Money	◑	◑	◔	◔	○	◔	◑	○	◑
Energy security and system operability	○	◑	◔	○	○	○	◔	○	◔
Decarbonisation	◔	◔	◑	○	◔	◑	◔	○	◔
Competition	◔	◑	◔	◔	○	◔	◑	○	◑
Challenge to implement	◑	◔	○	◑	◑	◔	◕	○	◑
Investor confidence	◔	◔	◔	◔	◔	○	◑	○	○
Full chain flexibility	◑	◑	◑	○	○	○	◑	○	◑
Whole system	◑	◔	◔	○	◑	◔	◑	○	◑
Adaptability	◔	◑	◔	○	◔	◑	◔	○	◔
Consumer fairness	○	○	○	◑	◔	○	◔	○	○
Total	◑	◑	◑	◑	◔	◑	◑	○	◑
Total - prioritise VfM, security and decarb	◕	◕	◑	◑	◔	◑	◑	○	◔

Build

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

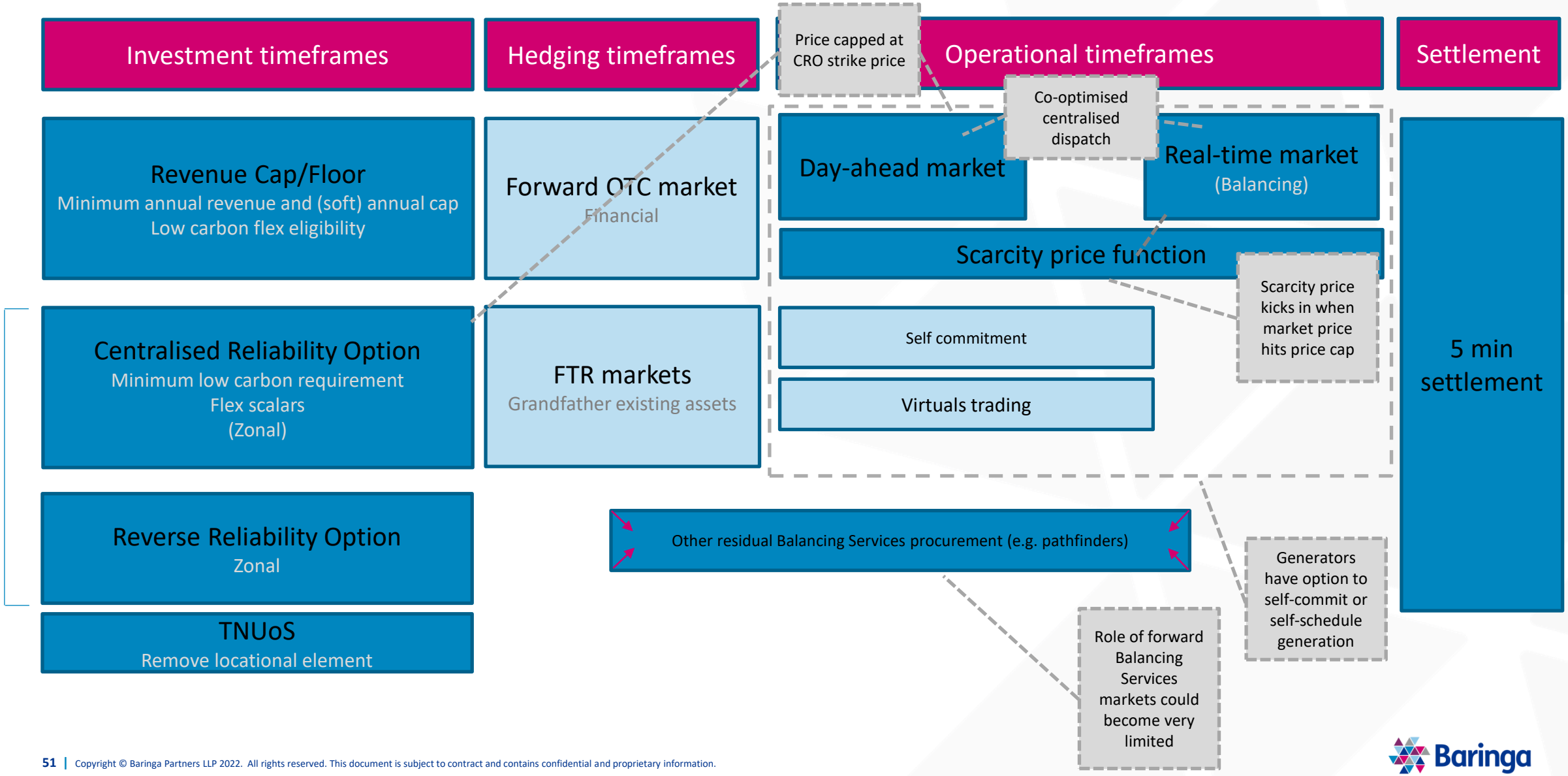
Nodal Pricing - Baseline

Nodal pricing with centralised dispatch; Revenue Cap/Floor and Optimised CM



Nodal Pricing – Build

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



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 (or through locational price averaging for some demand).
- Implementation 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 as Centralised Reliability Options (with dimensions for flexibility and minimum carbon) 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	Revenue Cap/Floor	CM + Enhanced Flex	Co-optimisation	FTR / PTR	Settlement Period Reform	Elective Participation	Optimised CM - Minimum Carbon	Nodal	Central	Package score
Value for Money	◑	◑	◔	◔	◔	○	◔	◕	◔	◕
Energy security and system operability	○	◑	○	○	○	○	○	◔	○	◔
Decarbonisation	◔	◔	◔	○	○	◔	◑	◑	◔	◑
Competition	◔	◑	◑	◔	◔	○	◔	◔	◑	◕
Challenge to implement	◑	◔	◕	◑	◑	◑	◔	●	◑	●
Investor confidence	◔	◔	◔	◔	○	◔	○	◑	◔	○
Full chain flexibility	◑	◑	◑	○	◑	○	○	◕	◑	◕
Whole system	◑	◔	◔	○	◔	◑	◔	◕	◑	◑
Adaptability	◔	◑	◔	○	◔	◔	◑	◑	○	◑
Consumer fairness	○	○	◔	◑	○	◔	○	◔	○	○
Total	◑	◑	◑	◑	◑	◔	◑	◕	◕	◑
Total - prioritise VfM, security and decarb	◕	◕	◑	◑	◑	◔	◑	◕	◕	◑

Build

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

Conclusions

Conclusions – package assessment

All packages show an improvement on the Status Quo, with the Nodal Build package scoring best overall but with a longer implementation lead time; other options offer lower risk transition but lower long-term benefit

Nodal Build is the highest scoring package, but has the biggest implementation challenge

- It scores consistently high across most criteria, and by including additional options such as FTRs (with grandfathering) its areas of potential weakness (investor confidence and consumer fairness) are countered.
- Given the greatest delivery challenge is in implementing the nodal market itself, it would make most sense if going for this approach to target the Build rather than Baseline version and capture more of the benefits; noting that some of the options included in Nodal Build are optional.

Zonal Build scores as strongly as Nodal Build if value for money, energy security and decarbonisation are prioritised

- The somewhat lower implementation risk of this option offsets the slightly lower scores across the other criteria.
- The Zonal Baseline would face further reduced delivery risk but scores less favourably for criteria including decarbonisation and energy security.

The National packages would become more attractive, if implementation was weighted more highly in the assessment

- The National Baseline is the easiest package to implement and might be considered a low regrets option as a transitional step to one of the Build packages.
- The Revenue Cap/Floor option (and option for elective participation) is compatible with all pricing models and could be implemented as part of a transitional step to a locational pricing model.

Criteria	*National Baseline*	*National Build*	*Zonal Baseline*	*Zonal Build*	*Nodal Baseline*	*Nodal Build*
Value for Money	◑	◕	◑	◕	◕	●
Energy security and system operability	◔	◑	◔	◑	◔	◕
Decarbonisation	◔	◑	◔	◕	◑	◕
Competition	◔	◕	◑	◕	◕	●
Challenge to implement	◔	◑	◑	◕	●	●
Investor confidence	◔	◑	○	◔	○	◔
Full chain flexibility	◔	◑	◑	◕	◕	●
Whole system	◔	◑	◑	◑	◑	◕
Adaptability	◔	◑	◔	◑	◑	◕
Consumer fairness	○	◔	○	○	○	◔
Total	◔	◑	◑	◑	◑	◕
Total - prioritise VfM, security and decarb	◔	◑	◔	◕	◑	◕

Caveats

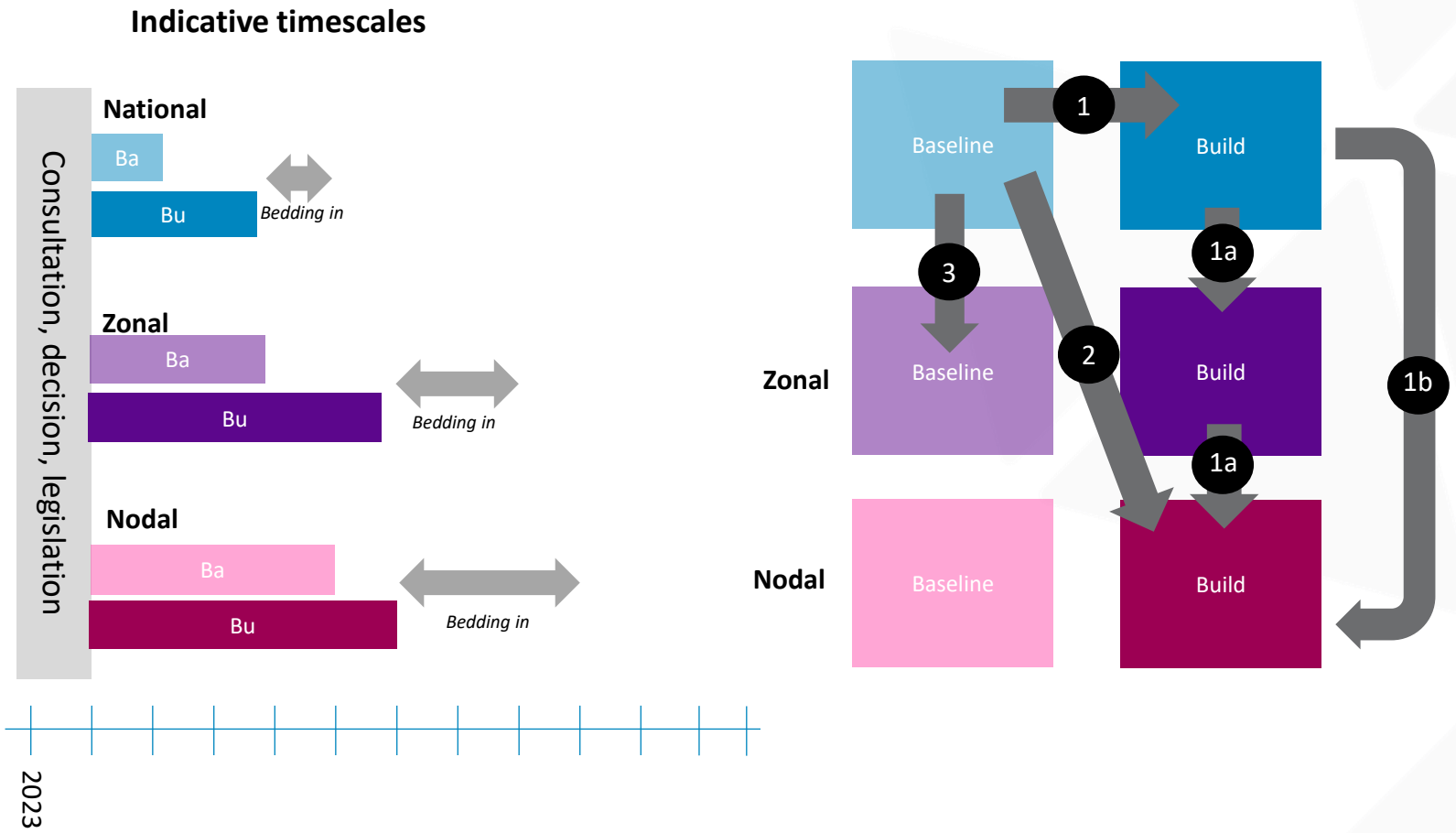
- Scoring is indicative at this stage and the design of some of the constituent policy options is formative. Uncertainty around how wider market developments will affect the extent to which Build packages can unlock greater benefits.
- The Zonal and Nodal Build package includes options such as Centralised Reliability Options and Reverse Reliability Options which could be implemented with the National Build package, although noting we have found the incremental value of these options is greatest with locational pricing in the wholesale market.
- Implementation is potentially the biggest swing factor in the assessment, with its importance heightened if the 2035 decarbonisation objective is prioritised; a detailed assessment of the implementation challenge and risks of each package would be needed ahead of firm recommendations.

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 and efficient cost of capital	◔	◔	◔	◔	◔	◑						
	Increase system flexibility	◑	◑	◕	◕	◕	●						
	Reduce inefficient inframarginal rent	○	◑	◔	◕	◑	●						
Energy security and system operability	Ensure sufficient capacity to meet peak system needs	◔	◑	◔	◑	◔	◑	◔	◑	◔	◑	◔	◕
	Ensure sufficient available capacity 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	◔	◕	◔	◕	◑	◕	◔	◑	◔	◕	◑	◕
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	○	○	◑	◔	◔	○						
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	○	◔	◔	◔	◑	◔						
Total		◔	◑	◑	◑	◑	◕	◔	◑	◑	◑	◑	◕
Total - prioritise VfM, security and decarb		◔	◑	◔	◑	◑	◕	◔	◑	◔	◑	◑	◕

Preliminary conclusions - potential REMA pathways

We have identified the 3 most likely general pathways which consider the trade off between optimal market design and confidence in achieving 2035 and 2050 targets



Pathway 1: Evolutionary approach through National Baseline to Build with intention of migrating through Zonal to Nodal Build (1a), or to Nodal Build in one step (1b), after 2035 (starting implementation in early 2030s).

Rationale: prioritising achievement of 2035 objective before establishing a market fit for purpose to achieve approximate doubling of the size of the electricity system by 2050.

Pathway 2: Target Nodal Build as soon as possible, but pursue National Baseline as an interim step during implementation phase

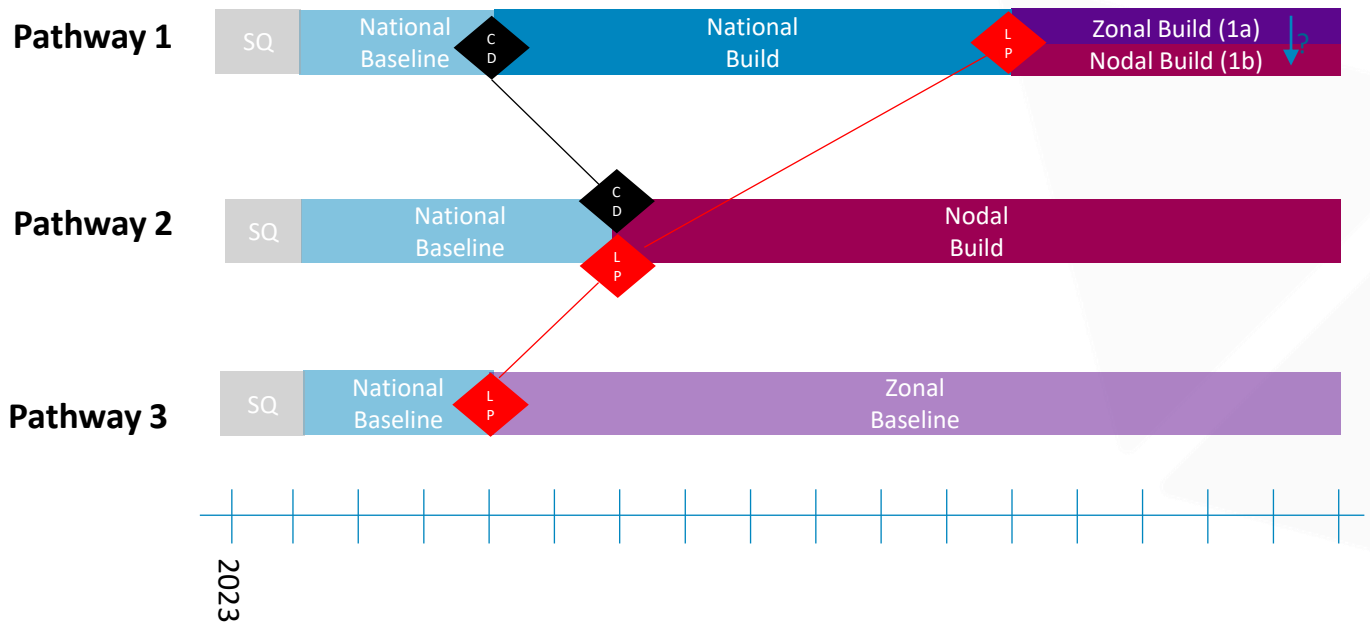
Rationale: prioritising getting fit for Net Zero market, even if that might slow decarbonisation in the near term and/or increase the cost of achieving the 2035 target.

Pathway 3: Evolutionary approach to Zonal Baseline.

Rationale: a means of introducing locational wholesale prices as soon as possible to mitigate constraint issues, but avoiding the degree of market disruption associated with implementing Centralised Dispatch.

Illustration of implementation phasing

The packages are illustrative of potential future market designs but different elements of the packages could be phased over different timeframes



CD = Centralised Dispatch

LP = Locational Pricing (Zonal or Nodal)

Timing of introduction Centralised Dispatch (CD) and Locational Pricing (LP) are perhaps the biggest decisions

- We show CD implemented ahead of LP in Pathway 1, and simultaneously in Pathway 2
- However, different phasing is possible, and detailed design choices and implementation of centralised dispatch may vary depending on pathway.

The timing of replacement of current CfD with recommended Revenue Cap + Floor could be made independently of decision on CD and LP

- It is assumed that this could be done within the existing EMR policy/regulatory framework

Implementing an Optimised CM could be done relatively quickly but the introduction of a Centralised Reliability Option or Reverse Reliability Option would take longer

- Changes to the CM could be made independently from decisions on CD and LP although design interdependencies would need to be recognised
- The Optimised CM could probably be implemented within the EMR policy/regulatory framework
- The introduction of a Centralised Reliability Option or Reverse Reliability Option would require legislation

Appendix

A) Elective participation and Low Carbon Futures Market

CfD – Elective Participation

This option would allow certain customers to opt out of the centralised CfD scheme, and meet a decarbonisation obligation by sourcing their own low carbon power

Current situation

- A number of larger energy users have entered into long term PPAs to source low carbon power as part of their decarbonisation strategies
- However, most corporates are exposed to CfD settlement payments which could mean they are 'over-hedged', which ultimately could act as a disincentive to contract for more low carbon power
- Where organisations are looking to go further and faster than national targets policy this should be encouraged

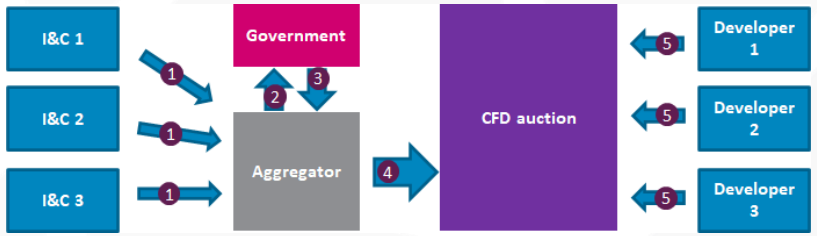
Elective participation

- A potential solution could be to allow certain customers to opt out of the centralised CfD scheme, and demonstrate they are meeting their decarbonisation objectives through their own contracting; or this could be for a whole class of customers, for example I&C customers above a certain annual consumption threshold
- These customers may then elect to bid into CfD auctions for bilateral agreements (giving them access to larger offshore wind projects, for example), as illustrated on the right

Risks

- It would be necessary to ensure that customers opting out are not avoiding contributing to system decarbonisation, probably requiring a minimum decarbonisation obligation
- Larger customers may be able to cherry pick the lower cost low carbon projects through PPAs (a risk that exists today), pushing up the costs of CfDs for other customers
- The PPA market is more flexible, which could mean that elective participation in CfD auctions is limited (unless there is a range of different financial hedging products available – see next slide)
- The cost of supporting more nascent technologies through CfDs could fall on wider consumers if large consumers have the option of opting out; this would need to be addressed

Bilateral participation in CfD auctions



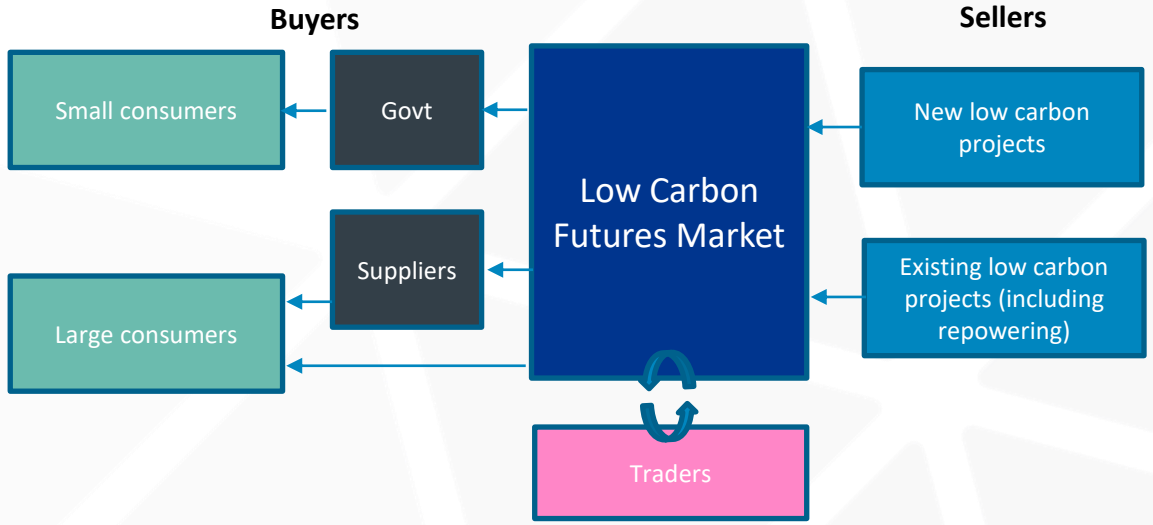
1. Customers submit a 'complex' bid that specifies demand at different prices and in different years
2. Government assesses further need on the basis of policy goals (this may be to cover demand from residential and smaller business customers)
3. Government supplements demand if necessary
4. Third party aggregator puts the bids together to form a single demand curve and set of auction parameters
5. Generation developers submit bids into the CfD auction

A similar concept could work for alternative low carbon investment options, such as the **revenue cap and floor**, with participants signaling their demand for bilateral cap and floor agreements, although more likely they may be looking for fixed price hedges (see next slide for the evolution of the concept to a broader Low Carbon Futures Market)

Low Carbon Futures Market

Current very bespoke CfD contracts could evolve into more standard financial instruments that could be tradeable

- The CfD auctions with Elective Participation could evolve into a Low Carbon Futures Market
- Very bespoke CfD contracts could be replaced with standardised financial swaps with different contract tenors which could be bilaterally traded
- This would give access to financial hedging instruments for assets operating outside of a standard CfD e.g. existing RO supported plant, plants whose CfDs have ended, plant looking to repower
- This could reduce the risk for investors associated with the 'merchant tail', particularly where future design of the wholesale market is uncertain; whilst price risk remains the existence of a liquid futures market (backed by Govt) should increase investor confidence
- It would expand the range of options that larger consumers have for sourcing low carbon power and hedging their energy costs
- Government could inject liquidity by buying low carbon futures contracts on behalf of mass market customers, settled through the equivalent of the CfD levy
- This could operate alongside a change in mass low carbon support in future to Revenue Cap & Floor, but with probably more focus on shorter dates contracts since low carbon generators would have less need for mitigating long term price risk



Differences between GPP and Low Carbon Futures Market

Characteristic	Green Power Pool	Low Carbon Futures Market
Market type	Physical	Financial
Contract tenor	~15 years	Multiple tenors from 1 to 15 years – standardised products
Balance responsibility	Managed by GPP	Market participant – self-dispatch or part of centralised dispatch
Eligibility	Intermittent renewables Certain consumer groups	All low carbon resources All suppliers Traders
Pricing	Based on LCOE	Competitive, settled via spot market
Participation	Mandatory	Voluntary

Financial CfD

Key mechanism design features and assessment of compatibility with Elective Participation CfDs and a Low Carbon Futures Market

Key design features

- The instrument decouples payments from the actual production of an individual low carbon generator and provides a predictable fixed payment.
- Under the Financial CfD, the government or a centralised funding body makes a fixed monthly payment to the low carbon generator. In return, the generator pays the government the spot market revenue of that month.
- The payments are not based on the generator's actual production and revenues but on those of a benchmark generator.
- Fixed payments remove the wholesale price risk from the generator (as in the current CfD), but critically also removes the volume risk for the generator, which is passed on to customers.
- The choice of benchmark is critical for the amount of 'basis risk' the generator faces; if the benchmark plant's output closely mirrors that of the plant the basis risk is low, but the generator could be exposed to large difference payments if its output is lower than the benchmark plant due periods of high prices.
- Basing return payments by the generator on those of a benchmark generator retains the incentives for the generator to optimise dispatch.
- The contract can be awarded competitively through an auction.
- The features of the contract in terms of tenor, size and the properties of the benchmark asset are standardised.

Compatibility assessment

- The core idea is based on allocation by a centralised body through an auction. Compatibility with a two-sided market would be determined by whether the product meets the needs of potential buyers.
- The instrument is standardised from the perspective of buyers and sellers – and mimics a tolling contract where the offtaker is effectively paying for the right to procure energy from the plant at a reference price.
- Contract length would need to vary to satisfy varied duration preferences in a Low Carbon Futures Market – this can potentially be achieved by splitting contracts and including existing and repowered projects.
- The contract passes on volume risk to the buyer – which can only mimic wholesale products or PPAs if combined with weather insurance.

Crowding out of private markets

- Given the need for the buyer to absorb or insure weather risk – comparability with traded wholesale products, and risk of crowding out, are likely to be low. However, this would push weather/volume risk on the buyer, and it is not obvious that buyers can hedge this risk more cost effectively than generators, who to date have been able to manage it.
- Note that an elective participation CfD under the standard design can crowd out private market PPAs but potentially replacing them with a product that is more widely available.

B) Revenue Cap and Floor

Revenue Cap & Floor – allocation options

Auctions could be implemented in the context of a revenue cap and floor model but requires some key design choices to be made

Auction

Fixed cap

- A structure that fixes the cap and allows participants to bid the floor level would allow developers to signal their debt financing costs and risk appetite
  - A higher floor level would be required to support financing structures with a higher level of gearing and a lower risk appetite
  - A lower floor level would be required by developers with lower financing cost
- A fixed cap level (potentially with some gain sharing above the cap level) would allow government to determine the maximum acceptable level of cost paid by consumers for low carbon power

Fixed floor

- A structure that fixes the floor level and allows developers to bid the cap would require the Government to determine the level of debt financing cost and risk appetite on behalf of developers
- This structure may allow developers to signal their risk appetite indirectly
- A higher cap implies a higher equity financing cost

Floating cap and floor

- A structure that allows developers to bid both cap and floor
- Award of contracts based on relative competitiveness against value for money criteria that consider a range of potential future market price outcomes
- For transparency it is likely that these criteria are published in advance

Non-auction

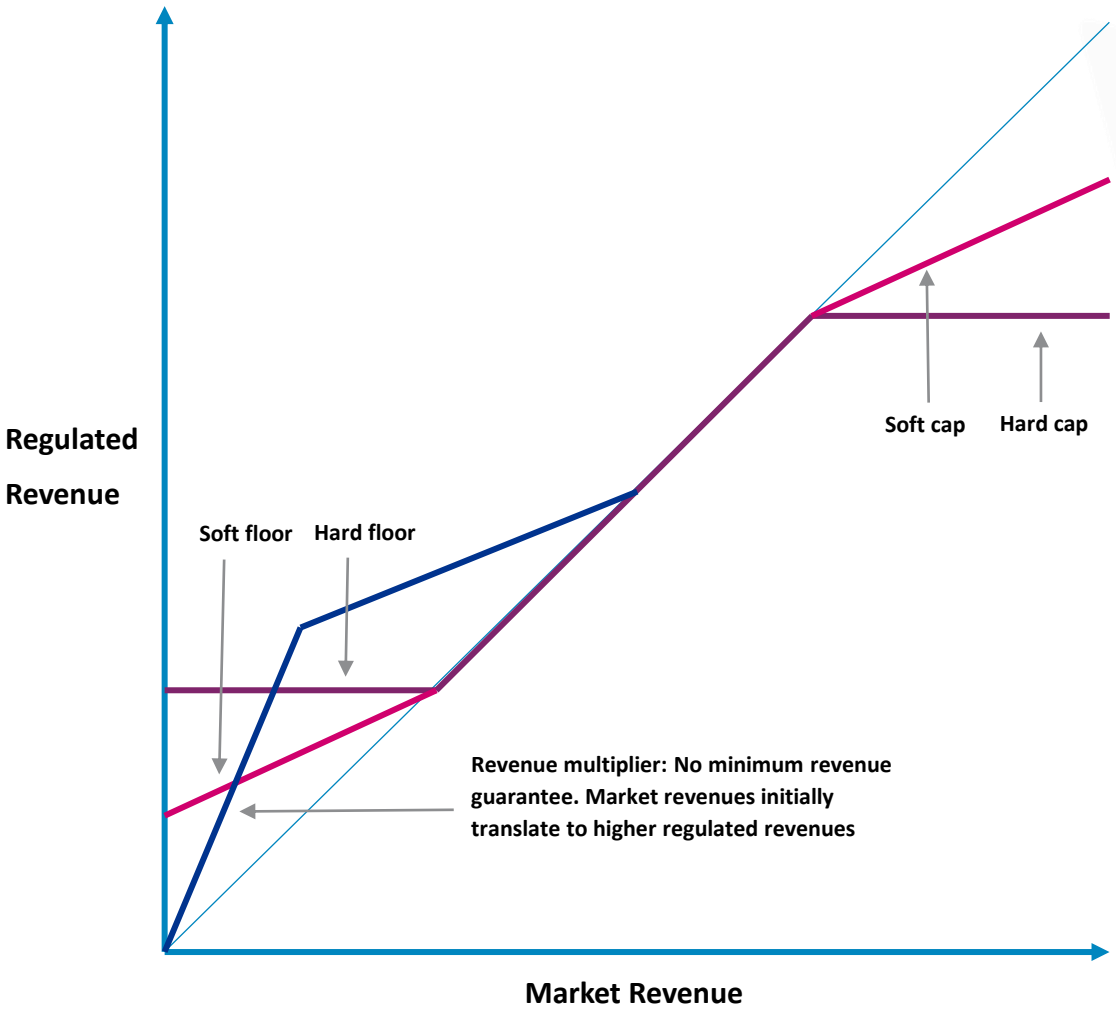
Bilateral agreement

- Under this approach Revenue Cap and Floors would be bilaterally negotiated between developers and Government
- Decisions made based on a value for money assessment and wider decarbonisation objectives

Fixing the cap and allowing developers to bid the floor level is likely to deliver the best risk allocation and outcome for consumers

Revenue Cap & Floor – design options

The Revenue Cap and Floor model could be constructed with either a hard or soft cap



- A cap and floor, if implemented, can offer the upside of a revenue floor providing certainty to developers, as well an appropriately determined cap to protect consumers, retaining the market incentives within those bounds.
- The floor reduces project risks by providing a guarantee of a minimum amount of revenue so that a developer can, for example, cover its annual operating expenditure and service its debt.
- The cap is set to ensure that equity investors receive sufficient, but not excessive, returns.
- However, setting a 'hard' cap and floor, while securing benefits to project costs of capital associated with de-risking investment, can distort incentives below the floor and above the cap.
- The width between the cap and floor levels is designed so that developers are exposed to the benefits that the asset provides and so are incentivised to operate in a way that maximises these benefits – although greater width means less project de-risking for investors.

Hard cap and floor: Between the cap and floor operational incentives are aligned with system benefits to the extent that marginal revenue opportunities align with system benefits. However, if prospects of achieving lower/higher than the floor/cap in a year are substantial, incentives to revenue maximise are distorted as the investor may not secure these additional revenues.

Soft cap and/or floor: A soft cap and/or floor maintains the incentives for an asset to maximise revenue across a greater range of outcomes. Below the floor and above the cap, asset owners are not insulated completely from downsides/upsides, but are exposed to a proportion of the losses/gains.

Revenue multiplier: Even under a soft floor, the downside risk for a developer is limited depending on the proportion of losses they face. An alternative model would apply a revenue multiplier greater than 1 up to a certain level of annual revenue, before gradually bringing this transformation back so market revenue matches regulated revenue.

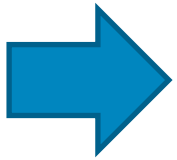
C) Reliability Options

Incentives for Long Duration Energy Storage

Reforms to the Capacity Market alone may not be sufficient to incentivise investment in LDES

Problem statement:

- The VRE 'ratio' -> too much, too soon leading to periods of excess supply but also possible renewable droughts
- Capacity Market (and potential proposed variants) address the peak capacity issue, but:
  - Do they send long enough duration signal?
  - Is the market signal when the system is long sufficient to give investor confidence in the injection leg of the 'spread'?



Option 1 BAU+

- Sharper market signals e.g. more locational pricing
- Reforms to CM to strengthen signal for long duration availability

Leave to the market to determine the right volume of LDES

Option 2 Bespoke auctions for LDES

- Bespoke auctions for LDES
- Could be based on competition on availability payments or Cap and Floor on overall revenues
- Would be dispatched through the market

Central planner determines the correct volume of LDES

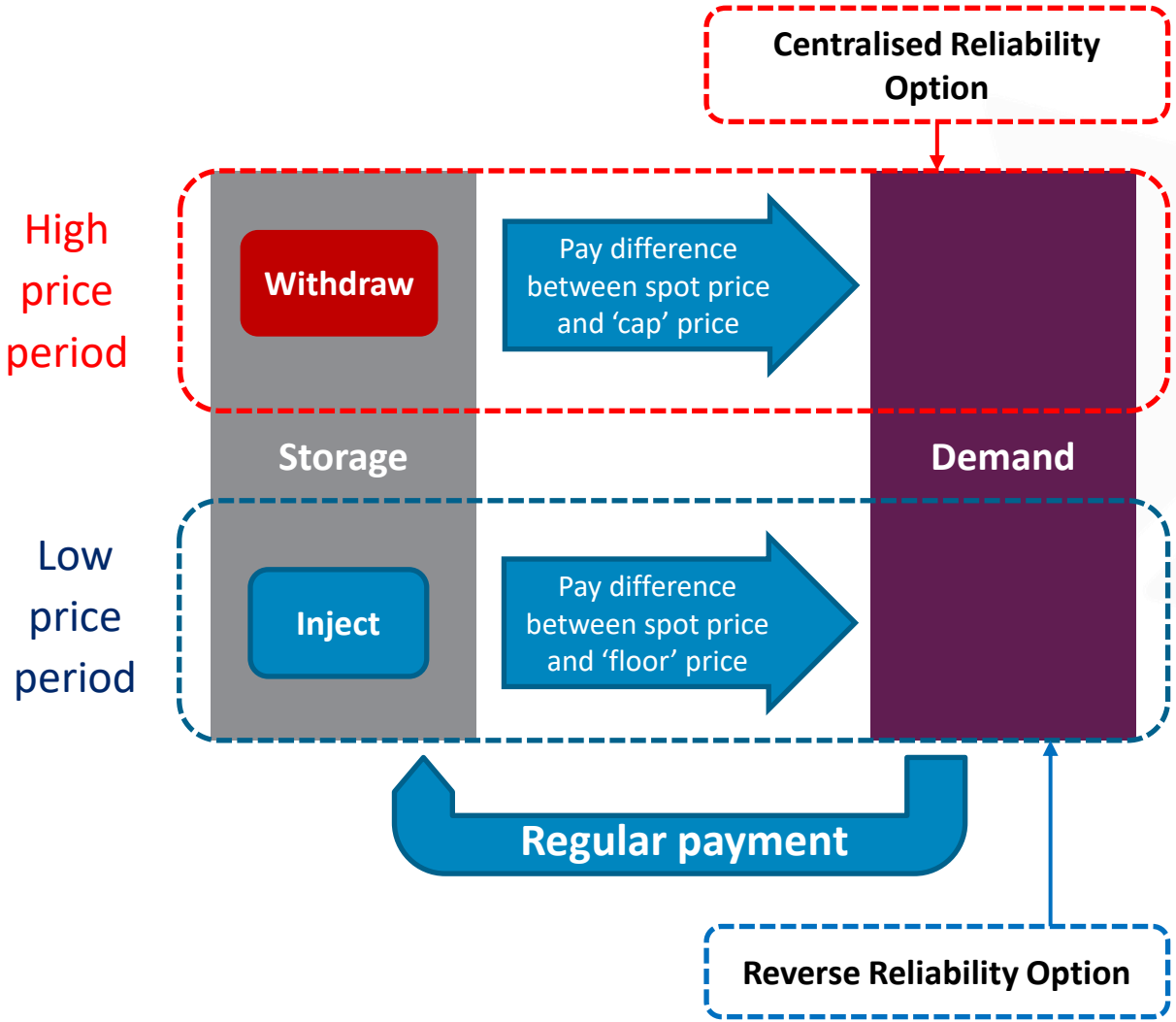
Option 3 'Reverse Reliability Option'

- Akin to a Centralised Reliability Option in reverse – a put option rather than a call option
- The Reverse Reliability Option holder (i.e. Govt/FSO) has the right to sell energy at a floor price
- This would provide the LDES developer with certainty on the 'injection leg'
- Combination of Centralised Reliability Option and Reverse Reliability Option could support LDES investment case
- Auctions for CRO and RRO could be linked

Strengthen business case for LDES, and send stronger signal for all forms of demand turn up

Reverse and regular reliability option for Long Duration Energy Storage (LDES)

The RRO would strengthen business case for LDES and send stronger signal for all forms of demand turn up



Description

- The RRO is akin to a Centralised Reliability Option in reverse – a put option rather than a call option
- The Reverse Reliability Option holder has the right to sell energy at a floor price
- This would provide the LDES developer with certainty on the 'injection leg' at a price that incentivises injection and a stream of regular payments to underpin debt financing
- Combination of Centralised Reliability Options and Reverse Reliability Options could support LDES investment case

Implementation mechanisms

- Auctions for CRO and RRO could be linked and they could be transacted as a single instrument
- While demand is the natural counterparty to a regular CRO – it is zero marginal cost generators that may benefit most from a floor price

CRO/RRO – reference price under nodal or zonal pricing

In a zonal or nodal market design, the choice of strike price and reference settlement price for Reliability Options will be important in determining the strength of locational signal

	Strike price (cap – CRO, floor – RRO)	Reference price	Auction	Locational signal
1	Uniform	National	National	• Participants would be exposed to the difference between their locational price and the national price, and would need FTRs to manage that risk • Participants in areas of import constraint would be competitive and therefore likely clear in the auction, passing through the locational signal from the wholesale market
2	Uniform	Locational	Zonal	• All else equal, participants in import constrained zones would bid higher given opportunity cost of lost peak prices making them uncompetitive in the auction • Hence under this approach the CRO auctions would need to be zonal in nature, requiring a central authority to decide the relative volumes by location; an additional centrally administered locational signal • Implementation could be through separate auctions or with minimum capacity requirements by zone and separate clearing prices from a single auction
3	Varied by location	Locational	National	• Under this approach strike prices would be set to be higher in import constrained zones, ensuring that participants in these zones would be competitive and clear • A single national auction would be retained • Successful passing through the locational signal from the wholesale market will depend on accuracy of forecast of locational price differential

Of these options, Option 2 is deemed to present a less complex implementation challenge than the other options, and there is international precedent for zonal capacity markets; the same arguments apply equally for Centralised and Reverse Reliability Options

D) Local Markets

Alternative Local Markets Models

Alternative approaches to Local Markets are defined by who has dispatch primacy and the dispatch approach

		Dispatch primacy			
		ESO	**Hybrid**	**DSO**	**Third party**
Dispatch approach	**Coordinated**		**ENA World B** Power Potential Intraflex		
	Two-tier optimisation			**ENA World A** Pownall DSO regional aggregator	**ENA World E** Olivella Rossell
	Co-optimisation	**ENA World D** Centralised dispatch incorporating distribution system			

Models in REMA consultation

Pownall model involves LMP at the distribution level, with distribution system optimised first. Balance responsibility is at individual distribution nodes

Olivella Rossell model involves third part aggregator offering flex to the DSO first with residual flex offered to ESO. The aggregator is the balance responsible party

E) Financial Transmission Rights

Financial Transmission Rights

Under a locational wholesale market design, participants will need access to tradeable Financial Transmission Rights in order to manage basis risk between locations where they hold positions

Design choices

Direction

- **One-way (option)**: pays out only if price at Location 1 exceeds price at Location 2
- **Two-way**: pays out for positive or negative price differences between for two locations

Volume profile:

- **Baseload**: flat volume, 8760 hours per year
- **Peak**: e.g. for EFA blocks 3, 4, 5 (7am to 7pm), Monday to Friday
- **Offpeak**: e.g. for EFA blocks 1, 2, 6 (7pm to 7am), Monday to Friday, and all day weekends
- **Variable volume (bespoke)**: pay-outs out depending on plant output

Tenors: Quarters, seasons, years, multi-years

Locational coverage:

- **Node to Zone**: price difference between a single node and closest zone (only applies to nodal pricing)
- **Zone to Zone/National System price**: price difference between zones, or from zone to notional national system price

Allocation

- Possible allocation through auctions
- Some allocation for existing assets at zero cost through grandfathering principles i.e. to protect existing access rights/limit distributional effects for customers
- Tradeable bilaterally (standard products)

Cost recovery

- Revenues generated through auctioning FTRs less the difference payments, added to congestion rents, and included in the Maximum Allowed Revenue for transmission operators

Asset class	Perfect hedge*	Imperfect hedge
Intermittent renewable – merchant/RO	Bespoke/variable volume	2 way baseload
Intermittent renewable – CfD (settled at locational price)	n/a	n/a
Intermittent renewable – Revenue Cap + Floor	Bespoke/variable volume	2 way baseload
Baseload	2 way	n/a
Mid merit	1 way	2 way baseload + peak
Peaking	1 way	2 way peak
Storage	2 x 1 way options	n/a

*Assumes range of tenors and locational coverage. FTR would cover dispatch risk unless it included bespoke volume arrangements

Risk management framework for CfDs under nodal and zonal pricing

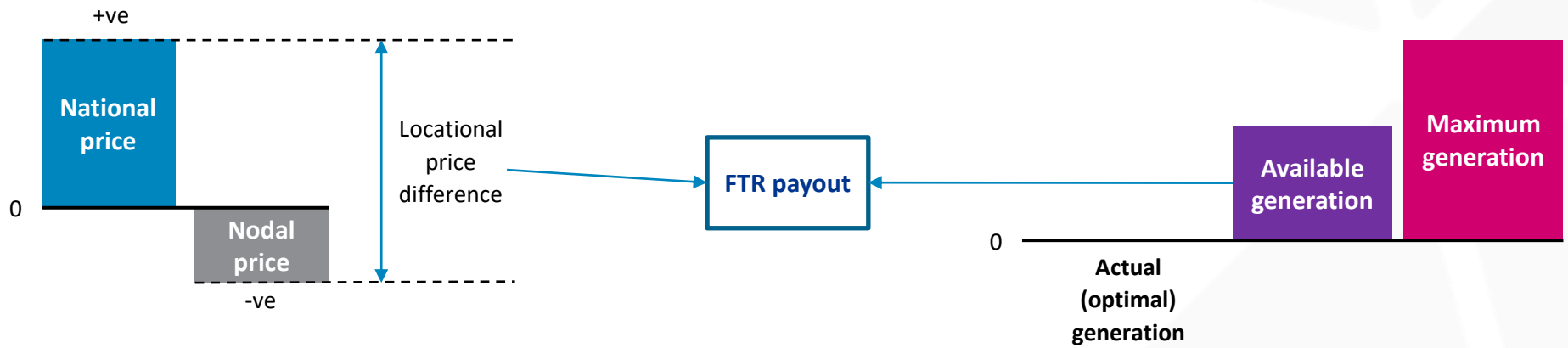
Conventional FTR design does not protect intermittent renewables from locational price risk

Problem statement

- A move to locational pricing will affect revenues of generators exposed to wholesale prices, including CfD generators where national wholesale prices are referenced.
- Existing CfD holders are protected by their contracts from regulatory change that can significantly impact their revenues. In order to avoid increasing perception of regulatory risk, significantly mitigating the impact of locational pricing on profitability of existing merchant and RO renewable generation is likely to be required. The solution therefore needs to address the effect on all of these groups.
- A CfD struck against a zonal or nodal price would expose the generator to additional locational risk if CfD payouts are suspended in periods of negative pricing, which are likely to be more frequent under nodal or zonal pricing.
- Standard FTR instruments do not hedge locational price exposure for intermittent generators because they pay out on price differences even when generation is below full capacity.
- An FTR that pays a generator on the basis of actual output would create an incentive to generate in times when it would be optimal to turn down generation, undermining the locational signals under nodal or zonal prices.

Alternative hedging instrument

- Protecting intermittent generators from additional risk created by locational pricing without distorting locational incentives is a complex problem.
- An FTR would need to be based on the maximum hourly <u>available</u> generation to hedge locational pricing risk without distorting locational dispatch incentives of intermittent generators. This can be calculated on an ex-post basis but would still require an extensive monitoring and audit function in addition to systems that exist today.



F) Access and Charging Reforms

Access and charging reforms under national pricing

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

Problem statement

- Absence of locational dispatch signals results in thermal constraint management being handled through the balancing mechanism.
- The time of use profile of network usage and the associated effect on network and balancing system cost is not fully reflected in the structure of network charges.
- Connect and manage means that newly connecting projects are imposing an externality on existing system users which is unpriced and socialized.
- Network users require clear and transparent signals on future charges and ability to access the network, balancing the trade-off between certainty and cost-reflectivity, in order to form their expectations and reduce inefficient risk premia on investment.

	Long-term signalling		Short-term signalling	
Measure	**More cost-reflective charges**	**Deeper connection charges**	**More dynamic charges**	**Non-firm connections**
Description	Network charges better reflect the cost that users impose on the wider network at different locations	Network charges reflect the change in the cost of reinforcing the wider network when a new user connects	Charges reflect the time at which the user makes use of the network and the effect on network costs	Option for connecting parties to obtain expedited non-firm access to the transmission network
Pros	Potential to provide improved economic signals for location of new capacity	Potential to signal the true marginal cost of reinforcement to new capacity	Potential to provide improved economic signals for generation dispatch and demand response	Allows the system operator to control constraint directly and to 'internalise' constraint externalities
Cons	Methodology for estimating cost-reflectivity is controversial and subject to dispute	Process lacks transparency and may lead to very inconsistent connection cost estimates depending on timing of connection	Increases complexity in charging regimes while still providing less dynamic and less accurate signals than locational prices	Process lacks transparency and imposes a risk on generators choosing this option that they may struggle to quantify

G) Interconnector trading and efficiency

Interconnector trading arrangements

There are some significant considerations for how locational pricing with centralised dispatch would operate alongside interim and planned Multi-Region Loose Volume Coupling (MRLVC) arrangements

Context and considerations

- Locational pricing would essentially create a number of individual but linked prices in GB with higher wholesale market concentration, subject to network constraints.
  - With **interim trading arrangements**, under explicit auctions, a trader must now determine the optimal trading position in any period, no longer relying on the market coupling process and algorithm.
  - While locational pricing has significant benefits, under explicit trading arrangements, the consequences of limited information, or errant forecasts, can be greater for prices at particular nodes. In the short term, or in periods of market volatility, this could contribute to inefficient utilization of interconnection.
- Volume coupling creates greater organisational and operational complexity compared to price coupling. **MRLVC** involves processes with separate governance arrangements: flow forecaster, MRLVC market coupling operation, Single Day-ahead Coupling (SDAC) and GB Day Ahead Market. Operational processes need to be closely coordinated.
- Under **MRLVC**, using common order books will entail changes to the SDAC operational timeline and will pose a challenge for alignment with GB locational pricing operations:
  - The feasibility and timescales for any such changes will need to be resolved before implementation of MRLVC arrangements. There is no immediate path forward under national pricing and, in the context of a package with locational pricing, a sub-optimal solution may endure for the UK-EU trading arrangements.
  - For the purpose of formulating and assessing our Baseline and Build package, we have assumed an enduring trading regime is agreed but note some challenges for interconnector trading arrangements under zonal or nodal pricing with centralised dispatch.

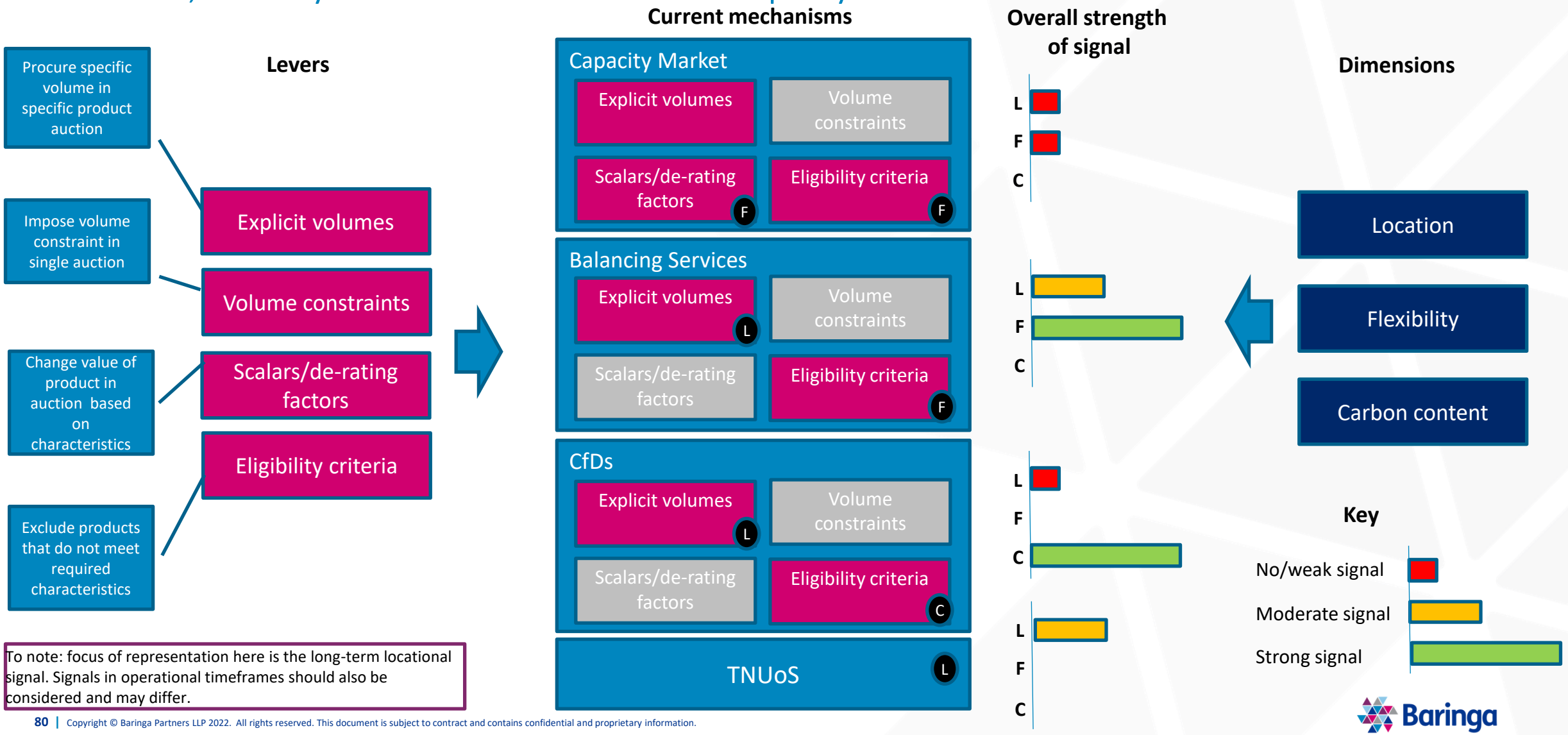
Locational pricing challenges

Information flows	**Dispatch decisions and price formation**	**Participation**	**Timing**
Centralised unit-based bidding would require a significant overhaul of the information flows between market participants and TSOs. Market participants would submit bids and offers at unit level for real-time balancing, together with unit-specific technical constraints.	A *Security Constrained Economic Dispatch* (SCED) algorithm would be responsible for dispatch and prices. Locational prices would represent the optimal cost of meeting an incremental MW at each location, given the bids and offers, which may be uncertain for interconnector participants.	In nodal markets, participation at the day-ahead stage can be mandatory, optional, or not applicable in the absence of day-ahead wholesale markets. All three design options have been observed in international nodal markets.	The SCED algorithm would likely need to be run on a 5-minute basis, as it is in most US markets. In the US markets, all ISOs have adopted two-settlement systems, with financially binding day-ahead nodal markets and real-time nodal settlement of deviations from day-ahead schedules. In markets where prices are cleared in real-time only, such as New Zealand and Singapore, all metered quantities are settled at the nodal real-time price.

H) Options for Optimised CM and CRO

Levers and dimensions

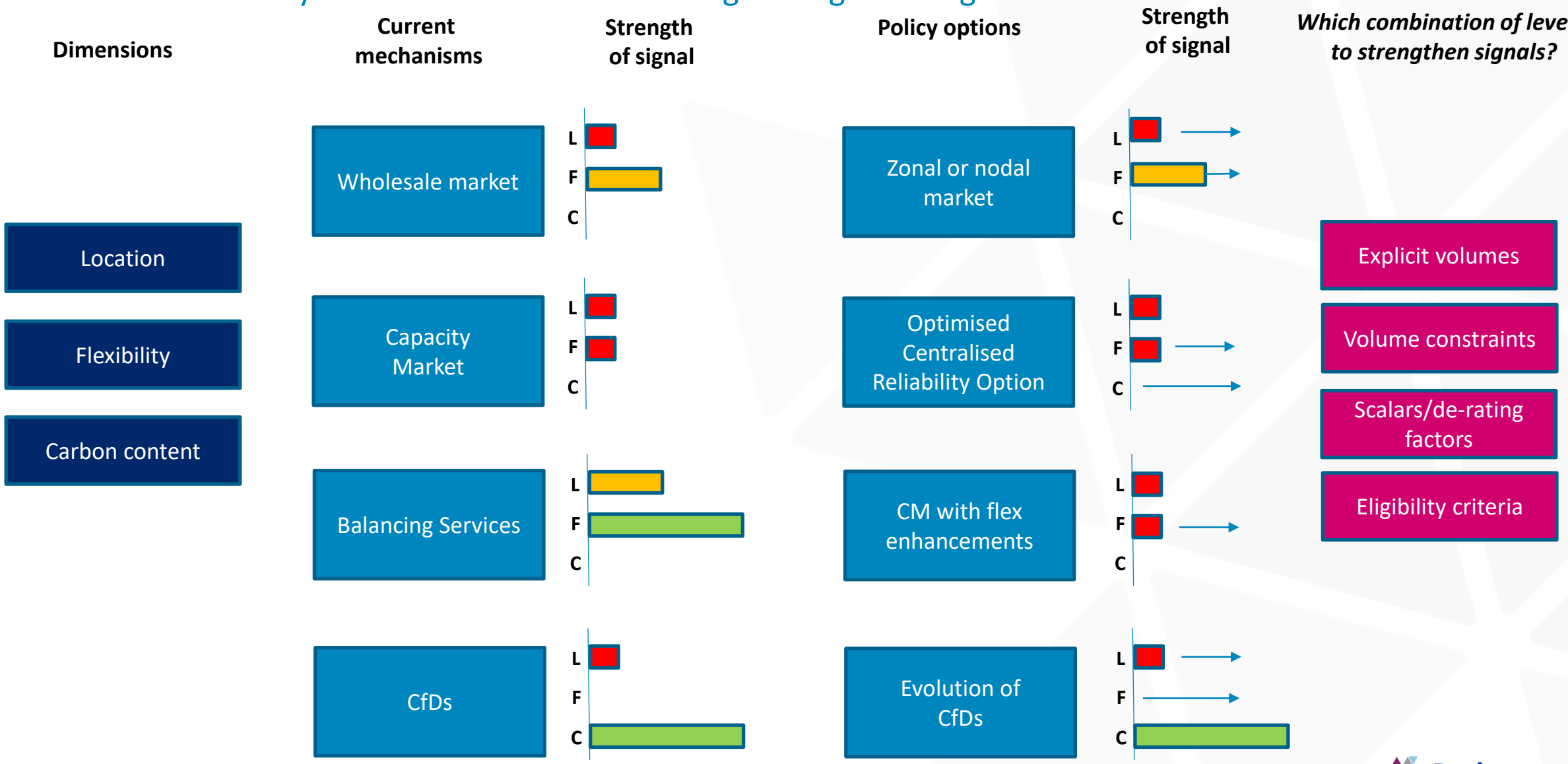
Optimised CM or Centralised Reliability Options could incorporate new dimensions to strengthen the signal for location, flexibility or low carbon dimensions for capacity



To note: focus of representation here is the long-term locational signal. Signals in operational timeframes should also be considered and may differ.

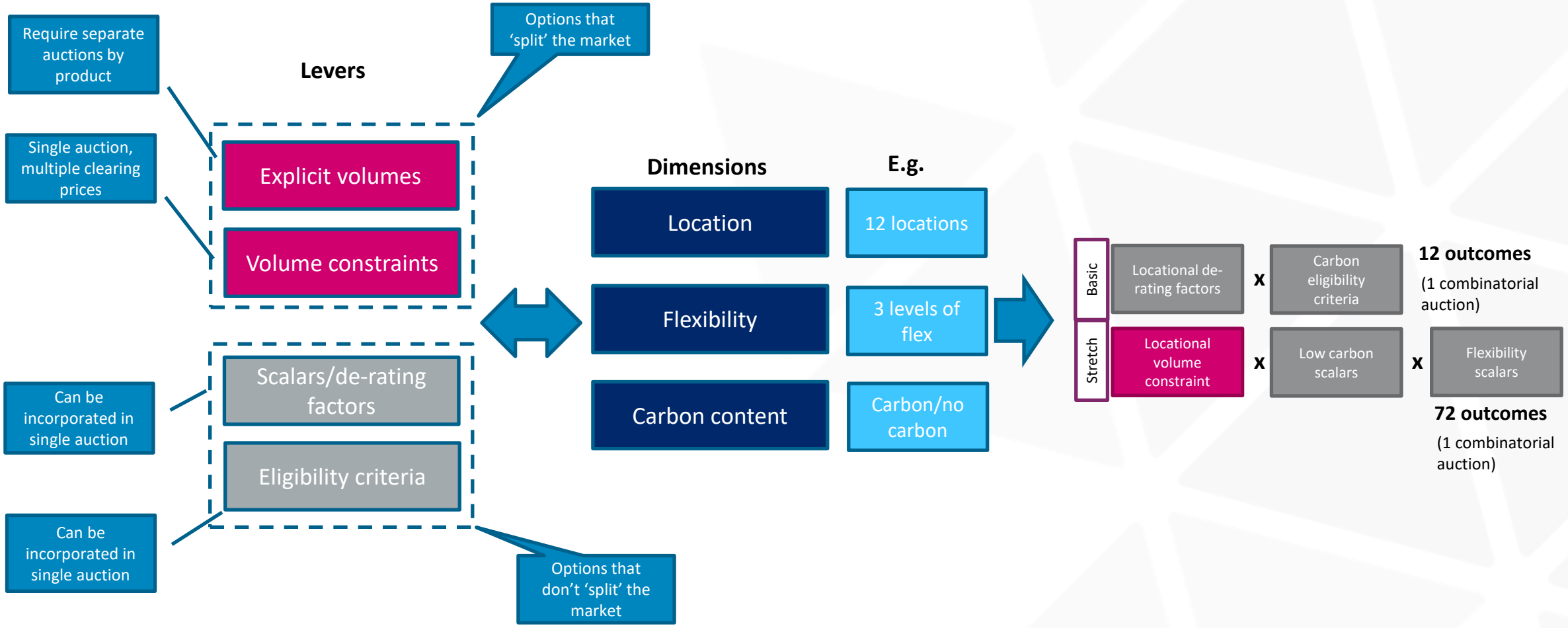
Current mechanisms and future policy options

There are essentially four different levers for strengthening these signals



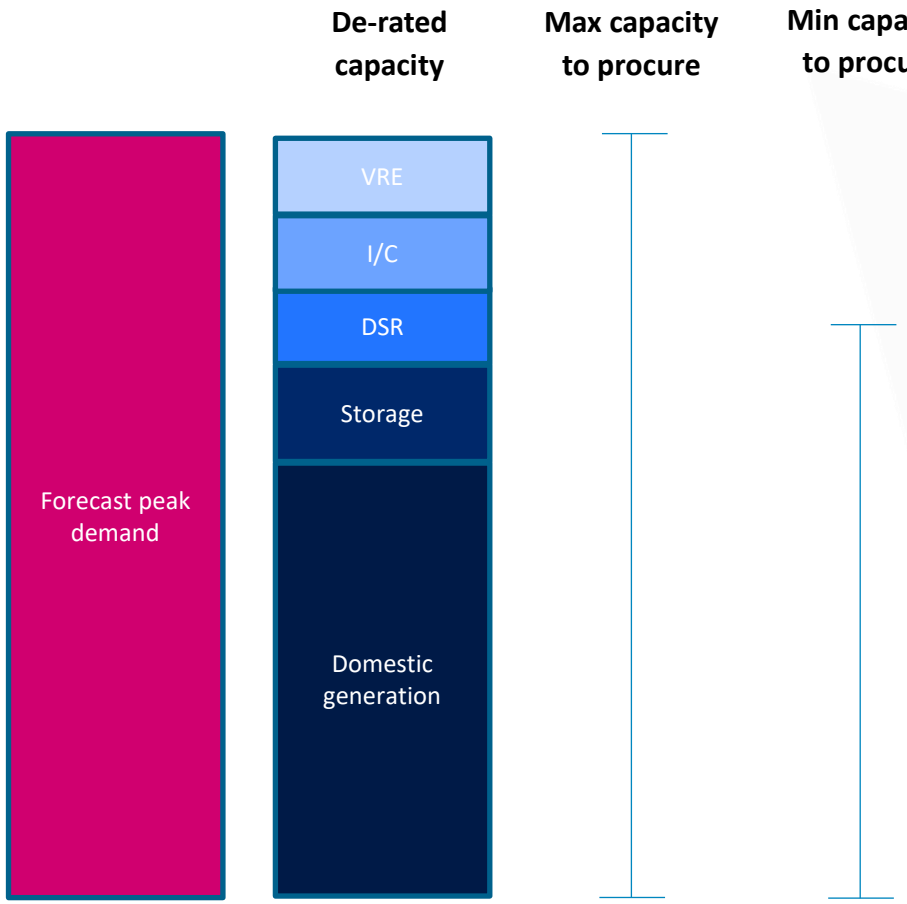
Worked example: Capacity adequacy

The choice of levers and number of categories will determine the number of alternative outcomes from auctions and auction complexity



Capacity adequacy

The eligibility of interconnectors and DSR for future Optimised CM or CRO needs to be considered; sharper wholesale price signals may be considered sufficient and volume requirement reduced accordingly



Rely fully on response to market signals?

Y → No further measure required

N →

1. Strengthen market signal with scarcity pricing function
2. Fully or partially cover with strategic reserve

Delivery Body may recommend lower volume than peak demand where:
1. There is capacity that may contribute to peak demand which is ineligible (e.g. CfD plant)
2. Certain asset classes are excluded since their contribution at peak is uncertain (or difficult to verify) but not zero
3. Eligible capacity chooses not to participate in the capacity mechanism

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