Capacity markets and ancillary services

Future challenges in European capacity markets, and the interactions with ancillary service procurement

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EPSCR & National Grid workshop: Mathematics and Economics of Energy Markets

19 January 2017

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Agenda

- What are the wider issues and key questions?
- Focus: Capacity Markets
- Focus: Ancillary Services procurement
- Summary and key questions

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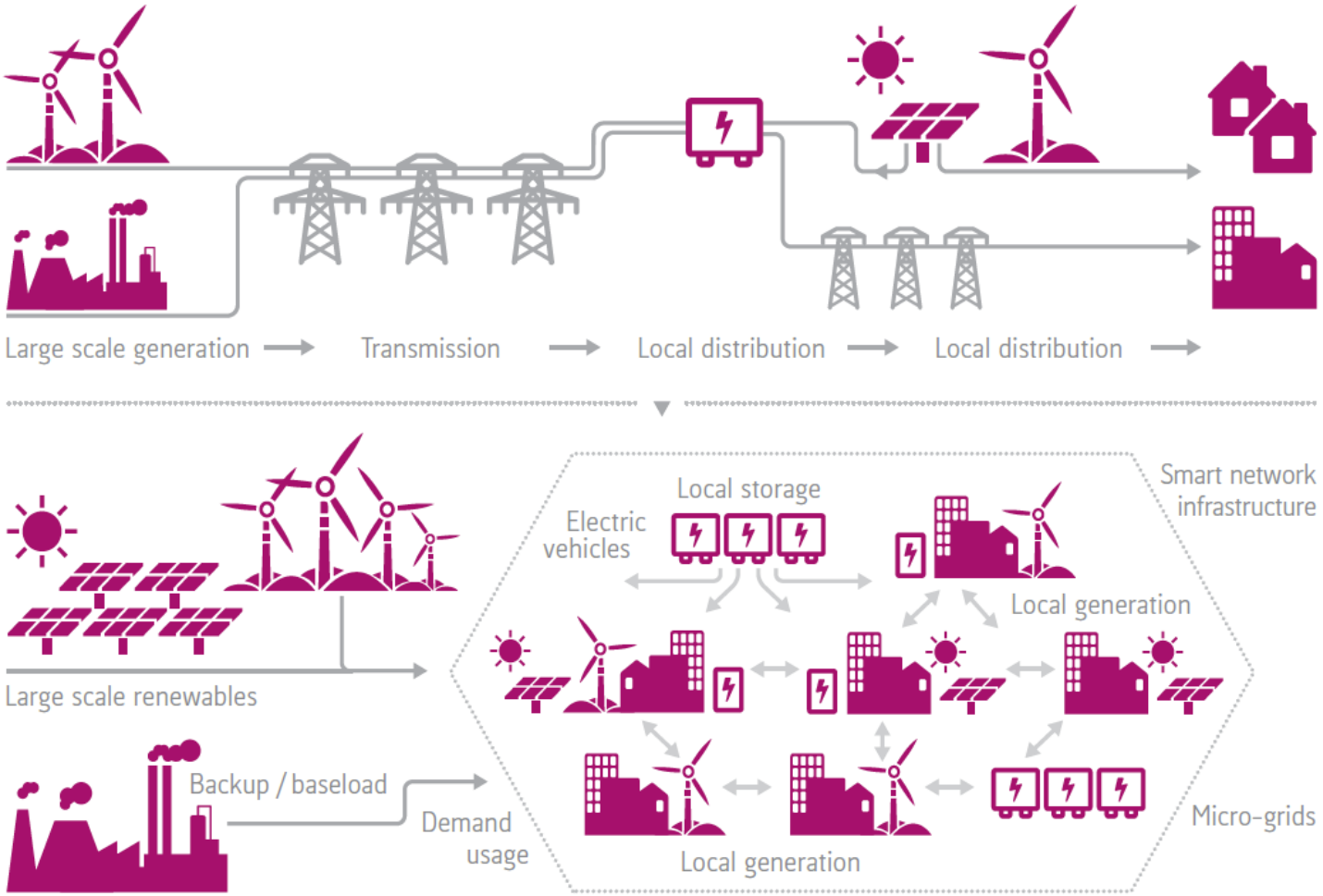
The electricity system revolution



'Old world'

- Electricity provision by major utilities
- 95 per cent large-scale generation and transmission
- Niche DG
- No Smart Grids / Homes

'New World'

- Decentralised generation
- Smart Grid and Smart Homes
- Battery storage and EV deployment
- Emerging markets may not require large generation

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Capacity markets

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Capacity market auctions – the challenges (1)

There remain key challenges in terms of how much to buy (and when), the treatment of interconnected markets, and the impact of penalties

- **With auctions well in advance of the delivery year, there is an important question of how much to buy four years advance (T-4) and how much to leave for year ahead (T-1)?**
- **How should the contribution to security of supply from interconnected markets be treated, and who should be paid?**
- **How could a coordinated multi-jurisdictional approach to CMs be taken in future, given the fundamental differences in scheme design?**

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Capacity market auctions – the challenges (2)

There remain key challenges in terms of how much to buy (and when), the treatment of interconnected markets, and the impact of penalties

- How do we ensure the right signals for Distributed Energy Resources (DSR, storage and embedded generation or Behind the Meter generation)?
- How should penalties and/or outturn signals be set to incentivise delivery whilst avoiding/minimising potential distortions in energy markets and balancing?
- How should the costs of the Capacity Market be recovered, without introducing double value for DSR or behind the Meter generation?

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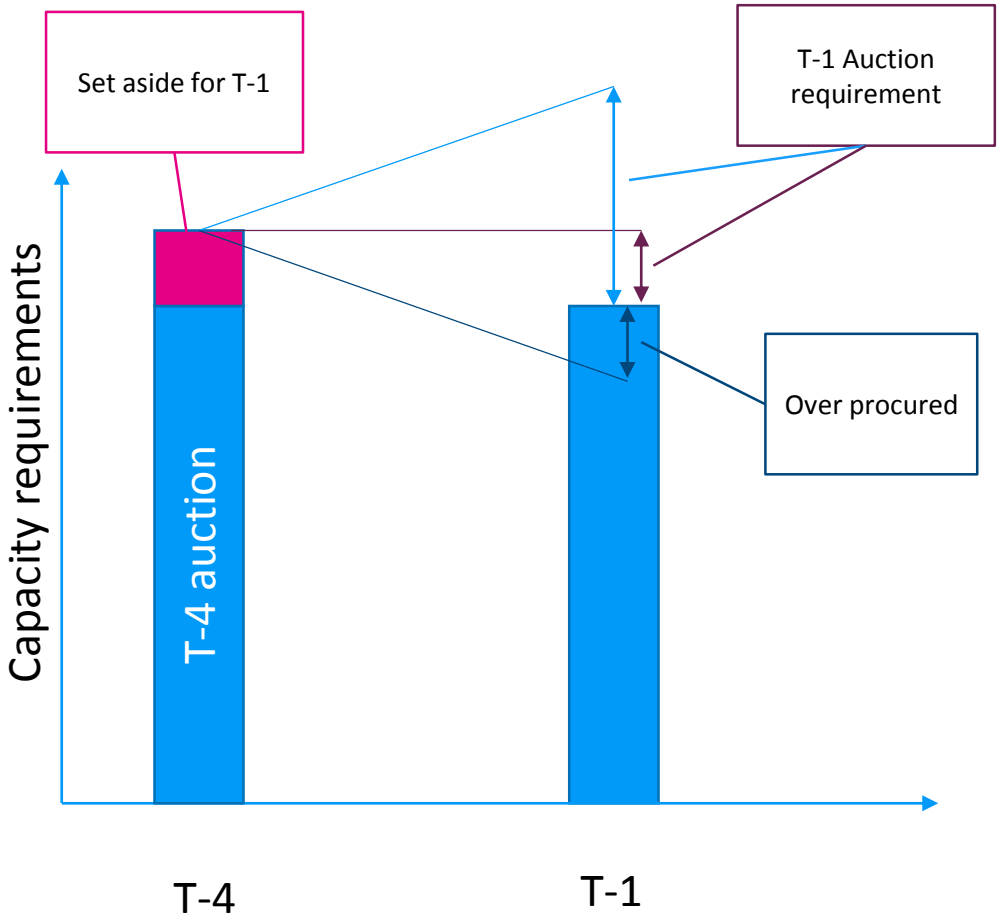
How much to buy (and when)

Long term auctions come with the risk of stranding which must be balanced with under-procurement



- National Grid applies a Least Worst Regrets approach to determine the total capacity requirement
- BUT: how much to buy now and how much to leave for T-1?
  - Differences in risk in under-procuring at T-4 vs. T-1 (**following slide**)
  - Different competitors at T-4 and T-1: new capacity may not be able to compete in T-1 (unless prepared to commit without CM contract) and DSR is typically expected to be unable to commit at T-4 stage
- Currently a Secretary of State decision
  - Set aside for T-1 in 2016 T-4 auction was 600 MW, compared to 2.5 GW in 2015 T-4 auction.
  - This change suggested greater concern over increases in demand and non-delivery of capacity and a preference for the security that the T-4 auction brings
- How could the set aside and other issues of timing be incorporated in the Least Worst Regrets analysis?

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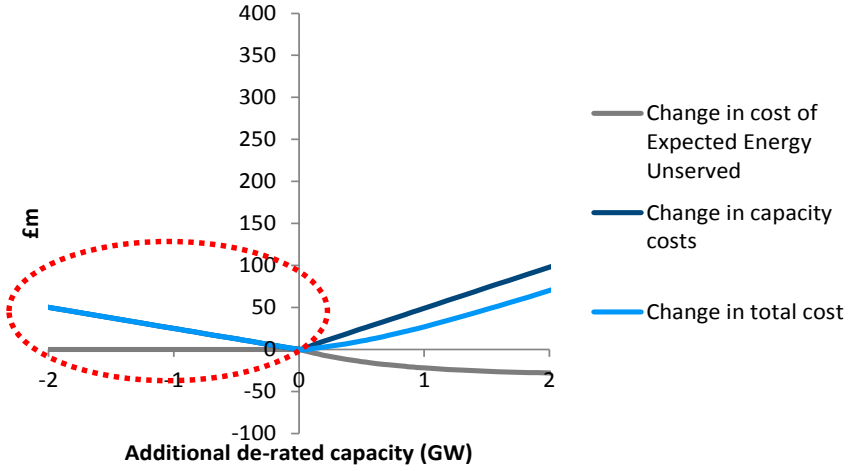
How much to buy (and when)

Long term auctions come with the risk of stranding which must be balanced with under-procurement

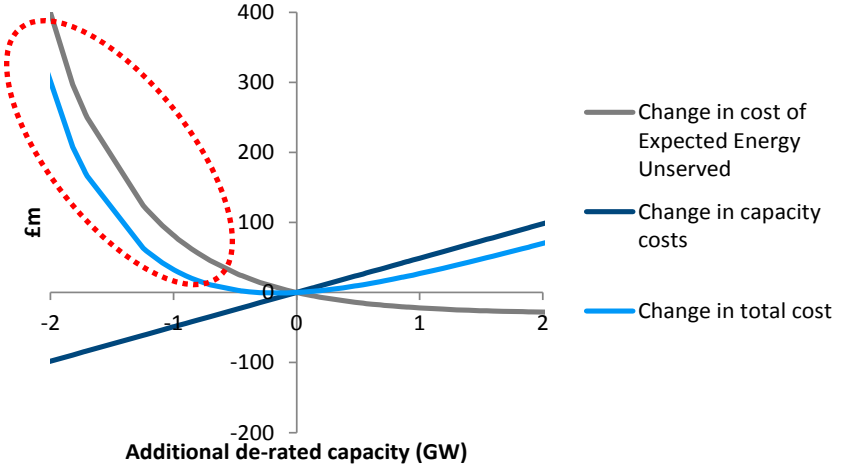
- There is an inherent asymmetry at the T-4 stage:
  - there is an option to make up any capacity shortfalls in the T-1 auctions
  - But it is not possible to sell back any unwanted capacity

Auction	Risk factors	Impact of buying too little	Impact of buying too much
T-4	▶ Long term "scenario" differences in demand and non-CM capacity	▶ Can be made up in T-1 (albeit may be at a higher cost) ▶ Assuming volume is available at T-1	▶ Volume: Additional cost of capacity ▶ Price: Potential for higher clearing price
T-1	▶ Lower volume risk ▶ Short term factors well characterised in LOLE models	▶ Cannot be made up therefore increase in LOLE and Expected Energy Unserved	▶ Volume: Additional cost of capacity ▶ Price: Potential for higher clearing price (but affects a much smaller volume than in T-4)

T-4: Theoretical value of under/over procurement



T-1: Theoretical value of under/over procurement



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Treatment of interconnected markets

The treatment of interconnection is a particular challenge in current Capacity Market designs

- How to determine the contribution to security of supply from interconnected markets?
  - To what extent can we rely on the other market?
  - Which modelling approach/data to use?

Deterministic	Historic flows	Forecast availability at times of stress	Forecast energy flows at times of stress

- Who should be paid?
  - Currently defaulting to interconnectors but neither is a great option!

Interconnectors	Generators

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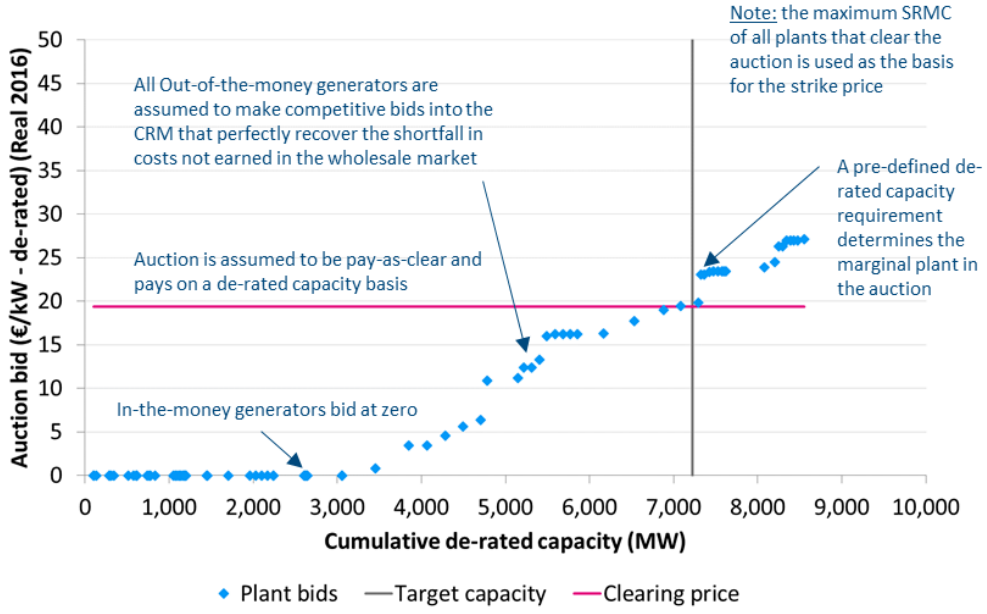
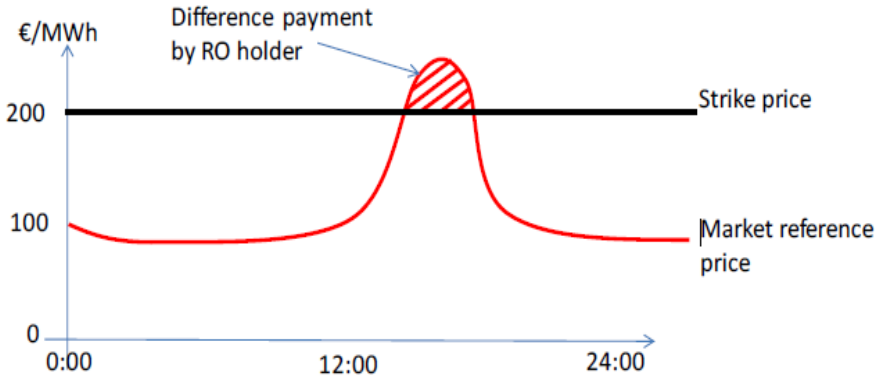
I-SEM Capacity Remuneration Mechanism

Due for first auction in late 2017 (T-1) for delivery from May 2018

Schematic of I-SEM RO auction stack



Difference payments under a Reliability Option



- The capacity product under I-SEM will take the form of Reliability Options
- These are one-way CfDs or call options
- Volume of ROs to be procured will be determined centrally to meet the security standard
- Competitive allocation by auction
- Successful participants are paid the €/kW auction clearing price 'option fee'
- Contract holder must make 'difference payments' if the market reference price exceeds the contract strike price
- Stop loss limit set at 1.5 times the contract value
- One year contracts for existing plant, up to ten years for new build

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Interconnected markets and de-rating factors

Comparison of approaches to setting interconnector de-rating factors

Feature	GB	I-SEM
Security standard	3 hours LOLE	8 hours LOLE (same as current standard, but actual LOLE today ~0 hours)
Who gets paid?	Interconnectors	Interconnectors
Interconnector penalty regime	Similar to domestic generation	Weaker – based on availability, not delivery
Approach to setting de-rating factors	Multiple models and data sources: ▶ Historic flows ▶ Wind/temperature correlations ▶ Forward modelling of flows at times of system stress Combined with technical availability	Single model based on probability of coincident stress in I-SEM and GB Combined with technical availability
2017/18 Delivery Year de-rating factors	National Grid range: 2-58% Final value: 30%	Moyle: ~70% (proposed/draft) EWIC: ~70% (proposed/draft)
2020/21 Delivery Year de-rating factors	National Grid range: 25-50% Final value: 26%	Moyle: ~50% (proposed/draft) EWIC: ~50% (proposed/draft)

- How can we be confident that these differences are real rather than based on model differences?
- How could a coordinated approach be taken in future, given the fundamental differences in scheme design?
- What is the joint value of interconnection to security across GB & I-SEM, and how should this be allocated?

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Ancillary services procurement

Interactions with Capacity Markets

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Ancillary services – the challenges

New services and new technologies create challenges

- What new services are required to balance the future system and how should these be procured?
- Who should bear the greater uncertainty in the need for and value of these services?
- How can we enable deployment of new technologies?
- How might roles and responsibilities for operating the transmission and distribution systems need to change?
- What are the options for procuring these services? Short term markets and/or long term contracts? What is the right product to purchase?
- Should we consider multiple simultaneous product procurement and what are the options for auction design (Combinatorial, Simultaneous Descending Clock Auction, etc)?

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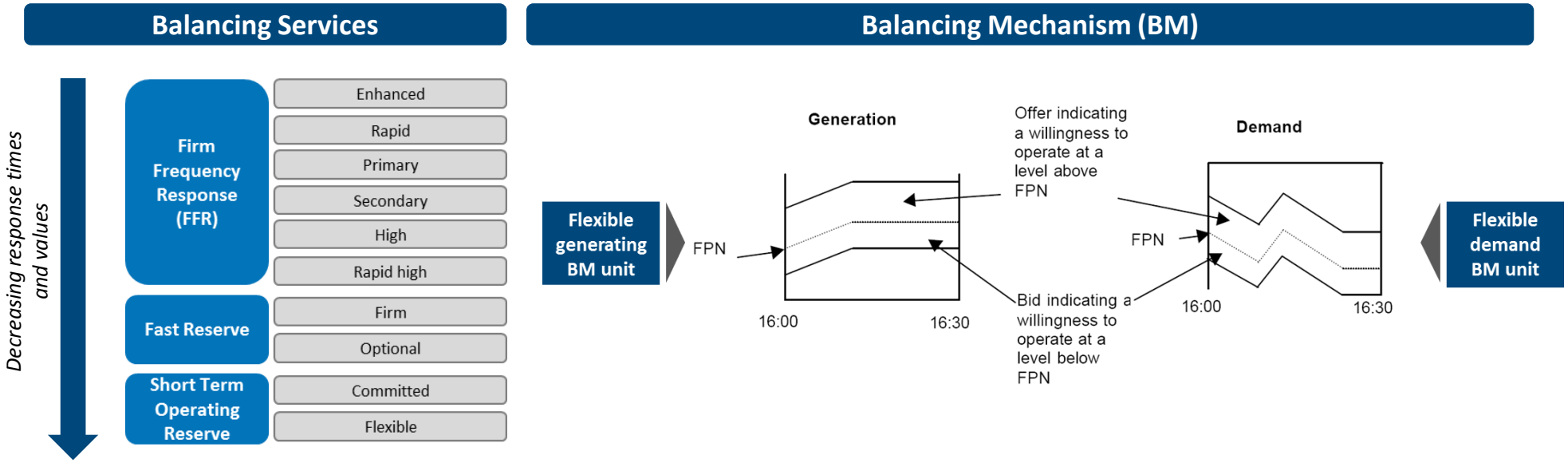
GB: System Operator's Balancing Actions

How does the System Operator manage real time energy and system imbalances?

- The Balancing Mechanism is the main mechanism for National Grid to access Balancing Actions from large thermal generators, typically >50 MW
- National Grid also procures a range of Balancing Services which are accessible to a wider range of resources
  - Firm Frequency Response
  - Fast Reserve
  - Short Term Operating Reserve
- Contracts for balancing services traditionally cover a range of tenors from 1 month to approx. 2 years ahead
- New Enhanced Frequency Response product covers 4 years



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Building a business case for flexibility

Flexibility can be complex to monetise – flexible asset business models are characterised by an ability to contract for multiple, often mutually exclusive revenue streams

- The complexity of a flexible assets contracting options has both advantages and disadvantages, in that the complexity may cause inexperienced operators to sub-optimally contract across revenues, where more experienced operators will recognise the value of this diversification, and build a business model that has both revenue resilience and redundancies across revenue streams

National Grid System Reserve Provisions

Balancing Mechanism ?

Provided by Balancing Mechanism (BM) parties (typically large generators). Possibly by DR assets through BEGA agreements with NG, though this is not typical. BM Cash-out prices have become sharper with cash-out reform (EBSCR)

Internal Supply/Demand Balancing ?

Using DR to manage internal supply/demand balances, avoiding punitive cash-out prices

Wholesale & Capacity Markets

Electricity arbitrage/peaking ✓

Generating to access peak power price volatilities in winter peaks or otherwise, which are expected to increase as capacity margins decrease

Capacity Market *(T-4, T-1, transitional auctions)* ✓

Capacity based auction for fixed payments up to 15 years in duration, contracted 4 years ahead of time (with a smaller T-1 auction) with delivery of first capacity in 2018/19

Balancing Services

A variety of balancing services contracted by the system operator (National Grid) to help them perform their system balancing role

Decreasing value

Firm Frequency Response (FFR) ✓	Enhanced
	Rapid
	Primary
	Secondary
	High
	Rapid high
Fast Reserve ✓	Firm
	Optional
Short Term Operating Reserve ✓	Committed
	Flexible

Mandatory Frequency Response ✗

Others – Fast start, BM start-up and other BM services etc. ?

Embedded Generation

Embedded benefits ✓ ↓

Supplier agreements to avoid and monetise demand charges. Primarily demand TNUoS avoidance (TRIADs) and DNO Red-Band benefits, which are location and time dependant and would necessitate an agreement with a supplier

Locational benefits ?

Bespoke system constraint management services and contracts, typically with DNOs (i.e. offset network reinforcement upgrades, constraint management in high wind generation areas)

Potentially accessible and attractive ✓

Difficult to effectively monetise, low value and/or technically challenging ?

Technology and asset classification dependant, but likely to be inaccessible and/or unattractive ✗

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I-SEM: New DS3 ancillary services regime

The new DS3 ancillary services regime will replace the current Harmonised Ancillary Services arrangements, resulting in an expansion in the scope and budget

Overview of DS3 ancillary services market

- The DS3 programme is expanding the scope and budget for the delivery of system services in the SEM.
- The market design changes are planned to deliver a substantial 400% increase in the potential budget for system services, growing from €80m in 2016 to €235m in 2020.
- Designed to ensure that increasing amounts of variable non-synchronous renewable generation can be accommodated over the coming years (**50% SNSP to 75% by 2020**)
- Proposed design was a **combinatorial auction** for 14 services for at least **one year** and **up to 15 years (for new capacity only)**
- **Strong industry pushback** on auction design proposals and tight implementation timelines caused the SEMC to postpone their final design decision, with the first auction deferred to the first half of 2018 at the earliest.
- Interim tariffs for system services will go live in October 2016; enduring tariffs will apply from October 2017.

'Pillars' of the DS3 programme

Implications for European harmonisation

- Complex set of interactions with the new **I-SEM Balancing Market**
- **Interactions with Capacity Remuneration Mechanism**
- Arguably, long term procurement of system services is not consistent with direction of travel for NC EB.

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I-SEM: DS3 system services overview

Seven of the fourteen DS3 services are new and many are accessible to batteries or wind*

Category	Product	Status	Start Time and Duration	Potentially accessible for batteries	Potentially accessible for wind	Unit	Interim Tariff Rate €
Inertial Response	Synchronous Inertial Response (SIR)	NEW	Dispatch-dependent; units will only receive payments when synchronised.	No	No	MWs2h	0.0046
	Fast Frequency Response	NEW	Available within 2s of event, sustained up to 10s post event	Yes	Yes	MWh	2.06
	Fast Post-Fault Active Power Recovery (FPFAPR)	NEW	Dispatch-dependent. Must remain connected for at least 15 minutes	Yes	Yes	MWh	0.14
Voltage Control	Dynamic Reactive Response (DRR)	NEW	Dispatch-dependent. Must remain connected for at least 15 minutes	No	Yes	MWh	0.04
	Steady-state reactive power	Existing	Dispatch-dependent, units will only receive payments when synchronised	No	Yes	MVArh	0.21
Reserve	Primary Operating Reserve	Existing	Available within 5s of event, sustained to 15s post event	Yes	No	MWh	2.93
	Secondary Operating Reserve	Existing	Available at 15s, sustained to 90s post event	Yes	No	MWh	1.78
	Tertiary Operating Reserve 1	Existing	Available at 90s, sustained to 5m post event	Yes	No	MWh	1.41
	Tertiary Operating Reserve 2	Existing	Available at 5m, sustained to 20m post event	Yes	No	MWh	1.12
	Replacement Reserve (De-Synchronised)	Existing	Available at 20m, sustained to 1 hour post event	No	No	MWh	0.50
	Replacement Reserve (Synchronised)	Existing	Available at 20m, sustained to 1 hour post event	No	No	MWh	0.16
Ramping	Ramping Margin 1 Hour	NEW	Available in 1 hour and sustainable for 2 hours duration.	No	No	MWh	0.10
	Ramping Margin 3 Hour	NEW	Available in 3 hours and sustainable for 5 hours duration.	No	No	MWh	0.16
	Ramping Margin 8 Hour	NEW	Available in 8 hours and sustainable for 8 hours duration.	No	No	MWh	0.14

* Existing assets will require upgrades to be able to deliver FFR, FPFAPR and DRR

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Multiple product procurement

The challenges of procuring multiple products with an uncertain demand in a single auction

What are the challenges with this approach?

- Complexity of auction design
- Who has to commit when and **who holds the risk**
- The risks of TSOs committing long term for a short term uncertain requirement, and buying the full requirement at one point in time
- Target Model is moving towards **shorter term procurement**
- The interaction with the BM and ensuring that impacts on energy prices are efficient
- The challenges for service providers to decide what they can offer, and hold risk of non-delivery (of availability or utilisation)
- Difficulty of providing a level playing field

What are the alternatives?

- Procure the use of the asset, rather than a set of services (a tolling agreement).
  - Ok if for services are for a single buyer only, but what if asset has the potential for energy market revenues, wants to enter CM or provide services at distribution level (in future)
  - Risk of overpaying
- Others?

How can new procurement approaches draw on the best features of these alternatives?

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Key questions for the future

Questions to focus on in the realms of mathematics and economics, relating to the procurement of capacity and ancillary services

General

- Is there a need to adapt markets to ensure a level playing field for new technologies?
- Is there a continuing case for long term contracting in either Capacity Markets or ancillary services?
- What is the impact of Distributed Energy Resources in Capacity Markets and ancillary services?

Capacity markets

- How can we understand the costs and benefits of locking in procurement?
- How could a coordinated approach to CMs be taken in future, given the fundamental differences in scheme design?
- What is the joint value of interconnection to security across GB & I-SEM, and how should this be allocated?

Ancillary services

- Short term markets and/or long term contracts? What is the right product to purchase?
- For multiple product procurement, what are the options for auction design (Combinatorial, Simultaneous Descending Clock Auction, etc) and are these better suited than individual procurement?

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