A conceptualised electricity market design fit for GB's net zero future

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BIES Brown Bag
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- Exploration of the ‘Distribution Gap’, raising constraint costs and lacking regional differences
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- Next steps

What is the market design?

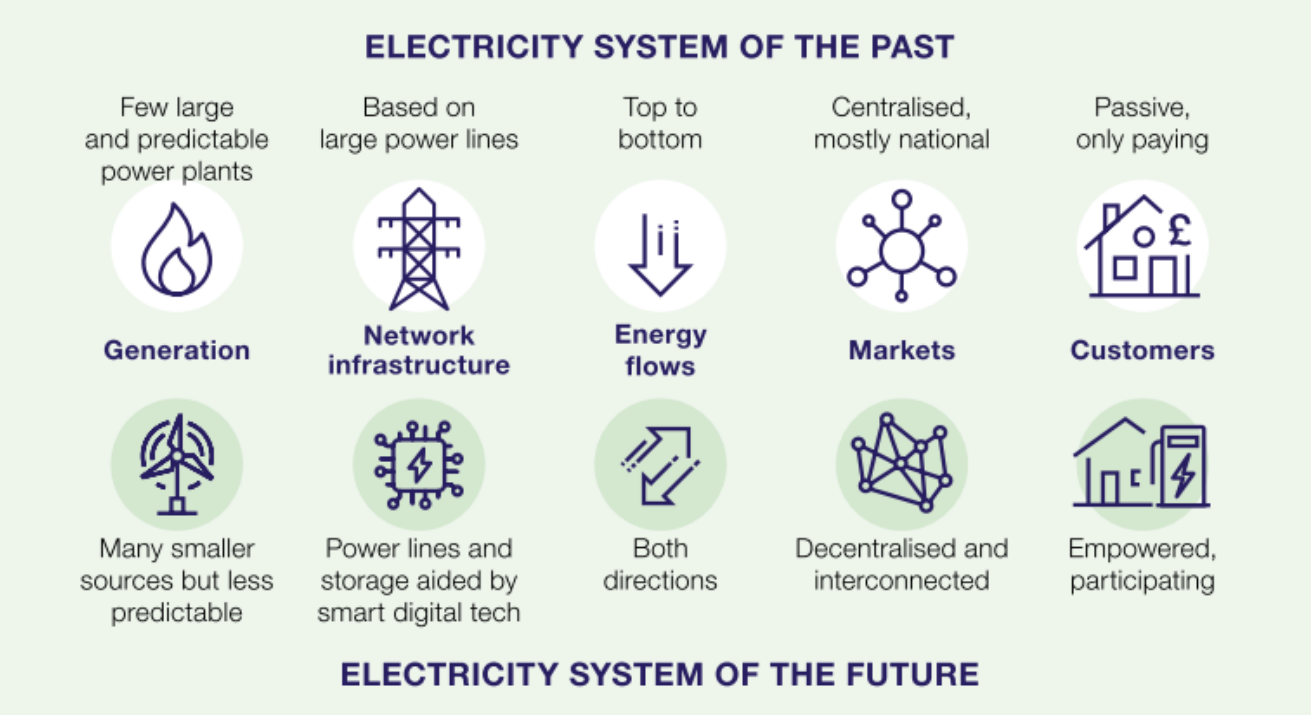
*"Market design is the '**rulebook**' for energy market players. The **rules establish the general principles and technical details on energy market participation,** as well **as specify rights and responsibilities among market participants**.*

'Market design' is the 'software' on which our energy markets run, while the energy infrastructure is the 'hardware'."

[2]

The electricity market design needs to evolve

- Different system operation
- Reaching net zero
- Changing system characteristics
- New market participants i.e. the demand side
- Zero-carbon flexibility



[1]

Why is market design important?

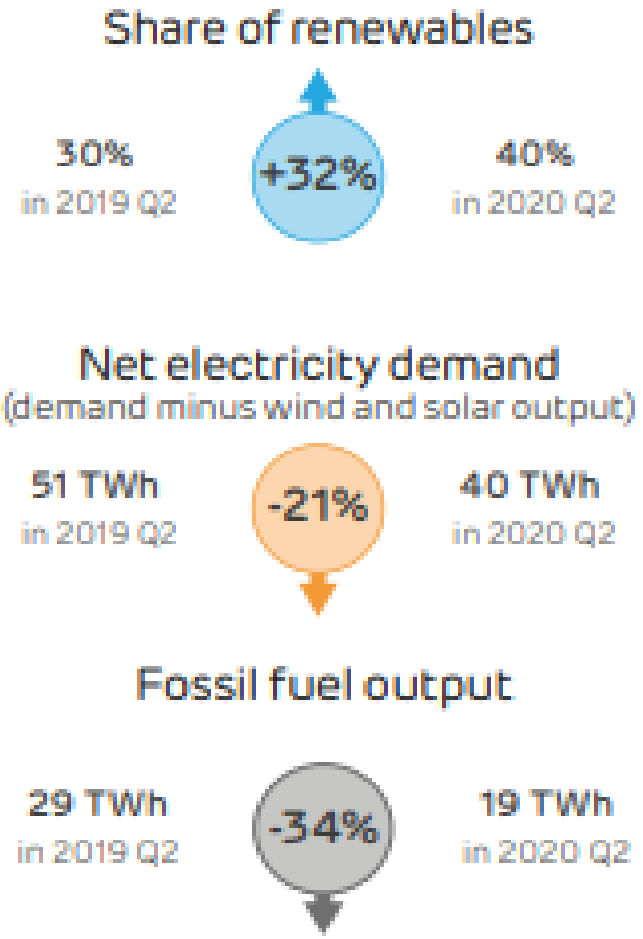
- Facilitating key objectives:
  - Security of supply
  - Long term investment
  - Efficient dispatch
  - NEW: net zero
- New opportunities in how we achieve these objectives
- Value setting – transition pathway

Market	Value (2019)	Size (2019)	Carbon intensity[5]
Balancing mechanism[1]	£590m	Abs.: 20,000 GWh Net: 630 GWh	Fossil fuels >99% of turn up
Short Term Operating Reserve (excl. spin gen)	£50m	2,000 GWh	>99% fossil fuel contracts
Fast reserve	£90m	220 GWh	85% fossil fuel contracts
Firm Frequency Response	£40m	3,250 GWh[4]	20% fossil fuel contracts
Mandatory Frequency Response	£30m	2,500 GWh[4]	Large units only. Will be primarily fossil fuel generation.
Capacity market (delivery 2021/22)	£500m (but varies by year)	55GW (de-rated)	70% fossil fuel contracts
DNO tenders	£1.5m	c.850MW (MWh unknown)	>80% fossil fuel contracts
Wholesale market	£13,000m[3]	219,000 GWh	~40% fossil fuel generation

[3]

COVID-19: glimpse into the future

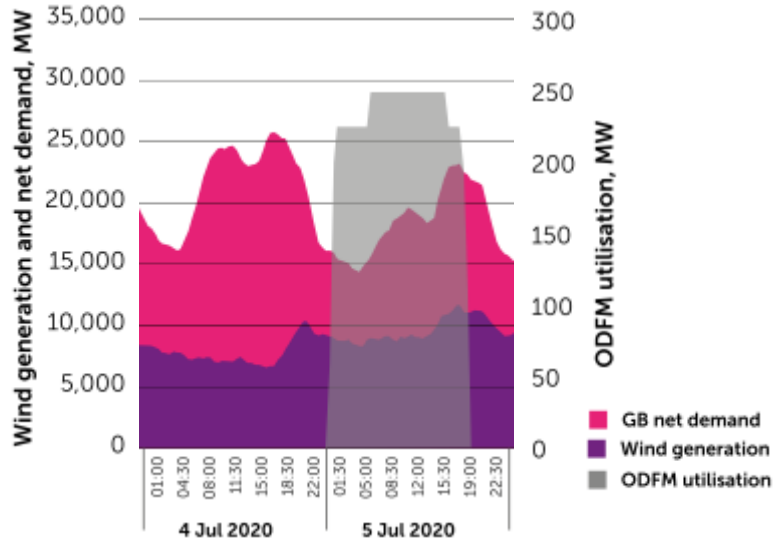
- Trends in generation and demand reflective 2025-2030 GB electricity system:
  - High levels of variable generation
  - Reduced levels of demand
  - Reduced output from traditional generators

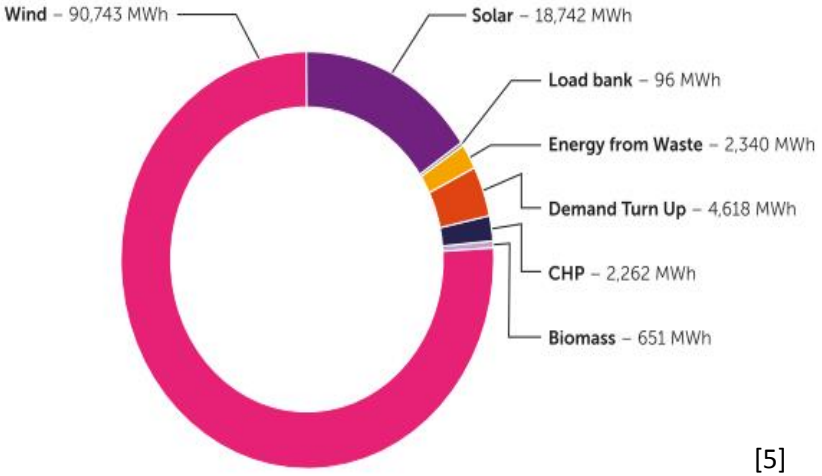


[4]

The distribution gap

- Skewed economics:
  - Favouring transmission connected technologies
  - Distributed energy resources currently have limited means of capturing their system value – i.e. the distribution gap – despite being able to provide it

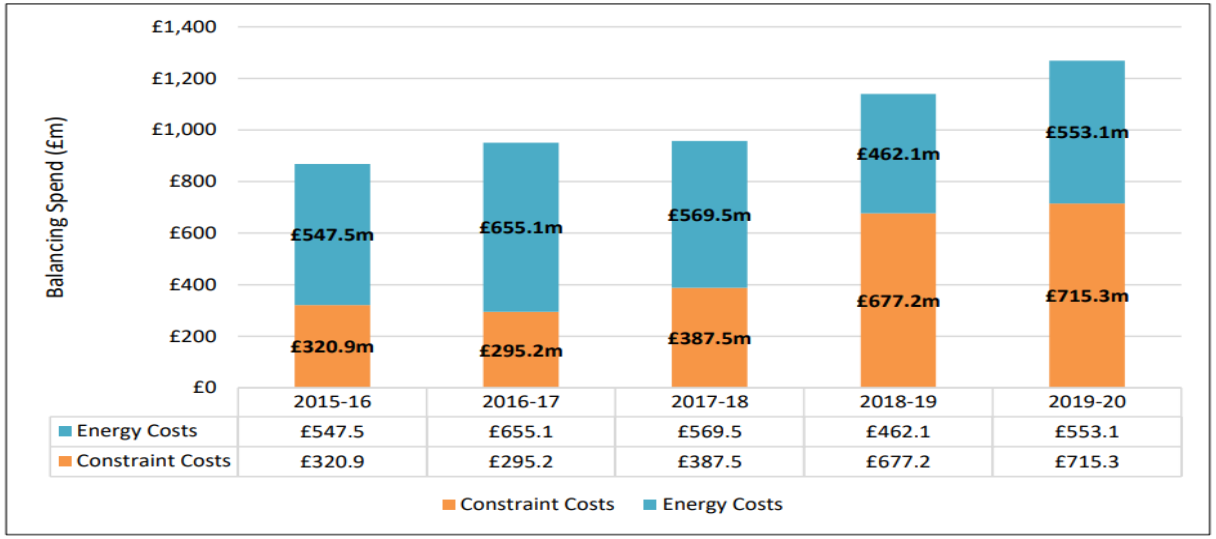




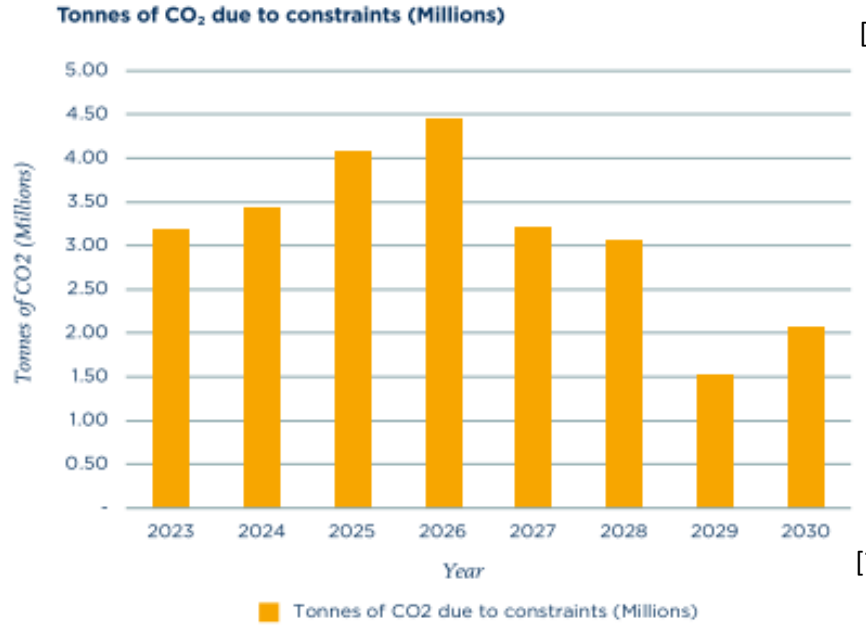
[5]

Constraint costs and regional differences

- GB operating on a national pricing scheme
  - Trading as one unconstrained zone
- Provides very few locational signals
- Rising constraint costs within GB



[6]



[7]

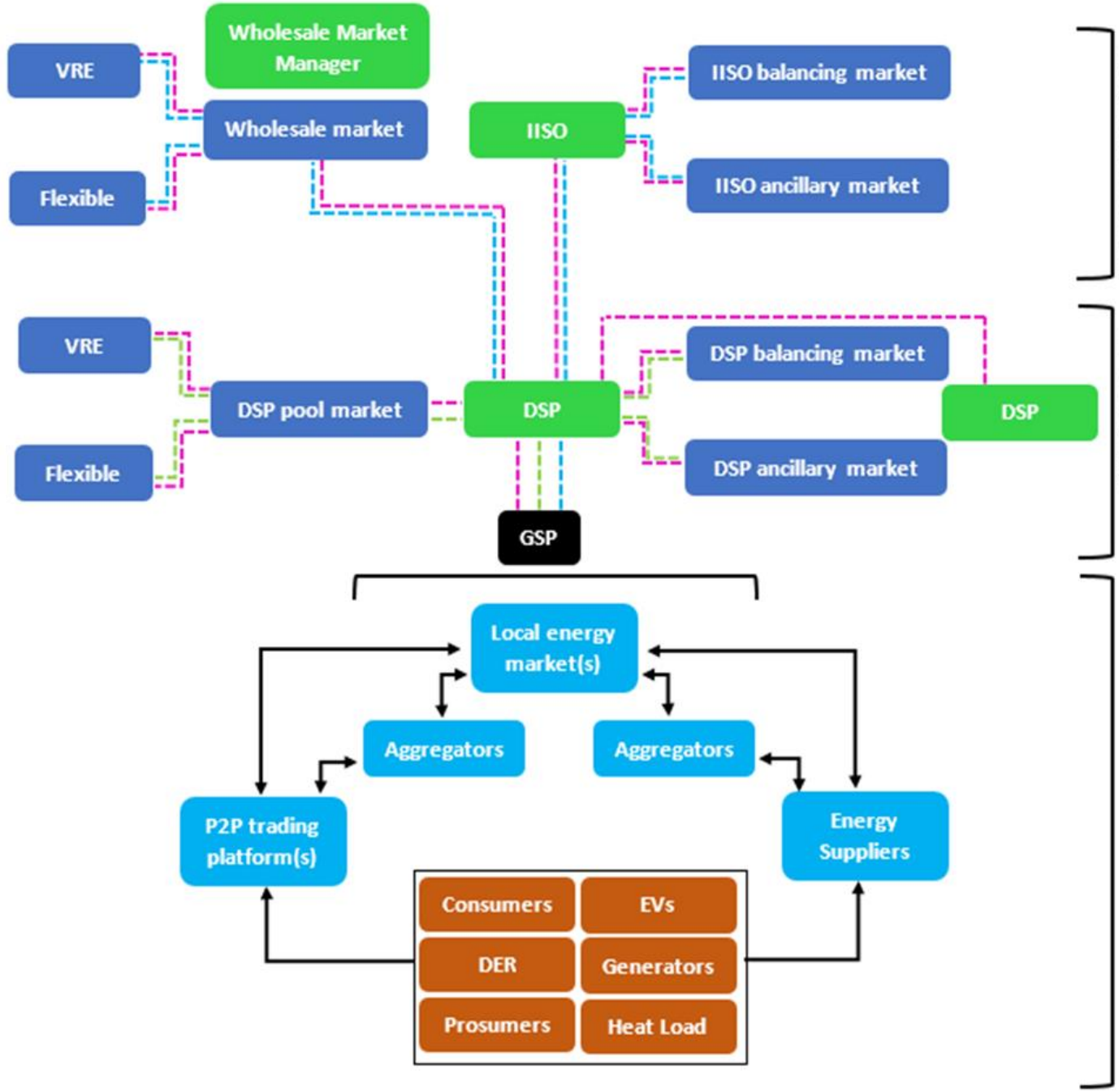
The proposed market design

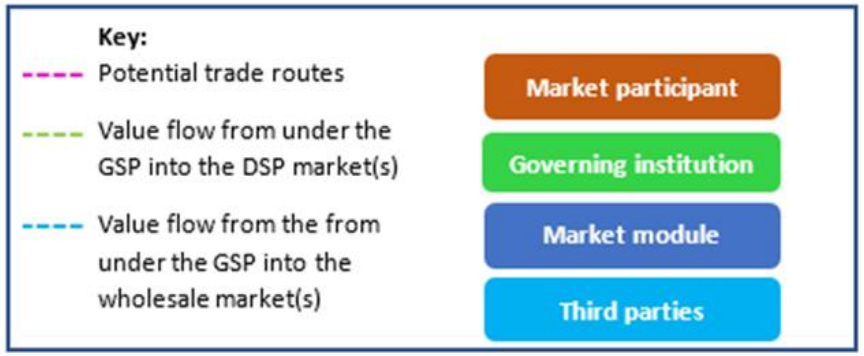
- 5 goals for market re-design identified within the literature:
  - **Goal 1**: As renewables become the dominant player within the markets, the market design should be designed around their characteristics
  - **Goal 2**: Promote services required in an increased variable grid i.e. flexibility
  - **Goal 2a**: Promote market conditions which provide investment signals
  - **Goal 3**: Promote the revealing of regional geographies
  - **Goal 4**: Open markets up to all technologies and services, regardless of their size or location on the network
  - **Goal 5**: Promote a liquid, competitive set of markets

Key differences in my design

- Markets located on the Distribution network (slide 12)
- Local coordinating and balancing markets located at the GSP (Tx-Dx interface) (slide 13)
  - Pay as clear pool
  - Two markets: Priority dispatch for renewables and flexibility markets as a residual top up
- Evolution of Distribution Network Operator to facilitate local balancing and a local ancillary market at each GSP (slide 13)
- National markets reflect the structure of market set up at the GSP (slide 13 and 14)
- Two gate closures (slide 15)
  - Local first

The proposed market design

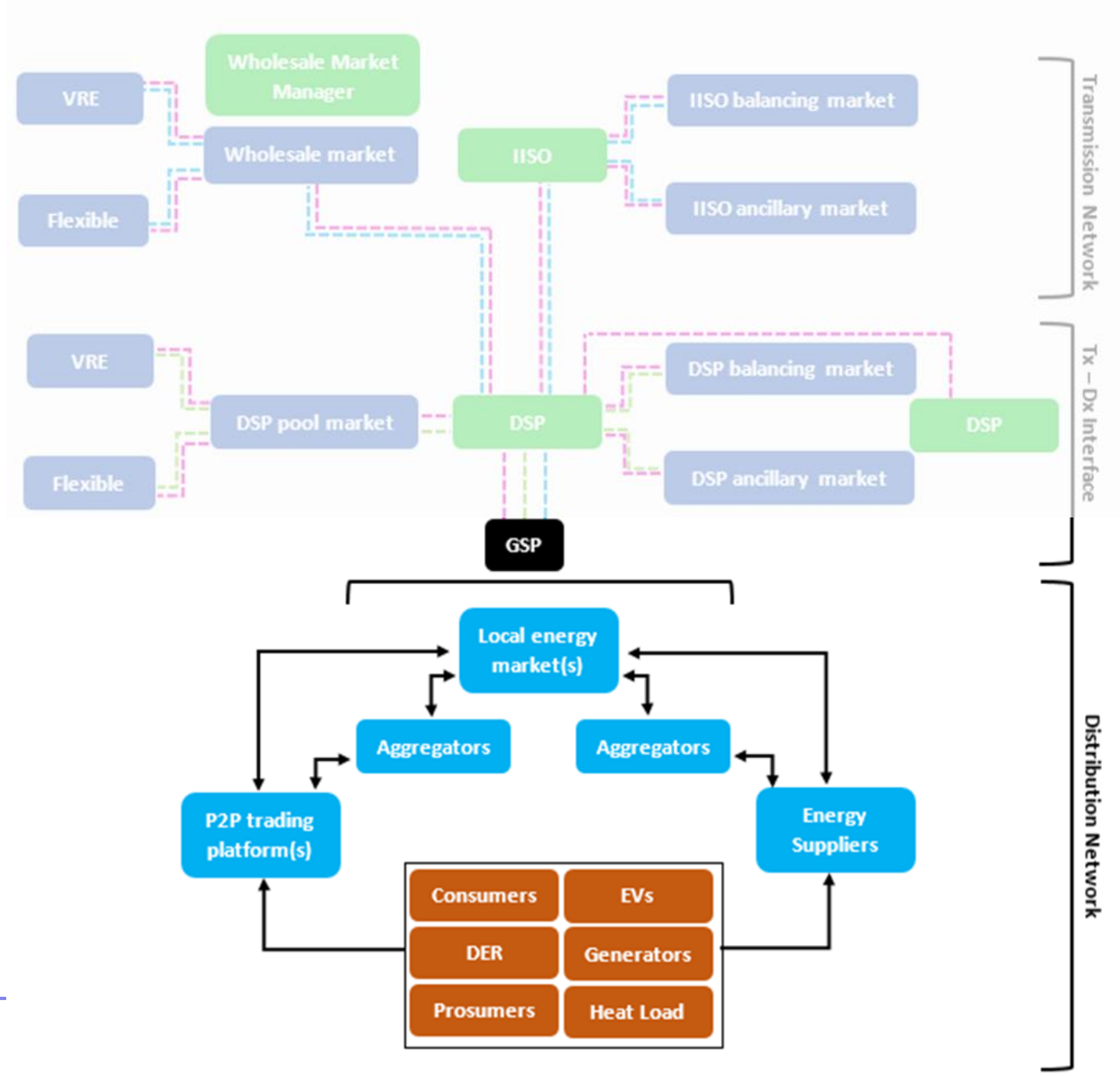


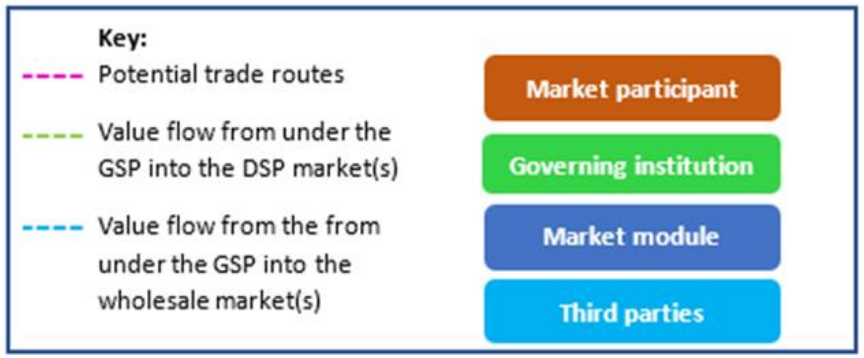


[8]

Local trading on distribution network

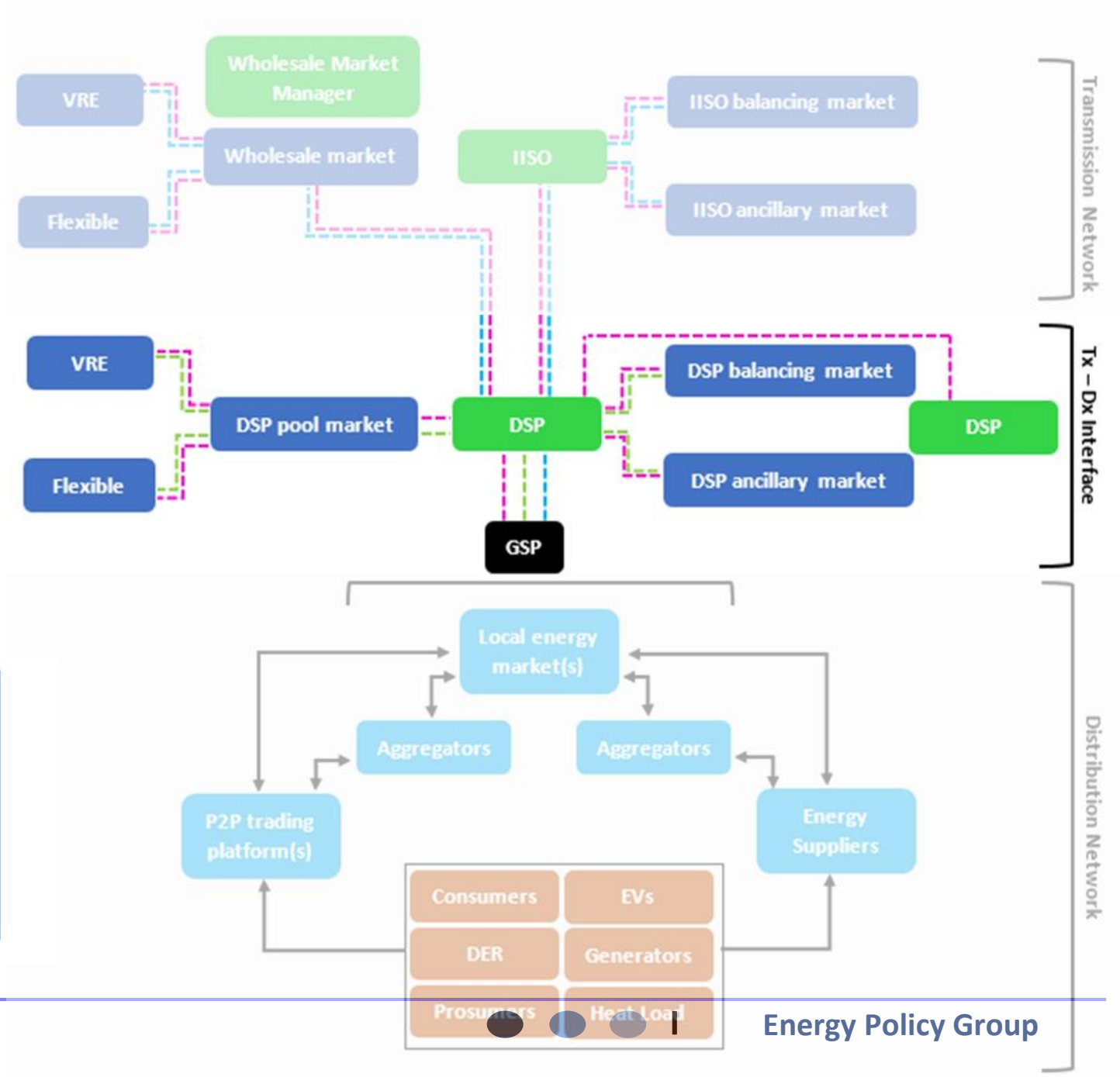
- Emergence of new market participants
- Freedom to trade within Grid Supply Point

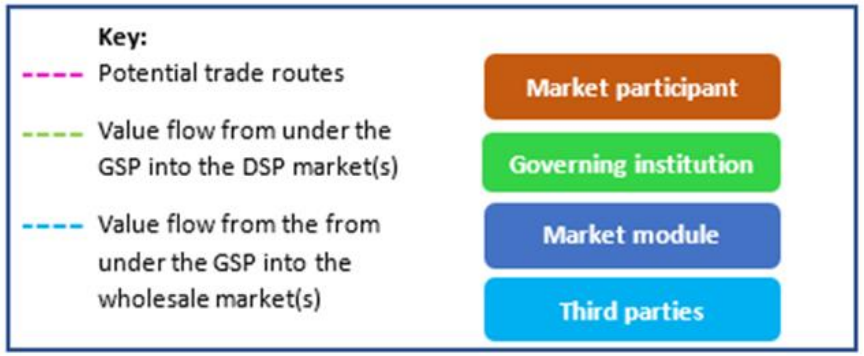




local balancing and coordinating market

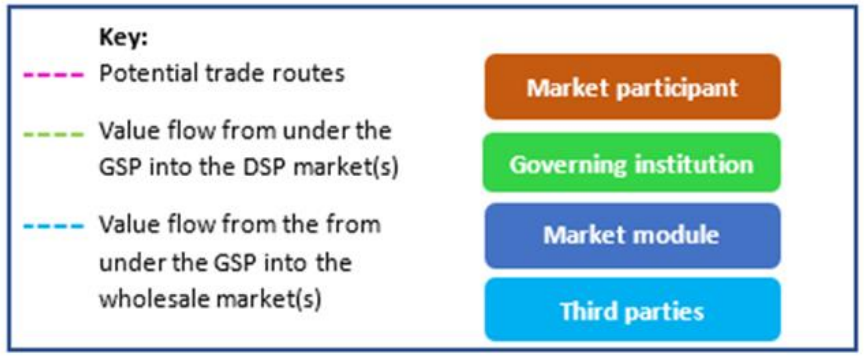
- Located at each of the transmission-distribution connections
- Operated by the DNO evolution

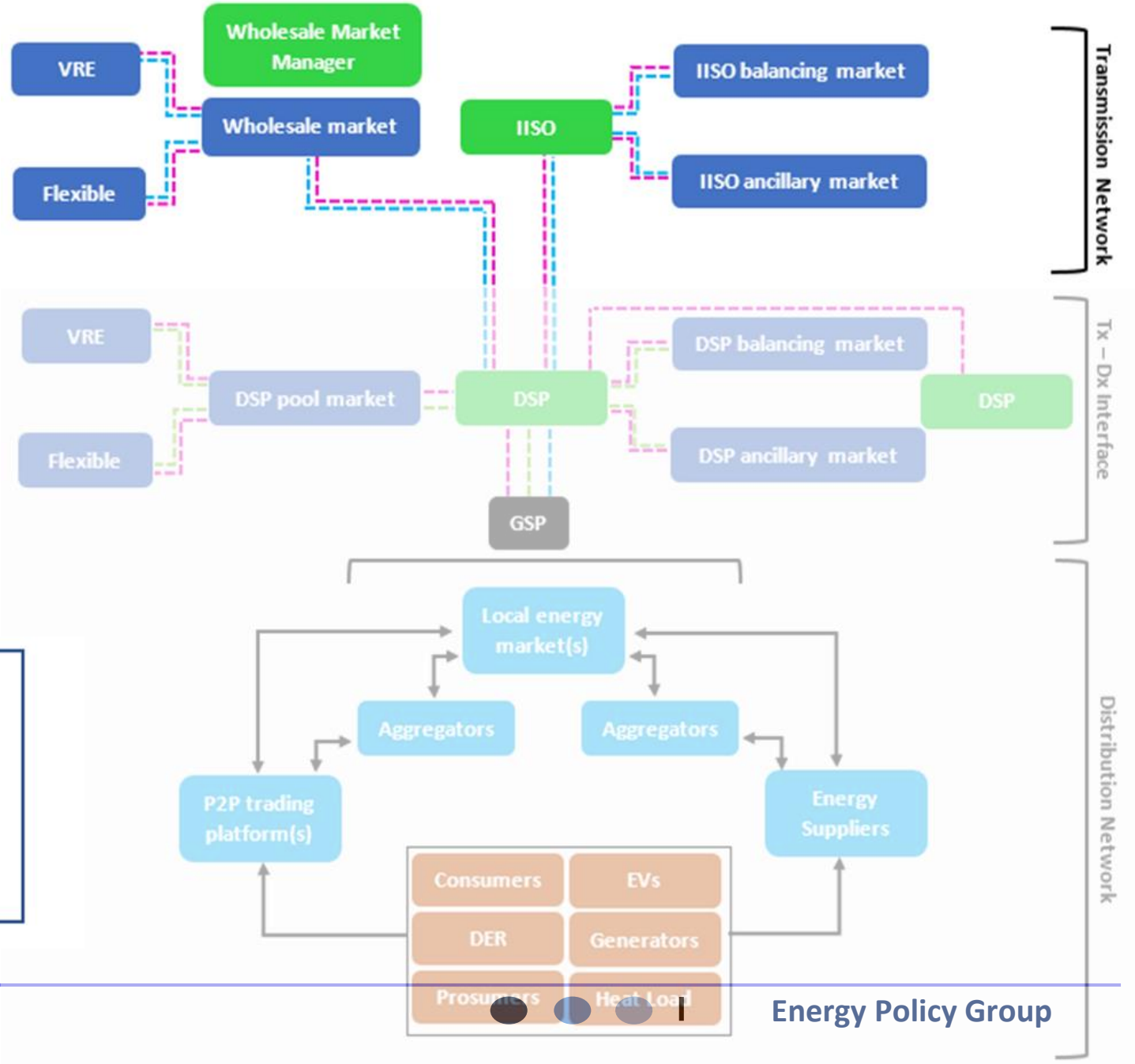




Links between national and local markets

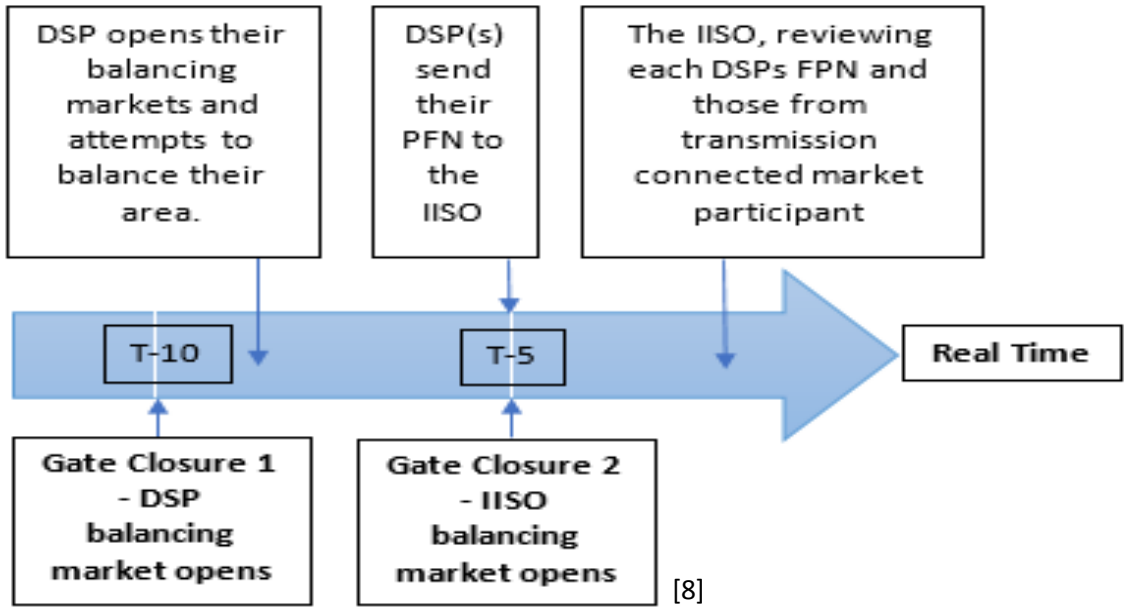
- Similar to the marketplaces located on the transmission-distribution interfaces





Gate closure change

- Two gate closure periods
  - First gate closure for the distribution networks
  - Second for the overall network
- Allowing for oversight of the entire network



[8]

Recap on differences addressing aforementioned concerns with the electricity market design

- Several elements of electricity market re-design proposed
  - Foundation for most elements currently under consideration i.e., the recent Energy White Paper and local balancing
- Filling the distribution gap
  - New routes to market on the distribution network
  - Standardisation of products across the local and national markets
- Reducing network constraints
  - Regional markets which reflect network constraints
  - Local matching

Next steps

- Requirement of long term vision from BEIS and Ofgem

"Whilst we need to begin to consider the longer-term market design for the delivery of net zero, we are not imminently embarking on a major restructure of our market framework" BEIS. Enabling a High Renewable, Net Zero Electricity System: Call for Evidence 2020.

"The Government should develop a clear long-term strategy as soon as possible, and certainly before 2025, on market design for a fully decarbonised electricity system." Committee on Climate Change. Policies for the Sixth Carbon Budget and Net Zero 2020.

Thank you for listening

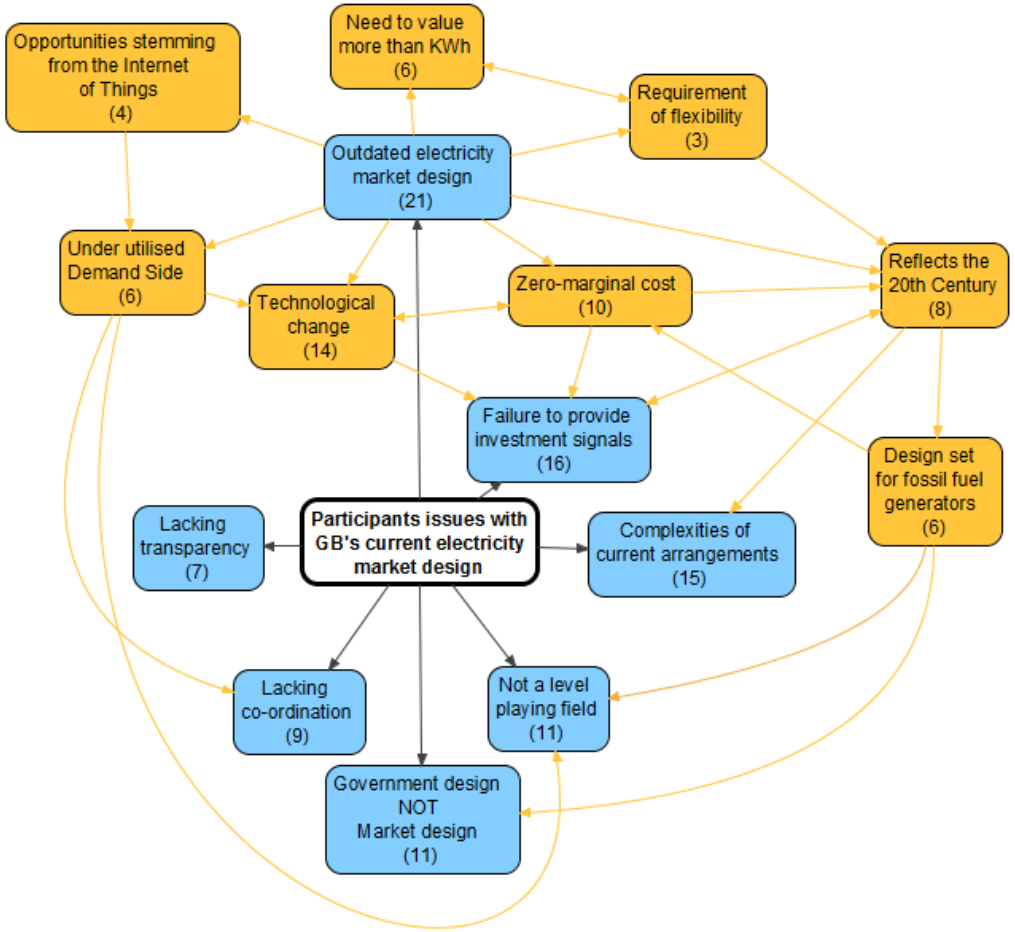
- Paper: https://www.mdpi.com/1996-1073/14/4/1124
- Email: t.pownall@exeter.ac.uk

References

- [1] HM Government. Powering our Net Zero Future. 2020.
- [2] European Commission. Clean energy for all New electricity market design: a fair deal for consumers 2016.
- [3] BEIS. Carbon in Flexibility Markets Workshop 2020.
- [4] Drax. Electric Insights Quarterly (Q2 2020). 2020.
- [5] National Grid ESO. Power Responsive: Annual Report 2020 2021.
- [6] Ofgem. Review of GB energy system operation 2021.
- [7] LCP. The need for new network infrastructure 2020:1–5.
- [8] Pownall T, Soutar I, Mitchell C. Re-designing GB's electricity market design: Recognising the value of distributed energy resources. Energies 2021;14.

Slide pack

Participant issues



Authors Own

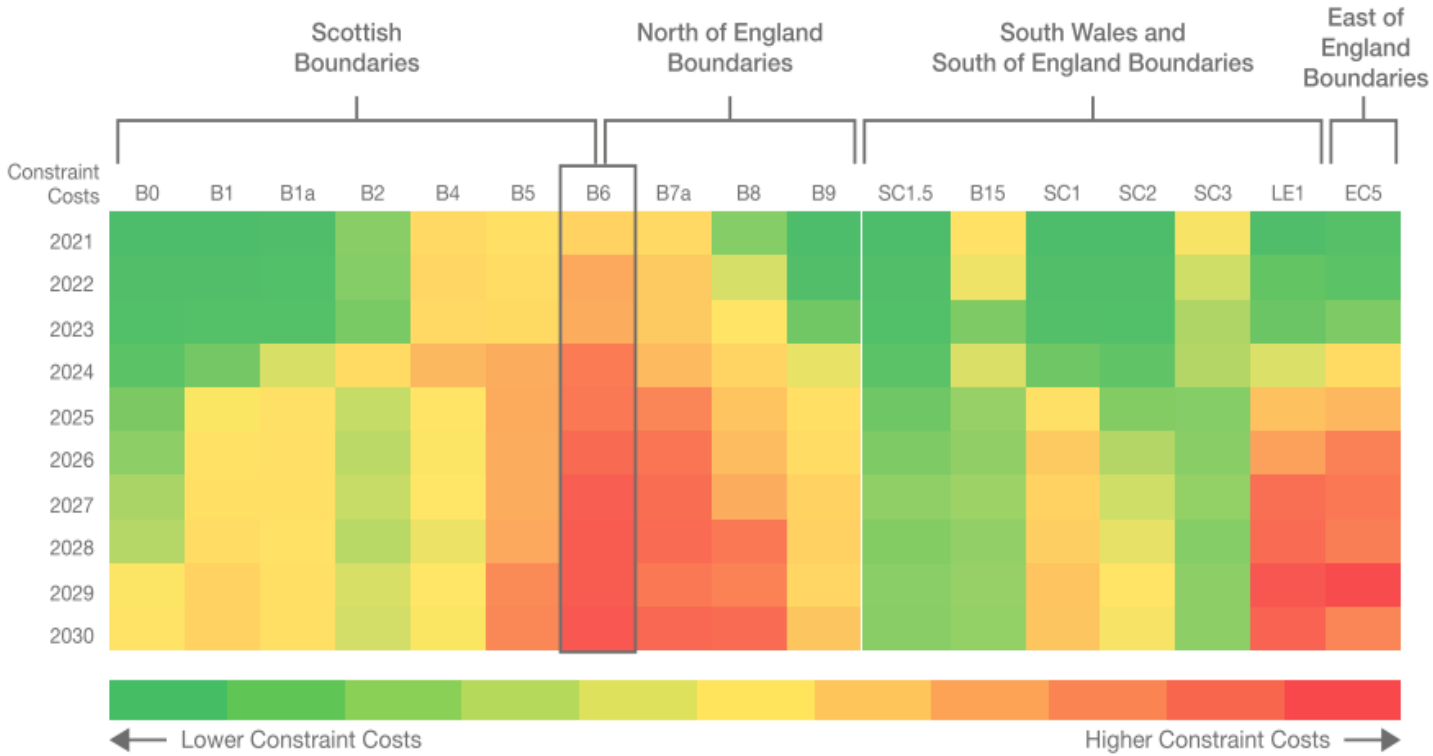
Nodal pricing in the west country

Figure 7 – Average LMP over SW England for current capacity

Figure 9 - Average LMP over SW England for future capacity

Edmunds C, Bukhsh WA, Gill S, Galloway S. Locational marginal price variability at distribution level: A regional study. 2018 IEEE PES Innov. Smart Grid Technol. Conf. Eur., 2018. doi:10.1109/ISGTEurope.2018.8571664.

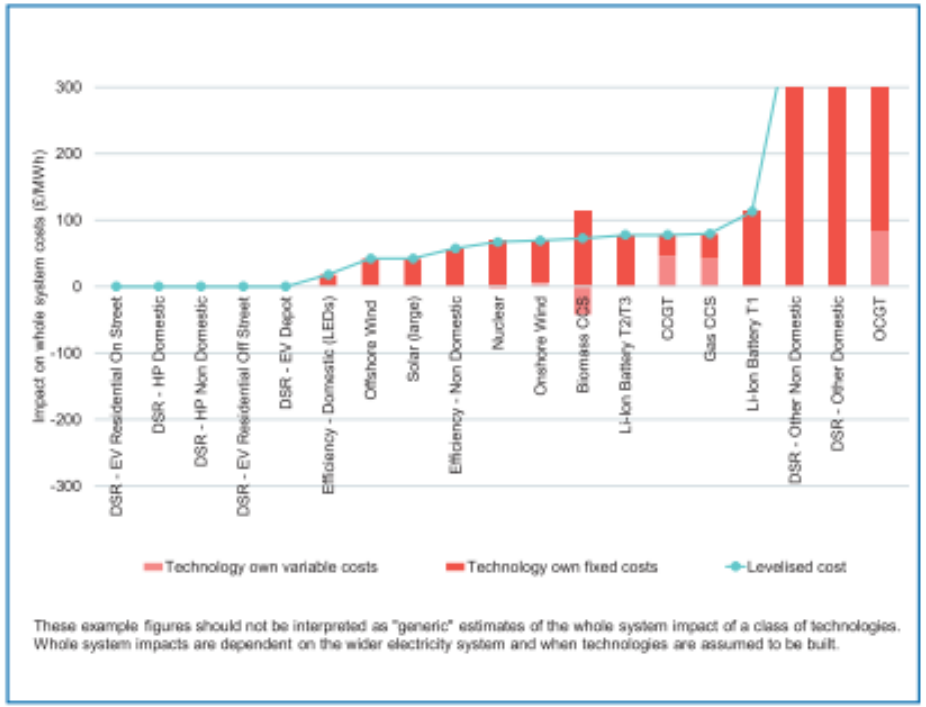
Constraint map



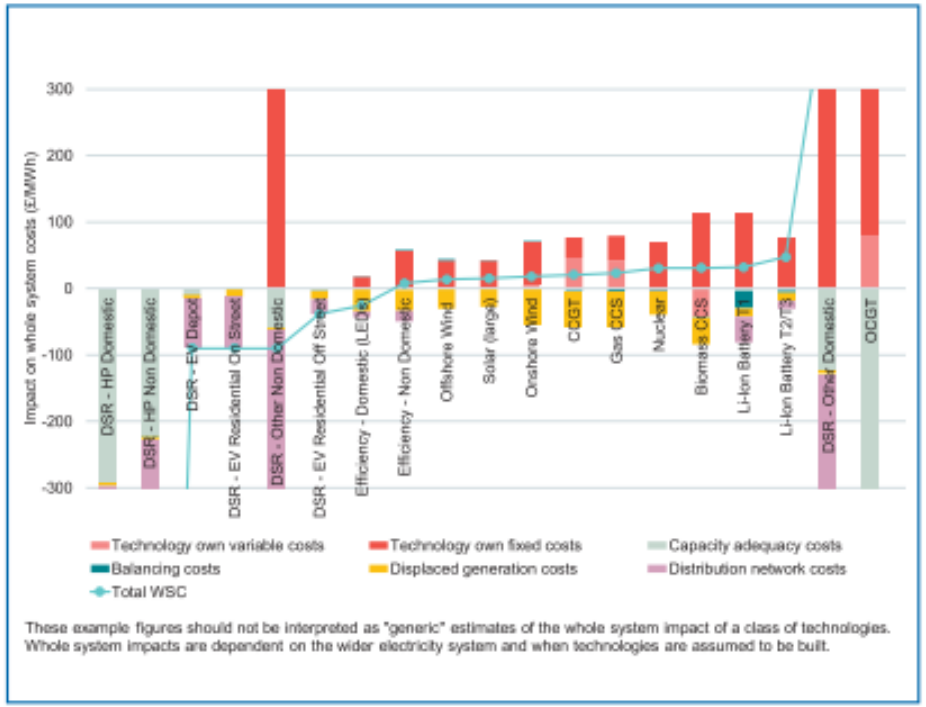
National Grid ESO. Roadmap to 2025 2021.

Modelling outputs on LCOE vs. Whole system costs: Insights from the Re-Costing Project

TODAY: LEVELISED COST



TOMORROW: WHOLE SYSTEM COSTS



Revealing <u>different</u> outcomes for all forms of demand and flexibility assets and generation assets, showing LCOE is not able to reflect the overall value or cost to the system

Sandys L, Pownall T. Building blocks for net zero: Episode 2 2020. Available online: http://www.challenging-ideas.com/wp-content/uploads/2021/02/FINAL-DOC-HR-1.pdf

Modelling outputs from the ReCosting Project: The potential revenue streams for a depot-based EV if able to provide services to the market

Figure 8 WESC components for depot-based electric vehicles

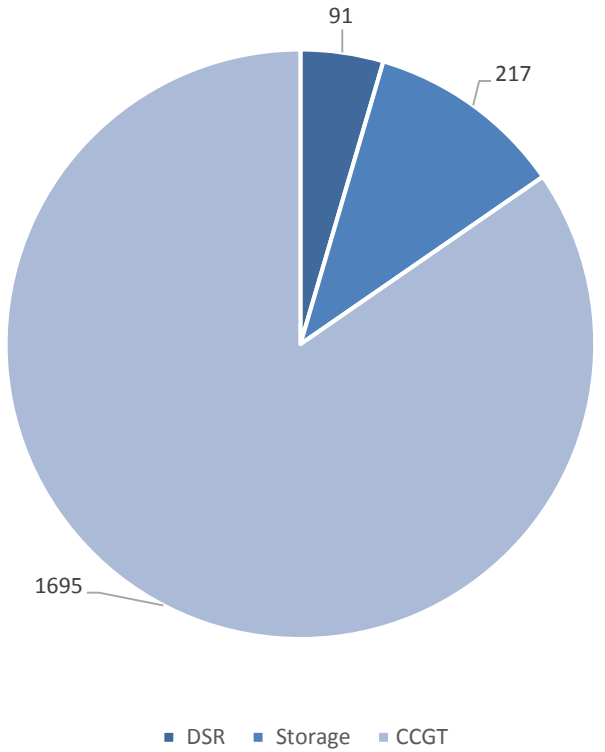
WESC component	Value per MWh	Value per van per year
Technology own variable costs	£0/MWh	£0
Technology own fixed costs	£0/MWh	£0
Capacity adequacy costs	-£10/MWh	-£56
Balancing costs	-£0.01/MWh	-£0.06
Displaced generation costs	-£5/MWh	-£28
Distribution network costs	£75/MWh	-£420
Total WESC	**£90/MWh**	**£504**

Sandys L, Pownall T. Building blocks for net zero: Episode 2 2020. Available online: http://www.challenging-ideas.com/wp-content/uploads/2021/02/FINAL-DOC-HR-1.pdf

Replacement of the capacity mechanism with a strategic reserve + Decentralised reliability option scheme

- Not aligned with net zero
  - The decision not to exclude coal.
  - Amortising CCGT
  - Limited scope for the financing of new builds
  - Treatment of DSR
  - Treatment of VRE
  - Undermining flexible generation/services
  - Set up for large-scale participants
  - Energy efficiency

Total funding allocation for DSR, Storage and CCGT in Capacity Market Auctions between 2015-2019. (£m)



Replacement of the capacity mechanism with a strategic reserve + Decentralised reliability option scheme

Replacement:

- Strategic Reserve + Decentralised Reliability Options

Figure 5.2 • Wholesale market supply curve with strategic reserve (illustrative)