#ERRAConference2025

AFRY IN BRIEF

About us

AFRY provides engineering, design, digital and advisory services to accelerate the transition towards a sustainable society.

We are

19,000

devoted employees creating impact for generations to come.

AFRY's business drivers

- Decarbonisation
- Circularity
- Electrification
- Digitalisation

Three mega trends are driving the energy transition and will shape the future energy system – decarbonisation, decentralisation and digitalisation

DECARBONISATION

- Renewable energy capacity has become a major source of power generation – T&D networks will need to adjust
- Heating and transport are to be electrified
- Coal and gas share in generation mix is decreasing - H_2 and CCS will start playing a role

DECENTRALISATION

- With rising solar, battery & EV penetration, the share of self-produced electricity from small-scale units (B2B & B2C) will increase
- The overall energy demand balance will shift away from gas towards electricity consumption, as heat pumps enter the heating sector at large scale

DIGITALISATION

- Entirely new business models will evolve around digital solutions, where value is created in the orchestration of assets
- Customers and their appliances will respond to dynamic incentives
- Peer-to-peer energy trading platforms will revolutionise power markets

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To successfully navigate the energy transition, governments will need to strike a balance between relying on markets and centralising decision making

Historical setup…

Generation is flexible and follows demand, which is inflexible

Large scale generation dominated by dispatchable thermal plants

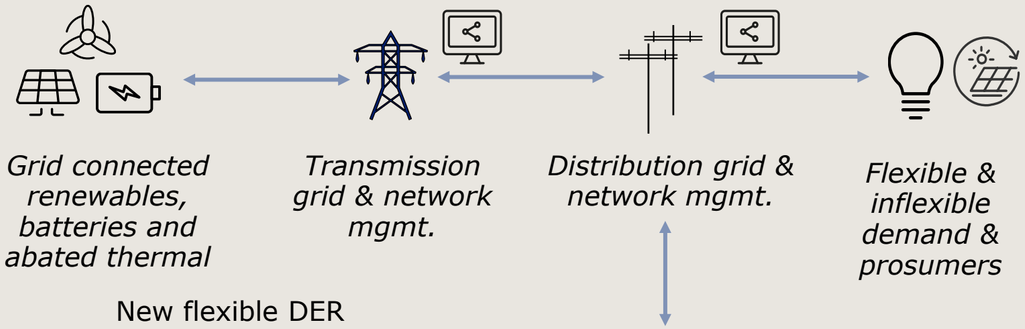
Transmission grid

Distribution grid

Inflexible demand

Future markets…

Demand is more flexible, and typically follows generation which is a mix of flexible and inflexible



Grid connected renewables, batteries and abated thermal

Transmission grid & network mgmt.

Distribution grid & network mgmt.

Flexible & inflexible demand & prosumers

New flexible DER

Distributed generation

Distributed storage

Heat pumps

DSR

EV chargers

Key questions:
- Can markets successfully deliver the energy transition?
- If yes, what changes are needed to current market designs, and how can these best be implemented?
- If no, what alternatives are there? (e.g. central planning, with support from markets)

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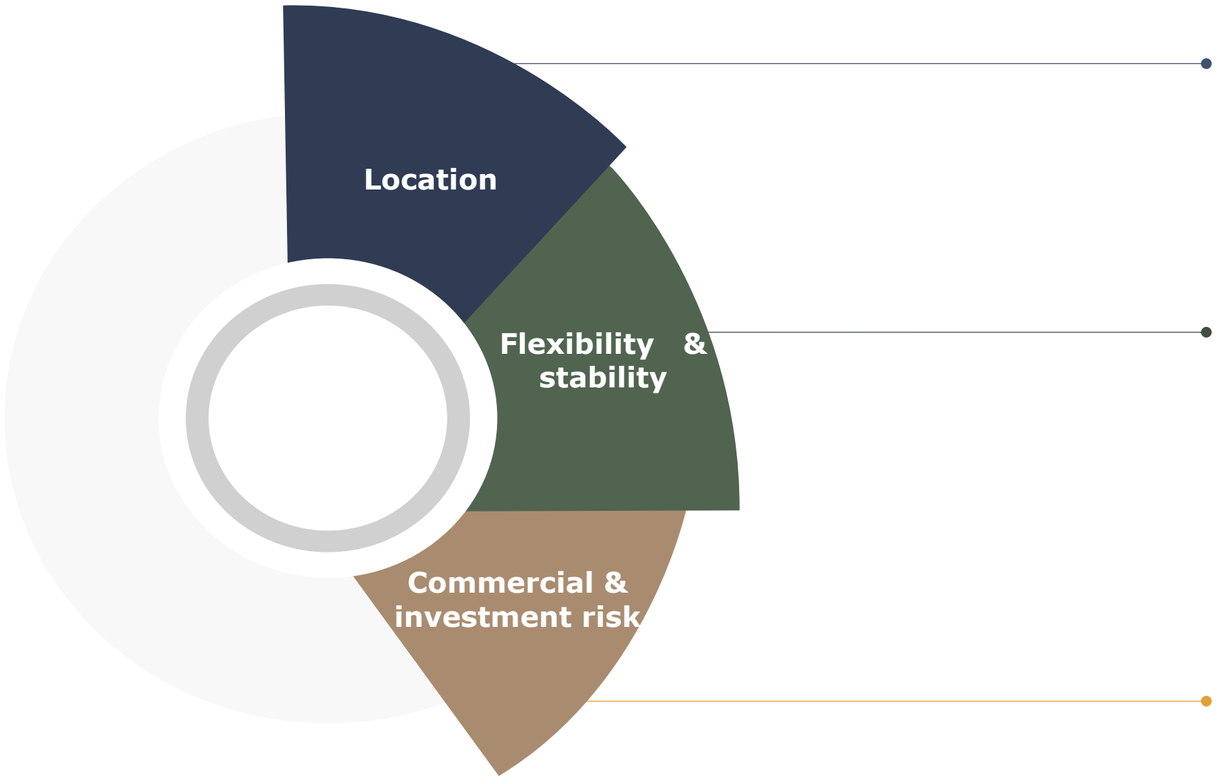
Decarbonisation creates challenges of “location”, “flexibility & stability” and “commercial & investment risk”

BARRIERS TO AN EVOLVING SYSTEM



- **Location of new generation is different from existing generation (substantially at Distribution not Transmission level)**
- **Pressure for smaller price areas**
- **Growing demand at lowest voltage levels → huge need for grid investment and Distribution congestion management**
- **Curtailment of renewable generation due to grid constraints**
- **Transition from traditional to new providers of flexibility and stability at Transmission and increasingly at Distribution level**
- **Accommodating new technologies, new buyers and new market products**
- **Stranded assets, ‘missing money’ and devaluation of existing generation**
- **Increased price volatility and volume risk**
- **Revenue cannibalisation and exposure to negative prices (wind, solar duck curve)**
- **Uncertain investment environment for novel technologies**
- **Regulatory risk to market arrangements**

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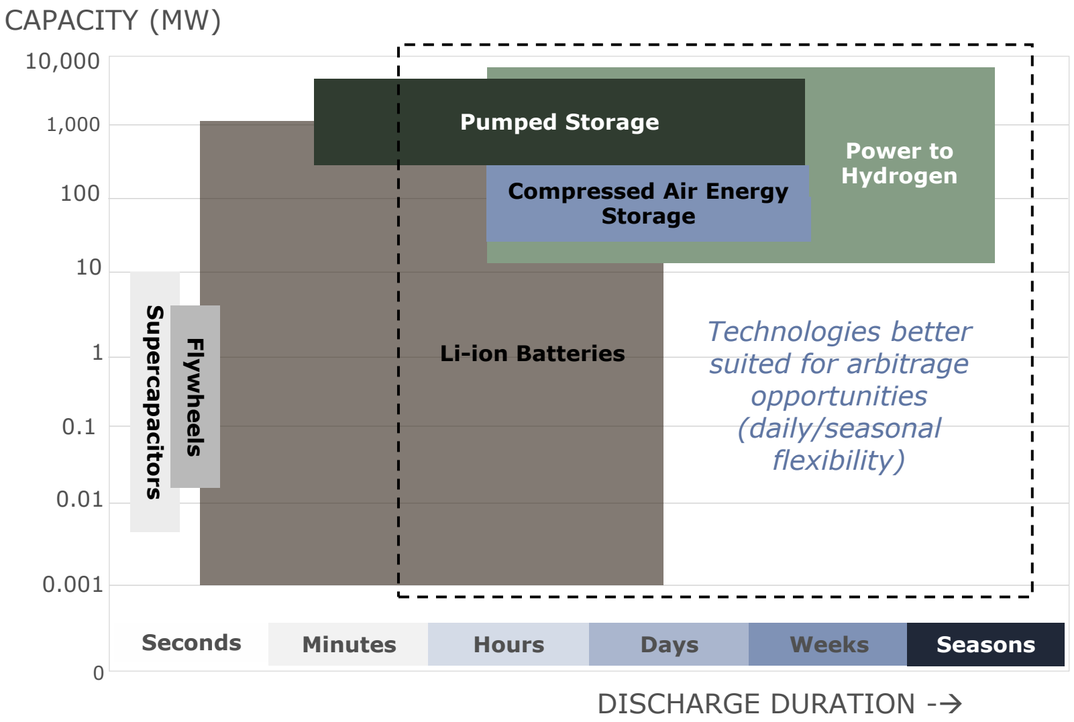
Appropriate technological solutions – and hence market design to incentivise new entrants – will need to account for changing system needs

SCARCITY EVENTS WILL BECOME LONGER IN FUTURE…

	Year	Distribution of critically tight periods (hours)										Mean length of critically tight periods (hours)
		<3	3-4	5-7	8-15	16-25	26-50	51-75	76-100	101-150	>150	
'Consumer Transformation'	2025	15	31	6	8	0	0	0	0	0	0	5
	2028	10	28	2	10	2	0	0	0	0	0	6
	2030	5	24	3	9	0	1	0	0	0	0	6
	2033	1	8	2	3	0	5	1	0	0	0	17
	2035	1	5	1	2	1	6	1	0	0	0	21
	2038	0	0	0	2	0	5	4	0	0	0	45
	2040	0	0	0	2	0	5	4	0	0	0	44
'No new CCS'	2025	15	31	6	8	0	0	0	0	0	0	5
	2028	13	25	1	9	2	0	0	0	0	0	5
	2030	11	12	2	2	0	4	1	0	0	0	10
	2033	0	0	0	1	3	4	8	1	0	0	44
	2035	0	0	0	0	2	4	4	3	1	0	57
	2038	0	0	0	2	0	3	4	2	0	0	51
	2040	0	0	0	1	0	5	3	1	0	0	52

Source: AFRY analysis - Long term capacity adequacy assessment JULY 2022

…REQUIRING A RANGE OF TECHNOLOGICAL SOLUTIONS



Key questions:
- What's the best approach to incentivise a technology mix that can meet changing scarcity patterns?
- Can this be achieved with markets, or is centrally planned investment more likely to succeed?

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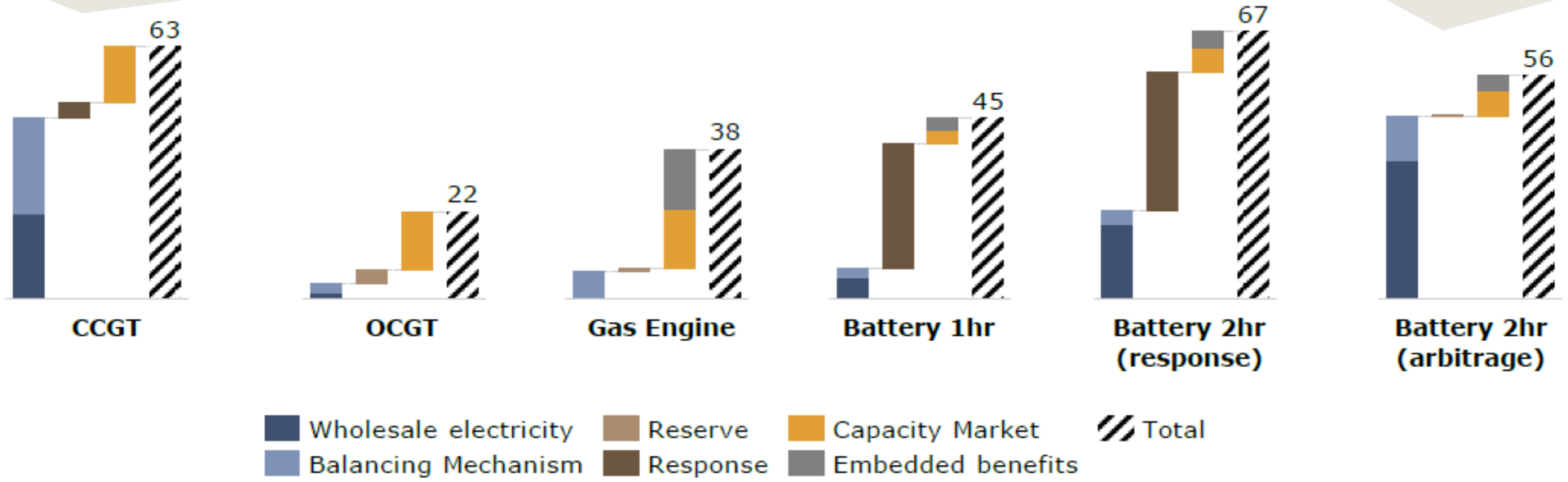
Business models will vary by technology, so it is vital that the right incentive structures are in place to attract investment in the right areas

ILLUSTRATIVE REVENUE STACKS BY TECHNOLOGY IN 2023

CCGT relies mainly on wholesale market revenue, but capacity market at BM revenues are also important

Batteries rely heavily on frequency response revenue



Key question: What new market products would be needed to incentivise the right mix of technologies that are needed to meet the ever growing complexity of current and future power systems?

Note: 1hr batteries predominantly performed DC, while a 2hr batteries primarily prvides DR. OCGTs and gas engine are both around 36% efficient and perform STOR, alongside generation revenues. Gross margins show revenues net of operating costs (e.g. battery charging costs, gas and carbon costs, variable O&M)

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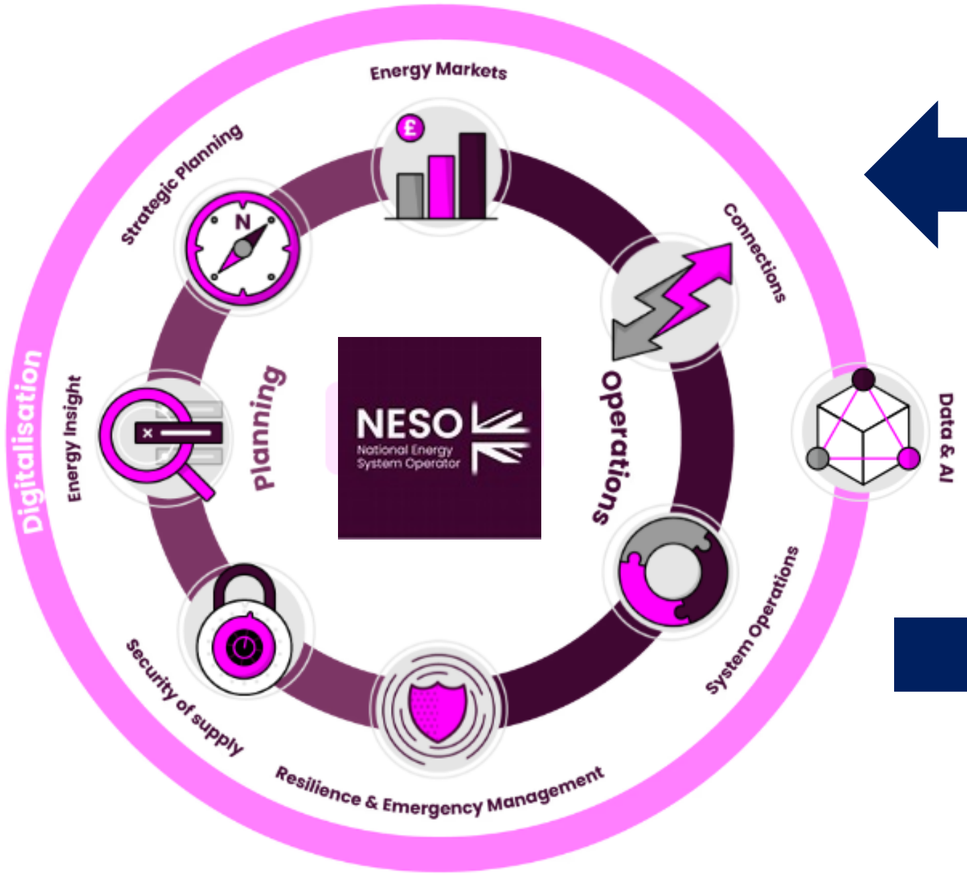
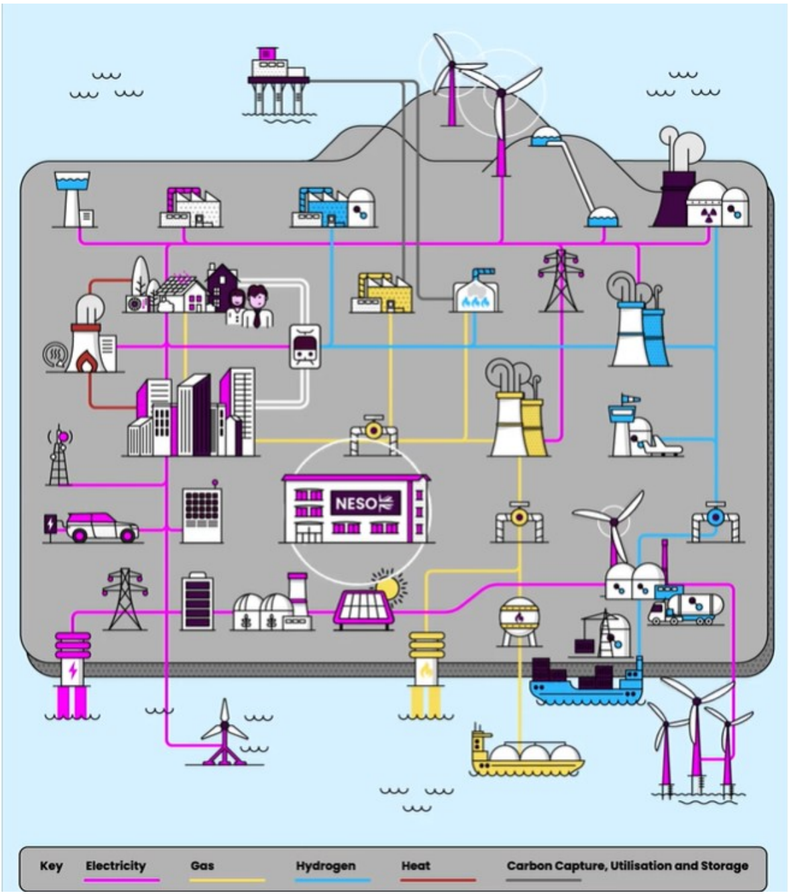
To successfully navigate the energy transition, Britain is centralising system planning across energy vectors and increasingly steering investment choices



ACTIVITIES

NESO
National Energy System Operator

MARKETS



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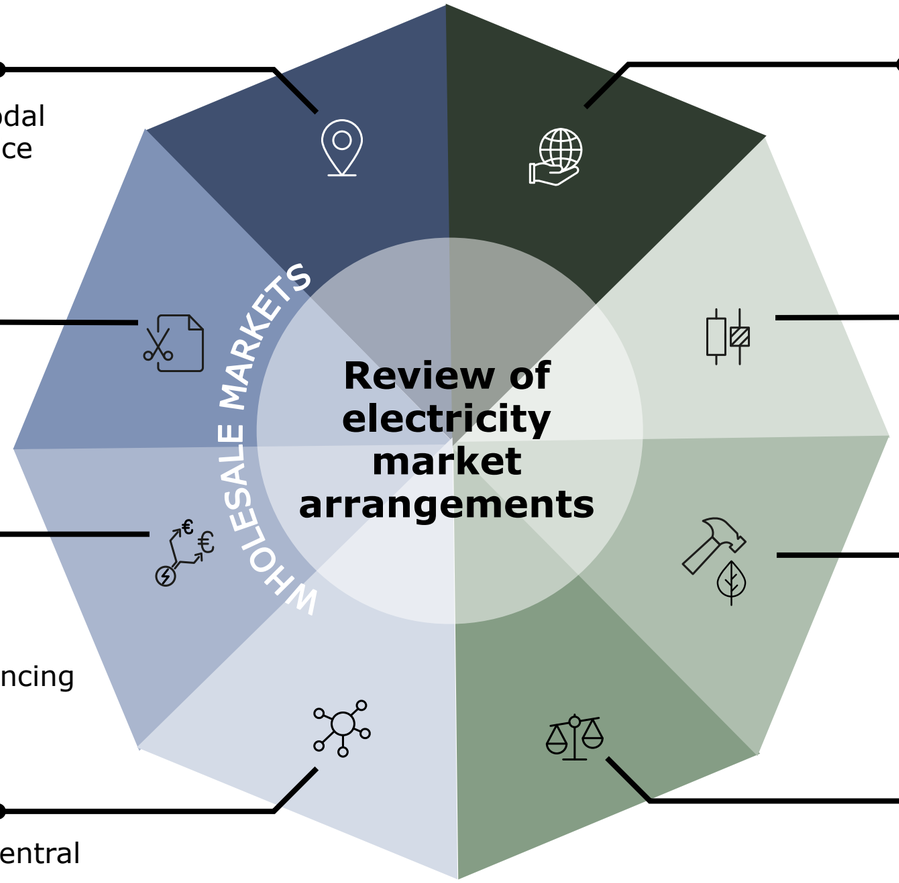
Addressing the new challenges, the UK launched their Review of Electricity Market Arrangements (REMA) considering various design options



Location

National / Zonal / Nodal / Local imbalance price

Technology

Unified / Split markets

Pricing & balancing

Pay-as-clear / Pay-as-bid

National / Local then national balancing

Dispatch

Self-dispatch / Central

Mass low carbon power

How to support renewables

Flexibility

How to incentivise flexibility which the system increasingly requires, including long duration storage

Capacity adequacy

How to design capacity market in line with net zero

Operability

Promoting low carbon ancillary services

Also considered in other processes by:

- Ofgem
- National Grid ESO

Source: UK Government (DESNZ, previously BEIS)

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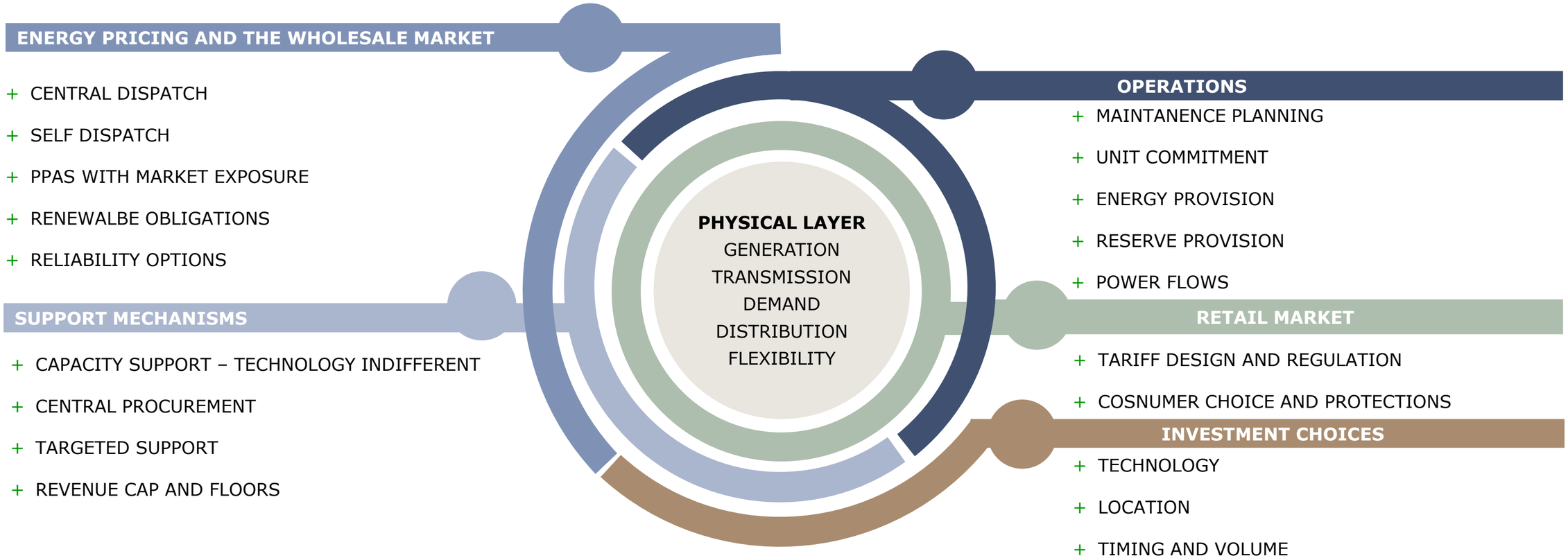
TRADE OFFS IN MARKET DESIGN

Market design is a series of compromises and trade offs around key decisions



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CONCLUSIONS

Takeaways

- Decarbonisation is creating challenges for energy systems
- The scale of the challenge is driving centralisation and co-ordination of decision making
- The broader market is becoming increasingly decentralised, with a wide range of new products, services, technologies
- Governments are increasingly taking control of decisions driving the technology mix through targeted support schemes and strategic planning … but once governments start intervening, it becomes hard to stop
- Markets still have an important role to play


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