



# Power 2.0

Building a smarter, greener,  
cheaper electricity system

Richard Howard, Policy Exchange  
7th November 2016

# The power system is changing...

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## Decarbonisation

- GHG emissions ↓50% since 1990
- 32.5GWs renewables
- ↓23GW thermal capacity

## Decentralisation

- ↓ Large-scale transmission-connected capacity
- ↑ Distributed capacity

## Digitalisation

- Smart meters, controls, storage
- Connectivity, “internet of things”

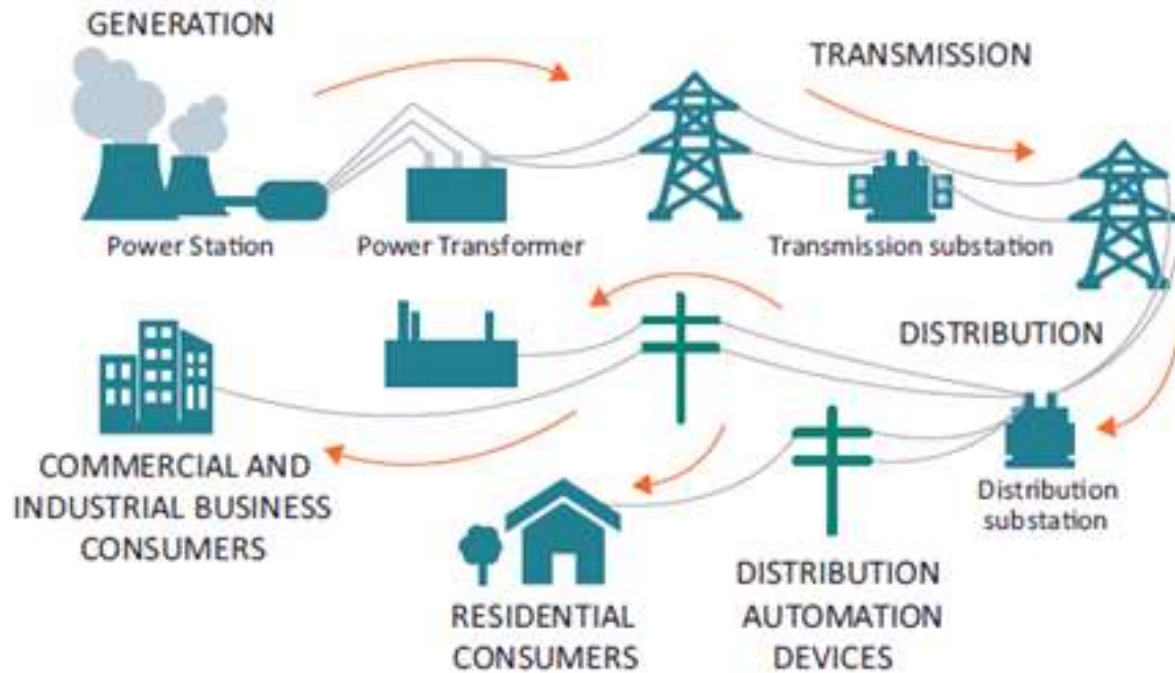
## Demand

- Total power demand ↓15% since 2005
- Electrification of heating and transport?

# The power system is changing...

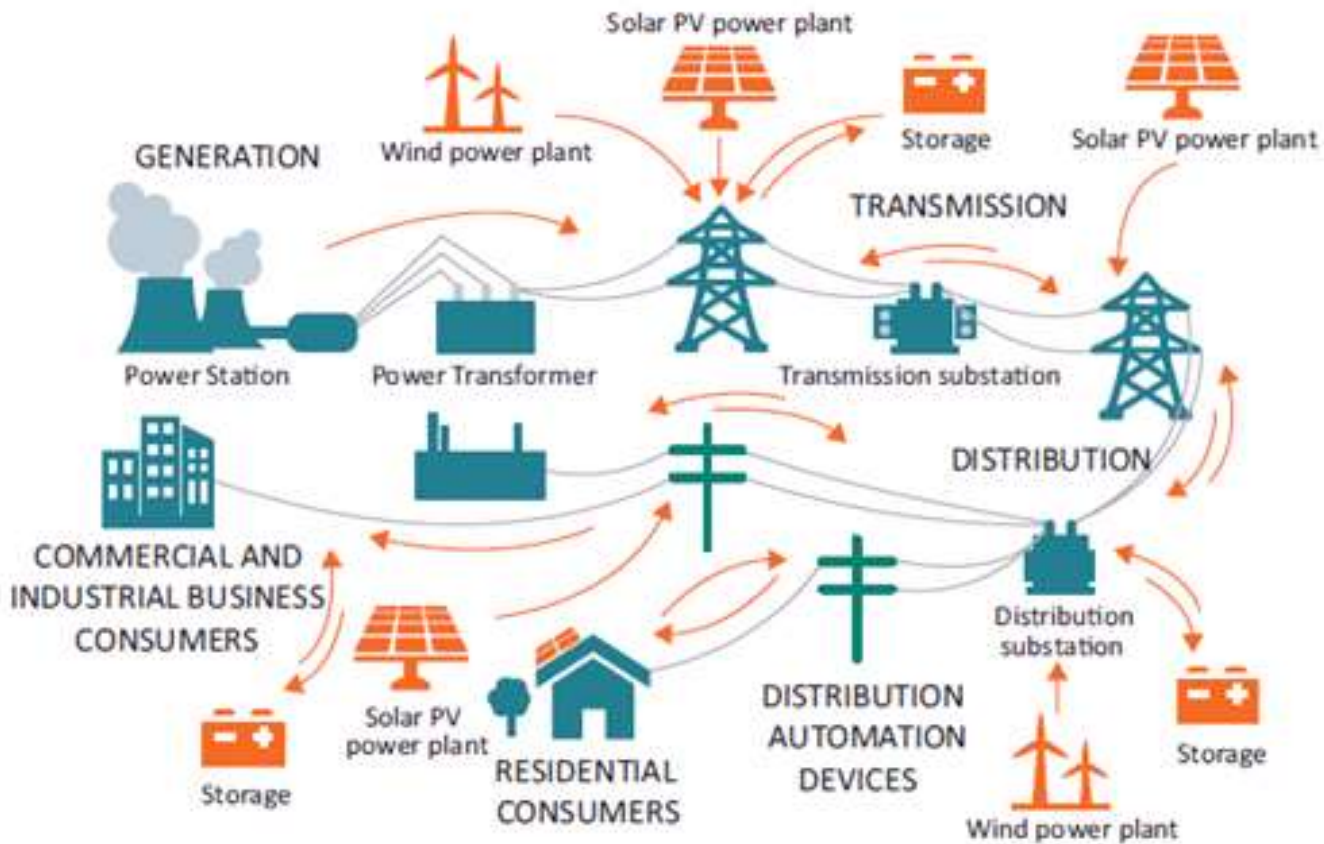
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## TRADITIONAL POWER SYSTEM



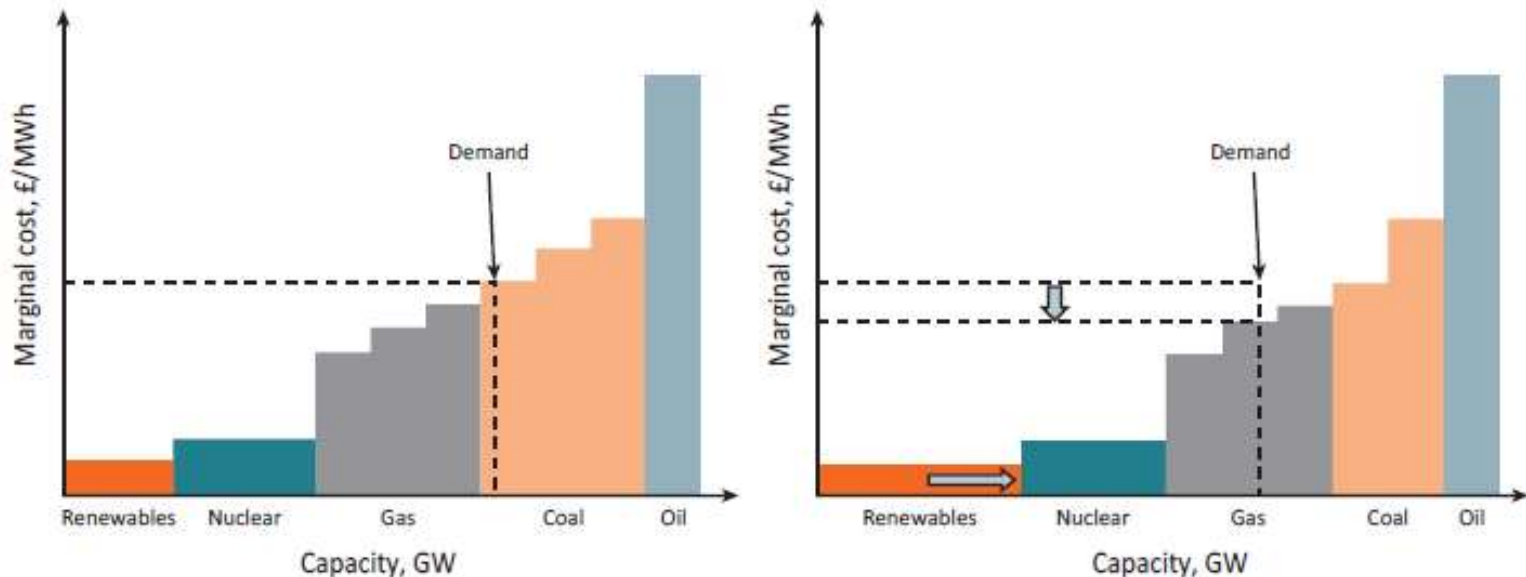
# The power system is changing...

## FUTURE POWER SYSTEM



# ...altering the economics of generation

- Growth of renewables = low/zero marginal cost
- “Merit order effects” ↓ wholesale prices
- Price volatility & negative prices
- Weakens signal to invest in new capacity



# Challenges for system operation

Balancing

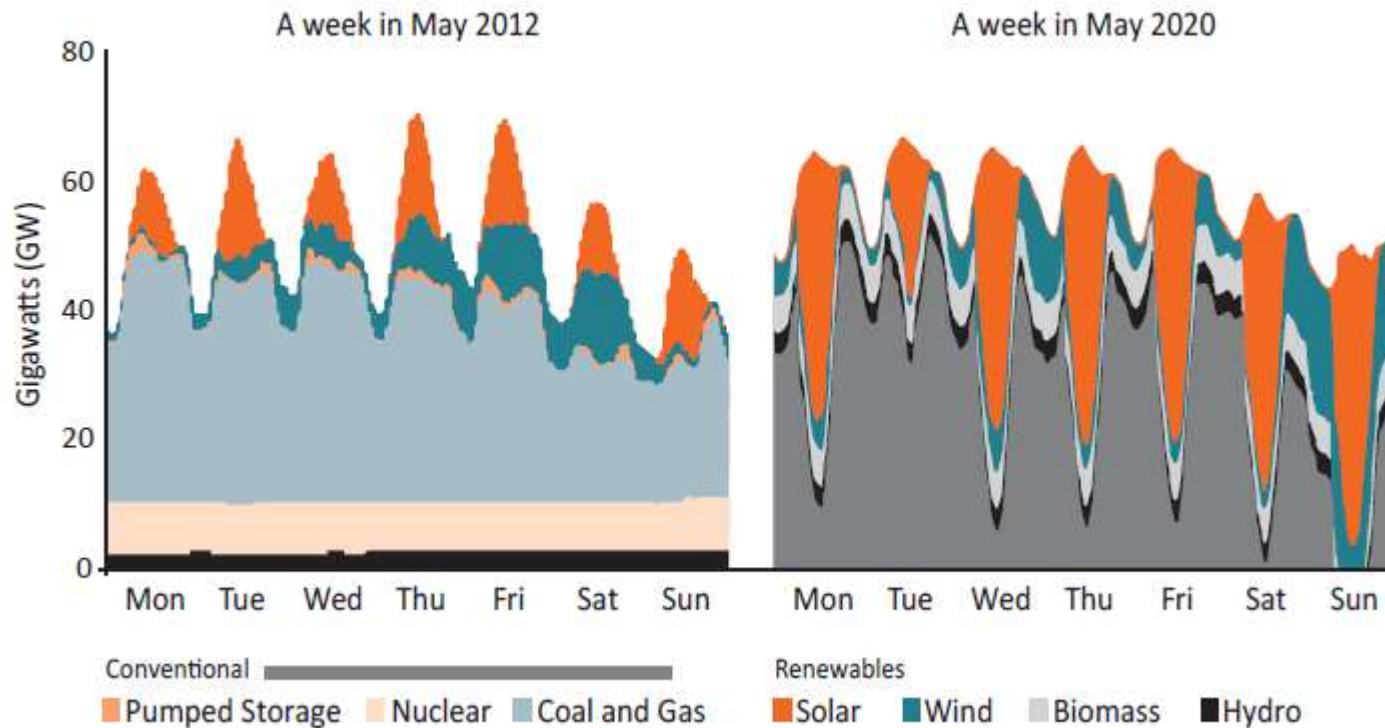
Capacity Adequacy

Excess Capacity & Constraints

Connections

System Stability

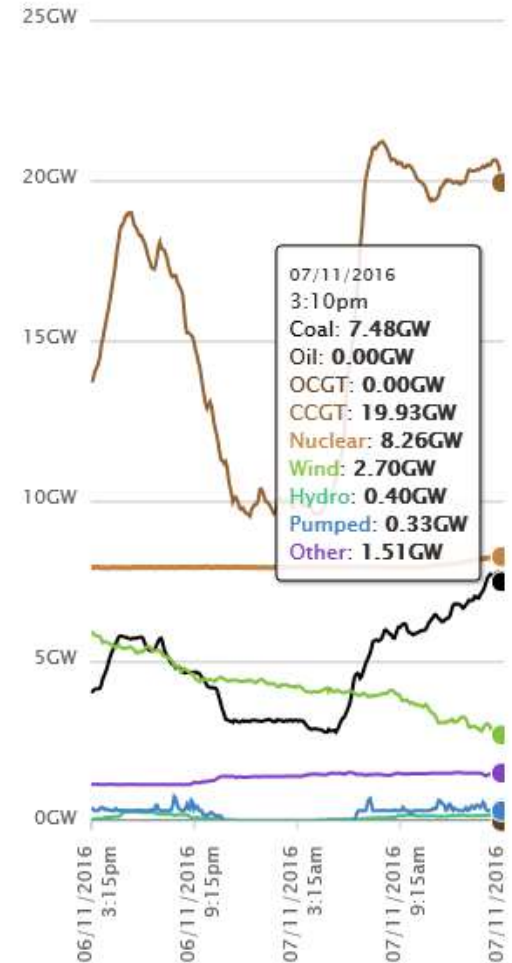
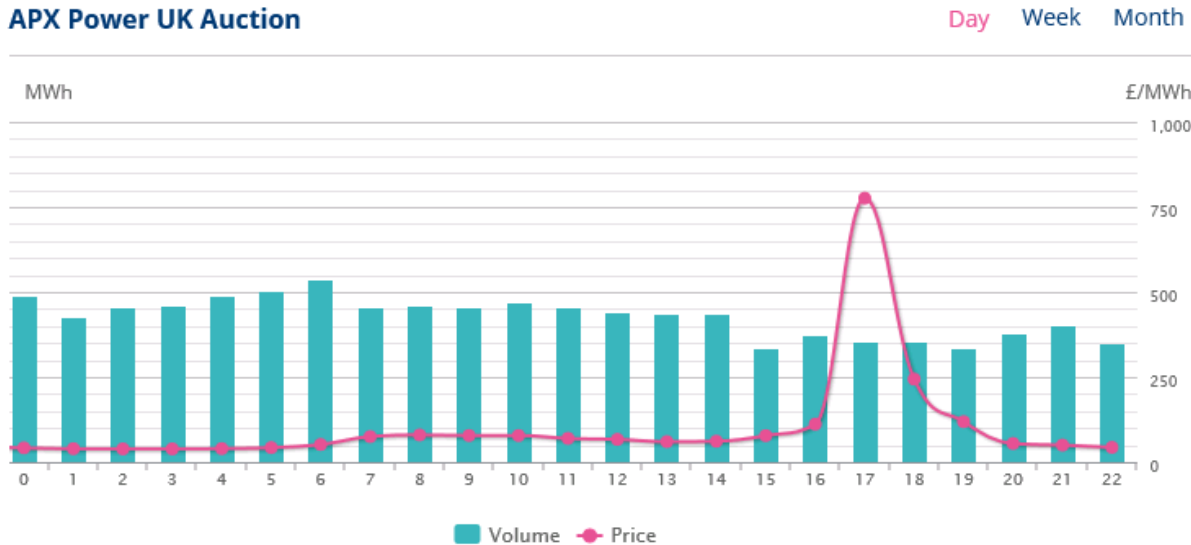
## Renewables integration and the need for flexibility in Germany



# What's going on right now?

- Capacity Market Notice @ 4:30pm
- Day ahead price £800/MWh
- Balancing Mechanism £2,500/MWh

APX Power UK Auction



# The case for flexibility

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- Decarbonisation / growth of renewables
  - ...will require smarter, flexible power system
  - System savings of flexibility = £2.9-8.1bn pa
    - Make better use of renewables output
    - Reduce need for conventional generation
    - Avoid/defer network reinforcement
    - Optimise system balancing
- Smarter = greener + cheaper



# The case for flexibility

- Many technologies can provide this flexibility

Thermal generation	Storage	Demand Response	Other
<ul style="list-style-type: none"><li>• Coal</li><li>• Gas CCGT</li><li>• Gas OCGTs</li><li>• Gas/diesel reciprocating engines</li><li>• Combined Heat and Power</li></ul>	<ul style="list-style-type: none"><li>• Pumped Hydro</li><li>• Compressed air</li><li>• Batteries</li><li>• Flywheels</li><li>• Supercapacitors</li><li>• Thermal storage</li><li>• Power to gas</li><li>• Superconducting Magnetic Energy Storage (SMES)</li></ul>	<ul style="list-style-type: none"><li>• Demand shifting / demand turn-down</li><li>• Demand turn-up</li><li>• Behind the meter generation</li></ul>	<ul style="list-style-type: none"><li>• Interconnectors</li><li>• Renewables</li><li>• Enabling technologies (e.g. Smart meters)</li></ul>

➤ NOT treated equally in policy/regulatory terms

# Levelling the playing field

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- **Storage + Demand Response (DSR)**
  - Define storage and DSR in regulation
  - Remove ‘double charging’ of environmental levies on storage
  - Allow aggregators to sell flexibility into Balancing Market
  - Amend Capacity Market rules to remove barriers to DSR & storage (including access to 3-year contracts)

# Levelling the playing field

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- **Distribution Network Operators (DNOs)**
  - Update DNO regulations to encourage use of storage & DSR to relieve network constraints
  - DNOs should *procure* services of storage, rather than owning directly
- **Diesel generators**
  - Defra should create set of national standards to regulate emissions (NO<sub>x</sub>, PM)

# Levelling the playing field

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- Recommendations we *don't* support
  - Setting targets for storage / DSR
  - Subsidies/grants for storage / DSR
  - Exempting storage from grid charges
  - Direct ownership of storage by DNOs
  - Excluding technologies from the Capacity Market
  - Splitting the Capacity Market, giving different payments to different technologies

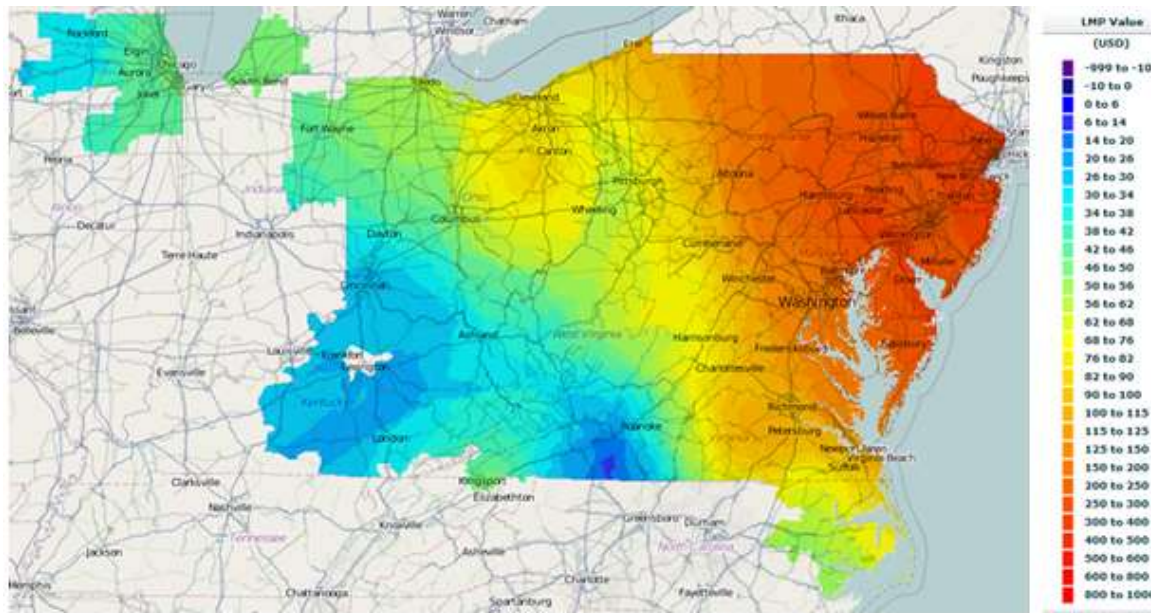
# Longer term: market redesign

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- **Reform wholesale market** to value and encourage flexibility
  - **Temporal:** Allow trading closer to real time
  - **Spatial:** Reflect geography of demand/supply and network constraints – e.g. through regional or ‘nodal pricing’

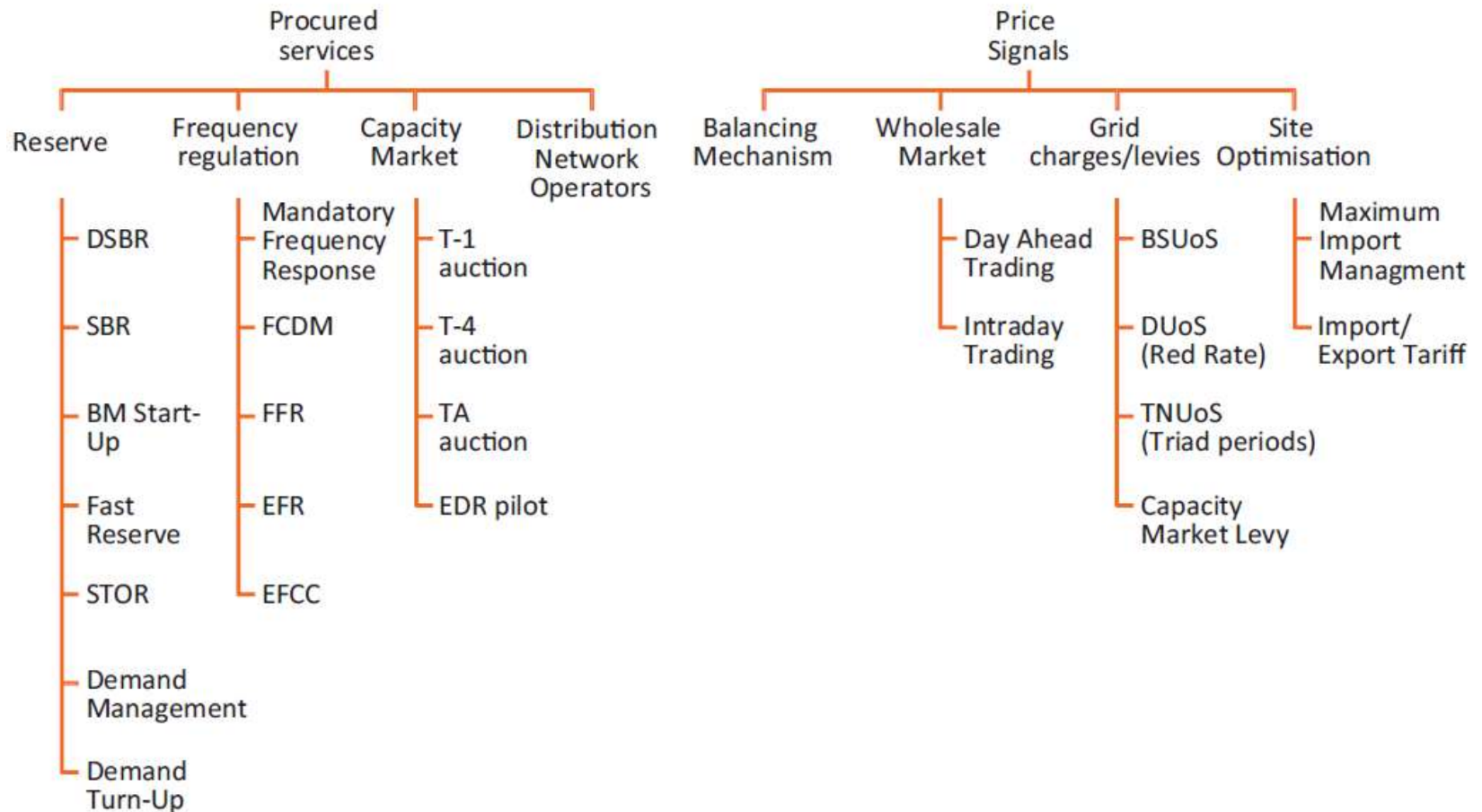
# Longer term: market redesign

- Examples of nodal pricing: US regional markets, New Zealand, Singapore
- PJM = 10,000 nodes, price varies by location
- Efficiency savings worth \$2.2 bn pa



# Longer term: market redesign

Figure 2: Markets for flexibility<sup>3</sup>



# Longer term: market redesign

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- **Reform ancillary markets:**
  - Reduce complexity
  - Follow system needs
  - Create liquid markets
  - Open competition
  - Technology neutral
  - Transparency



# Longer term: market redesign

REGELLEISTUNG.NET  
Internetplattform zur Vergabe von Regelleistung

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50hertz amprion  
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Home Tender details Data centre About control reserve Login DE / EN

### Next tenders

Category	Date	Period	Round
Primary control reserve	Tuesday, 08.11.2016	for 14.11 - 20.11.2016	Round: 1
	Tuesday, 15.11.2016	for 21.11 - 27.11.2016	Round: 1
	Tuesday, 22.11.2016	for 28.11 - 04.12.2016	Round: 1
Secondary control reserve	Wednesday, 09.11.2016	for 14.11 - 20.11.2016	Round: 1
	Wednesday, 16.11.2016	for 21.11 - 27.11.2016	Round: 1
	Wednesday, 23.11.2016	for 28.11 - 04.12.2016	Round: 1
Minute reserve	Tuesday, 08.11.2016	for 09.11 - 09.11.2016	Round: 1
	Wednesday, 09.11.2016	for 10.11 - 10.11.2016	Round: 1
	Thursday, 10.11.2016	for 11.11 - 11.11.2016	Round: 1
Immediately interruptible loads	Monday, 21.11.2016	for 01.12 - 31.12.2016	Round: 1
	Monday, 19.12.2016	for 01.01 - 31.01.2017	Round: 1
	Monday, 23.01.2017	for 01.02 - 28.02.2017	Round: 1
Quickly interruptible loads	Thursday, 24.11.2016	for 01.12 - 31.12.2016	Round: 1
	Thursday, 22.12.2016	for 01.01 - 31.01.2017	Round: 1
	Thursday, 26.01.2017	for 01.02 - 28.02.2017	Round: 1
Primary control reserve NL	Tuesday, 08.11.2016	for 14.11 - 20.11.2016	Round: 1
	Tuesday, 15.11.2016	for 21.11 - 27.11.2016	Round: 1
	Tuesday, 22.11.2016	for 28.11 - 04.12.2016	Round: 1

- German system
- 4 TSOs
- 1 platform
- 3 main markets
- Weekly/daily auctions

# Longer term: market redesign

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- **Reform network charges**

- Network charges = 25% of electricity bill
- Significant incentives for generators/users
- “Embedded benefits” - contributed to growth in embedded generation

➤ Ofgem should undertake *holistic* review of network charges to ensure they are *cost-reflective*