

Toward a Decentralised Demand-Focused Electricity System: Policy Design and Challenges

Matthew Lockwood

Thailand's Solar PV Roadmap Initiative
and the Governance of Energy Transition, Bangkok, April 2015

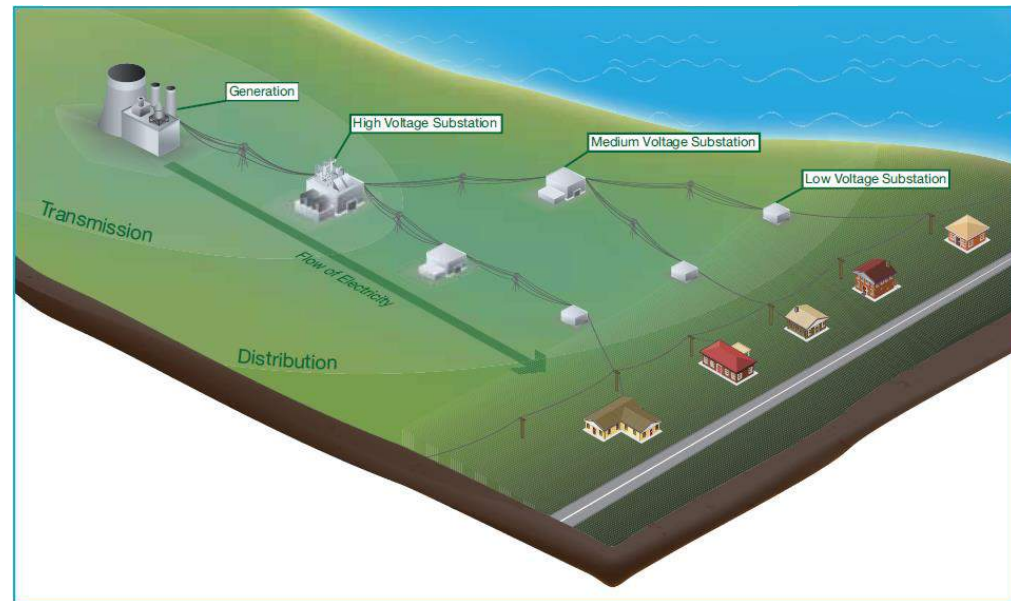
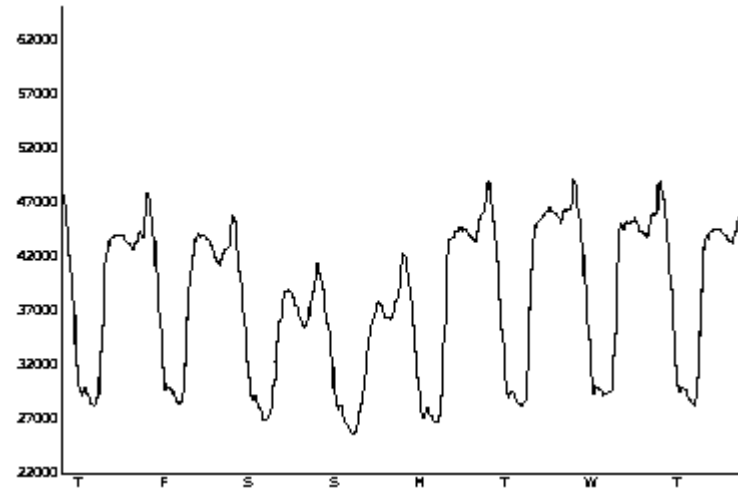


New Thinking For Energy



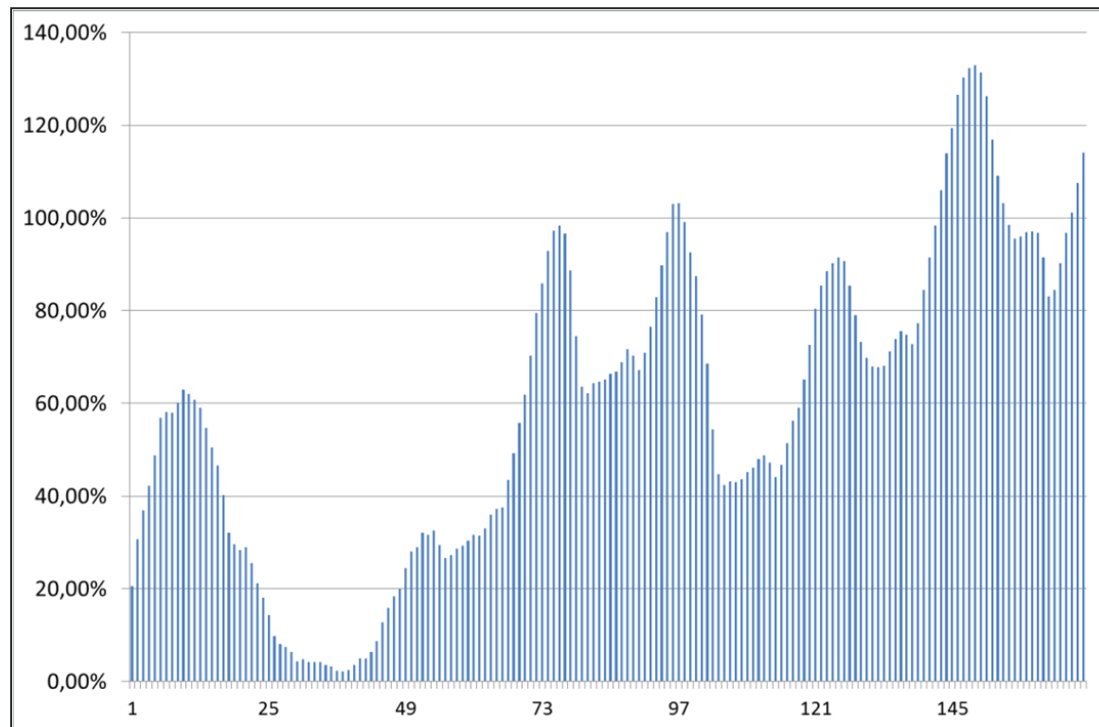
Characteristics of centralised systems

- Large-scale power generation, connected to high-voltage transmission network
- Regular cyclical load patterns with peaks
- Load-following generation, capacity sized for peak demand
- Passive distribution networks designed for loads not local generation
- Set of challenges to this system



1. Intermittent renewable sources

Danish wind output as % of demand, 13-19 January 2014

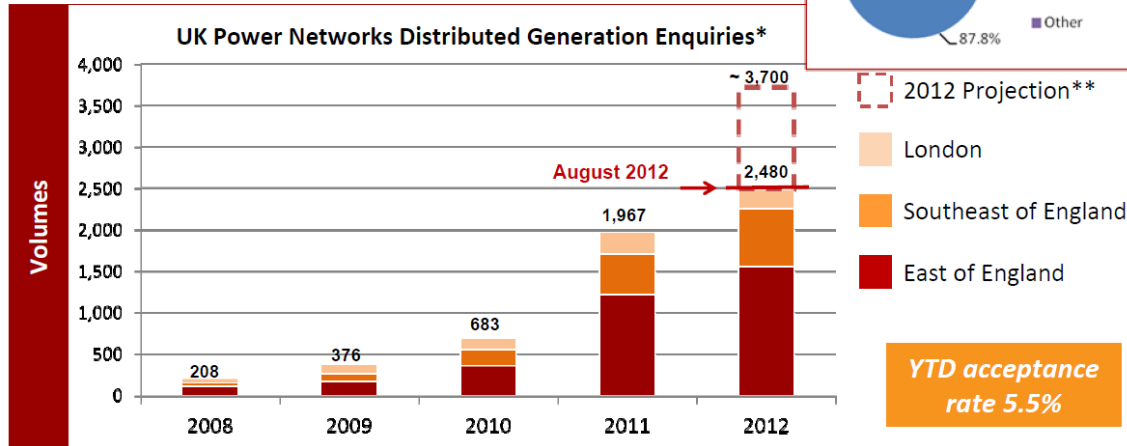


Source: Parbo 2014

- **Challenge of integrating intermittent renewables into the system, especially for balancing**

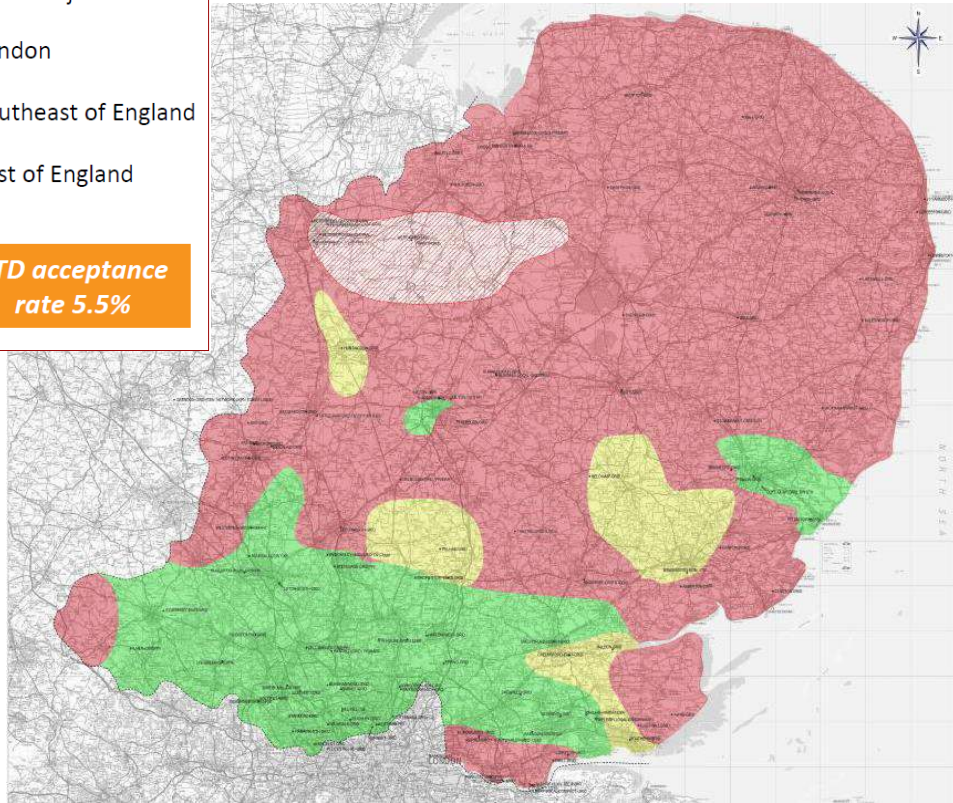
2. Distributed generation

Growth in Distributed Generation



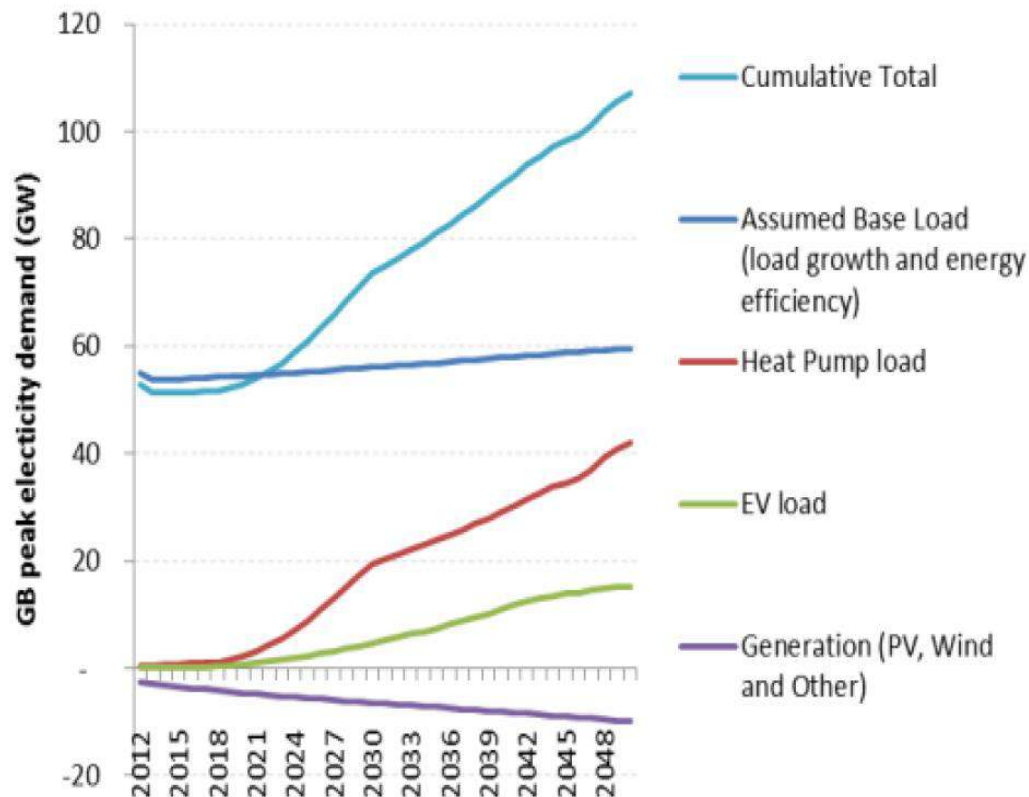
Sources: Scarsella (2012),
Wilson (2013)

- Distribution networks increasingly required to handle generation as well as loads



3. New demands for electricity (in UK, heat and transport)

Projected increase in peak electricity demand with growth of low carbon technologies under the Smart Grid Forum Workstream 3 Scenario 1.15

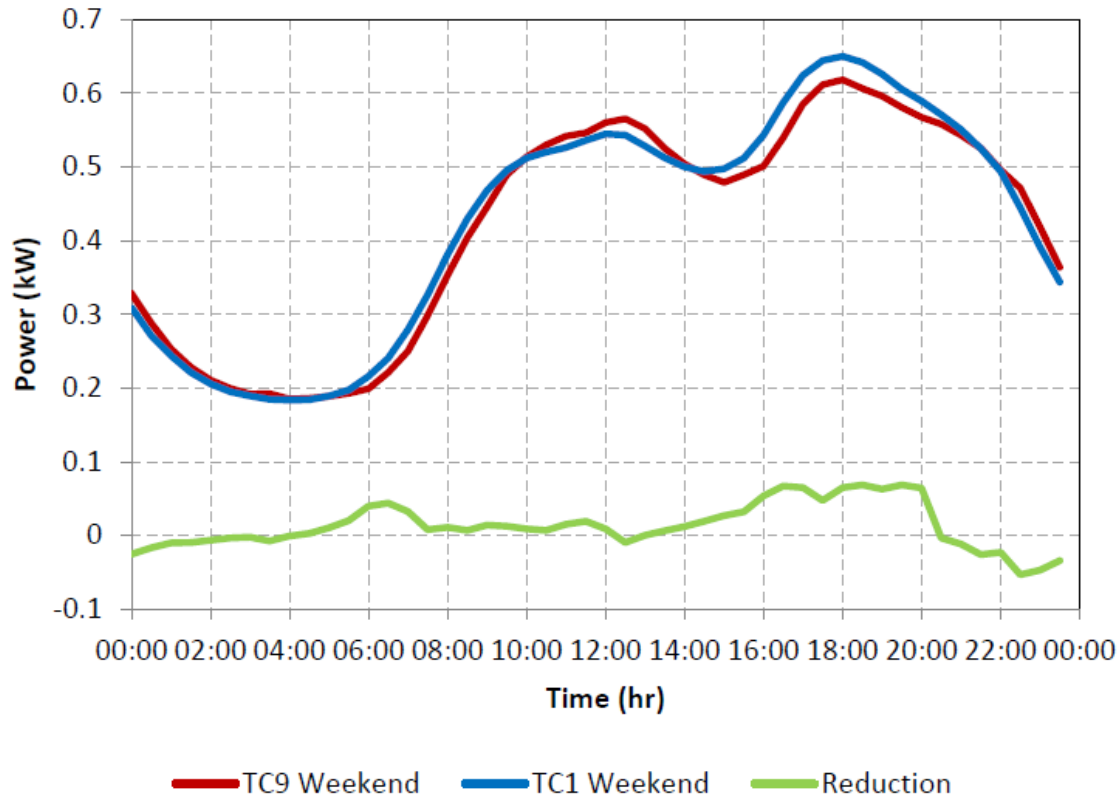


Source: Element Energy 2013

- Potentially huge increase in peak demand if BAU approach taken, with implications for required generation capacity and network reinforcement...
- ...but also new opportunity as large new flexible loads and sources of distributed storage, e.g. V2G

4. Demand response by residential consumers

Source: Jiang et al (2015)



- Demand side response by domestic consumers could help manage the system more efficiently but only with management and incentives

4. Demand response by consumers

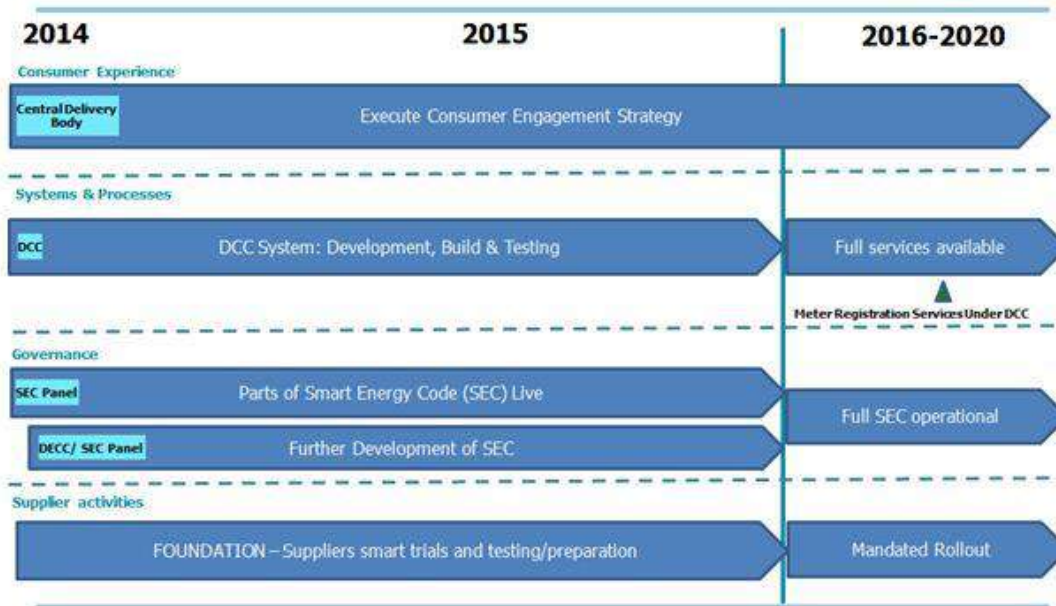
Southern California Edison Demand Response Programs 2014 forecast

SCE NONRESIDENTIAL	MW	SCE RESIDENTIAL	MW
Base Interruptible Program	628	Air Conditioning Cycling ³	294
Agricultural and Pumping Interruptible Program	63	Peak-Time Rebate ⁴	6
Air Conditioning Cycling ³	80		
Demand Response Contracts ⁵ (Day Ahead)	17		
Demand Response Contracts ⁵ (Day-Of)	142		
Demand Bidding Program	4		
Capacity Bidding Program (Day-Of)	11		
Capacity Bidding Program (Day Ahead)	0		
Critical-Peak Pricing	19		
SCE Nonresidential TOTAL	962	SCE Residential TOTAL	300

Source: California Senate Office of Research (2014)

5. Modern control and automation

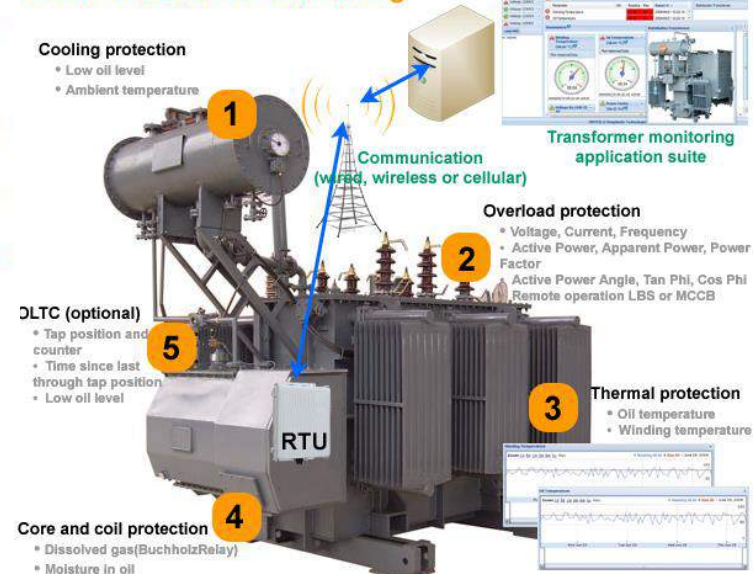
Smart Meter Rollout Timetable: Key activities



- Allows greater management of intermittency, efficient use of networks and limits need for new investment, but needs coordination and integration to avoid adverse interactions



Online Transformer Monitoring

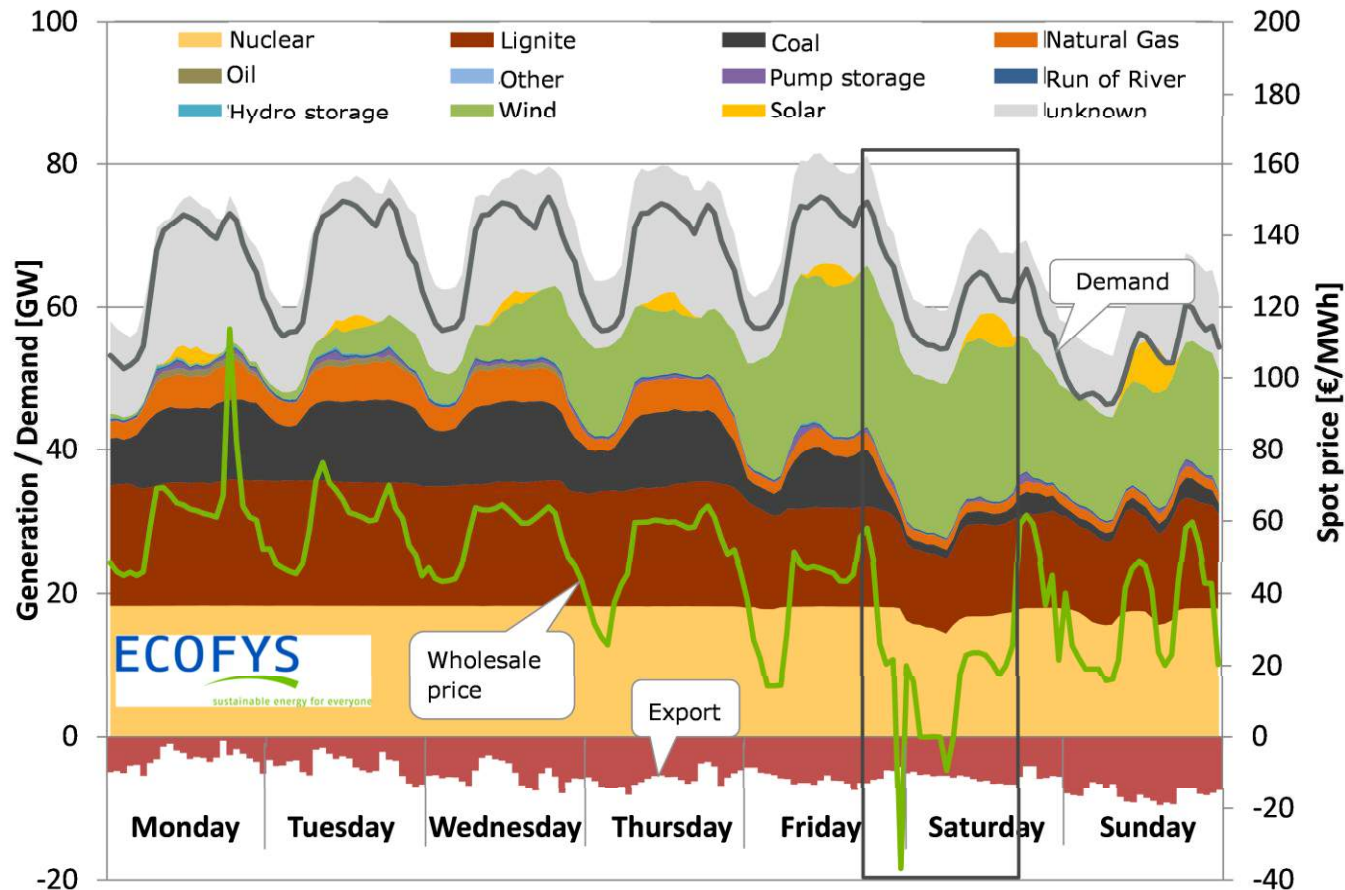


Policy agenda

	Integration into markets	Securing and transforming grid infrastructure
Increasing intermittent renewable generation	<ul style="list-style-type: none">• Ensuring flexibility (short-term security)• Ensuring adequacy (long-term security)	<ul style="list-style-type: none">• Facilitating new renewables and ensuring flexibility through transmission network
Increasing distributed generation	<ul style="list-style-type: none">• Integration of DG into markets	<ul style="list-style-type: none">• Smarter distribution networks• Services to 'distribution system operators' (DSOs)
New loads	<ul style="list-style-type: none">• Integration of demand side response (DSR) into markets	<ul style="list-style-type: none">• Smarter distribution networks• Services to 'distribution system operators' (DSOs)

Adequacy

One week in Germany Feb 2011



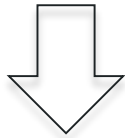
Source: Ecofys 2014

Implications of more renewables for risk and RoI on conventional plant:

- lower utilisation rates,
- lower prices, but also
- higher prices for ancillary and balancing services

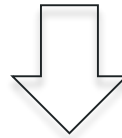
Policy options for adequacy

Continually model and assess capacity needs

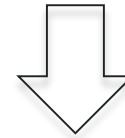


Energy only market

- Remove or raise price caps
- Support participation of DSR
- Longer-term energy contracts



**TSO contracts
strategic reserves
above strike price**

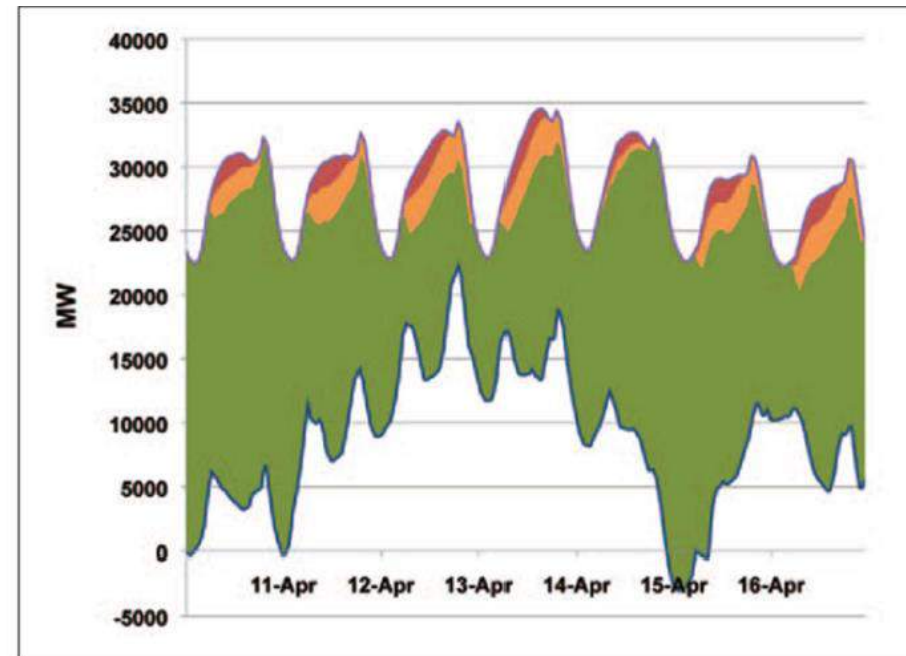
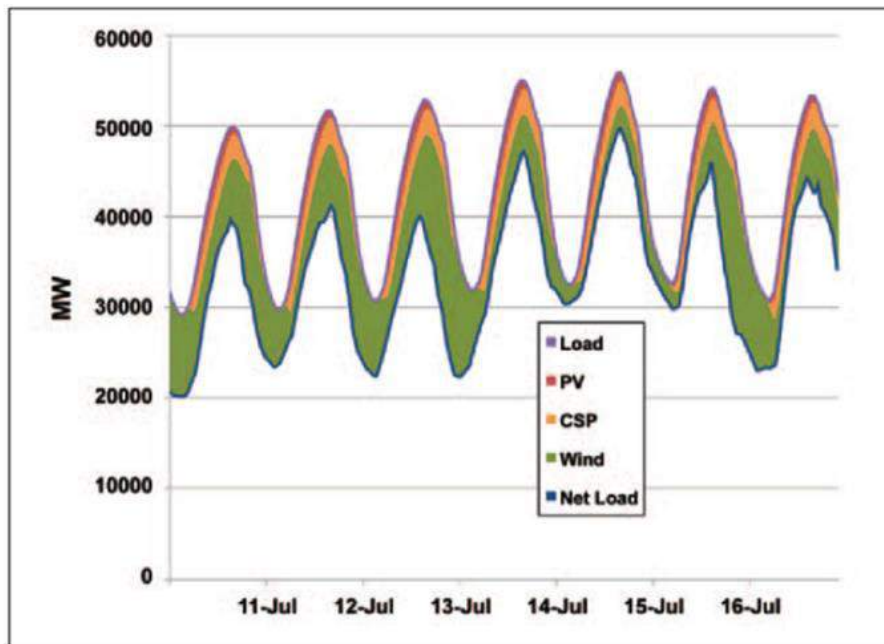


Capacity mechanism

- Fixed Capacity payments
- Capacity markets (auctions)

Flexibility

Flexibility requirements arising from renewables depend on relationship to load: 30% RES-E penetration in WestConnect region (S.W. USA), July and April 2010

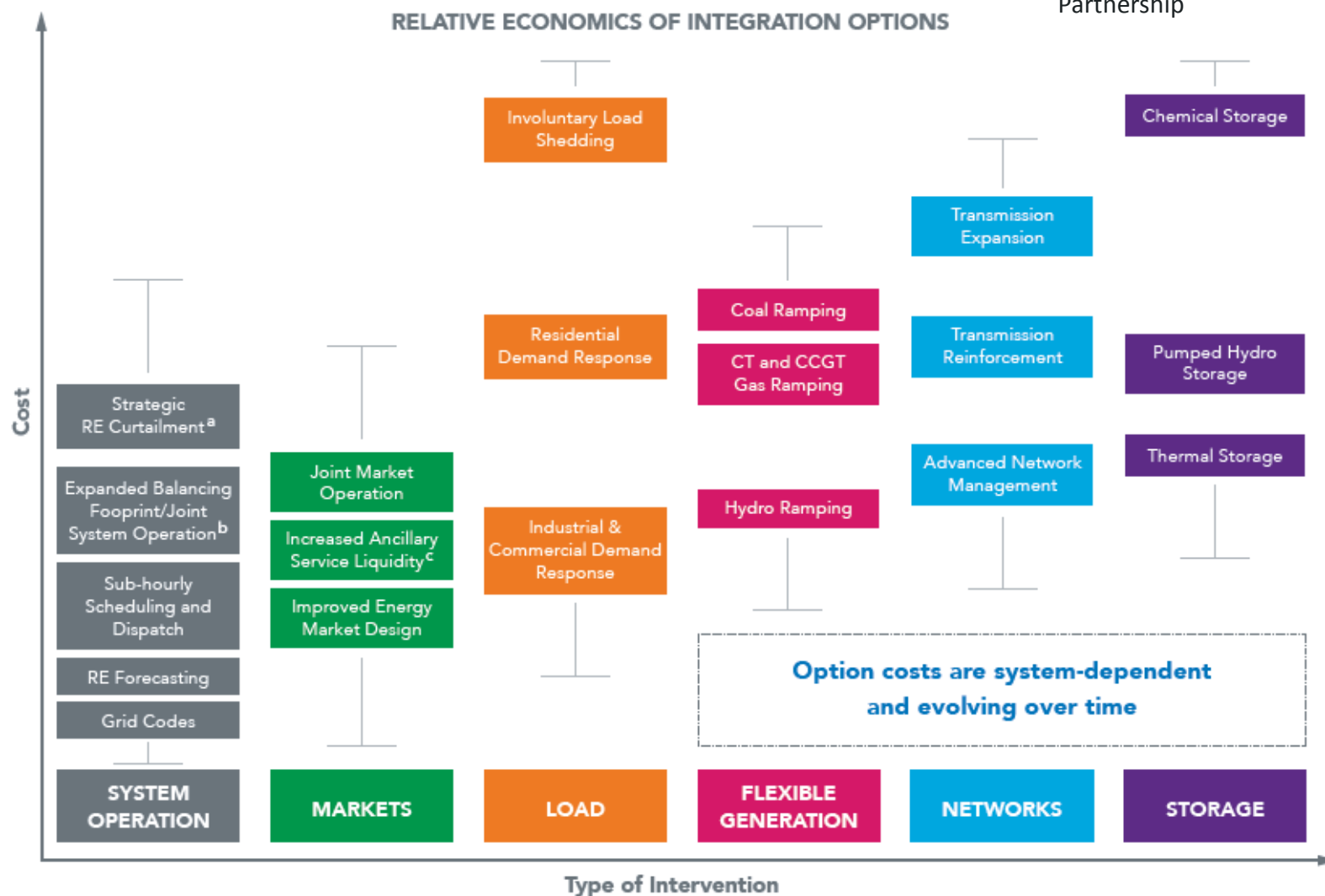


Source: Miller et al 2013

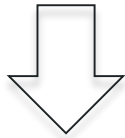
- Challenge of assessing flexibility and need for flexibility

Sources of flexibility

Source: 21st Century Power Partnership

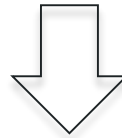


Policy options for flexibility



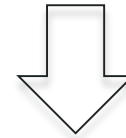
Capacity mechanism that rewards flexibility, e.g.

- **Apportioned Forward Capacity Mechanism**



Market design and system operation, e.g.

- **Faster clearance of intra-day markets**
- **Shorter gate closure time**



Additional short-term reserve (ramping, regulating)

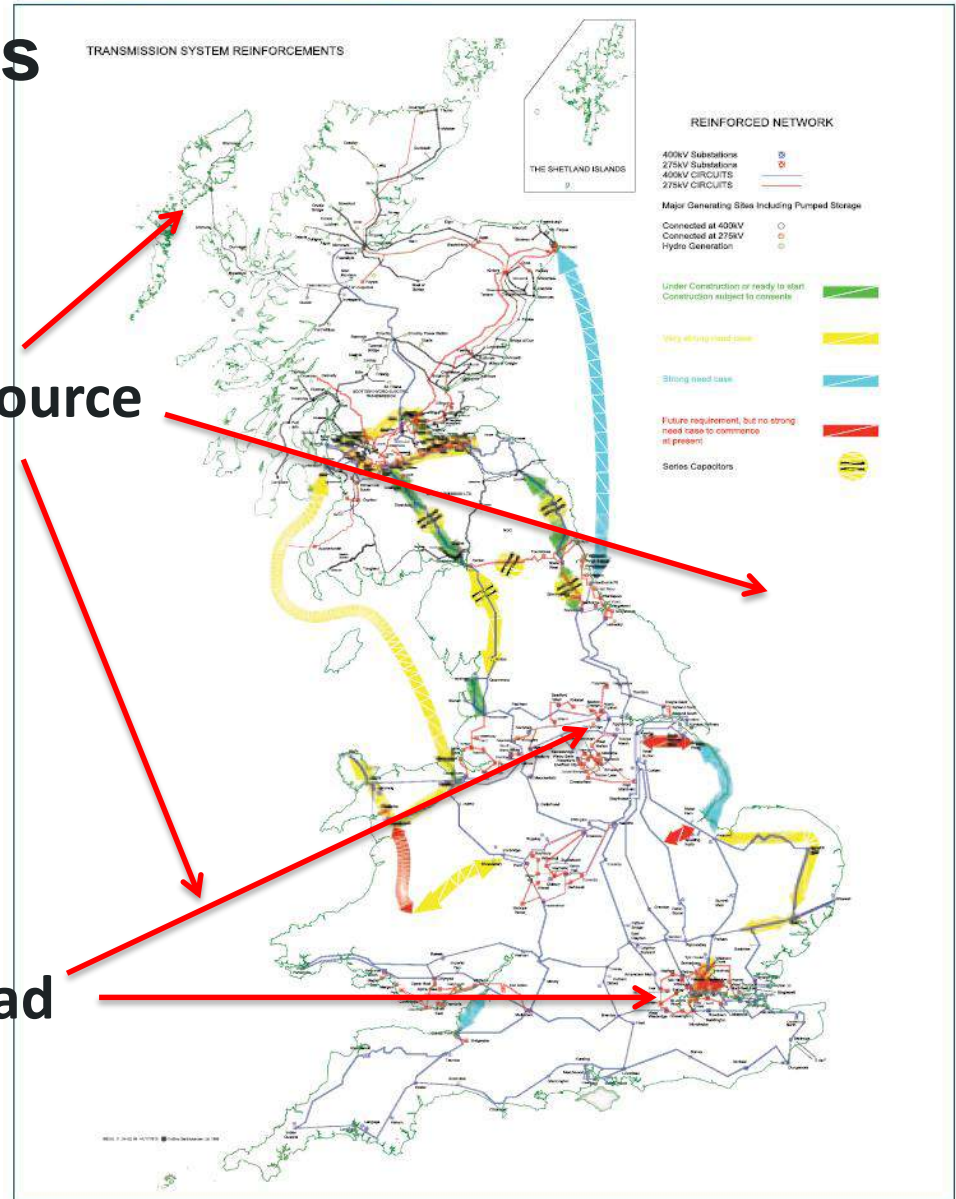
- **Dynamic reserve requirement**

Transmission networks

Figure 2: Proposed reinforcements NGET & SPT

Resource

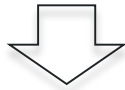
Load



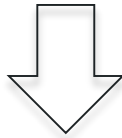
Source: ENSG 2009

Policy options for transmission

Revising network codes



Network extension

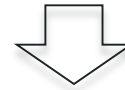


Coordination

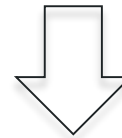
- Project clustering (Irish Gate)
- Renewable Energy Zones (ERCOT)

Contestable markets

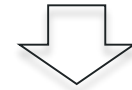
- Merchant construction of interconnection (GB)



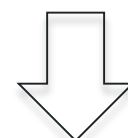
Congestion management



- Net transfer capacities (segmented markets) (Nordpool)
- Locational marginal pricing (US systems)
- Smart grid approaches (e.g. DLR, ANM) (Chile, NZ)

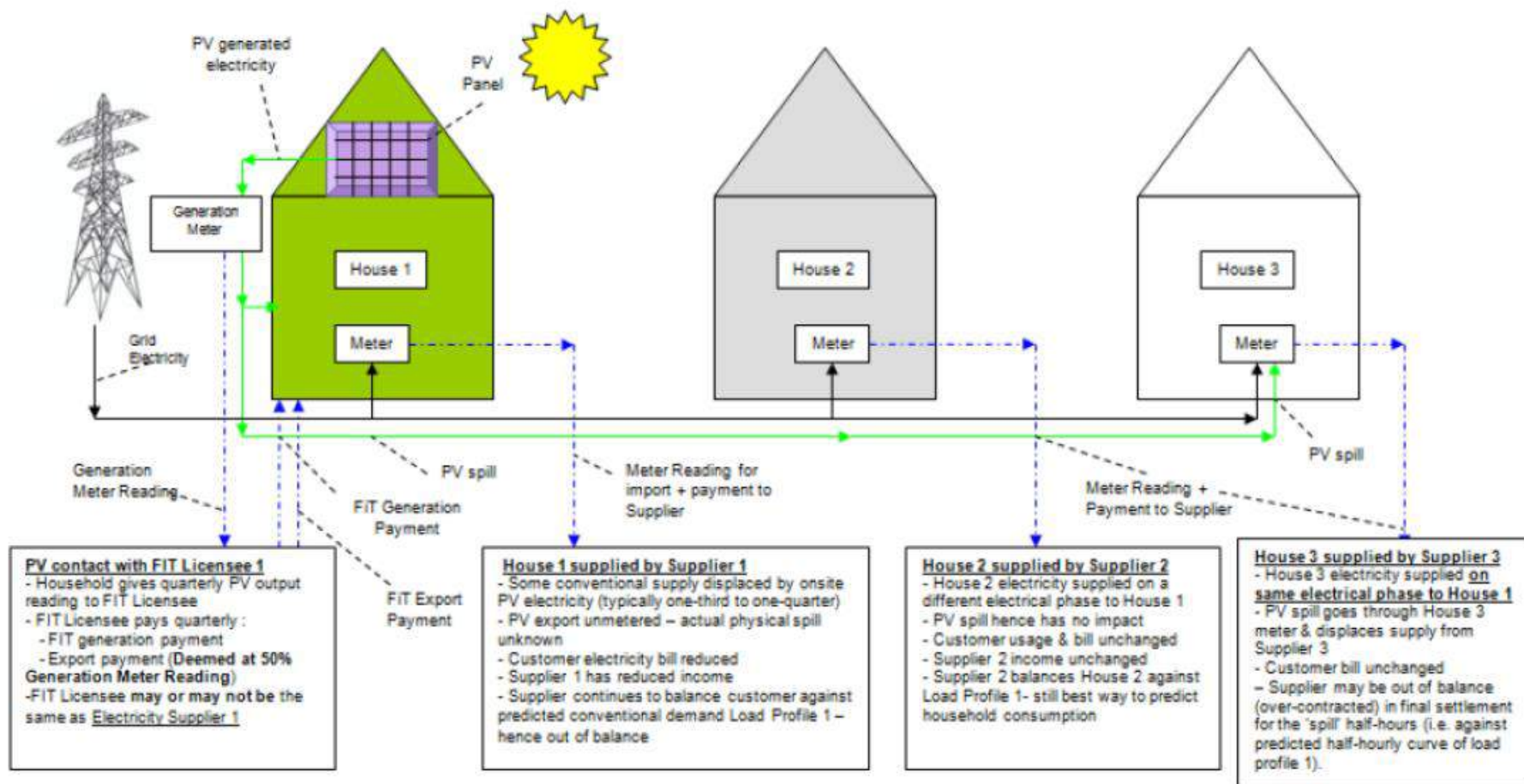


Allocating transmission capacity



- Non-firm access
- 'Connect and manage' (GB since 2009)

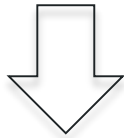
Integration of DG into markets



Source: Ahmed and Ward

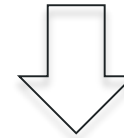
Integration of DG into markets

Commercial scale DG



- More liquid wholesale markets
- Lower market entry costs (IT, collateral, regulatory complexity)
- Identify and reduce barriers to aggregation

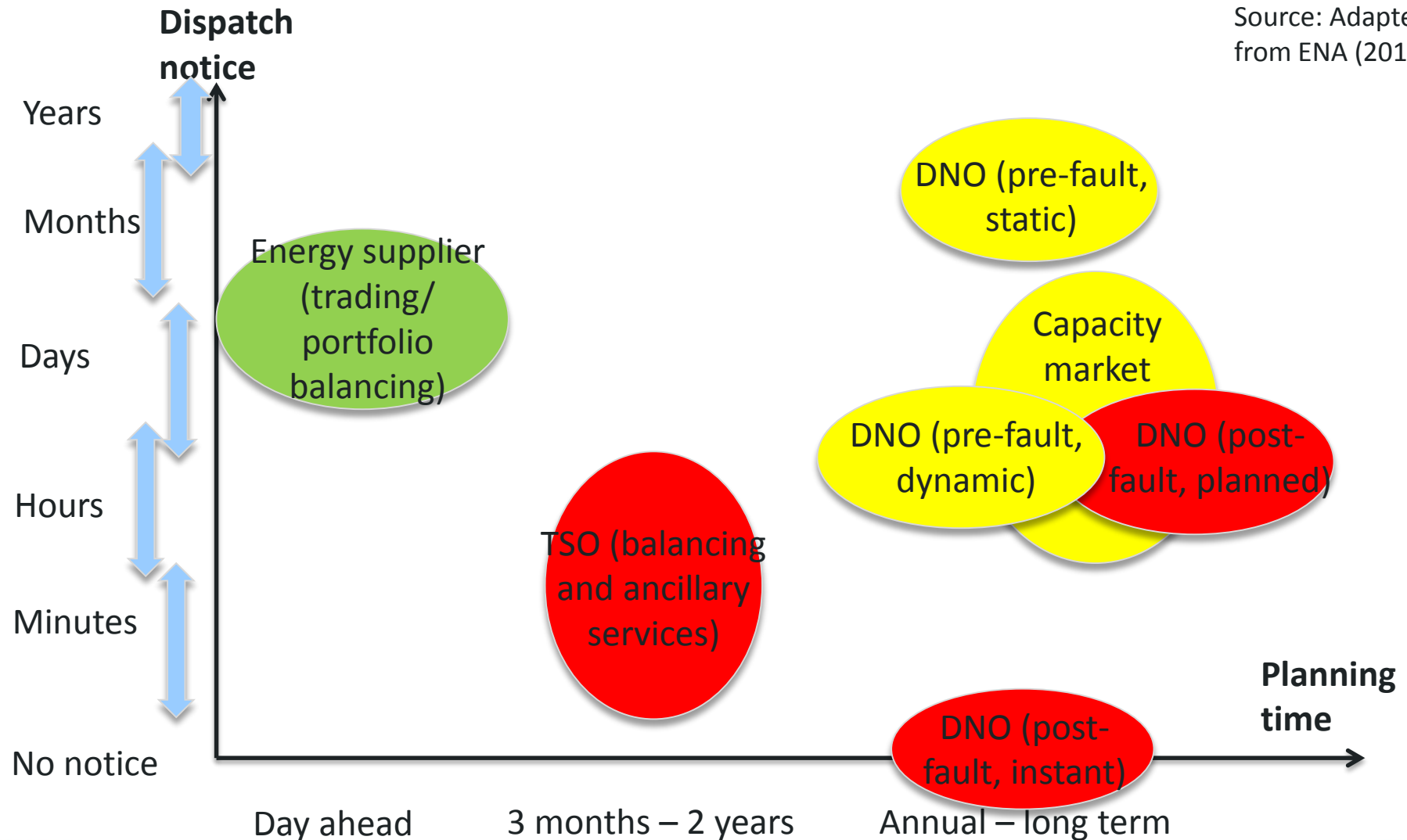
Micro-generation



- Incentivise matching of load to output
 - FiT with ToU element
 - FiT requiring on-site storage (Germany)
- Create market for local spill
 - Community-level retail tariff for export

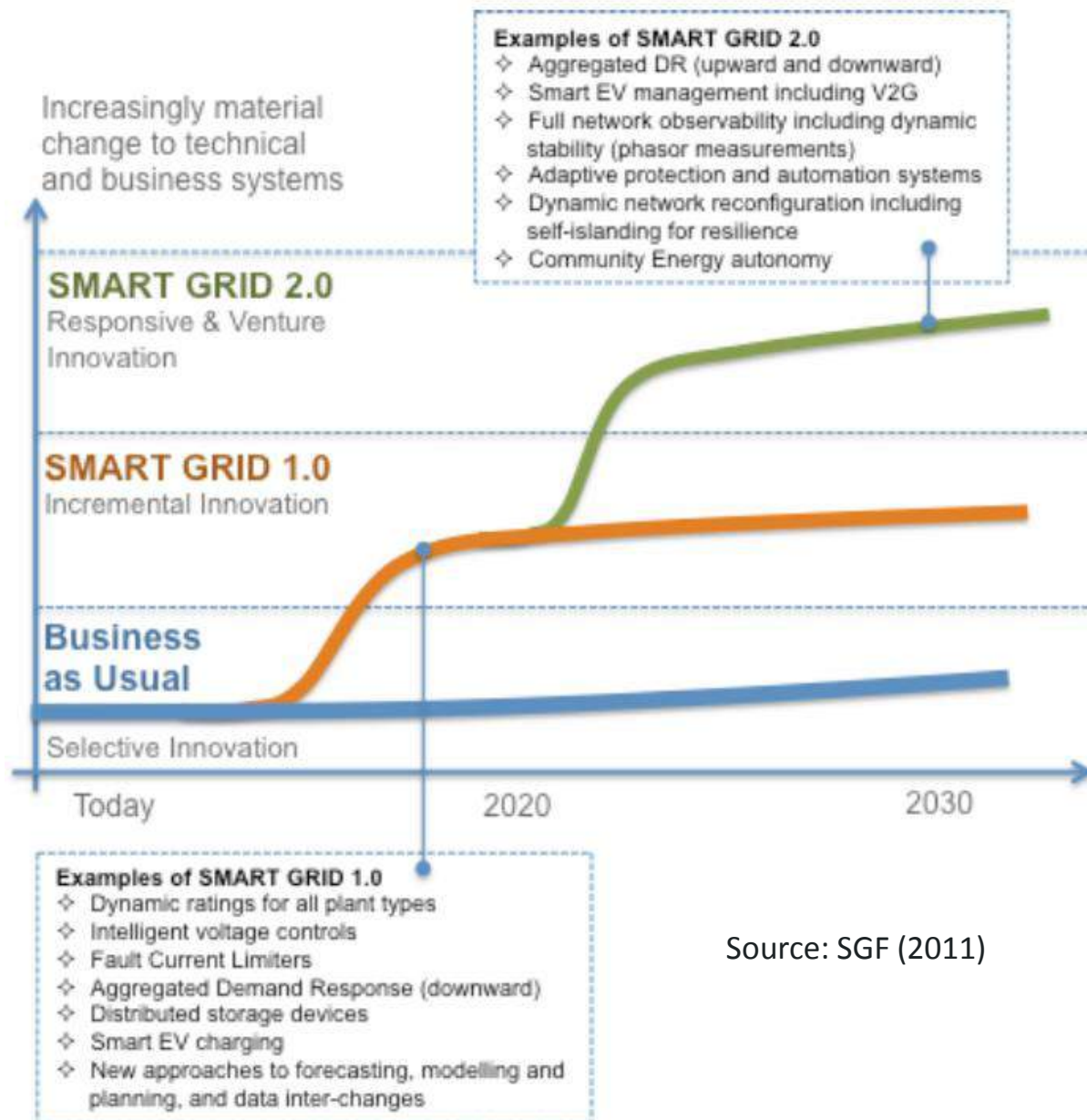
Integration of DSR into markets

Source: Adapted from ENA (2014)



Smart grids

- Reform economic regulation of networks, inc. support to RD&D
- Revise network codes



Source: SGF (2011)

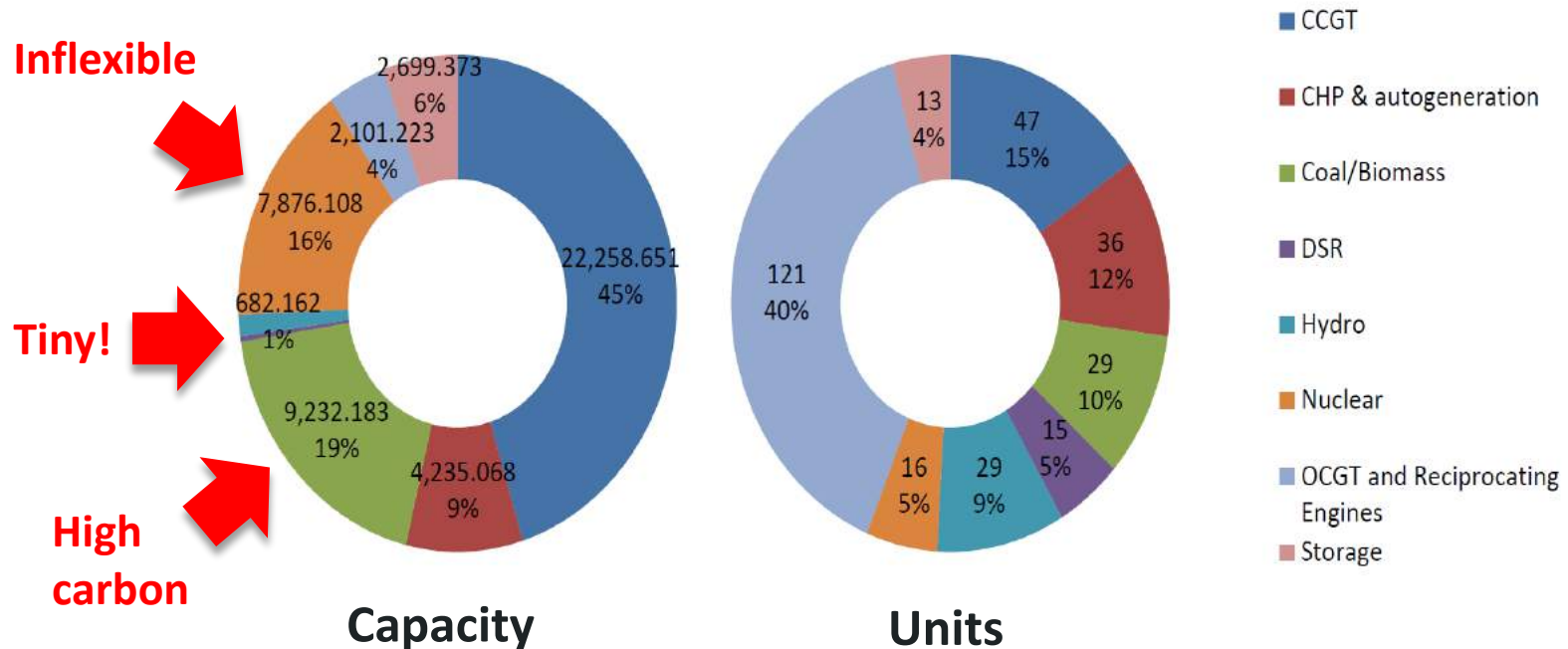
Overarching issues

- Need for coordination of change at different levels, across markets and networks
 - Vested interests resisting change
 - Balance between need for investment and options value of waiting
 - Balance between need for innovation and maintaining confidence through evolution
 - Sustaining public support, including for integration costs (e.g. network extension and transformation)
- **Challenge of achieving policy change in practice**

Some British examples

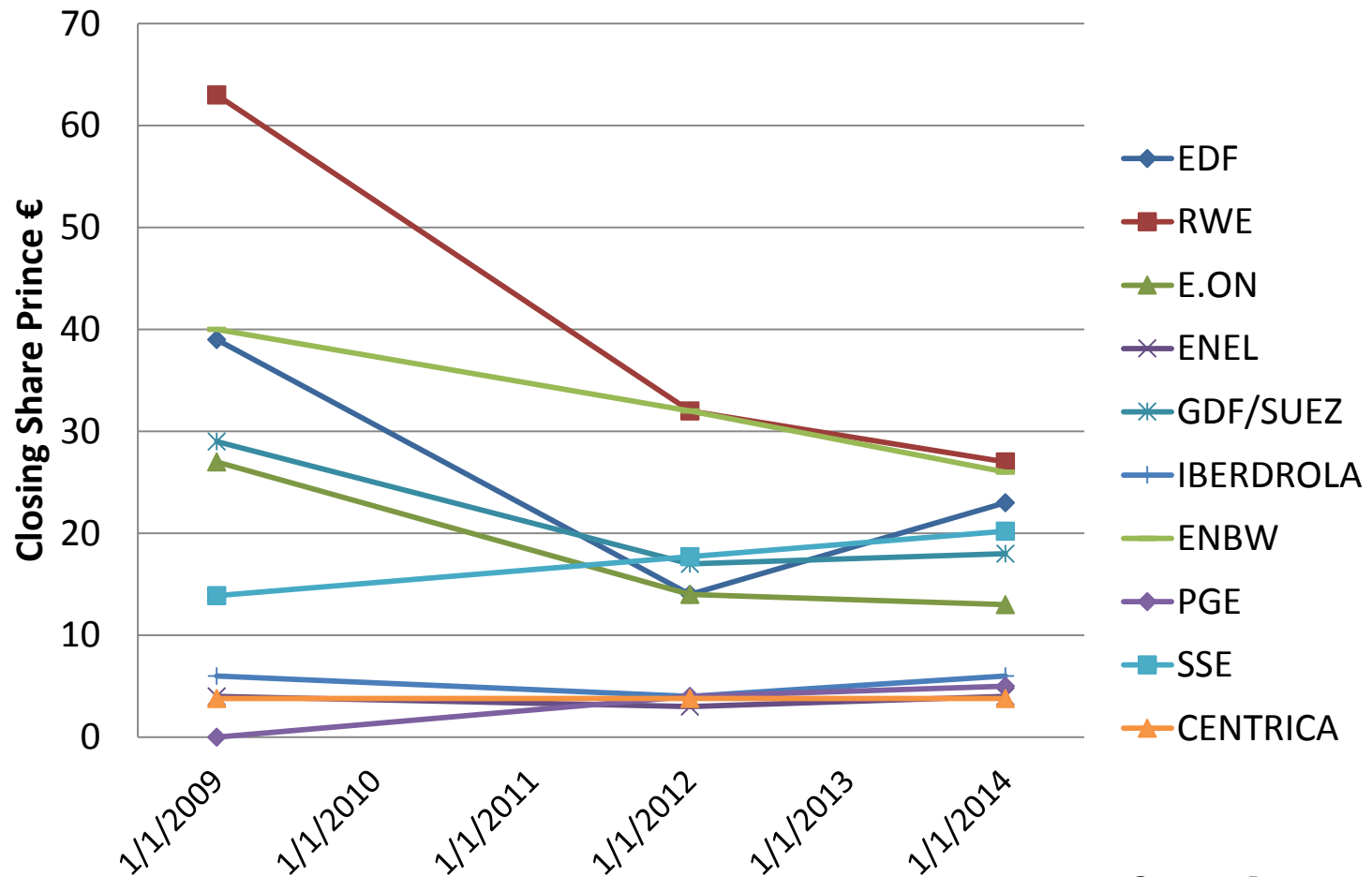
GB Capacity Market

December 2014 auction by technology



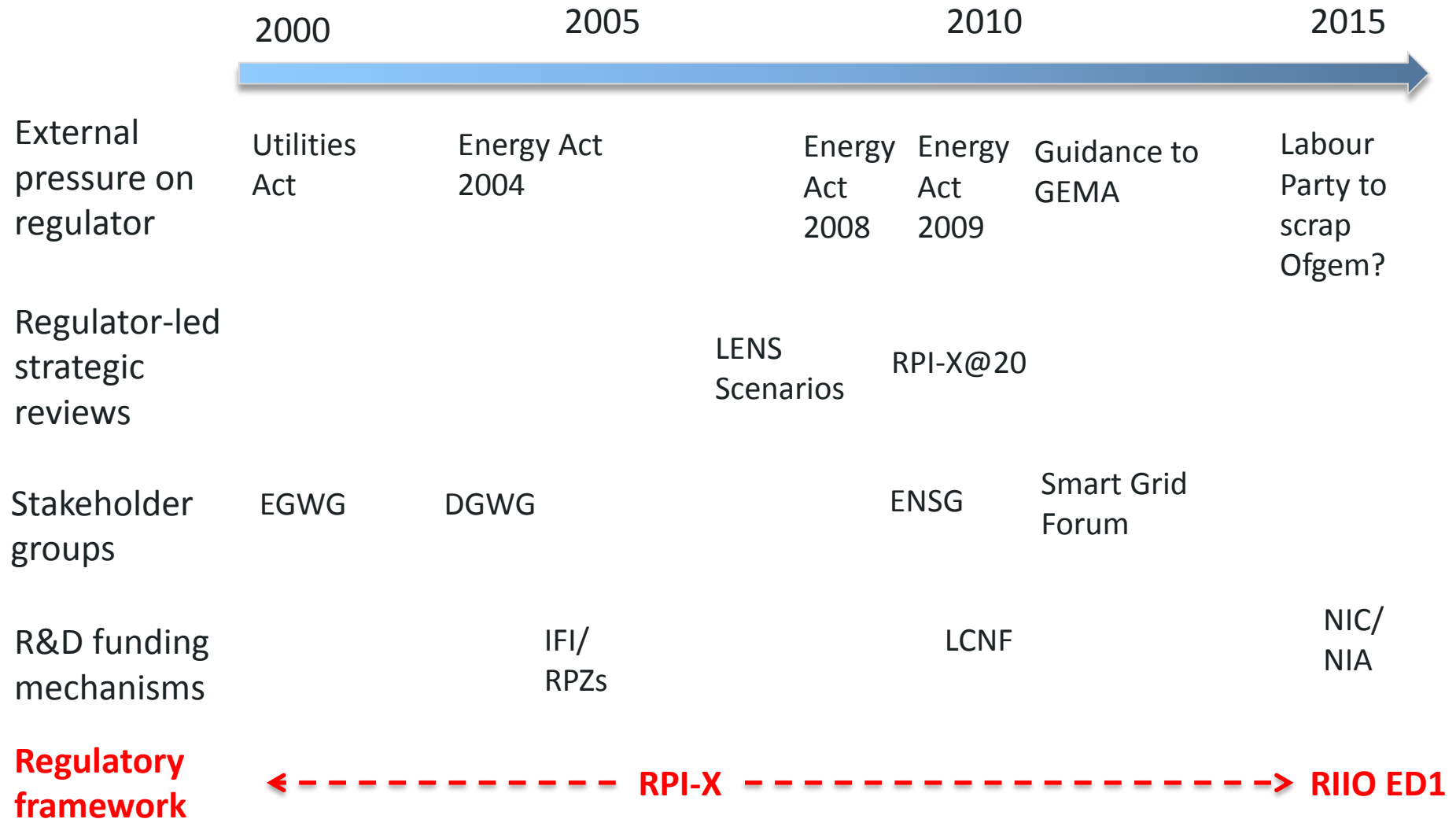
- Simple MW, not by characteristics (flexibility, carbon)
- Demand reduction (energy efficiency) not allowed to bid (EDR trial)
- Access problems for DSR, inc. classification as unproven, collateral requirements + weak aggregation market
- Generators now overpaid because of parallel balancing reform?

Vested interests?



Source: Reuters

Distribution network regulation



Distribution network regulation

RPI-X DPCR5 (2010-2015)

- Price-cap incentive regulation
- Capex/opex treated separately
- RAV additions based on actual capex
- 5 year price control periods
- RD&D fund



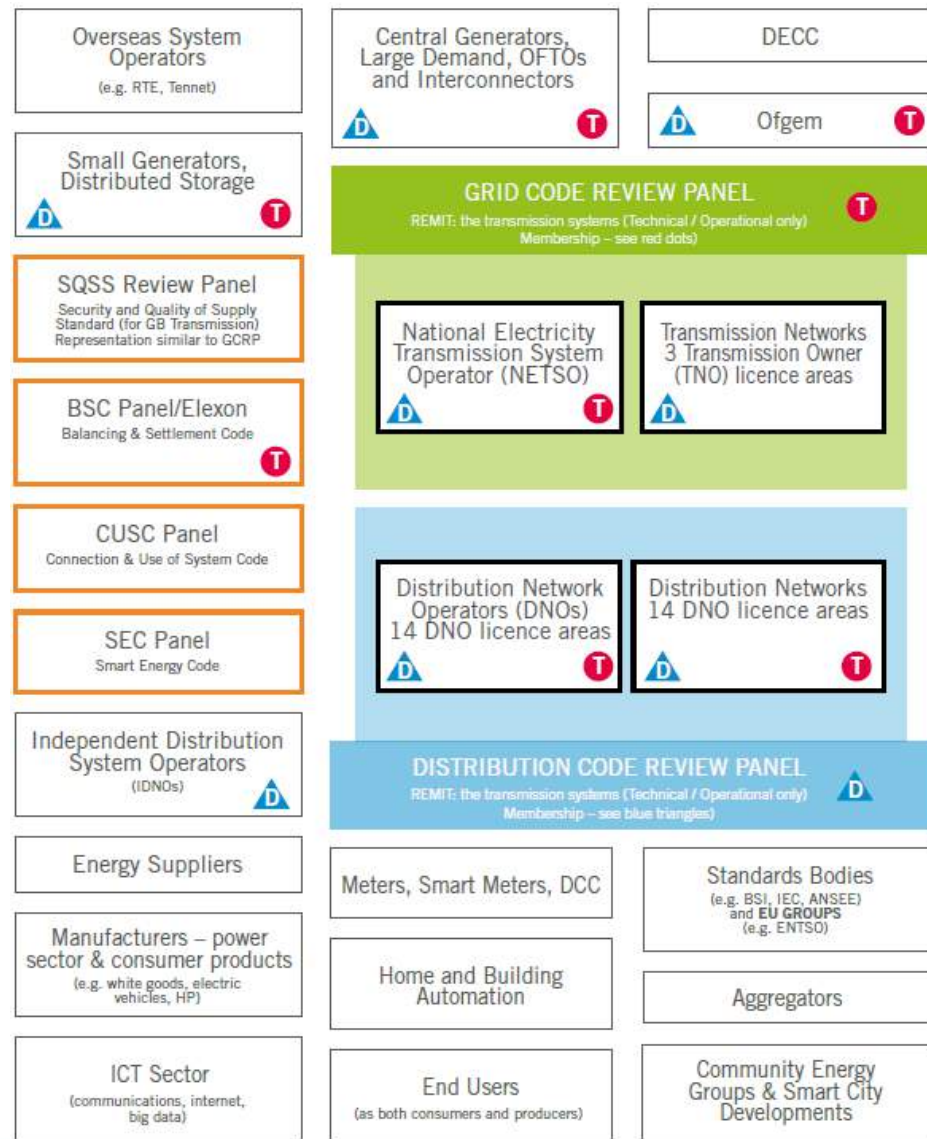
RIIO ED1 (2015-2023)

- Price-cap incentive regulation
- Single totex efficiency incentive
- RAV additions based on % of agreed totex
- 8 year price control periods
- RD&D fund, plus incentive for rollout
- Smart Grid strategies required for fast tracking

Electricity Codes reform

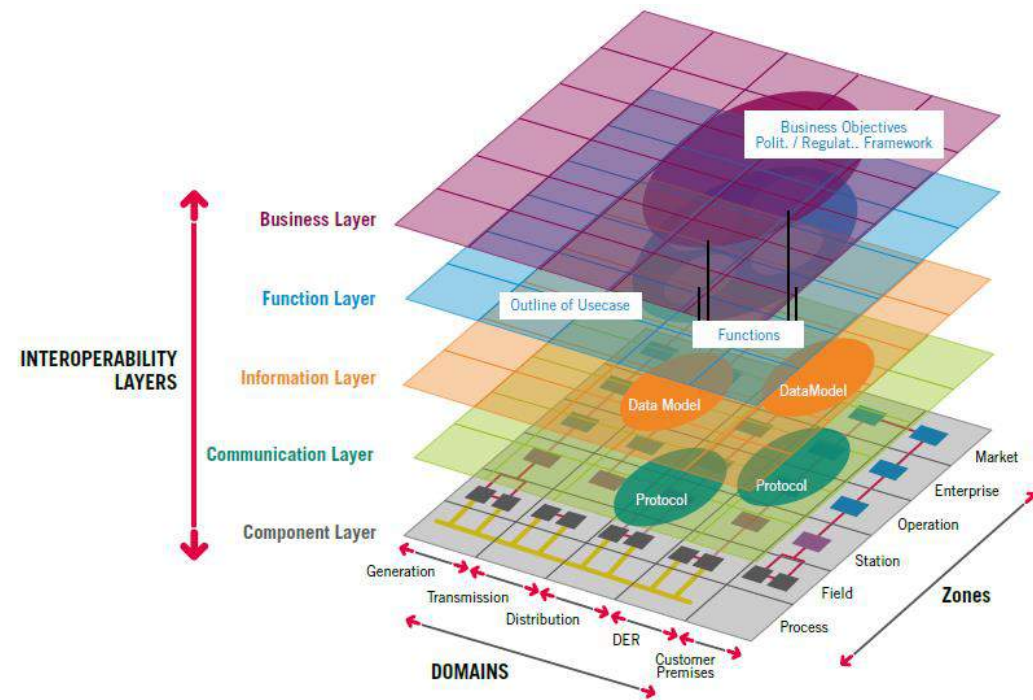
- Need to reform not just code *content* and code *membership and governance*
- GB electricity codes are effectively self-governed by industry with Ofgem overview
- High level of complexity, favours large incumbents
- Most codes do not have an explicit sustainability objective
- Ofgem can now initiate Significant Code Reviews, but slow process
- Case for more fundamental restructuring of code governance

Source: IET 2013



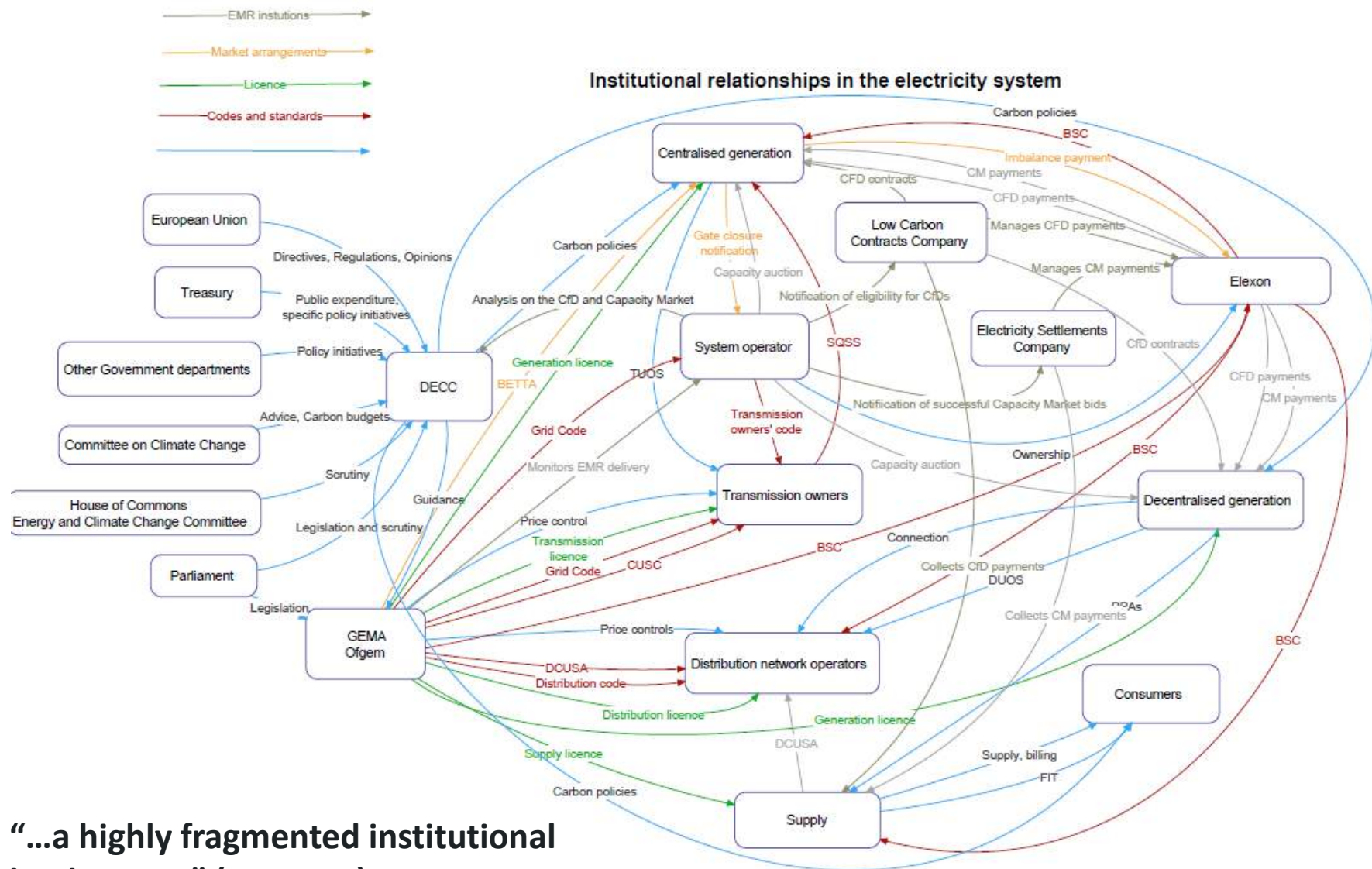
Coordination

- Increasing complexity across multiple actors and domains
- Call for 'system architect' to coordinate change so far resisted



	Today	2030
Generation providing frequency control	10-15 units	600,000 units
Automatic controls on distribution networks (e.g. voltage regulation)	10,000 devices	900,000 devices
Automatic controls in homes	None	15 million

Source: (IET 2014)



“...a highly fragmented institutional landscape...” (IET 2014)

Source: Mitchell et al 2015

Conclusions

- Electricity system facing period of deep change
- Almost certain to involve a shift to more decentralised systems, with more flexible demand
- The policy agenda spans markets, networks and consumers, and involves new actors
- Can build on existing institutions, but coordination will be important to avoid costly mistakes
- Policies are important but won't get adopted without supportive institutions and 'paradigms, i.e. that can
 - manage interventions in markets
 - allow innovation and change
 - resist capture by vested interests
 - build and maintain public support

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