ofgem Promoting choice and value
for all gas and electricity customers

Long-Term Electricity Network Scenarios (LENS)

Third Workshop
5 June 2008

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for all gas and electricity customers

Introduction

The purpose of today

- Present an update on the LENS project:
  - interim report (May 2008) on energy & network scenarios
  - academic team's more recent work
- Obtain stakeholder feedback on the 2050 interim scenarios & issues (or implications) for networks
- Seek initial stakeholder input on transitional (2025) issues for networks
- Seek initial stakeholder input on establishing issues for the regulation of networks
- Set out the next steps for the project

Context / background

- Energy White Paper, May 2007: Long-term scenario planning for electricity networks (pp141-2)
  - "…it is important to ensure that the flexible five-year allowances set in price control periods are compatible with any plausible longer term outlook for the network."
  - "Ofgem therefore intends to look at a range of future scenarios that could arise as a consequence of Government policy and market development…"
  - "Ofgem's role in the process will mainly be to provide guidance and a framework for scenario planning to be conducted by industry."

(Ofgem's underlining)

LENS project team

- Ofgem
- Lead academic partner:
  - Institute for Energy and Environment (InstEE), University of Strathclyde
- Supported by:
  - King's College London (KCL), University of London
- Peer review:
  - SPRU (Science and Technology Policy Research), University of Sussex

Input from stakeholders and other interested parties has been through two consultations and two workshops so far

Re-cap: LENS project objectives

- **Main objective**: To facilitate the development of a range of plausible electricity network scenarios for Great Britain for 2050, around which industry participants, Government, Ofgem and other stakeholders can discuss longer term network issues

Spanning a suitably wide range of plausible outcomes - see Ofgem 14 May consultation letter

- We have also set out to:
  - develop a consistent set of 2025 way-markers
  - quantify the scenarios (through energy system modelling)
  - establish a set of key issues for networks & for the regulation of networks, raised by the scenarios

- The project will **not** prescribe particular strategies

Scope of LENS project

- LENS is a '**pre-strategic**' project so stops at:
  - establishing a set of key issues for networks & for the regulation of networks, in light of the final GB electricity network scenarios
  - revisions of regulatory policy will not form part of the LENS project
  - may be considered as part of the recently announced '**RPI at 20**' review (or other Ofgem projects)

- LENS and the current distribution price control review (**DPCR5**):
  - We envisage that LENS will facilitate subsequent (i.e. post-LENS) strategic thinking concerning the medium to longer term future
  - May also help inform discussions on the short term investment requirements of DPCR5

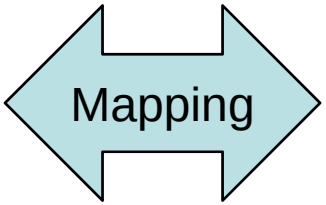
Progress to date

- Initial scoping letter – 15 June
- Consultation on scoping letter closed – 23 July
- **First stakeholder workshop** – 17 August
- Methodology statement and open letter – 12 November
- Scenario inputs report and consultation letter – 5 December
- **Second stakeholder workshop** – 14 December
- Consultation on scenario inputs closed – 18 January
- Interim report (qualitative scenarios) & consultation letter – 14 May
- Work in progress: modelling & 2025 way-markers
- **Third stakeholder workshop** – 5 June
- (Consultation on interim report closes – 10 June)

All materials published on LENS page of Ofgem's website:
http://www.ofgem.gov.uk/Networks/Trans/ElecTransPolicy/lens/Pages/lens.aspx

Interim report: contains 'energy' and 'network' scenarios

Energy Scenario (chapter 7)	
A	Switch Me On
B	Fix It For Me
Ci	Govt Led Green Agenda
Cm	Dynamic Green markets
D	Reactive Approach



Network Scenario (chapter 9)
Big T&D
Energy Services Market Facilitation
DSOs (Lean T)
Microgrids (Small T&D)
Multi-Purpose Networks

Academic team will explain these scenarios & how they were derived later today

Programme for today

- **10.10 – 10.40** **Key highlights of interim report**
- **10.40 – 11.10** **Update on current activities**
- **11.10 – 11.20** **Introduction to breakout sessions**
- **11:20 – 11.30** **Coffee break & split into groups**
- **11.30 – 12.30** **Breakout session 1:**
  2050 scenarios & issues for networks
- **12.30 – 13.15** **Lunch**

(Continued)

Programme for today (continued)

- **13.15 – 14.15** **<u>Breakout session 2</u>:**
  Transitional (2025) issues for networks & issues for regulation of networks
- **14.15 – 14.30** **Coffee break**
- **14.30 – 15.00** **Feedback from breakout sessions**
- **15.00 – 15.25** **Plenary discussion / Q&A session**
- **15.25 – 15.30** **Next steps and closing remarks**

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Interim Report Highlights

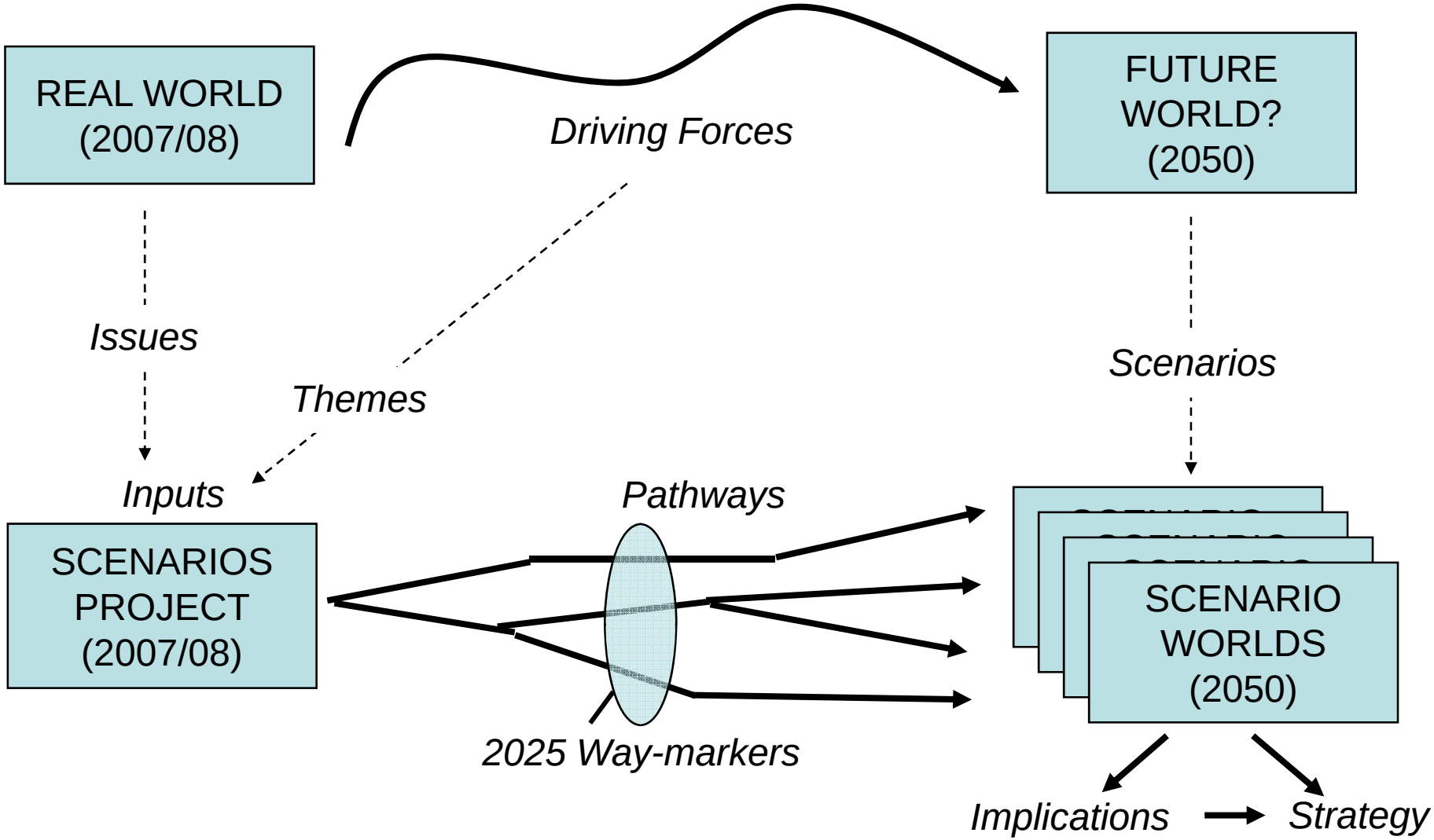
Dr. Graham Ault and Damien Frame

University of Strathclyde Engineering

Overview

- LENS scenarios development process
- LENS themes
- Energy Scenarios
- Energy Scenarios to Network Scenarios
- Network Scenarios

Scenarios terminology



Project Status

- December Workshop
  - Inputs report and themes
- January – May
  - Define and develop themes
  - Test theme interactions
  - Identify scenario ‘space’
  - Develop initial (energy) scenarios
  - Define methodology for network scenarios
  - Draft energy scenarios and network scenarios
  - Interim report
- Current activities
  - Merging scenarios
  - 2025 Way-markers
  - Markal modelling

Ofgem LENS Project Scenarios approach

Project in final stages following a structured scenario development methodology:

1. Define the recipient
2. Frame the focal question
3. Information gathering
4. Identify themes
5. Sketch possible pathways
6. Write scenario storylines
7. Model scenarios
8. Identify potential implications of scenarios on the focal question

http://www.ofgem.gov.uk/networks/trans/electranspolicy/lens/Pages/lens.aspx

Recipient, Focal Question & Information Gathering

Recipient:

GB power network stakeholders

[Primary stakeholders: Electricity consumers (and representative organisations), Network companies, Power generators, Suppliers, Government, Ofgem. Other stakeholders including: equipment suppliers, trade associations, lobby groups]

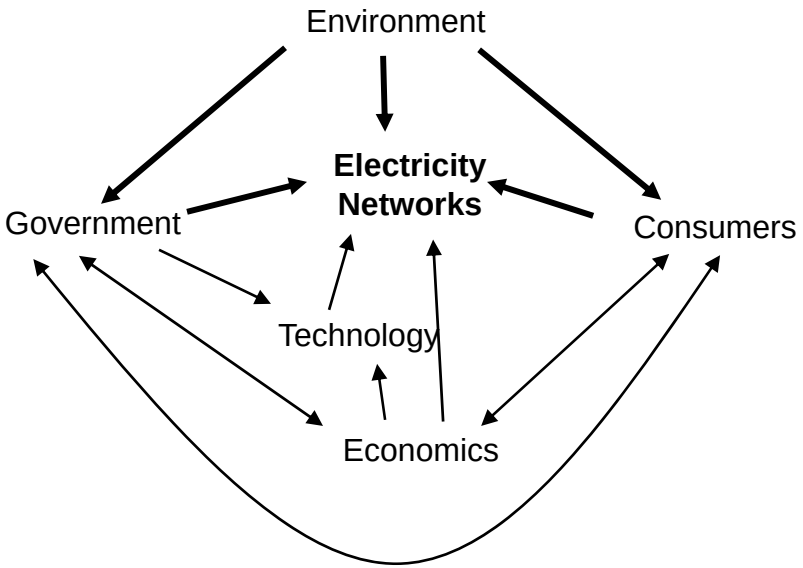
Focal Question:

What would be the impact of markets, policy, environmental, geopolitical and technology futures on GB power networks and their regulation?

Information Gathering:

Review of recent relevant scenarios
Power networks stakeholder issues
LENS consultation and workshops

Identifying Themes

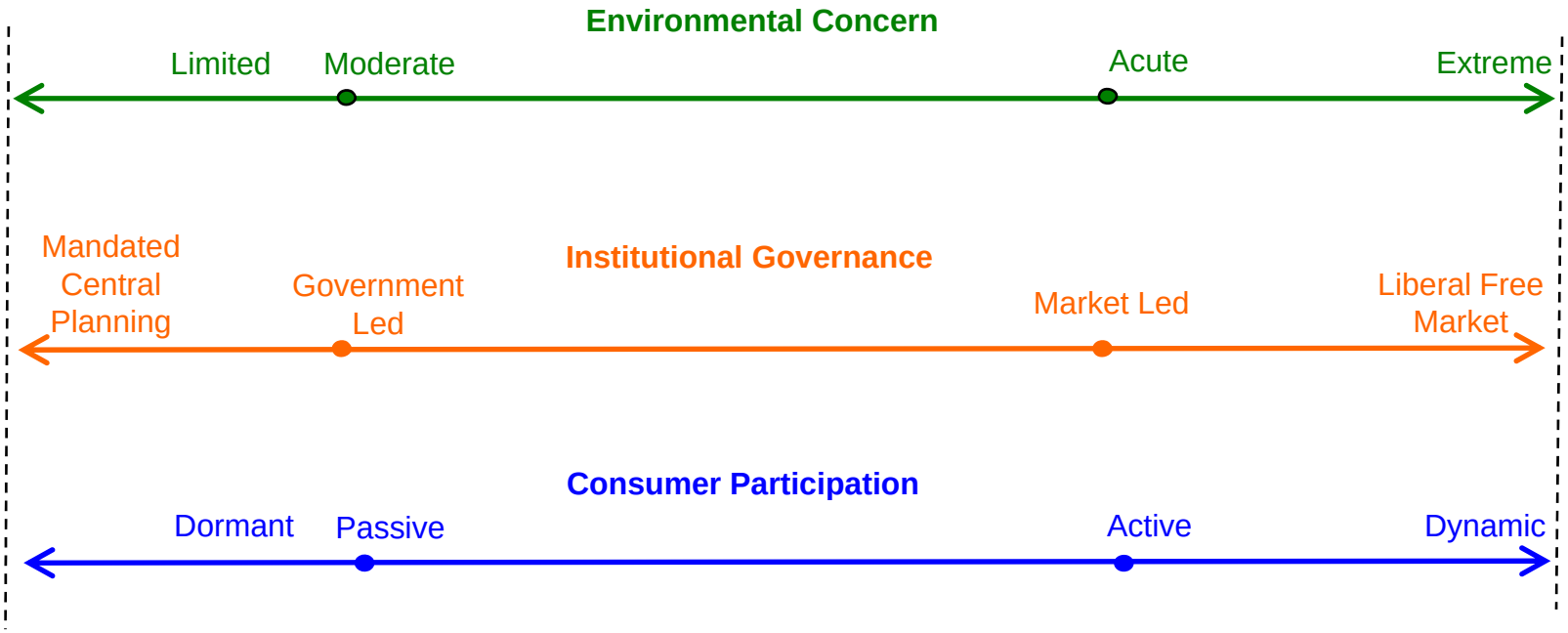


- Condensed set of considered themes
- Information taken from relevant literature, inputs report, Stakeholder suggestions (2nd workshop and written responses) and LENS team discussions

LENS Themes

- **Environmental Concern** is the level to which the environmental situation affects the decision making of individuals, communities, private companies, public institutions and the Government (on a UK and global basis)
- **Consumer Participation** is the level to which all types of consumers (commercial, industrial, domestic and public) are willing to participate in the energy market as a whole and specifically the electricity market and electricity networks
- **Institutional Governance** is the extent to which institutions will intervene through a variety of mechanisms in order to address specific societal concerns or further overarching policy goals relating to energy use and the environmental and economic implications

Identify Themes: Plausible 'Scenario Space'

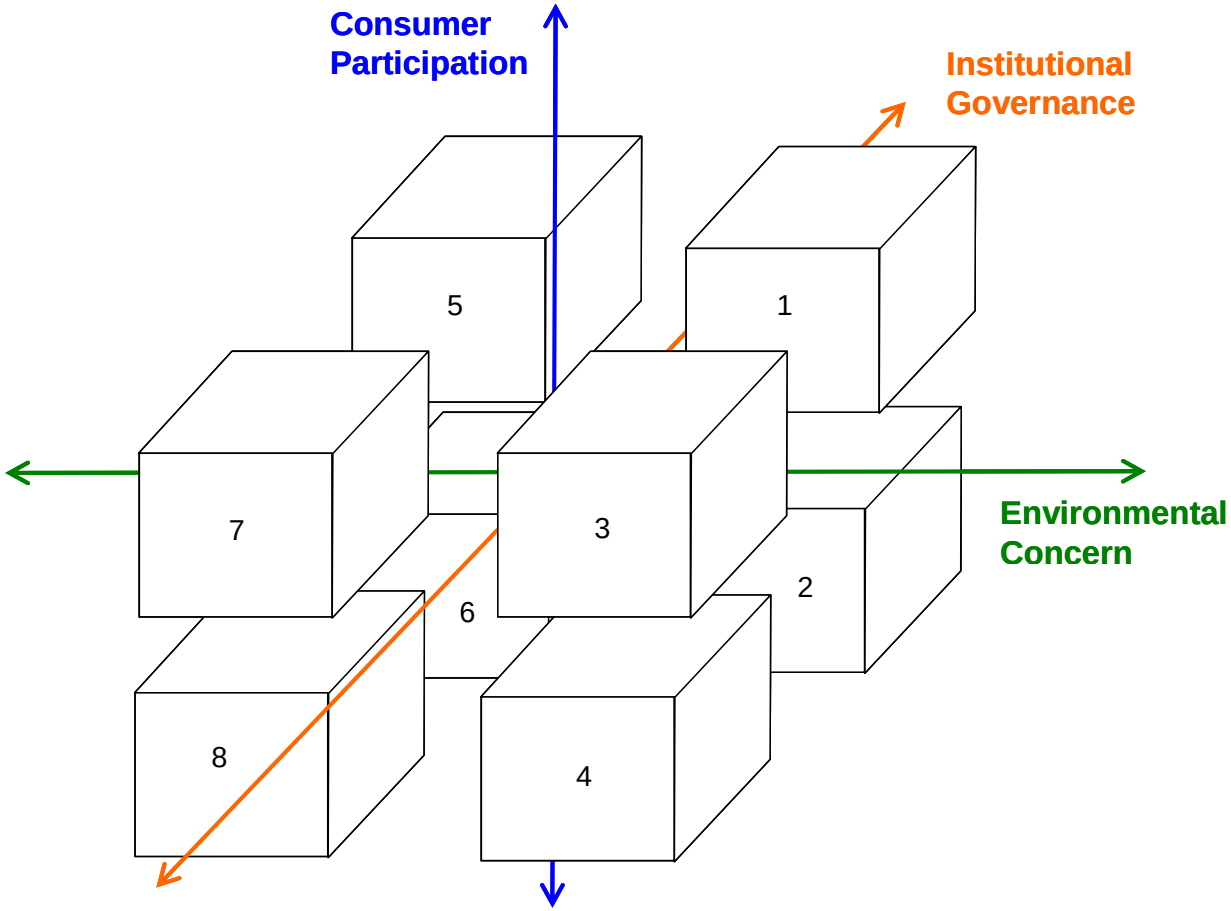


Reflects key uncertainties that would produce most interesting resulting GB electricity networks in 2050.

Energy Scenarios and Network Scenarios

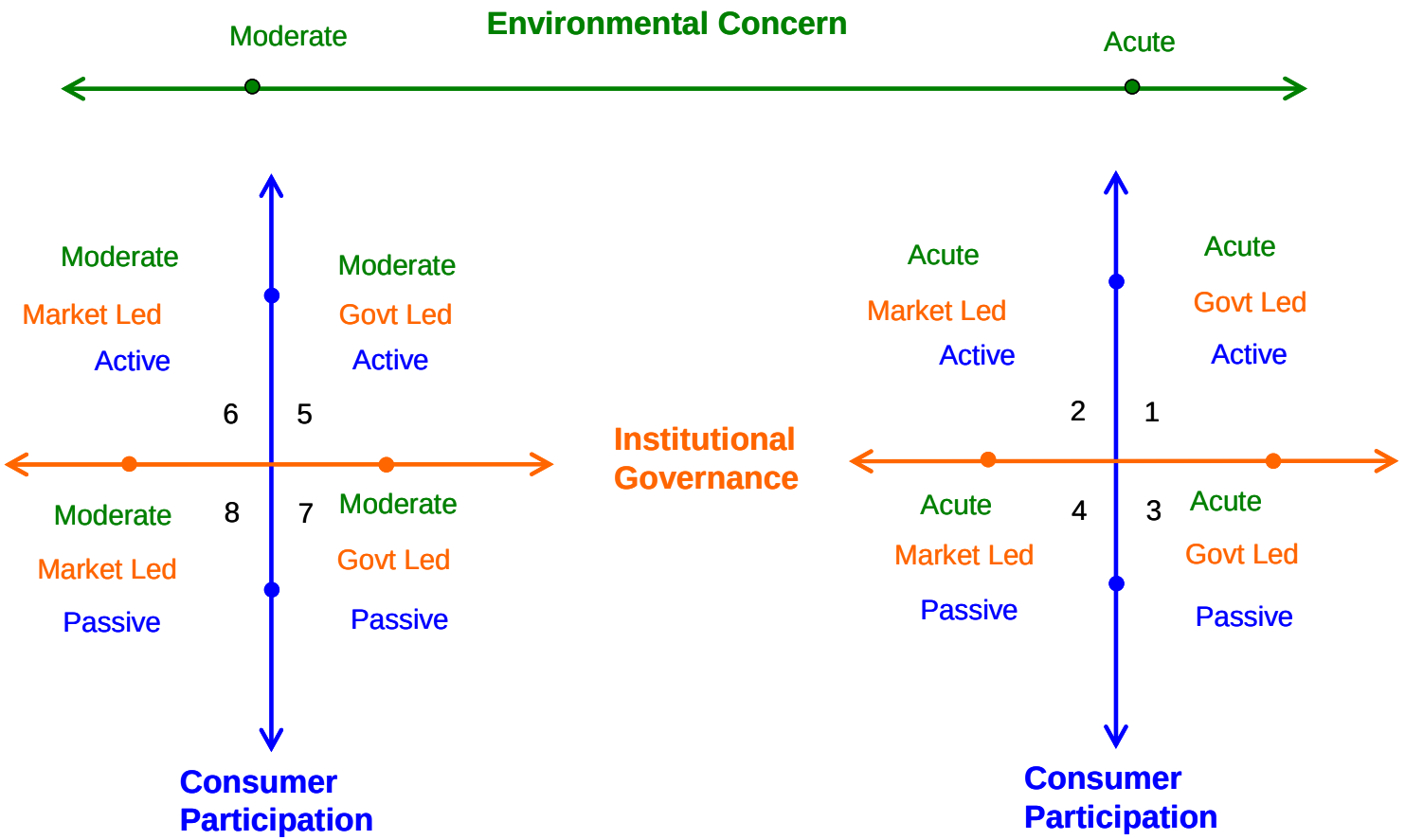
- Focus of the LENS project is ***Network Scenarios***
- 'Higher level' energy sector context is necessary to provide plausibility for network scenarios
- LENS project developed ***Energy Scenarios*** first using broad themes:
  - Provide detailed narrative describing the interactions of the chosen themes
  - Energy scenarios can be thought of as a possible "context" for future GB power networks
- Non-direct relationship between energy scenarios and network scenarios resulted in network scenarios being developed separately
- Mapping process required to probe into relationships between energy scenarios and network scenarios

Developing Energy Scenarios

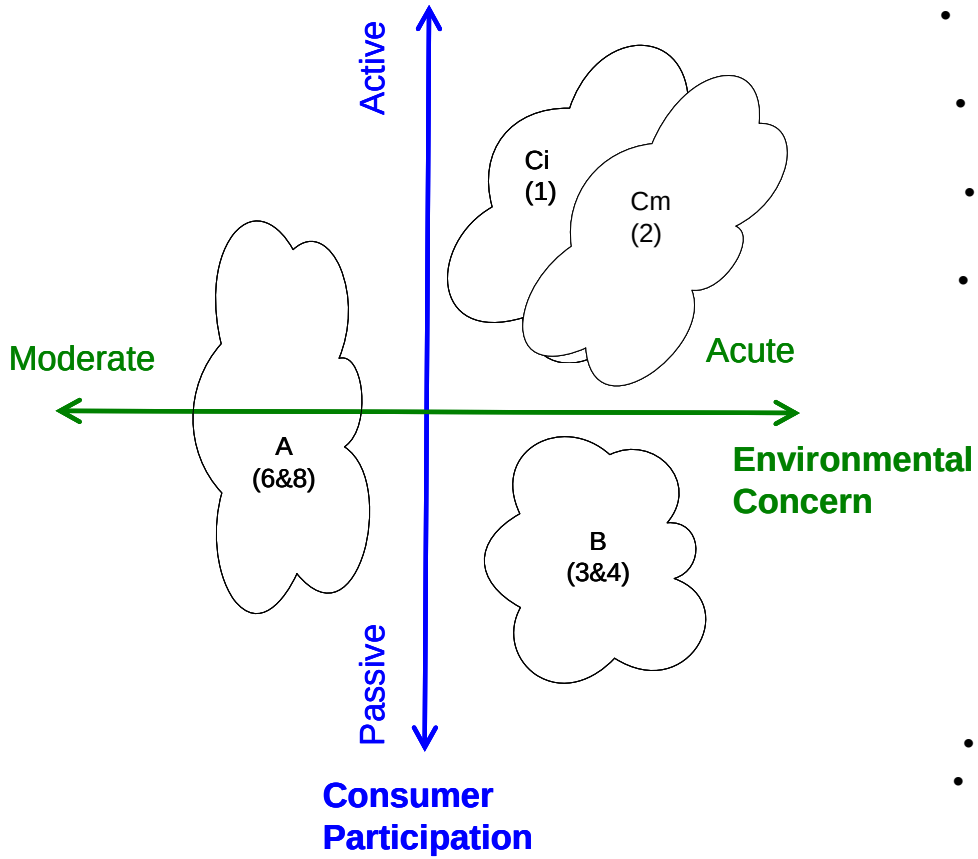


Developing Energy Scenarios

Two Focal Areas on each axis create the eight combinations



Developing Energy Scenarios



- **A** – Moderate Environmental Concern, Active and Passive Consumers, Market Led Institutional Governance.
- **B** – Acute Environmental Concern, Passive Consumers, Government and Market Led Institutional Governance.
- **Ci** – Acute Environmental Concern, Active Consumers, Government Led Institutional Governance.
- **Cm** - Acute Environmental Concern, Active Consumers, Market Led Institutional Governance.

- **Scenario D**
- Fluctuating environmental concern
- Various market led and Government led approaches
- Lack of continuity and a long term strategic approach.

Energy Scenarios

Energy Scenario	Environmental Concern	Consumer Participation	Institutional Governance
Switch me on (A)	Moderate	Active and Passive	Market Led
Fix it for me (B)	Acute	Passive	Market Led and Government Led
Government Led Green Agenda (Ci)	Acute	Active	Government Led
Dynamic Green Markets (Cm)	Acute	Active	Market Led
Reactive Approach (D)	Increased but below Acute	Active and Passive	Market Led and Government Led

‘Switch Me On’

- Consumers demand ***abundant supplies of electricity*** that require ***minimum participation*** on their part.
- ***Free markets*** persist as the main mechanism to service the energy requirements of the nation.
- The ***importance of environmental issues*** to society in general ***does not grow*** significantly higher but there is continued debate and policy development geared towards reducing carbon emissions.
- ***Fossil fuels are used widely*** for electricity generation, domestic and commercial energy supplies and transport with ongoing and increasing risks of ***scarcity in primary fuel supplies and reserves***.
- ***Centralised larger scale power generation*** (fossil, nuclear and/or renewable) dominates electricity production.

‘Fix It For Me’

- While the majority of people are concerned about the ***environment*** they strongly believe that it is the ***duty of government*** and the market to address the issues.
- Although the belief persists that ***markets are best placed*** to service consumer demands at the same time as meeting social and environmental needs, ***strong intervention is not ruled out*** to address environmental issues.
- The potential for markets to meet the energy services demands of consumers is met through the ***emergence of energy service companies (ESCOs).***
- ***Centralised electricity generation persists*** but alongside a relatively strong development of ***on-site and local/community scale demand side participation and smaller scale generation*** (e.g. combined heat and power) through the energy service companies.

‘Government Led Green Agenda’

- The belief develops that ***stronger Government intervention*** is required in the energy sector to meet consumer demands for energy services and to make a full contribution to the global action to reduce fossil fuel emissions.
- The decision is made to ***push for a hydrogen economy*** as part of a cohesive EU initiative.
- ***Consumers are active*** in their electricity supplies because of attitudes to the environment and a desire to secure the best possible supply of electricity based on price, service and reliability.
- There is a ***strong development of larger scale clean power generation***, ***renewable power generation*** and a relatively high penetration of hydrogen fuel cells in vehicles.
- There are consumer ***moves towards energy self sufficiency*** through efficiency measures and self generation.

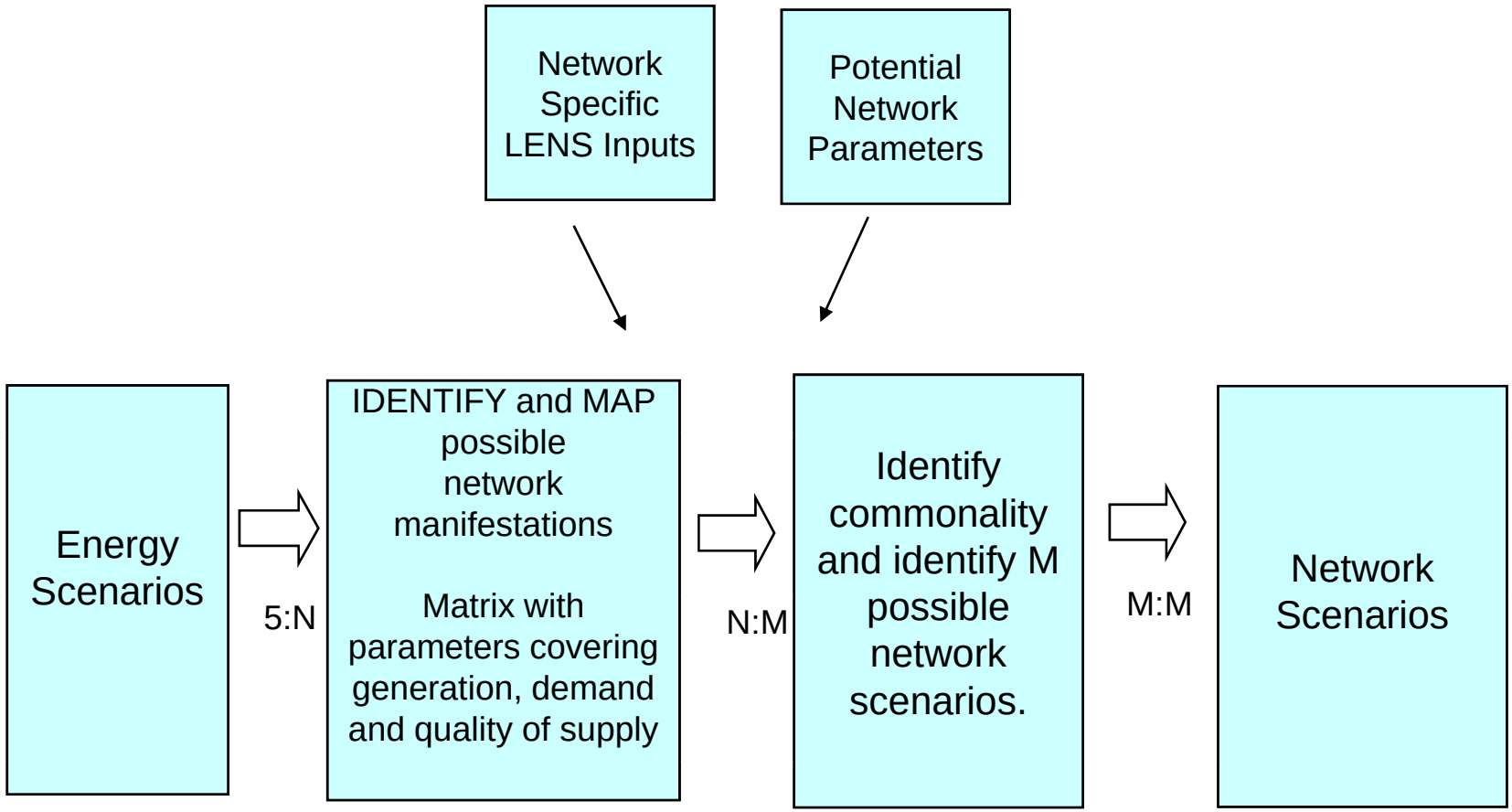
‘Dynamic Green Markets’

- The belief persists that ***markets are best placed*** to service consumer demands at the same time as meeting external needs such as tackling environmental issues.
- Global action to reduce fossil fuel emissions creates ***strong incentives for low carbon energy*** via a firm carbon price and efficient carbon markets.
- ***Active and concerned consumers*** radically change their approach to energy and become much more participatory in their energy provision.
- Markets respond to the new demands of consumers and, with supportive frameworks and incentives from Government, broadly liberal, free markets rise to the challenges of economic energy supplies with low environmental impacts
- ***Renewable generation is prominent*** and there are ***relatively high volumes of microgeneration*** creating the potential for a radically reformed electricity market with diverse types of generation.

‘Reactive Approach’

- ***Environmental concern*** never reaches a point that could be called acute for any consistent length of time but rather ***cycles*** through phases of acute concern in response to the latest environmental observations and reports/statistics.
- A lack of global consensus on environmental issues contributes to the ***uncertainty regarding environmental action***.
- There are ***various market led and Government led approaches*** pursued over time.
- Differing attitudes towards energy consumption develop among consumers resulting in ***varied types and levels of consumer participation*** depending on the geographic area, social demographics and services provided by energy companies.
- There are ***many types of generation in the national portfolio*** with centralised thermal generation and offshore renewables both prominent groupings.
- There is a ***strong potential for stranded assets and investment redundancy*** in the power sector.

Energy Scenarios to Network Scenarios



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Energy Scenarios to Network Scenarios

Energy Scenarios		Large scale, dispatchable central, (conventional) generation	Large scale renewable, variable output, peripheral generation	Distributed, self generation (microgrids, power parks, community CHP, micro-domestic)	Distributed, dispatchable, merchant generation	Distributed variable output, merchant generation	Electricity Demand magnitude	Demand profile management	Supply quality responsibility (consumer self-managed or 3rd party)
A Switch me on	A1	High	Low	Low	Low	Low	High	No	3rd party
	A2	High	High	Low	Low	Low	High	No	3rd party
	A3	High	High	Low	Low	High	High	Yes	3rd party
B Fix it for me	B1	High	High	Low	Low	High	High	No	3rd party
	B2	High	High	High	Low	Low	High	Yes	3rd party
	B3	Low	High	High	Low	High	High	Yes	3rd party
Ci Government green agenda	Ci1	Low	High	High	Low	High	Low	Yes	3rd party
	Ci2	Low	Low	High	Low	High	Low	Yes	Self
Cm Dynamic green markets	Cm1	High	High	Low	Low	High	Low	Yes	3rd party
	Cm2	Low	Low	High	High	High	Low	Yes	Self
	Cm3	Low	Low	High	Low	High	Low	Yes	Self
D Reactive approach		High	High	High	High	High	High	Yes	Both

Energy Scenarios to Network Scenarios

- Role identified for network under each of the possible outcomes in the energy scenarios
- Studying the common network roles contributes to identification and verification of network scenarios

Potential Network Scenario	Transmission Network	Distribution Network
A1	High levels of bulk transfer	Bulk transfer
A2	High levels of bulk transfer	Bulk transfer
A3	High levels of bulk transfer	Bulk transfer and DG integration
B1	High levels of bulk transfer	Bulk transfer and DG integration
B2	Low levels of bulk transfer	Some bulk transfer and ESCO integration
B3	Low levels of bulk transfer	Some bulk transfer and ESCO integration
Ci1	Bulk transfer for renewable resources	Integration of renewables and local CHP.
Ci2	Minimal role	Local balancing of DG
Cm1	Low levels of bulk transfer	Some bulk transfer and DG integration
Cm2	Minimal role	Local balancing of DG
Cm3	Minimal role	Local balancing of DG
D	Bulk transfer	Bulk transfer, integration and local balancing of DG

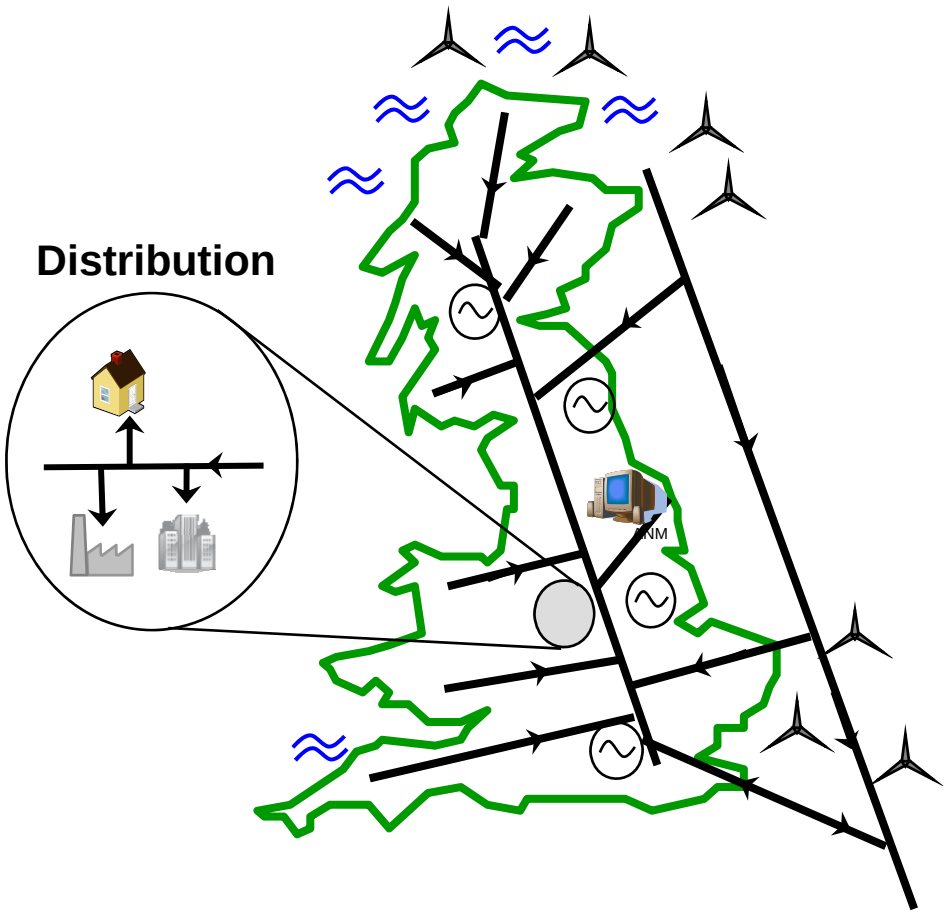
Energy Scenarios to Network Scenarios

Network Scenario	Potential Scenarios
Big T&D	A1+A2+A3+B1
Energy Services Market Facilitation	Cm1+B2
Distribution System Operator (lean transmission)	Ci1+B3
Microgrids (Small Transmission and Distribution)	Ci2+Cm2+Cm3
Multi Purpose Networks	D

- Mapping of contributing energy scenarios to the five identified network scenarios

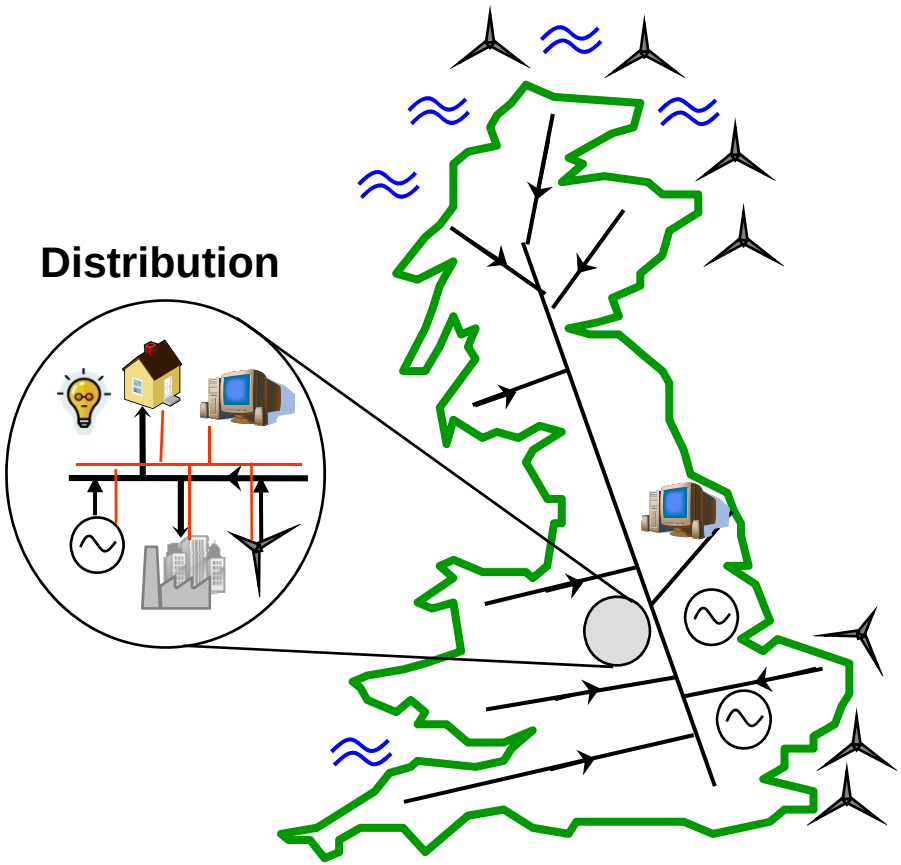
Big Transmission and Distribution

- Demand growth unhindered and relatively unmanaged in an operational sense.
- Geographical reach of transmission network is expanded to connect offshore and rural on-shore renewables sites and provide greater interconnection with European mainland power systems.
- T&D infrastructure development and management expands to meet requirements of growing energy demand and renewables development
- Network capability enhancing technologies deployed to meet growing demands for network services arising from demand growth.
- Network companies continue to take responsibility for providing security and quality of supply.



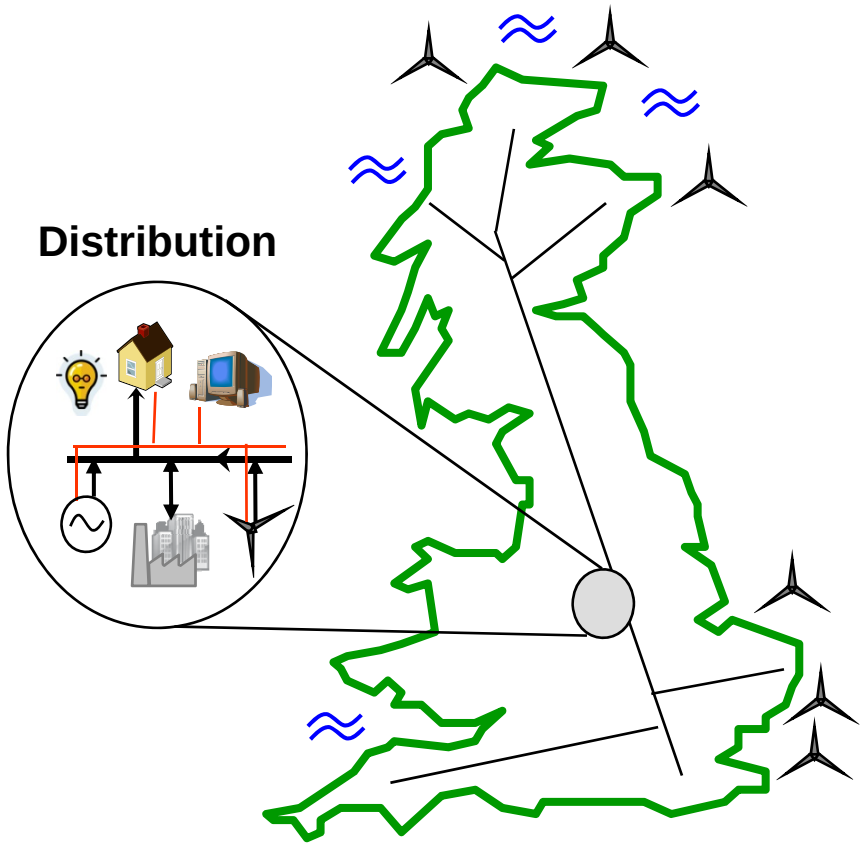
Energy Services Market Facilitation

- T&D infrastructure required to support super-supplier or ESCO centred world.
- ESCOs do all the work at the customer side and the T&D network operators and ESCOs contract with each other for the supply of network services.
- Wide ranging developments and vibrant markets in energy services (including micro-generation, on-site heat and power, demand side management, telecommunications and electric vehicles).
- Services supplied by the networks include transmission system connection to strategic, large scale renewables and access to municipal scale CHP and renewables tailored to local demands.
- System management is aided by the degrees of flexibility provided by ‘empowered’ customers with high capability ICT.



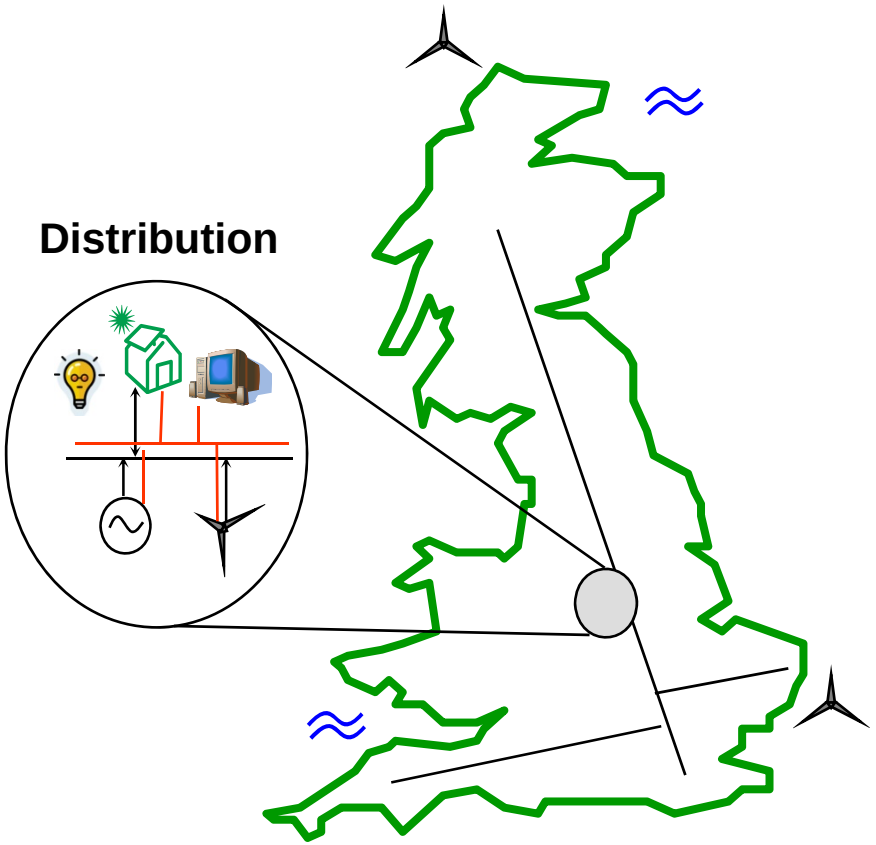
Distribution System Operators (Lean Transmission)

- Most electricity production facilities connected to distribution networks thus reducing the role for the transmission network.
- Distribution System Operators (DSOs) take much greater responsibility for system management including generation and demand management, supply security, supply quality and system reliability.
- DSM provides greater options for DSOs in system operations but also leads to a generally reduced demand.
- DSOs balance generation and demand in local areas with the aid of system management technologies such as energy storage and DSM.
- Transmission system acts to provide connections between DSOs and to strategic renewables deployments.



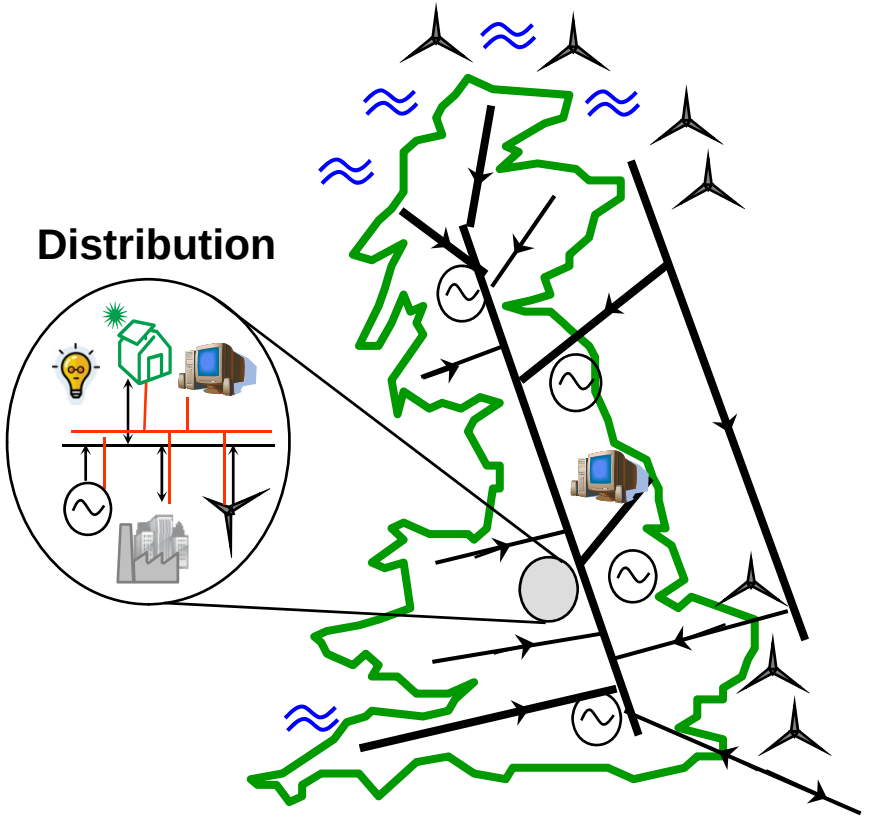
Microgrids (Small Transmission and Distribution)

- Self-sufficiency concept develops very strongly in power and energy supplies - electricity consumers take very much more responsibility for managing their own energy supplies and demands.
- Greatly reduced role for bulk power networks
- Individually and collectively customers actively manage their own energy consumption against their own or locally available supplies and minimise exports to and imports from the local grid.
- Microgrid System Operators (MSO) emerge to provide the system management capability to enable customers to achieve this with the aid of ICT and other network technologies such as energy storage.
- Customers take a lead role in their own energy provision and the security, quality and reliability of the supply with the support of the MSO.



Multi Purpose Networks

- Attempts have been made to exploit many energy technologies over time and there exists a large diversity in electricity production and demand side management initiatives implemented.
- Network is characterised by diversity in development and management approaches as a result of changing energy policies and company strategies.
- Substantial differences exist in network capabilities between areas.
- Electricity networks fulfil different roles including bulk transfer, interconnection, backup and security and meeting renewable and demand side objectives.
- Challenges in managing diverse system architectures are accompanied by opportunities from the diversity of generation, network and demand side provision.



- The stranding of certain power system assets becomes more apparent over time due to the lack of consistency in energy policy and the subsequent diverse network infrastructures that emerge

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Scenarios Merging and 2025 Way-markers

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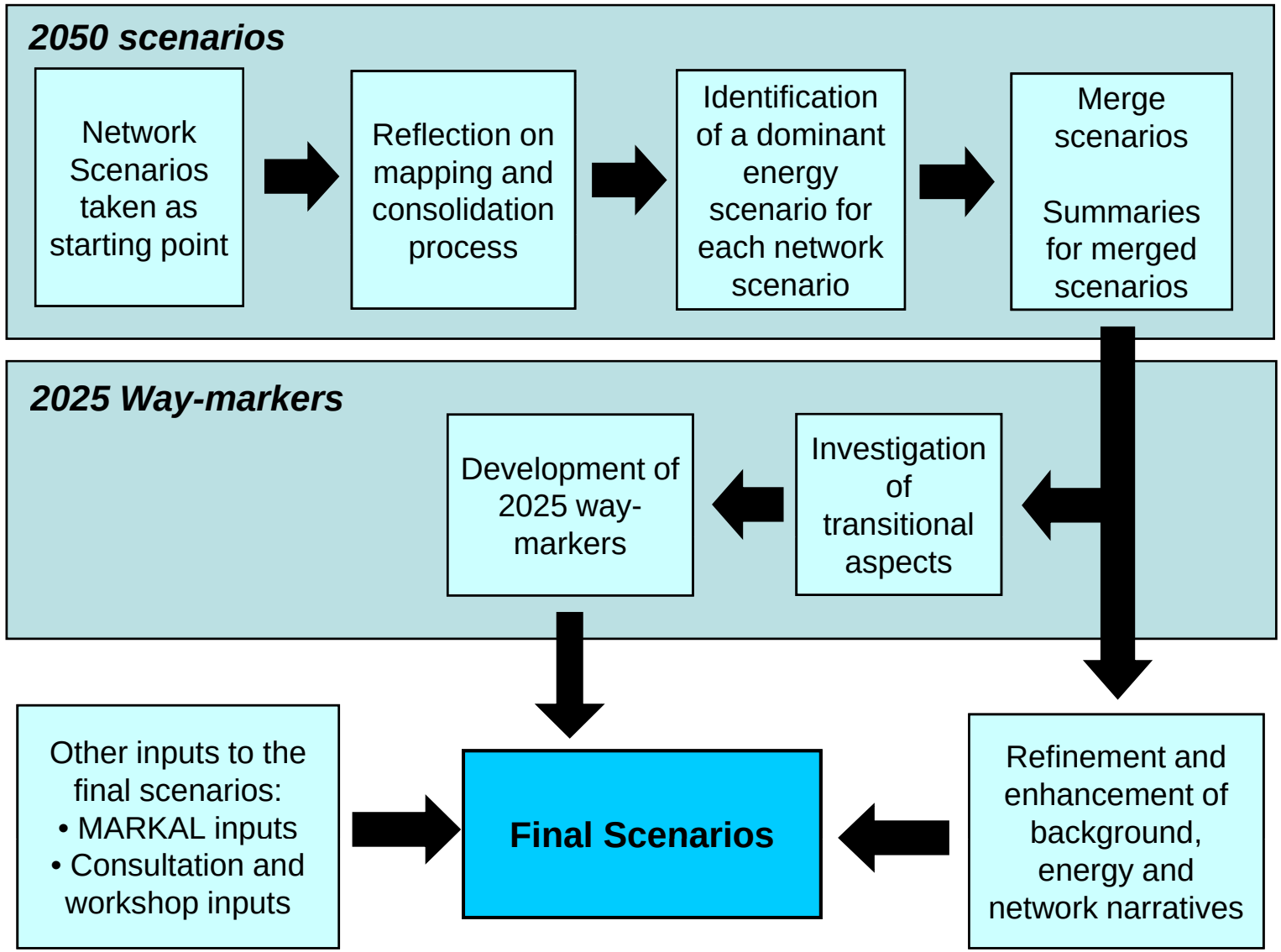
Energy and Network Scenarios

- Energy scenario to network scenario mapping exercise has clear benefits
  - Demonstrate that the resulting network scenarios could plausibly arise from a range of energy contexts
  - Provide convincing case that network scenarios cover a suitably wide range of plausible outcomes for electricity networks in 2050.
- Two sets of scenarios is problematic in some ways
  - Overly complex for users
  - No direct link from energy context to network scenario
- A single set of scenarios is desirable
  - Merged energy and network scenarios
  - Final set of network scenarios that have a single narrative outlining the overall energy context and the network detail

Process to develop final scenarios



Merging Energy Scenarios and Network Scenarios

Recap on Mapping

Network Scenario	Potential Scenarios
Big T&D	A1+A2+A3+B1
Energy Services Market Facilitation	Cm1+B2
Distribution System Operator (lean transmission)	Ci1+B3
Microgrids (Small Transmission and Distribution)	Ci2+Cm2+Cm3
Multi Purpose Networks	D

Initial Merged Scenarios Pairings

Network Scenario	Energy Scenario
Big T&D	Switch Me On
Energy Services Market Facilitation	Fix it For Me
Distribution System Operator (lean transmission)	Government Green Agenda
Microgrids (Small Transmission and Distribution)	Dynamic Green Markets
Multi Purpose Networks	Reactive Approach

Merging Scenarios

- The dominant energy scenario forms the initial body of the ‘context’ section of the merged scenario
- An iterative process of review and adjustment gradually reshapes the context scenario accounting for the influence of the other contributory energy scenarios and ensuring consistency with the network scenario
- Resulting coherent, internally consistent network scenario with richer high level energy context
- Merged scenarios ready to incorporate 2025 way-markers, MARKAL modelling results, consultation and workshop inputs

Transitional Aspects and 2025 Way-markers

- Integral part of a plausible scenario
- Provide richness to scenario narratives
- Provide milestones against which to:
  - Test plausibility
  - Monitor progress towards a particular scenario
  - Identify clusters of similar issues arising across scenarios
- Quantitative (from Markal) and qualitative 2025 way-markers
- Way-markers are not a separate set of 2025 scenarios but an additional layer of detail in the 2050 scenarios
  - Each network scenario will therefore have one set of 2025 way-markers

2025 Way-markers: example

- In the ‘Big Transmission and Distribution’ scenario:
  - demand growth continues at long-term trend rates due to low consumer activity and only moderate concern about the environment
  - large scale on-shore and offshore renewable projects are developed
- Possible sub-set of 2025 way-markers in ‘Big T&D’ scenario:
  - Continued demand growth
  - Higher demands for network capacity resulting in construction of currently identified transmission system upgrades (RETS)
  - Peak demand growth brings requirement for continued distribution reinforcement
  - Low growth rate for microgeneration
  - Further quantitative way-markers on renewable development and demand levels from Markal

Final scenario development activities

- Enhance and complete scenarios :
  - 2025 way-markers
  - MARKAL feed in to scenarios
  - consultation responses
  - workshop inputs
- Implications of network scenarios
  - Network implications
  - Regulatory implications

UKERC

KING'S College LONDON

The Energy System Context:

Modelling with MARKAL in Support of LENS Scenarios

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Ofgem LENS Stakeholder Workshop
5th June 2008

Summary

- Introduction to the MARKAL model
- Overview of results for each scenario
- Interim insights and conclusions

UK MARKAL modelling

A **least cost optimization** model based on life-cycle costs of competing technology pathways (to meet **energy demand services)**

Technology rich bottom-up model

- end-use technologies, energy conversion technologies, refineries, resource supplies, infrastructures etc

An **integrated energy systems** model

- Energy carriers, resources, processes, electricity/CHP, industry, services, residential, transport, agriculture

Physical, economic and policy **constraints** to represent UK energy system and environment

Model and data **validation**

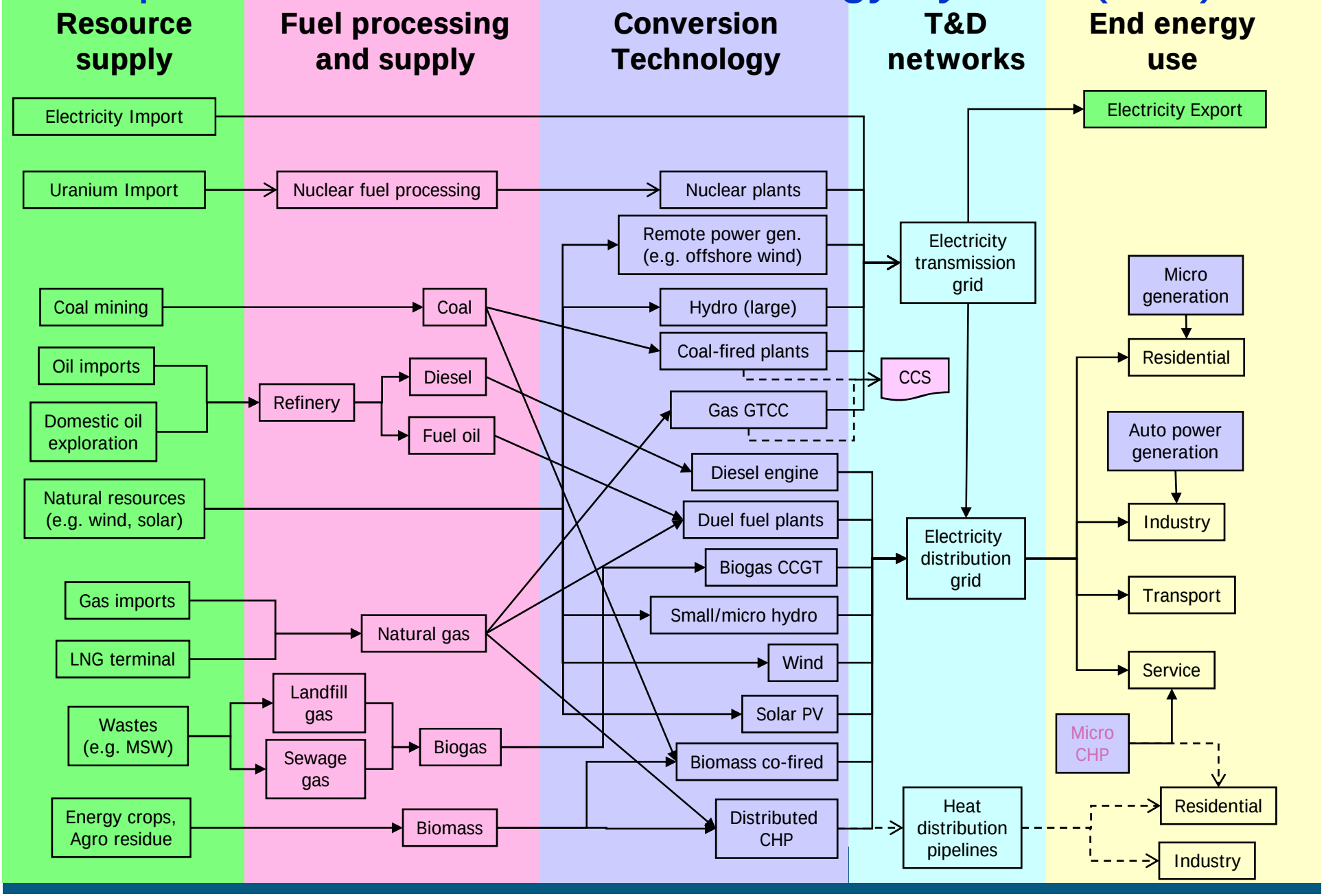
Emphasis on **sensitivity and uncertainty analysis**

- e.g., 2007 Energy White Paper

Substantially **rebuilt and revised**, in 2007 and 2008

Extension to MARKAL-Macro (M-M), Elastic Demand (MED), other variants

Simplified & Partial Reference Energy System (RES)



Key input and output parameters

INPUTS

System configuration - potential energy pathways and interactions

Resource supply curves - imports and domestic production

Energy service demands - to a detailed sub-sectoral level

Technology characterisation - capital costs, O&M costs, efficiencies, availabilities etc

Constraints – physical and policy driven

OUTPUTS

Total and annual energy system costs

Primary energy, final energy - by sector and/or by fuel

CO_2 - by fuel, sector; marginal emissions prices

Imports, exports & domestic production of fossil & renewable fuels

Electricity generation mix– by fuel and by technology

Transport fuels, transport technology by mode

Use of conservation, efficiency

MED - Behaviour change in individual demand services

MARKAL – Advantages, disadvantages and remedies

Advantages

- Well understood least-cost modelling paradigm
  - efficient markets
- Coherent and transparent framework
  - cost optimization
  - data, constraints etc
- Interactions within entire energy system
- Future technological options and system evolution
- Model variants to address key issues
- **Use of scenarios to ensure consistency with simultaneous variation of multiple parameters**

Disadvantages and remedies

- MARKAL is data intensive
  - characterization of technologies and RES
  - calibration (base year and projections)
  - data sharing and collaboration improving the situation
- Sensitivity to small changes in data assumptions
  - stepped supply curves and market share algorithms
- Limited ability to model behaviour
  - growth constraints, “hurdle” rates, demand elasticities (MED)

MARKAL modelling of LENS scenarios

- Carbon price applied to electricity and industry
- Technology variants - cost reduction, efficiency / performance improvement, discount rates
- Potential to reduce demand using MED
- Contrasting scenario results require multiple and diverging assumptions - ‘what if’ approach

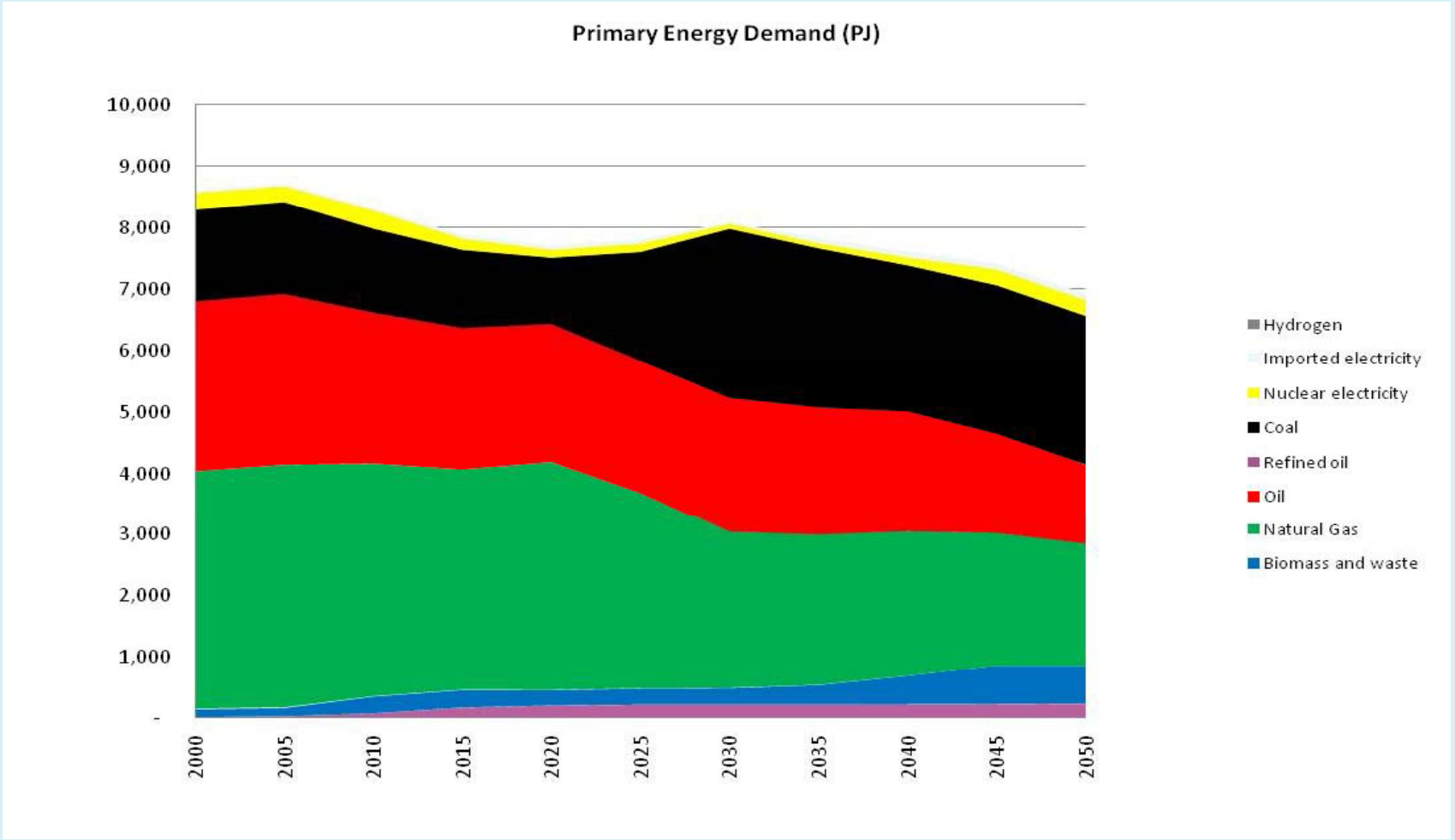
Scenario Summary Indicators

- **Final Energy demand**
- Big T&D: Rising final energy demands
- ESMF: Flattening final energy demand
- DSO: Final energy demand reduction
- MG: Final energy demand reduction. Large use of heat
- MN: Rising final energy demands
- **Electricity Generation**
- Big T&D: Coal CCS; imports
- ESMF: CCS; wind, large scale and micro
- DSO: Biomass, solar pv and microwind for residential demand
- MG: Biomass, microwind, residential and commercial scale gas CHP
- MN: Large capacities of nuclear, gas
- **Transport**
- Big T&D: diesel and petrol ICEs
- ESMF: plug in hybrids and battery vehicles supplement diesel and petrol fleets
- DSO: large contribution from hydrogen cars and buses
- MG: mix of hydrogen, battery EV, plug-in hybrids and conventional vehicles
- MN: full penetration of hydrogen and battery electric vehicles

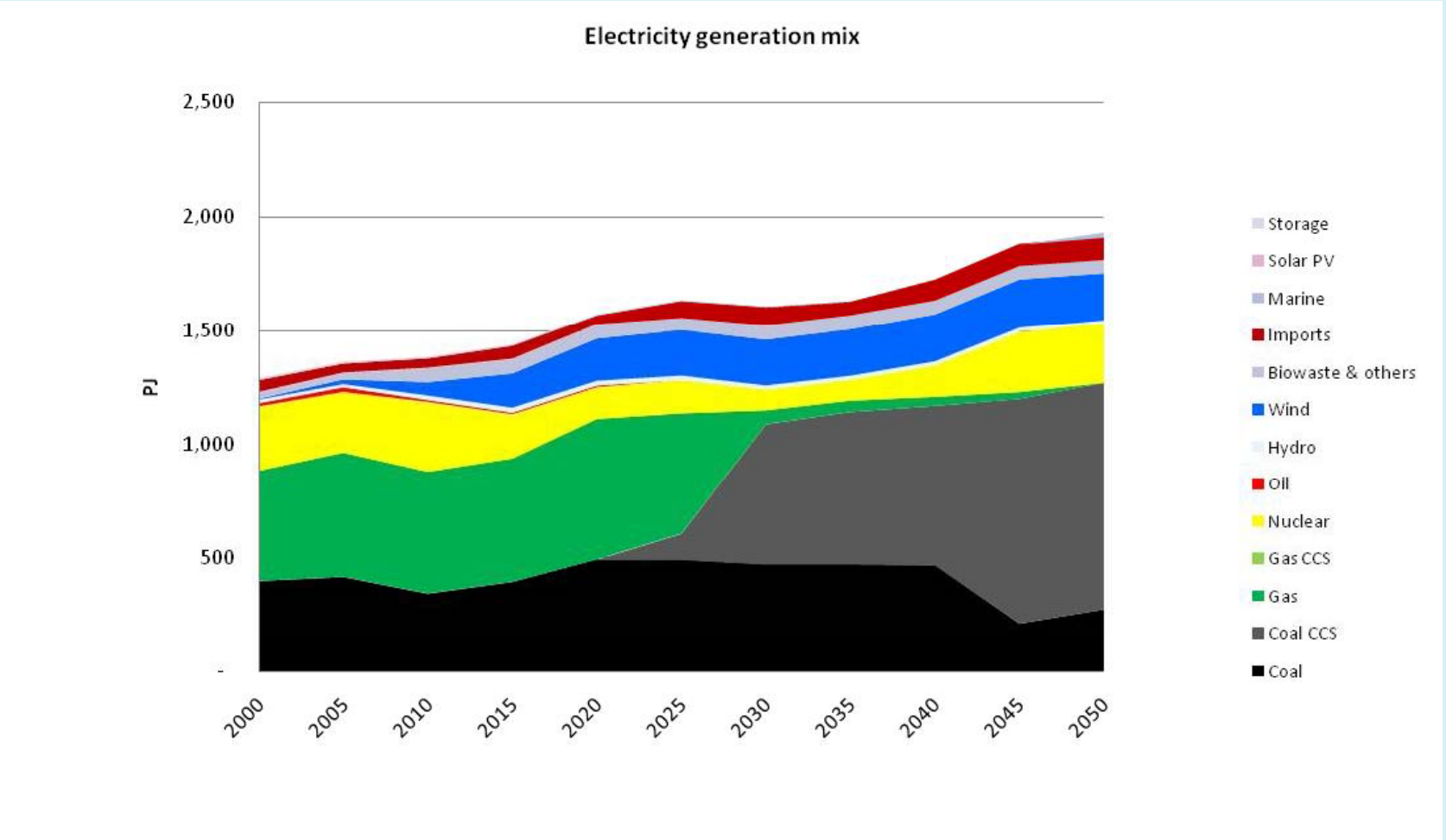
Big Transmission and Distribution (T&D): modelling approach

- Low carbon price: £14 - £30
- ‘consumers demand abundant supplies of electricity’- no demand reduction
- Increased capacity and lower cost of interconnectors and offshore connection

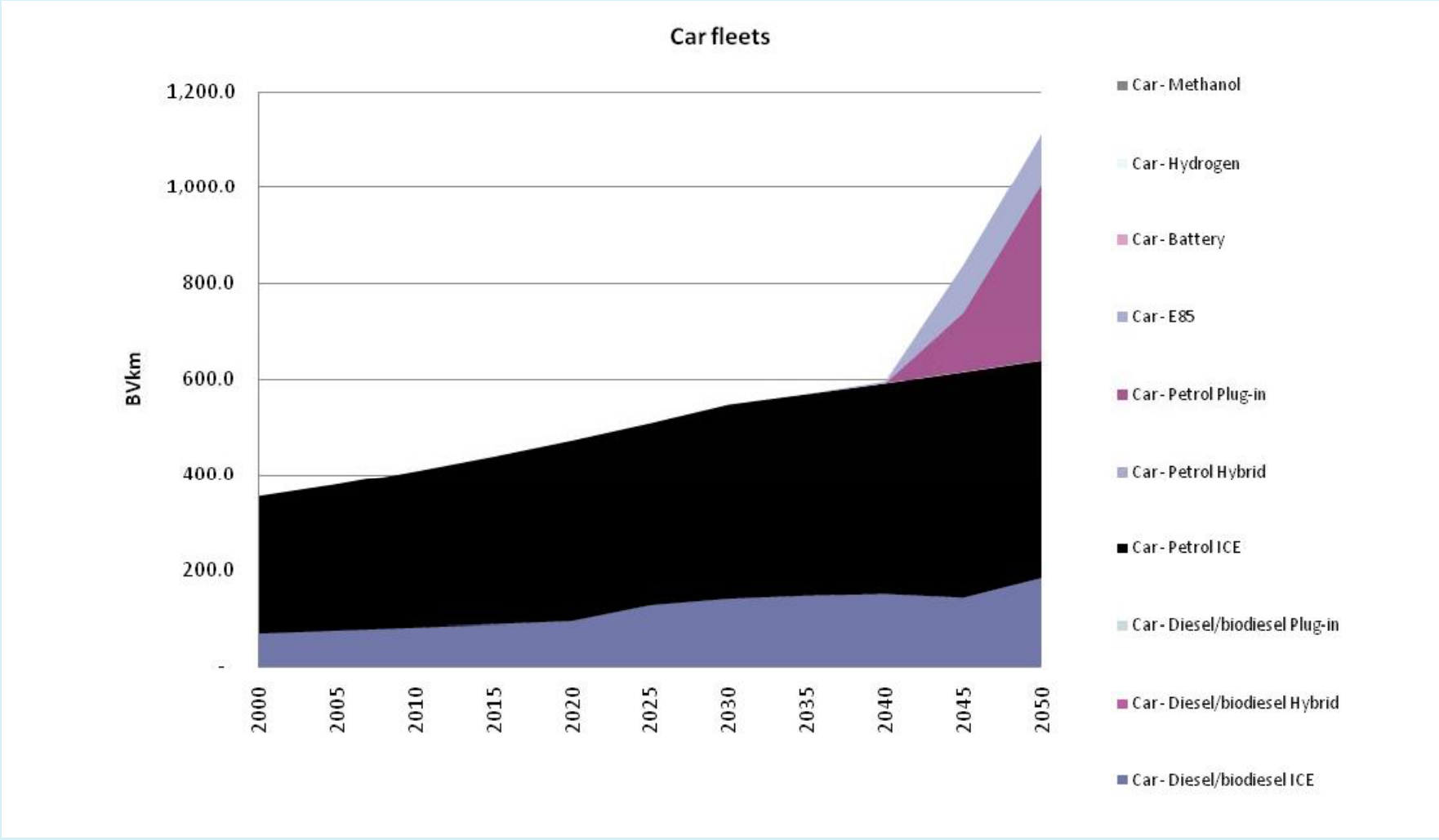
Big T&D - primary energy demand



Big T&D - electricity generation mix



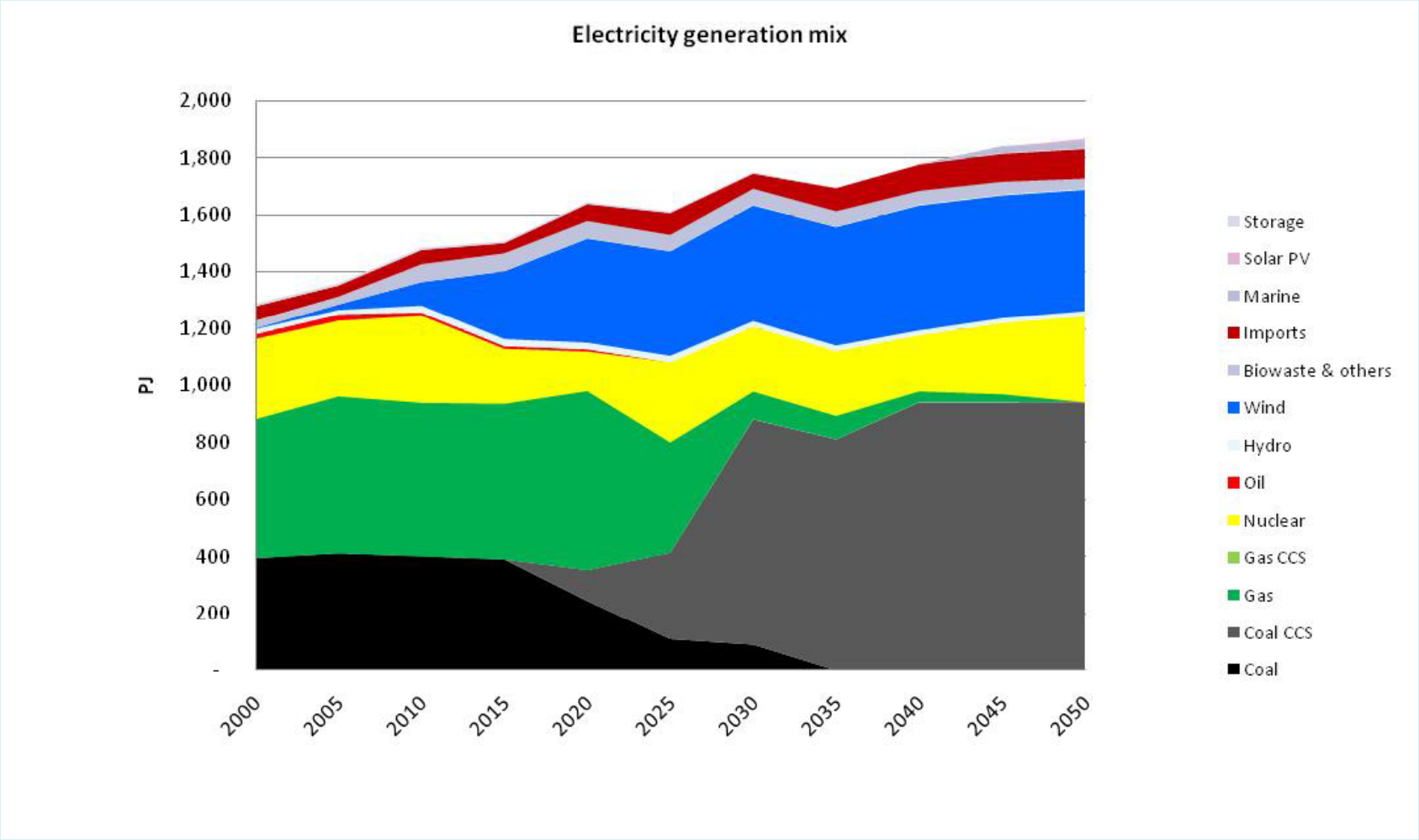
Big T&D - car fleets



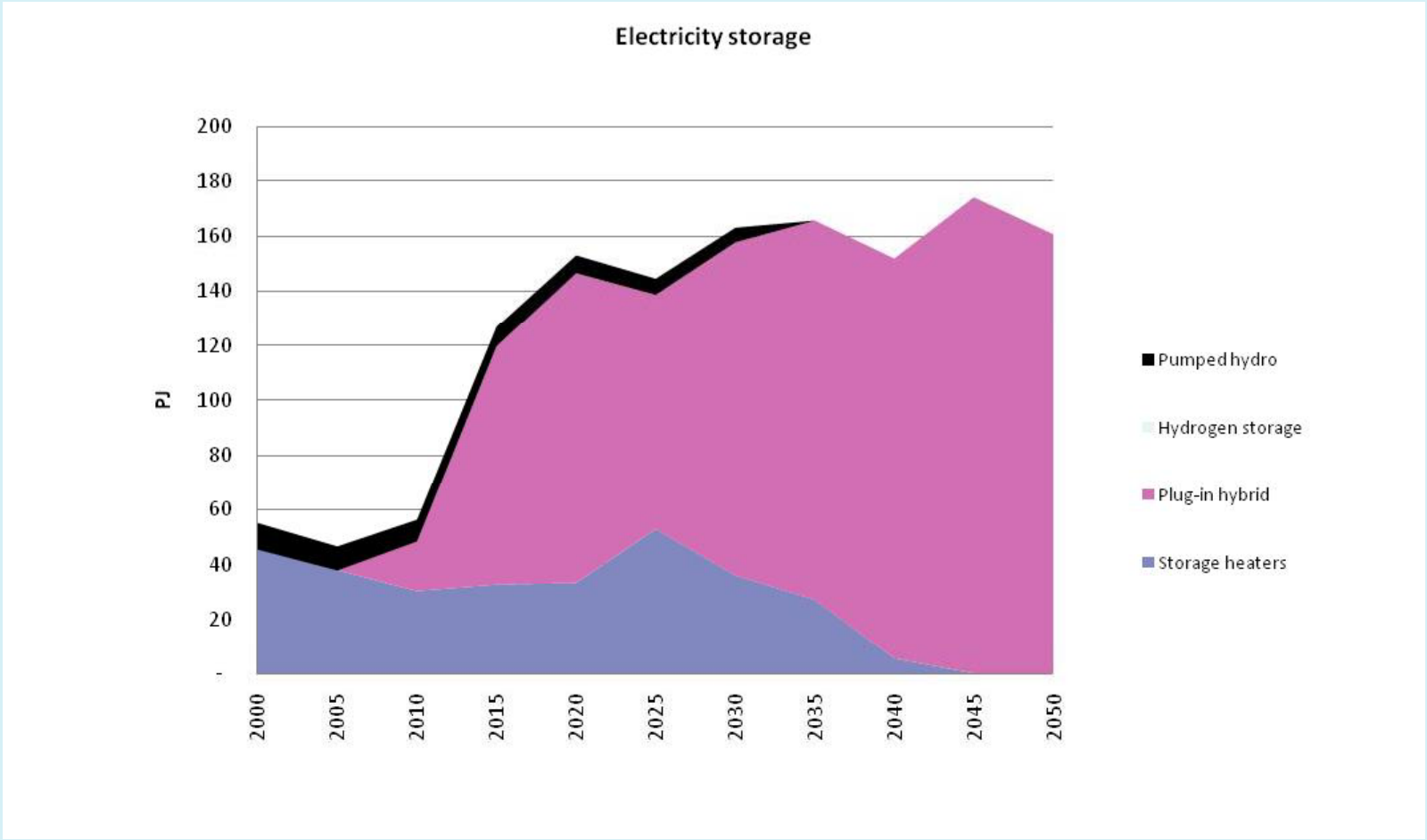
Energy Services Market Facilitation (ESMF): modelling approach

- Stronger government signal delivers medium carbon price: £14- £60
- ‘passive consumers’ - no demand reduction
- ESCOs: cost reductions and increased capacity for microgen, micro CHP, efficiency at residential and service level
- Reduced costs and discount rates of electric vehicles

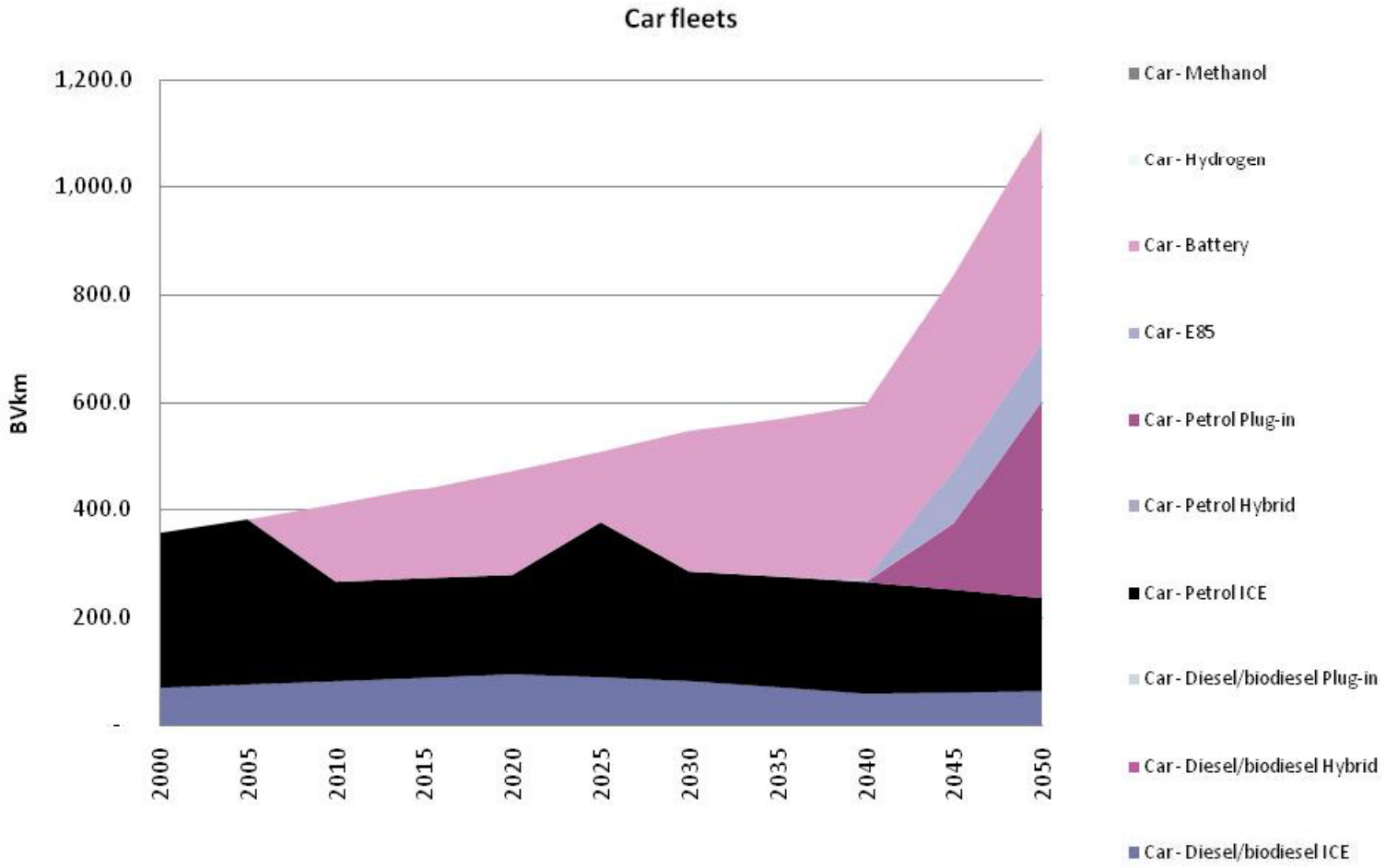
ESMF - electricity generation mix



ESMF - energy storage



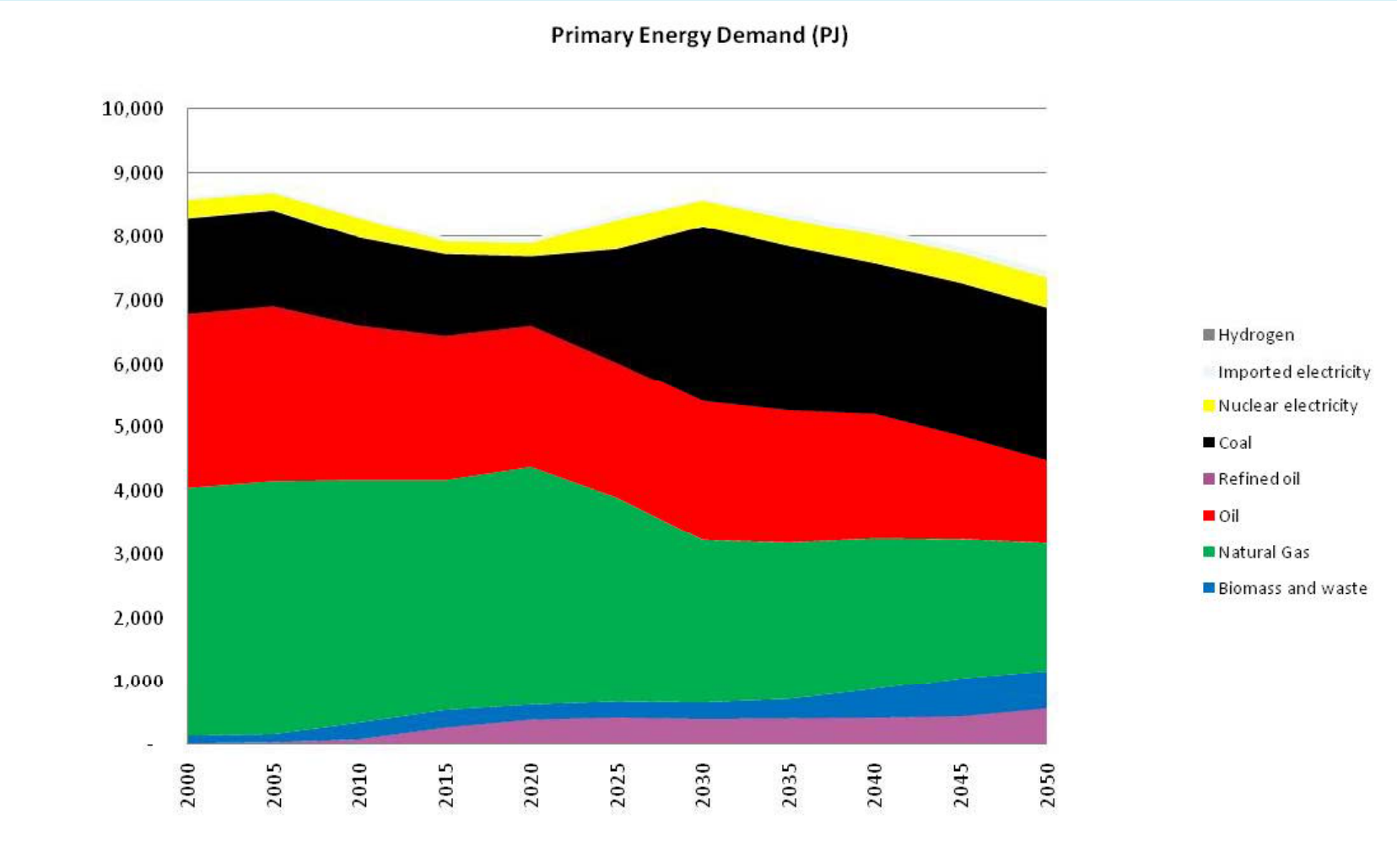
ESMF – car fleets



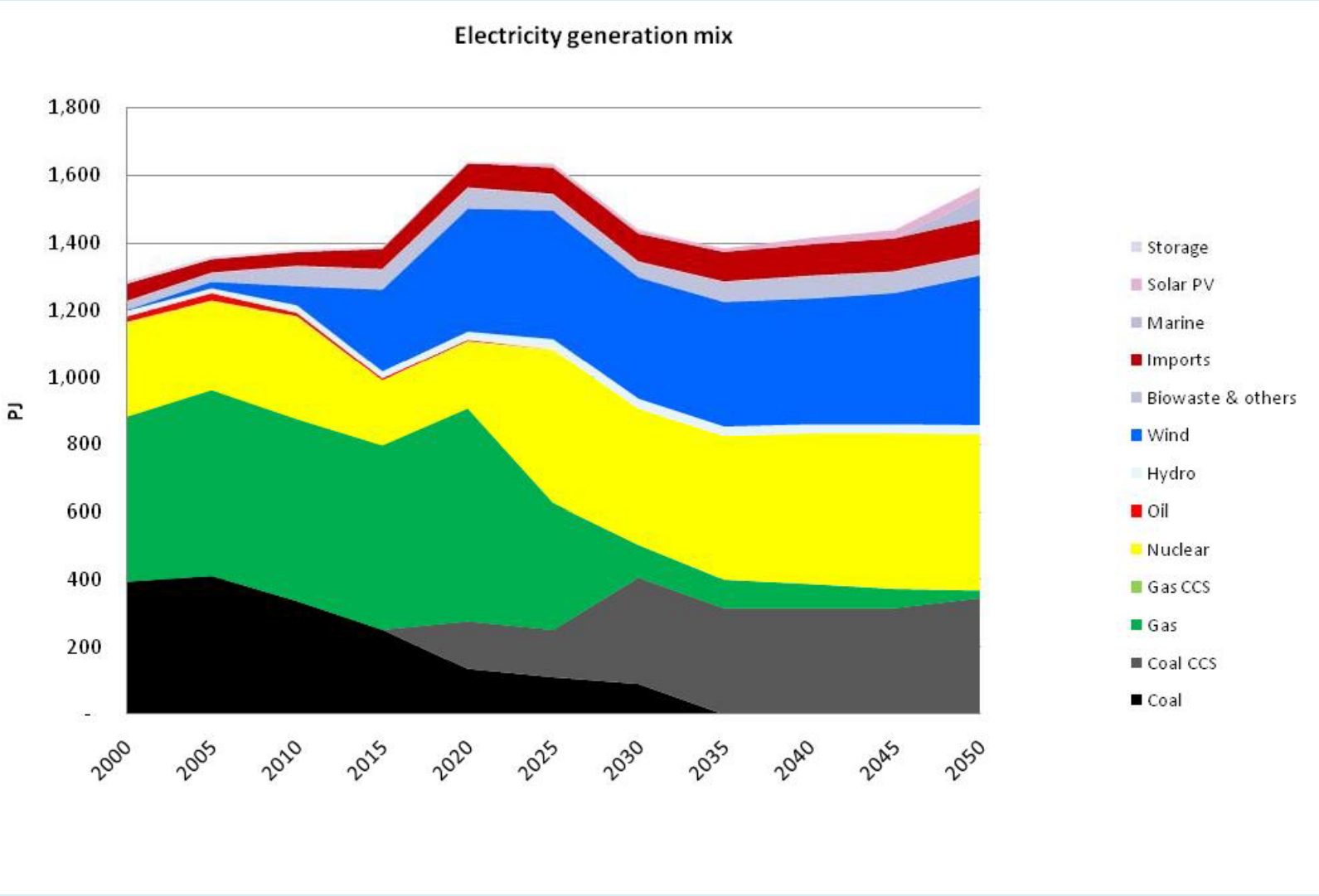
Distribution System Operators (DSOs)

- Even stronger government signal delivers high carbon price: £14 - £100
- Energy service demand reduction
- Constraints applied to transmission grid, particularly for residential and service demand
- Cost reductions in key H2 technologies and small scale H2 production (most optimistic industry estimate)
- cost reductions and increased capacity for microgen, micro CHP, efficiency at residential and service level - as ESMF

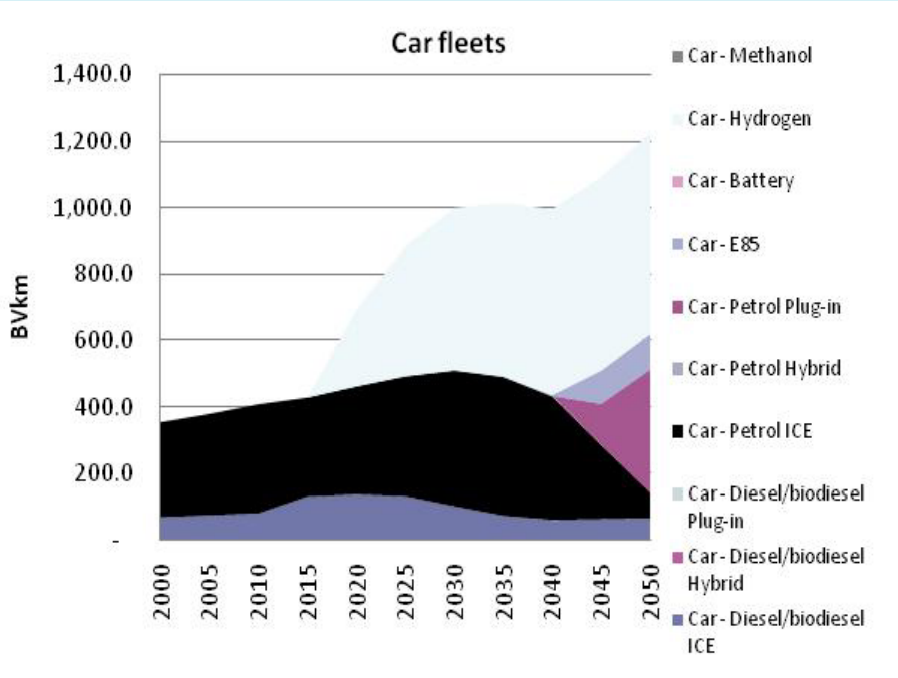
DSOs - primary energy demand

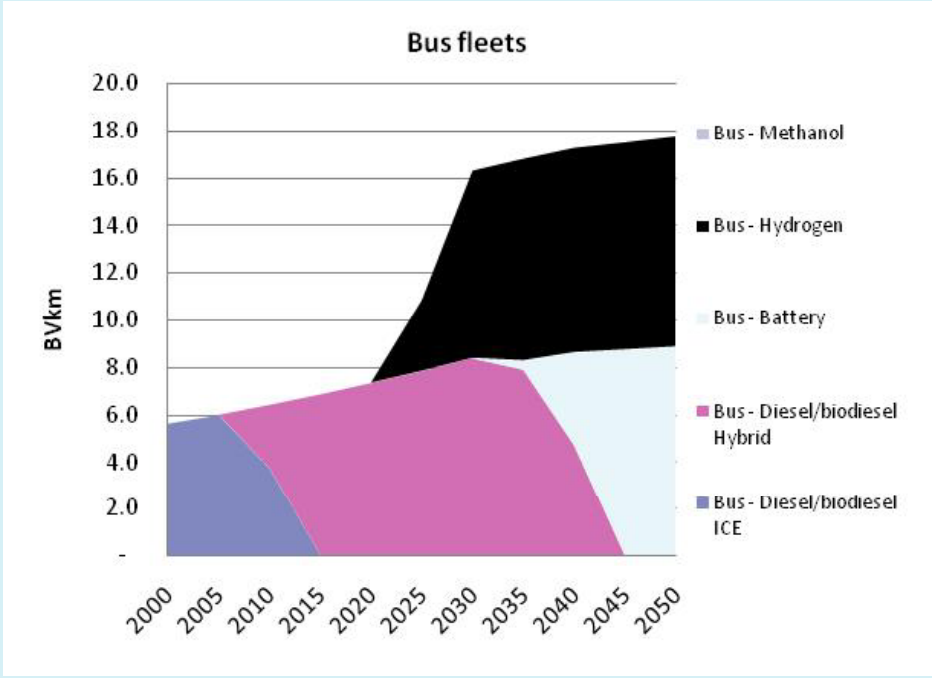


DSOs - electricity generation mix



DSOs - transport

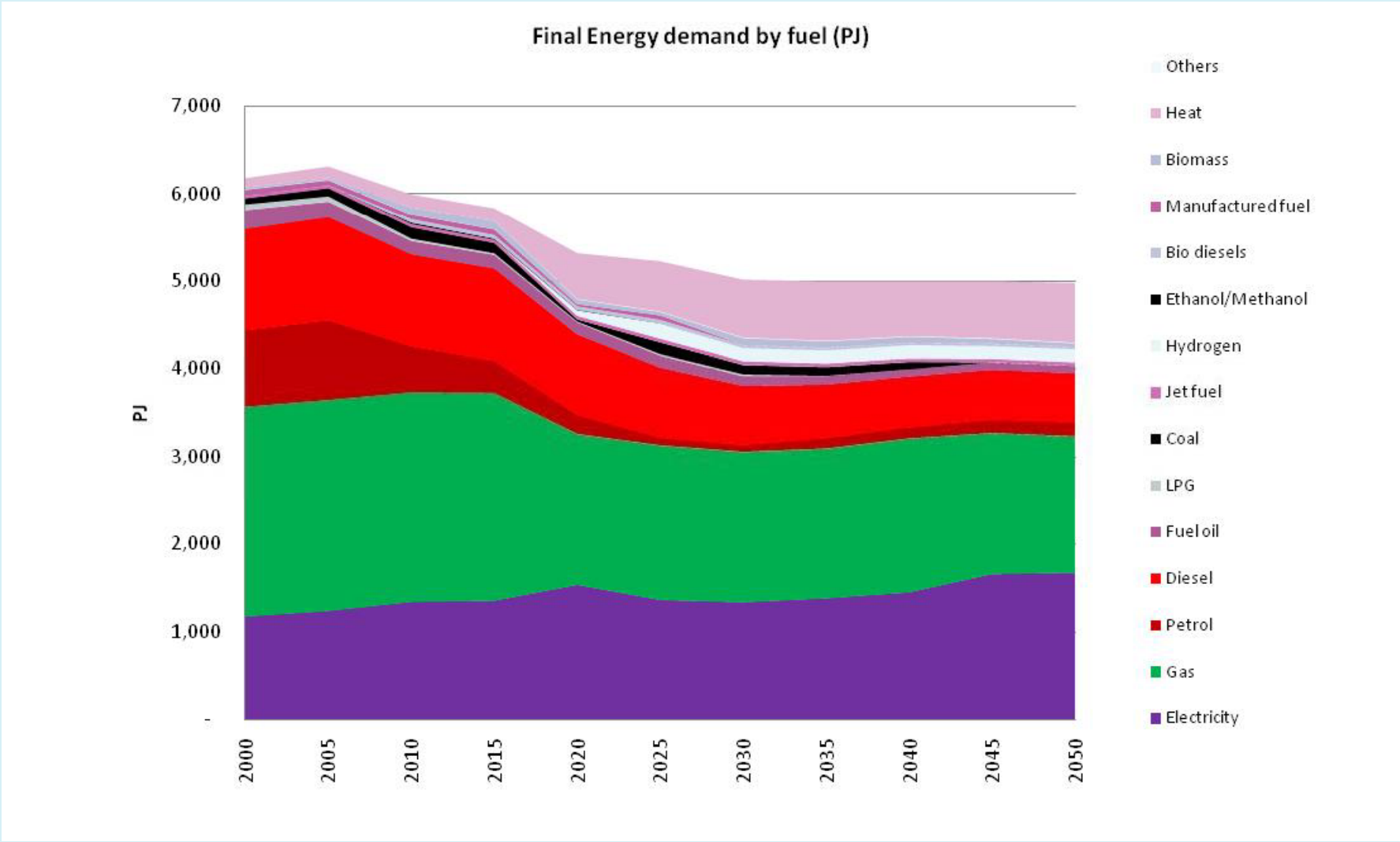




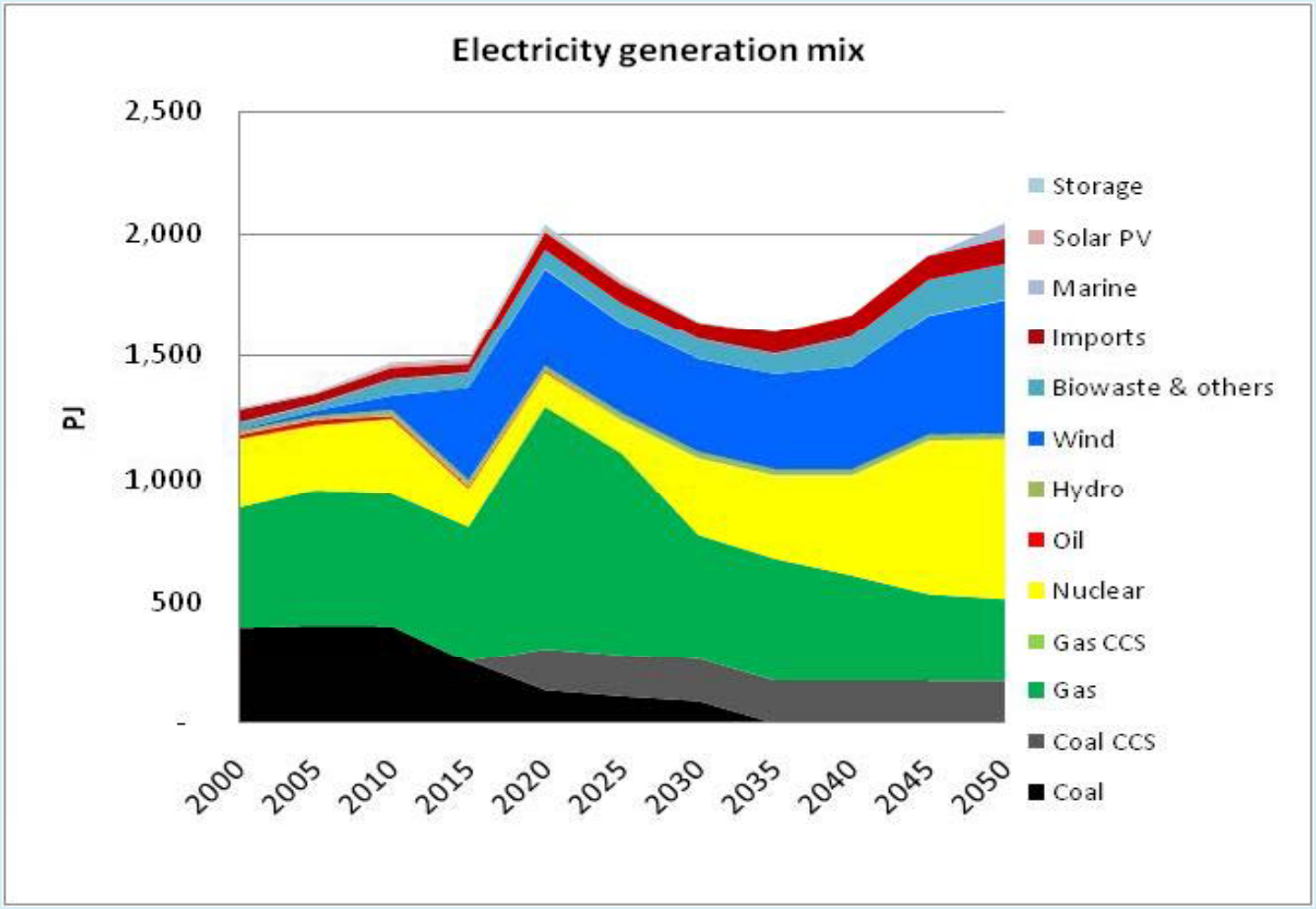
Microgrids

- ‘Global action to reduce emissions’- very high CO2 price: £14 - £135
- Energy service demand reduction
- Combined advanced development of electric and hydrogen technologies
- Major advances on small scale generation technologies, including increased availability factors- assuming some viable form of local storage, or dynamic demand-supply matching
- Increased constraints on transmission grid- no large scale electricity to residential or services

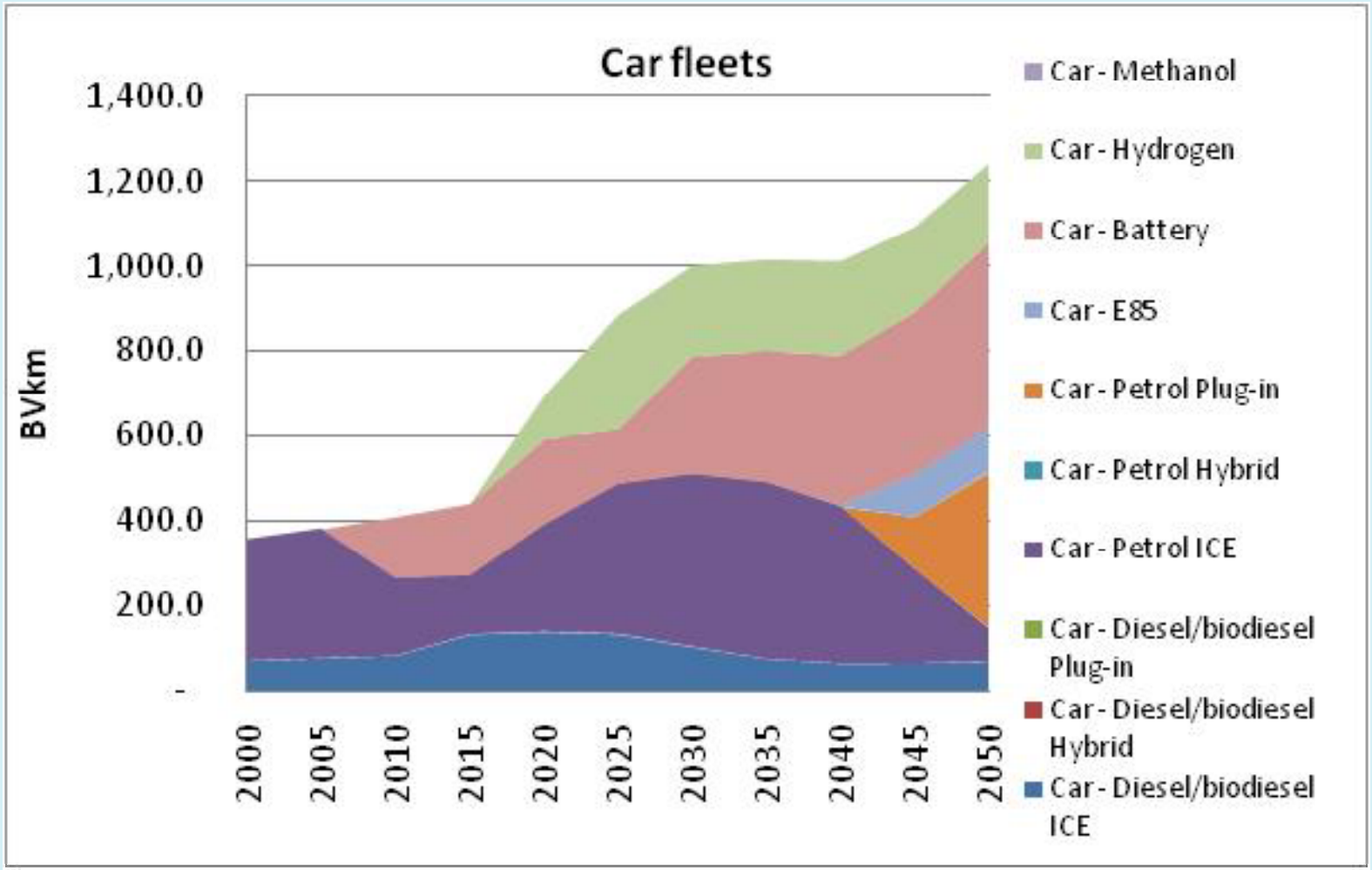
Microgrids - final energy demand



Microgrids - electricity generation mix



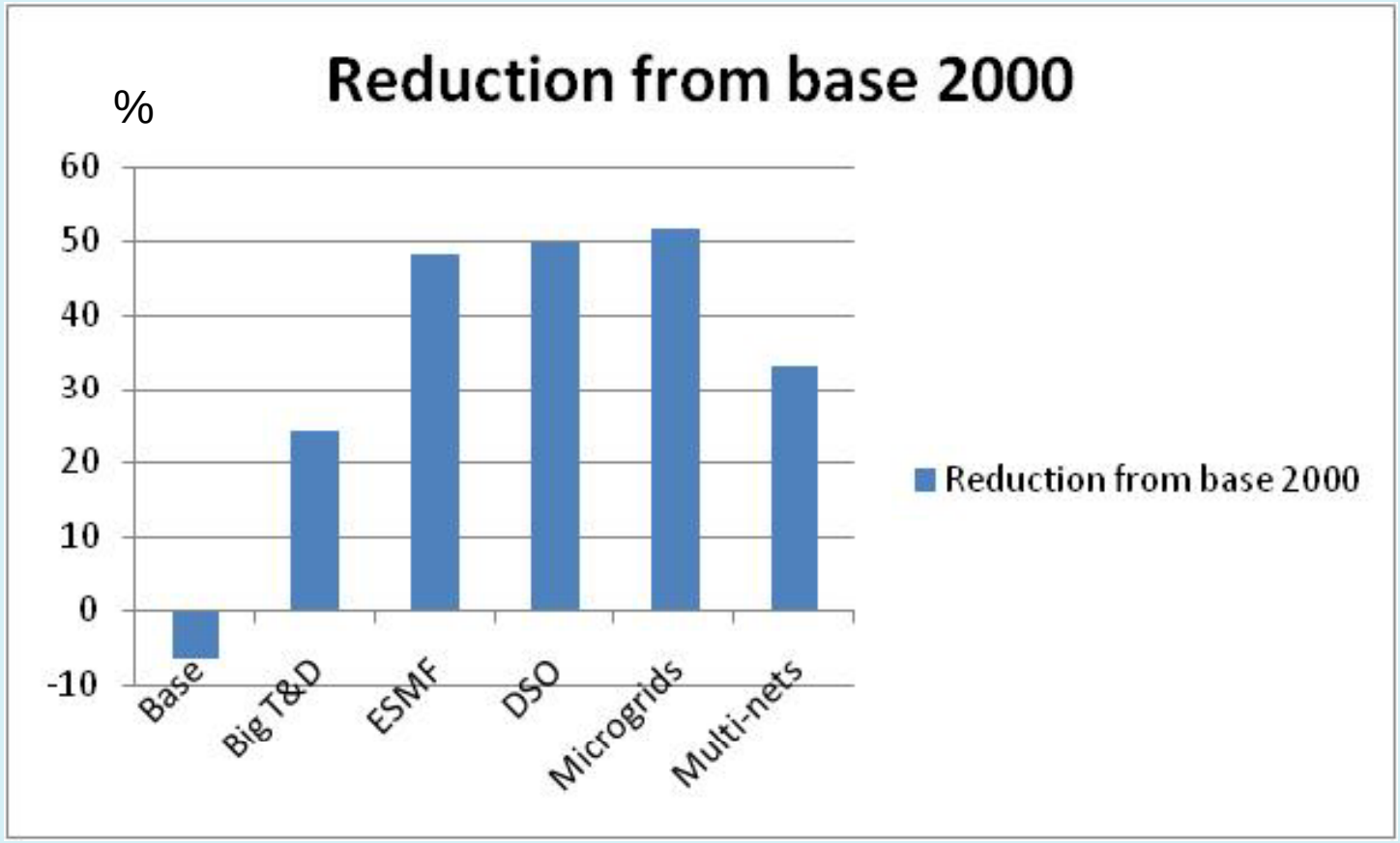
Microgrids - car fleets



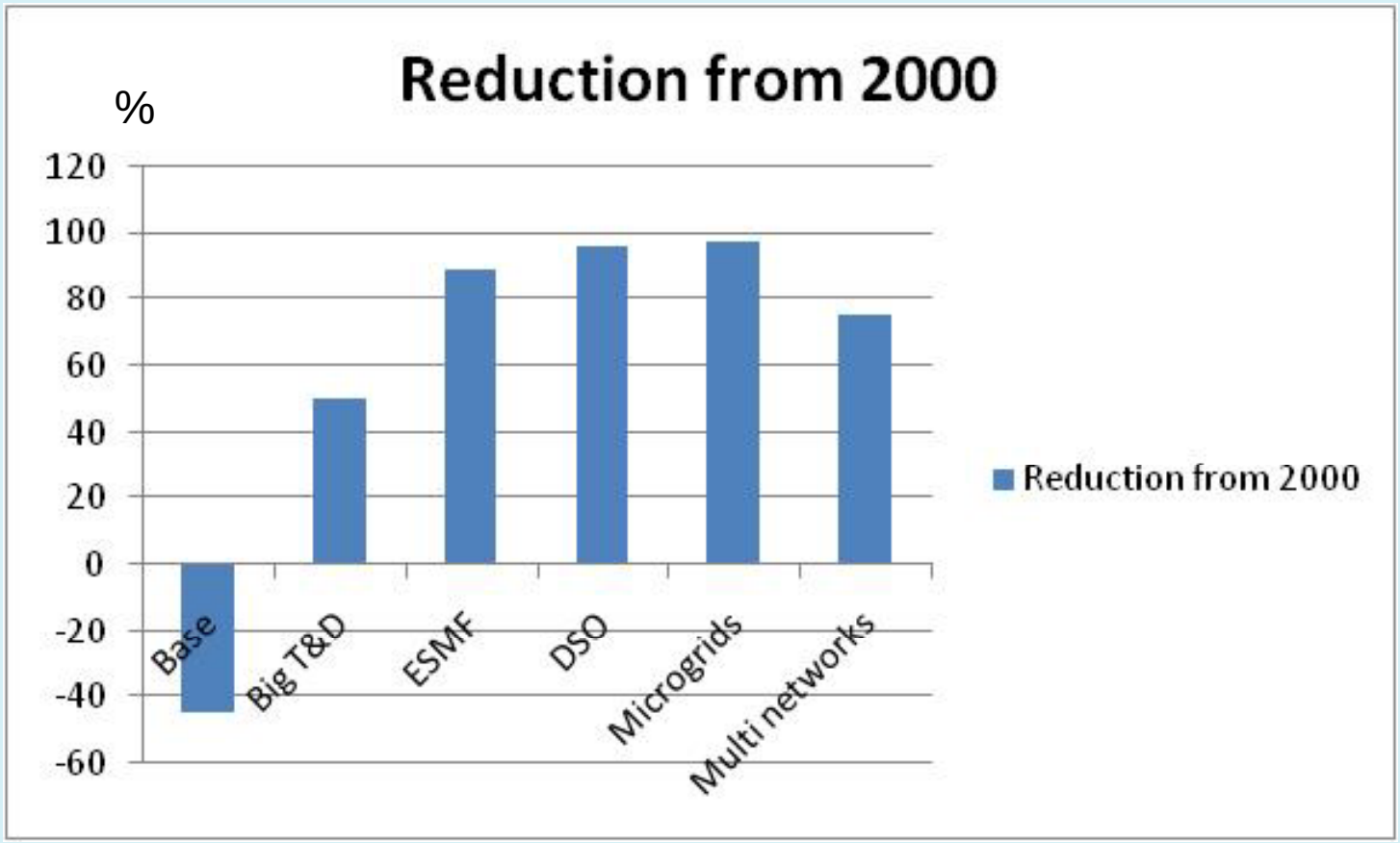
Multi-purpose networks: modelling approach

- *Problem: hard to represent investment uncertainty in model with 'perfect foresight'*
- Pervasive uncertainty towards environmental issues delivers long term 'low' average carbon price
- No demand reduction
- Contrasting technologies 'forced in' to represent strong investments under various policy signals at different times
- Need more specific steer from scenario process

CO2 reductions (whole energy system)



CO2 reductions (electricity only)



Interim conclusions and insights

- Carbon price key driver
- Representing scenarios required major assumptions in technology cost reductions, particularly microgen
- Discount rates also important for new technologies and efficiency measures, well below observed social preferences - importance of significant attitude shift or ESCOs
- Technologies which can provide storage and balancing are important, and likely to become crucial under high carbon prices
- Technical feasibility of independent microgrids needs exploration and justification in scenarios
- Potential importance of district heating networks in decentralised scenarios
- A carbon price of £60 / t drives very significant decarbonisation in the electricity sector, which can amount to close to 50% emissions reduction overall
- Cost effective measures likely to involve efficiency and the option of decentralised technologies. Importance of discount rates. Major constraints on transmission see rising costs

Relation of model outputs to scenarios

- Modelling is ‘what if’ approach: there are some big ‘ifs’ which need a coherent and plausible storyline to explain them (technology development, system management)
- Modelling outputs can also flesh out scenario storylines, with possible levels of CO2 reduction, system costs and welfare losses (due to reduced energy consumption), and interaction with other sectors including transport
- Possibility for scenarios to further refine modelling - for example more detailed storyline for Multi-Purpose Networks, to define ‘forcing’

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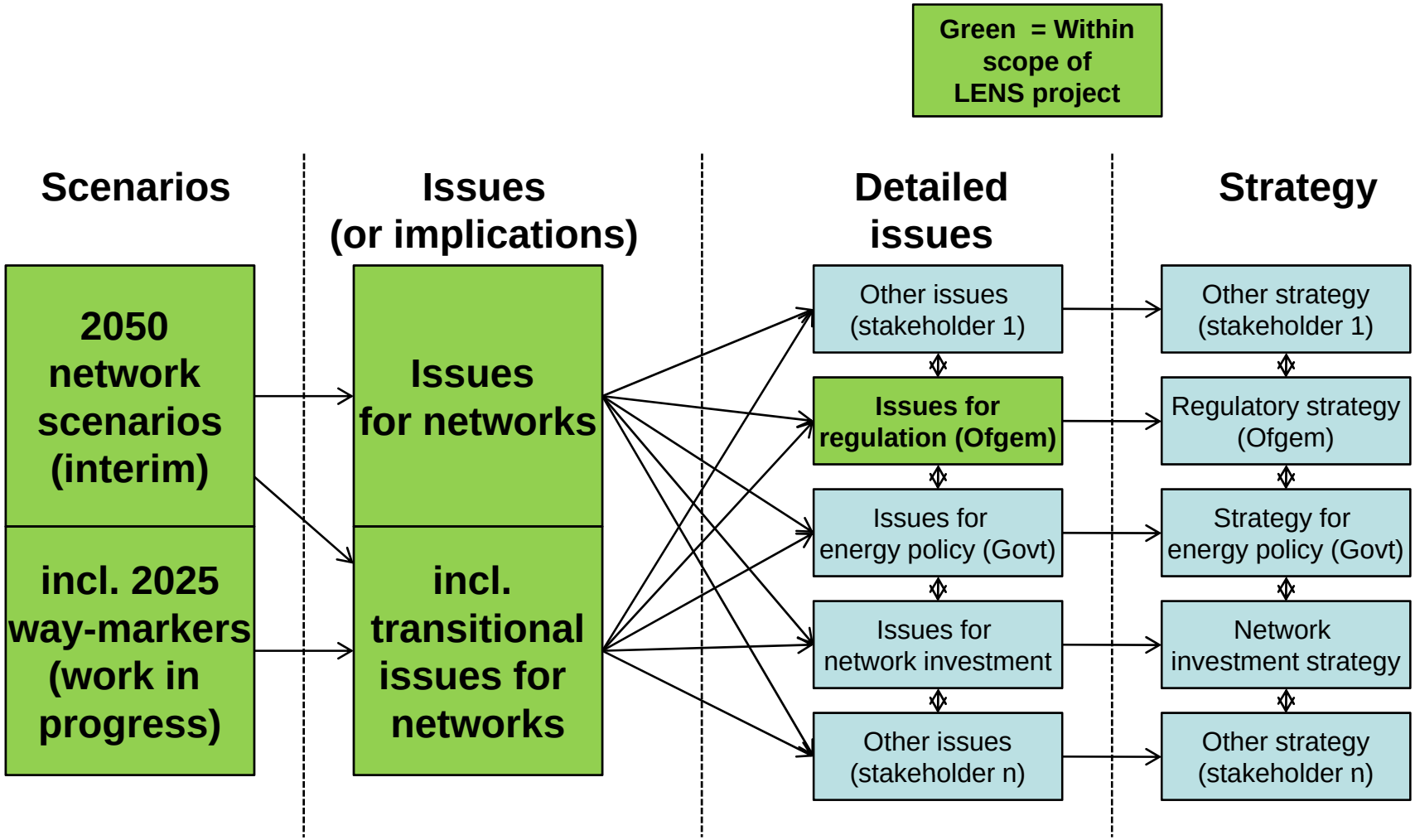
Introduction to breakout sessions

Main objectives of breakout sessions

- Breakout session 1:
  - Obtain stakeholder feedback on the 2050 interim scenarios & issues (or implications) for networks
- Breakout session 2:
  - Seek initial stakeholder input on transitional (2025) issues for networks
  - Seek initial stakeholder input on establishing a set of issues for the regulation of networks
- Composition of each breakout group will remain **identical** between breakout sessions 1 and 2
- Each breakout group has been allocated **one network scenario**, for discussion in both breakout sessions

Conceptual framework & scope of LENS



Definition of 'issues'

- '**Issues for networks**' = Implications raised by the 2050 scenarios (including necessary conditions and possible obstacles) that are important for considering the future of GB energy networks
  - Illustrative question for identifying 'issues for networks' (for a single network scenario):
    What would need to happen for this network scenario to come about, including any aspects of implementation, and what obstacles may prevent it from coming about?
  - Example: A need for more (dispersed) controls for monitoring real time power flows in DSOs network scenario – due to more active distribution networks

- '**Issues for the regulation of networks**' = Implications raised by the 2050 scenarios (and the issues they raise for networks) that are important for considering the future regulation of GB energy networks
  - Illustrative question for identifying 'issues for the regulation of networks' (for a single network scenario):
    What are the advantages & disadvantages of this network scenario, and how could any disadvantages potentially be mitigated through regulation (or otherwise)?
  - Using above example: Any regulatory implications – e.g. planning standards - of more (dispersed) controls

Further clarification on definition of 'issues'

- This work is about identifying/establishing a set of key issues for networks & the regulation of networks, it is **not** about:
  - stakeholders (including Ofgem) developing views/positions on these issues

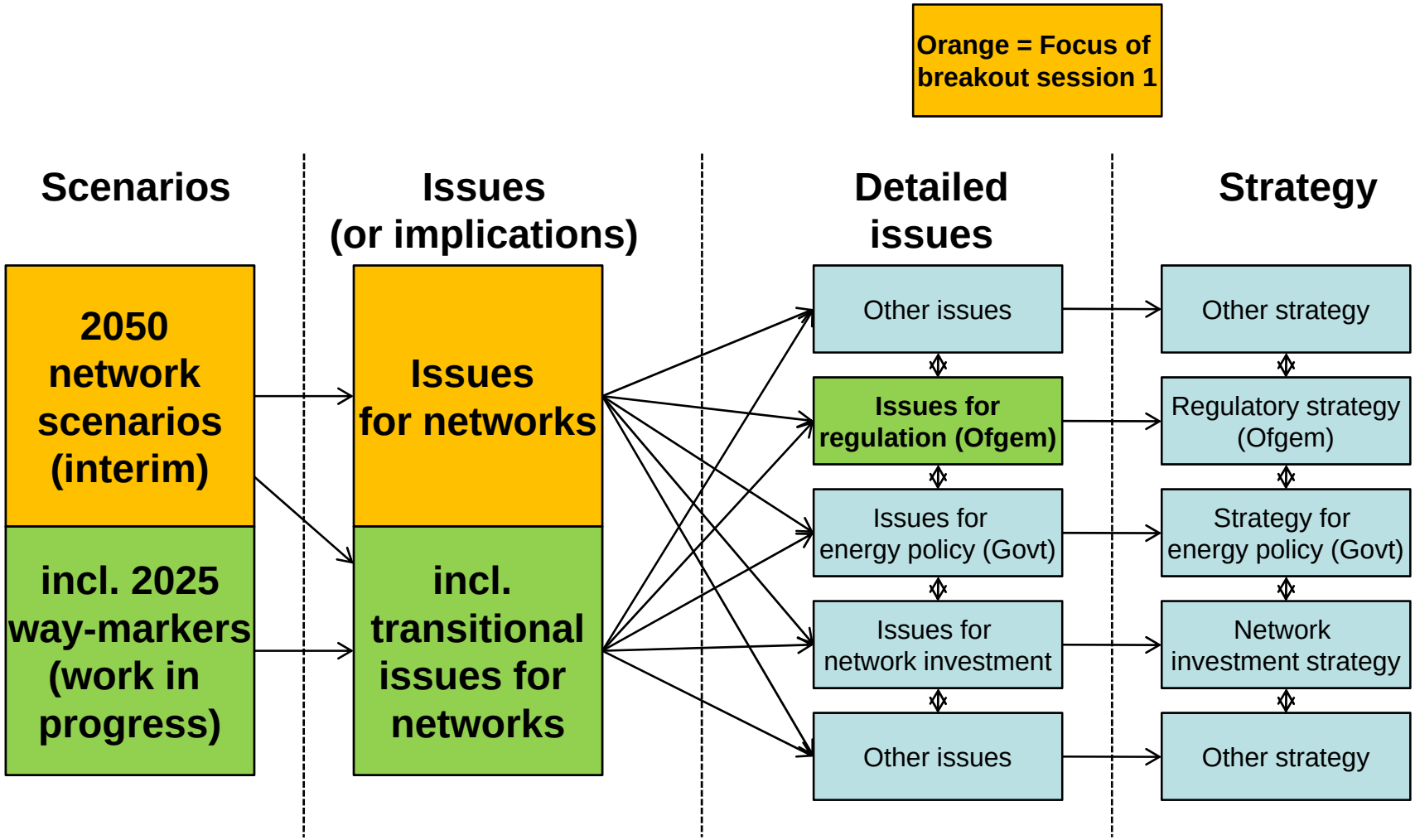
- Questions we are **not** addressing through identifying/establishing a set of key issues for networks & regulation of networks:
  - desirability of individual scenarios, or groups of scenarios
  - likelihood of scenarios

- Formation/development of **strategy** by stakeholders is a potential next phase of work (and outside the scope of the LENS project)

Breakout session 1 (11.30 – 12.30): 2050 scenarios & issues for networks

- Step one:
  - On balance, do the 2050 network scenarios in the interim report meet our brief? (of developing a set of scenarios that, between them, span a suitably wide range of plausible outcomes for GB electricity network scenarios in 2050)? If not, what essential features are missing? [Discuss for 20 mins]
- Step two:
  - Taking one of the 2050 network scenarios (as allocated), what issues for networks spring to mind? (Try to avoid transitional issues as well as issues for the regulation of networks – covered in breakout session 2)
    For example, what would need to happen for this network scenario to come about, including any aspects of implementation, and what obstacles may prevent it from coming about? [Discuss for 20 mins]
- Step three:
  - Agree a list of the most important issues for networks (in light of step two) [Write these down on a flipchart - 20 mins]
- Step four:
  - Nominate a participant from the breakout group to present feedback

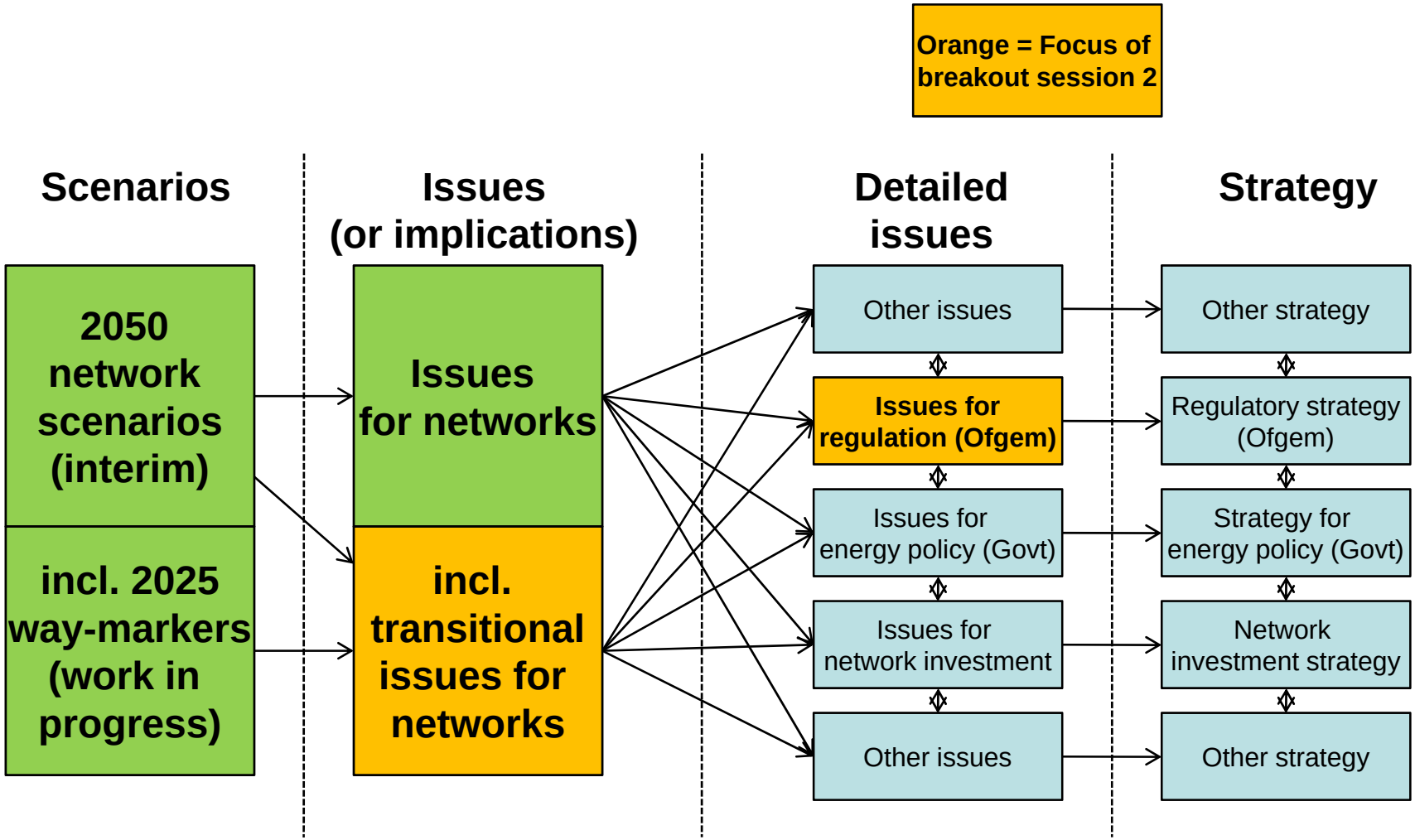
Focus of breakout session 1



Breakout session 2: (13.15 – 14.15) Transitional (2025) issues for networks & issues for regulation of networks

- Step one:
  - Taking the same 2050 network scenario as in breakout session 1, what transitional issues for networks spring to mind?
    For example, what would need to happen by 2025 for this network scenario to come about by 2050, including any aspects of implementation, and what obstacles by 2025 may prevent it from coming about?
    [Discuss for 20 mins. Agree & write down on flipchart - 10 mins.]
- Step two:
  - Taking the same 2050 network scenario again - and bearing in mind the issues for networks from breakout session 1 and the transitional issues from step one above - what issues for the regulation of networks spring to mind?
    For example, what are the advantages & disadvantages of this network scenario, and how could any disadvantages potentially be mitigated through regulation (or otherwise)?
    [Discuss for 20 mins. Agree & write down on flipchart - 10 mins.]

Focus of breakout session 2



Breakout sessions: Guidance on steps and timings

- At the start of each breakout session **facilitators will explain** the format of the session again, including details of:
  - the exercise for each step
  - timings

- **Printed copies of the instructions** for each session will be available to participants, with details of:
  - the exercise for each step
  - timings

NB to complete the work it is vital the timetable is adhered to

Feedback from breakout sessions (14.30-15.00)

- Nominated participant from each group presents a summary of the outcome of both breakout sessions [5 minutes per group]

- **Breakout session 1**: 2050 scenarios & issues for networks
  - Did we meet our brief? If not, what is missing? (from step one)
  - What have you identified as the most important issues for networks? (from step three)

- **Breakout session 2**: transitional (2025) issues for networks & issues for regulation of networks
  - What transitional issues for networks have you identified? (from step one)
  - What issues for the regulation of networks have you identified? (from step two)

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Plenary discussion / Q&A session

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Next steps & closing remarks

Consultation on May 2008 Interim Report

- We invite written responses to the consultation on the **interim report** from all stakeholders & interested parties, including:
  - consumer representatives, academic/scientific community, environmental groups, energy/electricity industry, equipment manufacturers & international stakeholders
- Please frame responses around the **five consultation questions** set out in the accompanying Ofgem consultation letter of 14 May
  - Any further comments in light of today's workshop are welcome in written responses also (please use consultation **question Q5** for this purpose)
- Consultation **closes 10 June** – our 14 May letter explains how to respond
- Interim report and 14 May consultation letter are available on our **website** (Ref. No. 63/08)
  http://www.ofgem.gov.uk/Networks/Trans/ElecTransPolicy/lens/Pages/lens.aspx

Remaining project outputs

- **Draft scenarios report** to include (reflecting stakeholder feedback):
  - updated 2050 network scenarios (merged)
  - scenario quantification from Markal modelling
  - consistent way-markers for 2025

- **Fourth (final) stakeholder workshop?**
  (after publication of draft scenarios report – probably in July)
  - Question to stakeholders today: Is there sufficient interest?
  - Please also indicate your interest in responses to consultation **question Q4** of May 2008 interim report

- **Final report** to include (reflecting stakeholder feedback):
  - final 2050 network scenarios & consistent way-markers for 2025 (including scenario quantification)
  - set of key issues for networks & their regulation

Expected timeline going forward

• Consultation on interim report closes	10 June
• Draft scenarios report	End of June
• Consultation of draft scenarios report	July - August
• **Fourth (final) stakeholder workshop?**	**in July?**
• Final report	September

Further details on project timeline can be found in the Ofgem consultation letter dated 14 May 2008 (Ref. No 63/08)

Closing remarks


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