Model choices and linkages across scales

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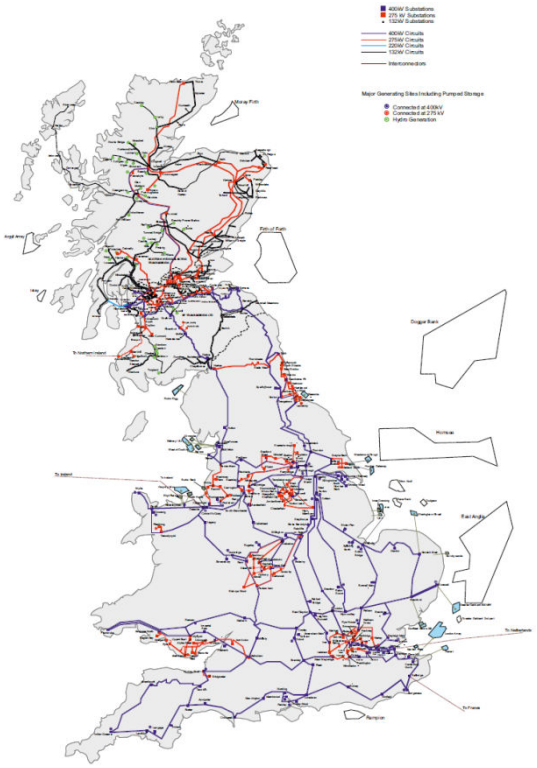
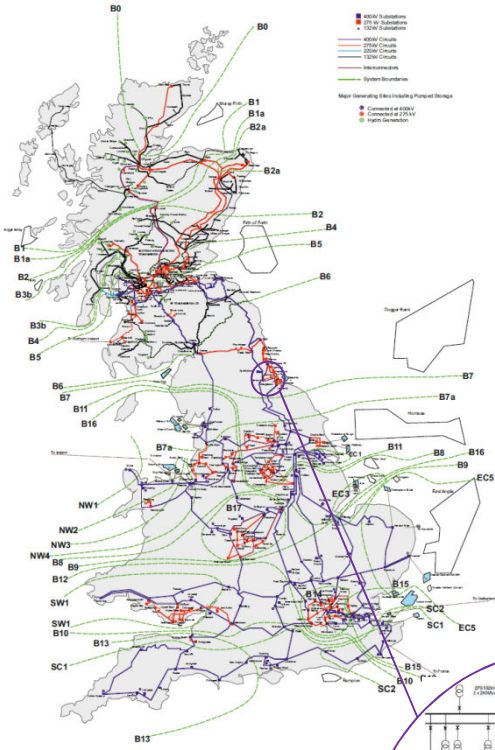
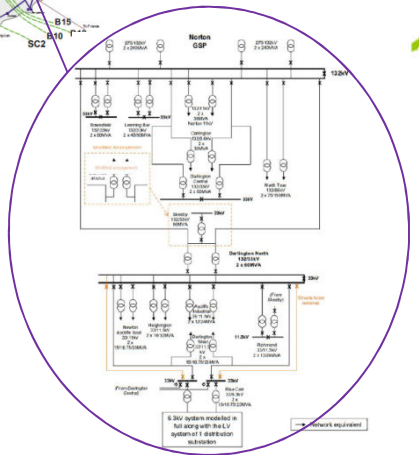
Different spatial scales



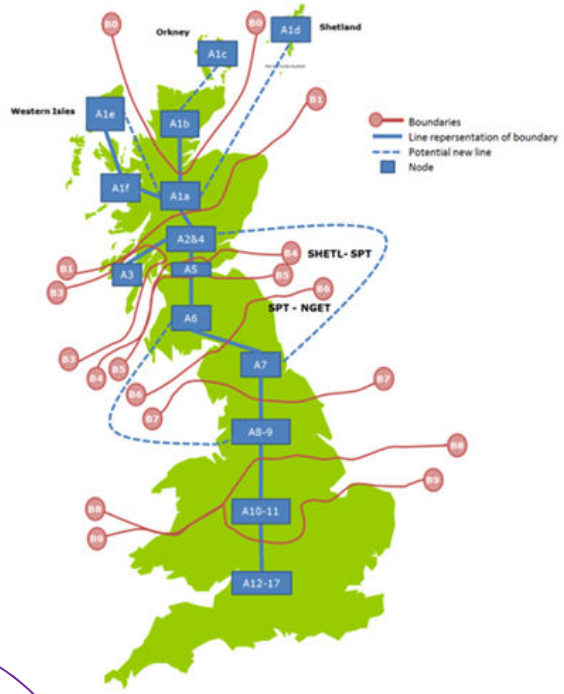
National Grid, ETYS



National Grid, ETYS

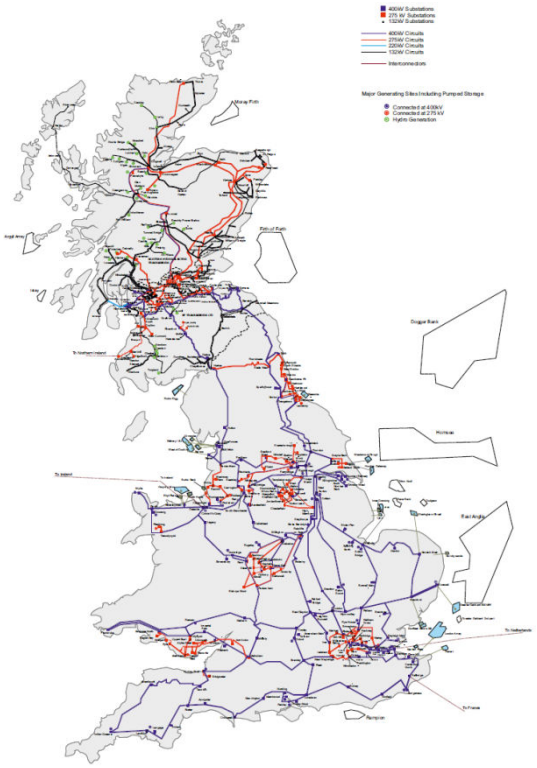


Northern Power Grid / DS2030 project



Scottish Government / SEDM

Different spatial scales



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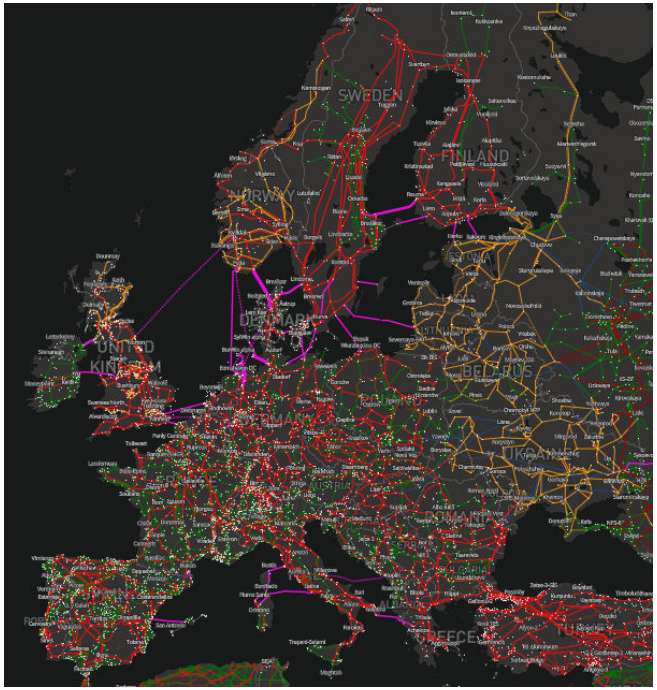
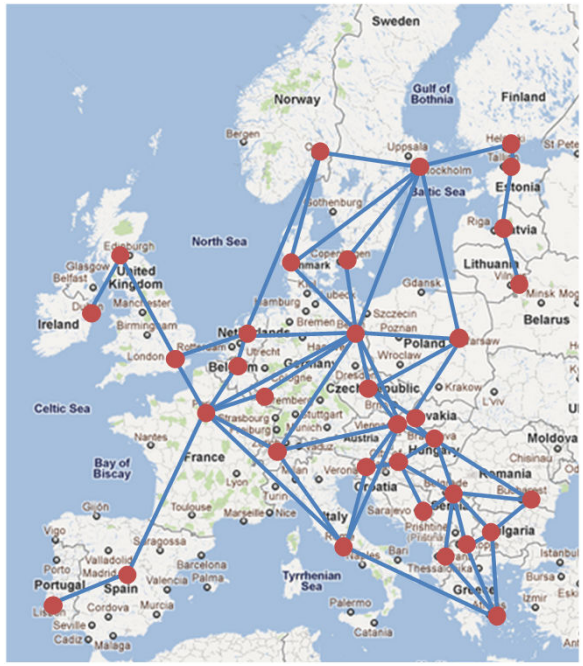


ENTSO-E



TWENTIES project

Modelling questions

- Spatial detail
  - Every node and branch?
- Temporal detail
  - Every hour of a year?
- Behavioural detail
  - Realistic market bids and offers?
  - Realistic energy use patterns?
  - Sensitivities to interactions?
- Modelling of uncertainty
  - What uncertainties do modelling choices bring
    - How epistemic uncertainty can you tolerate?
  - Which things cannot be known with confidence?
    - How to model them? (Aleatory uncertainty)

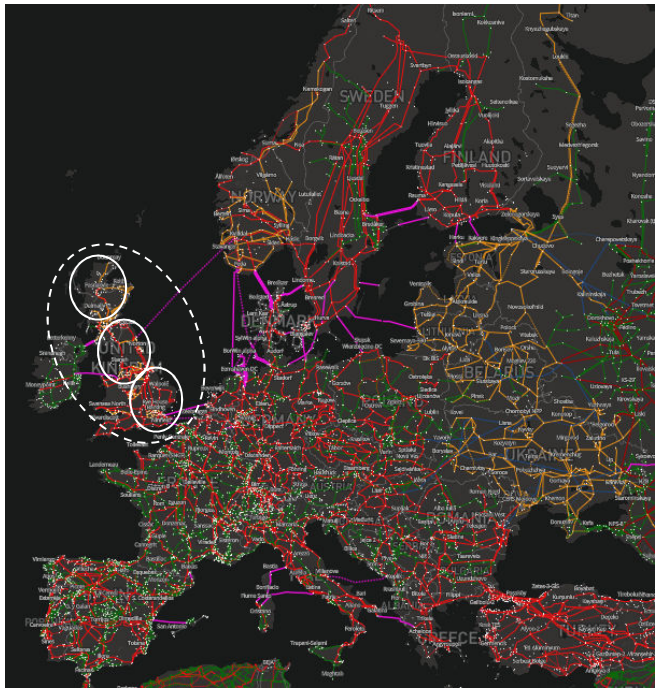


Figure: ENTSO-E

More modelling questions

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- What data do you have?
  - System parameters (things that are fixed)
  - Values of state variables (things that vary)
    - Access to a historic record?
    - Extrapolate from the past, assume the future is like the past, or…?
- What data can you usefully use?
  - How precise do you need to be?
  - How much can you compute?
  - What can you make sense of?
  - With so much uncertainty, is there any point in being precise when you will probably be precisely wrong?

Be careful: small groups are not like big groups

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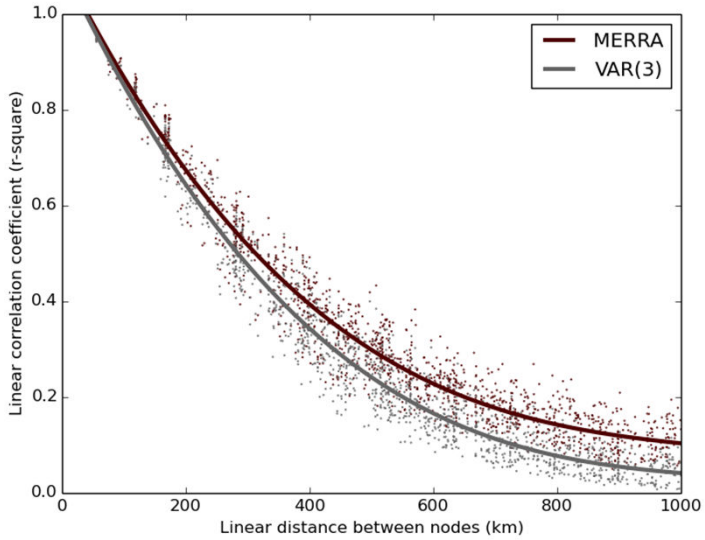
Electricity demand

Excluding heat

Including heat

Wind generation spatial correlations



Figures: Graeme Hawker

Answers to modelling questions

- Model what you can make sense of, e.g.
  - I understand transmission but don't understand distribution
  - I understand electricity but don't understand gas
- Key thing to resolve: what to assume for what is external to your model?
  - At a GB scale: how much power is flowing to or from the rest of Europe?
  - At a transmission scale: what are distributed resources doing?
  - At a distribution scale: is it ok to assume that transmission is an 'infinite bus'?
- Another key thing: what makes a reasonable proxy for actor behaviours?
  - Many models assume that an optimisation is a good proxy

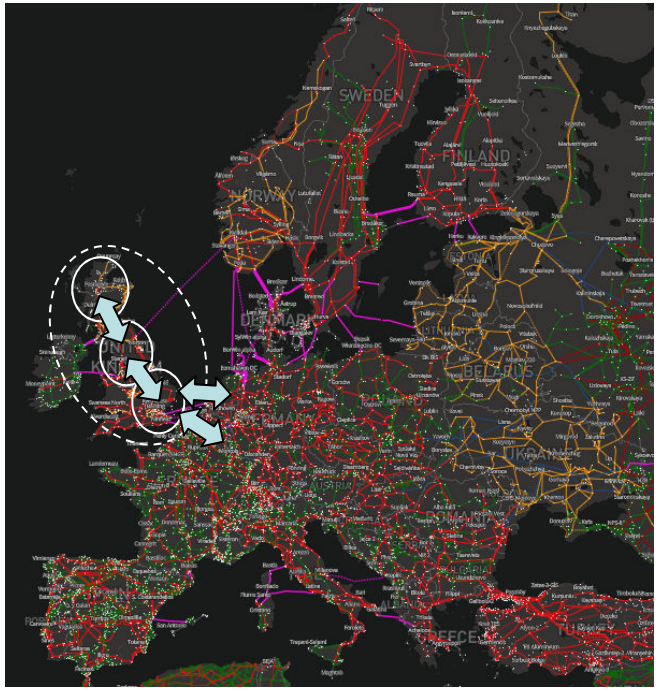


Figure: ENTSO-E

Temporal scale

- Do interactions between time slices matter?
  - If there is two-way storage or time-shifting of demand, yes
  - If rates of change of responses to inputs are restrictive, yes
- If not, which snapshots to use?
  - Annual peak demand?
  - Daily ‘cardinal points’?

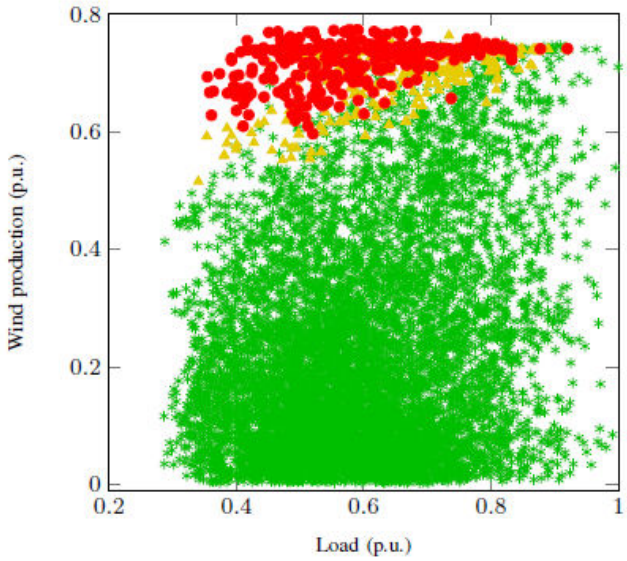
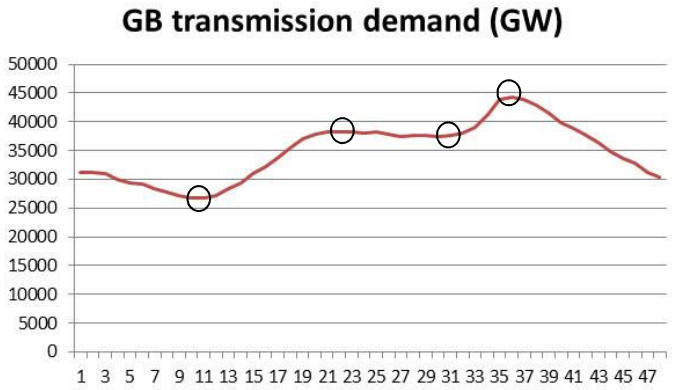


Figure: Waqquas Bukhsh



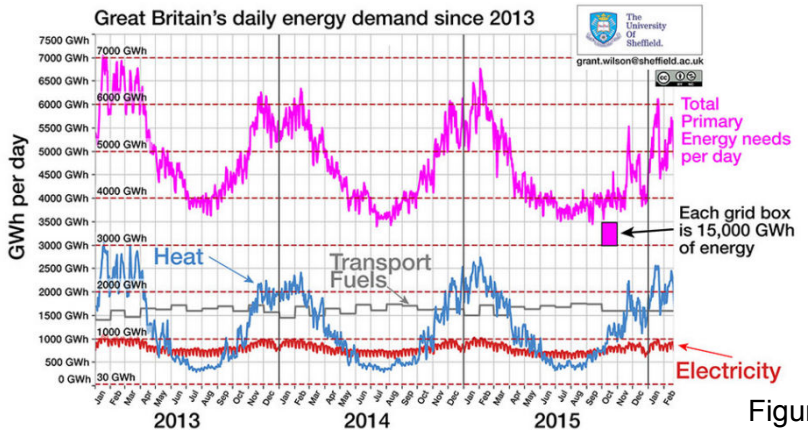
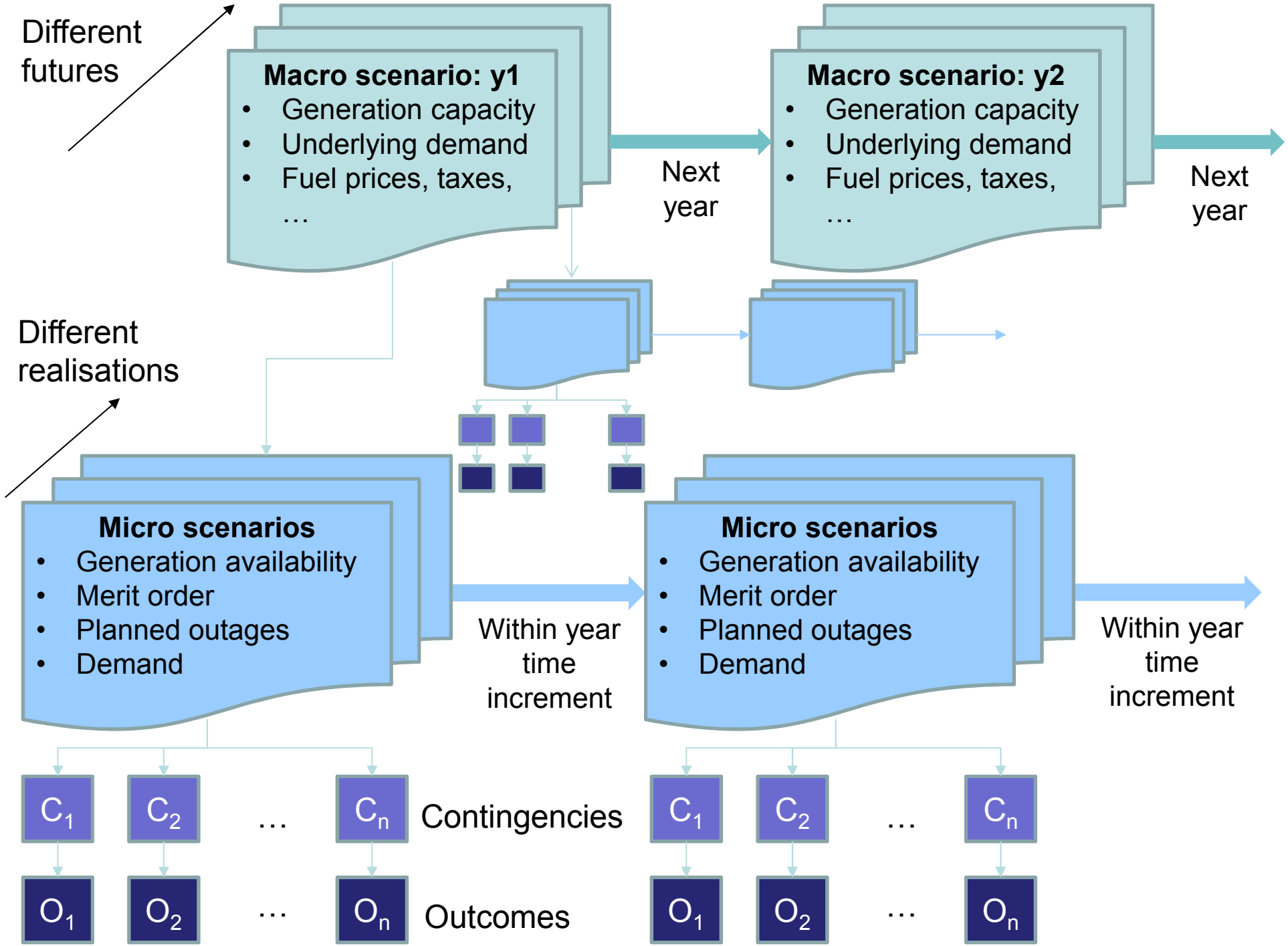


Figure: Grant Wilson

Investment planning

- System development planning identifies those facilities needed to enable the future system to be operated
  - There is generally some trade-off between investment in new facilities and the adverse impacts of lack of facilities, e.g. unreliability of supply or higher cost of energy
- What is the future need, i.e. what futures will be faced?
  - What are the credible ‘macro-scenarios’/backgrounds?
- What things affect operation in those futures?
  - What are the credible ‘micro-scenarios’/operation cases?


Different futures
Macro scenario: y1
• Generation capacity
• Underlying demand
• Fuel prices, taxes, …
Next year
Macro scenario: y2
• Generation capacity
• Underlying demand
• Fuel prices, taxes, …
Next year
Different realisations
Micro scenarios
• Generation availability
• Merit order
• Planned outages
• Demand
Within year time increment
Micro scenarios
• Generation availability
• Merit order
• Planned outages
• Demand
Within year time increment
C1 C2 … Cn Contingencies
C1 C2 … Cn
O1 O2 … On Outcomes
O1 O2 … On

Who has control over the levers?

- In electricity and gas sectors:
  - 'the market' decides on and invests in conversion or import facilities
  - regulated network utilities must
    - provide new connections when asked
    - provide timely, economically justified investment in shared infrastructure

Under the influence of policy makers (to some extent)

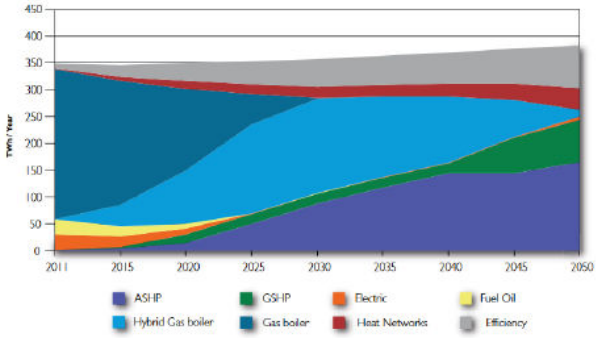
- Major market actors respond to
  - Short term price signals (including willingness to pay)
  - Forecasts of longer-term price signals. (*How long is longer-term?*)
  - (*Who decides how price signals are formed?*)
- Investors in big conversion facilities do consider cross-vector interactions
  - e.g. price of electricity versus price of gas
- What about smaller actors?
  - e.g. what will demand for electricity or gas be in future?
  - What influences are smaller actors sensitive to?
- Where there are no regulations, who provides shared infrastructure?

Modelling at different scales

e.g. work by Graeme Hawker at Strathclyde for UKERC

What assumptions are made about demand for energy services, relative costs of meeting it, and actors' responses to signals?

Aggregated whole system model



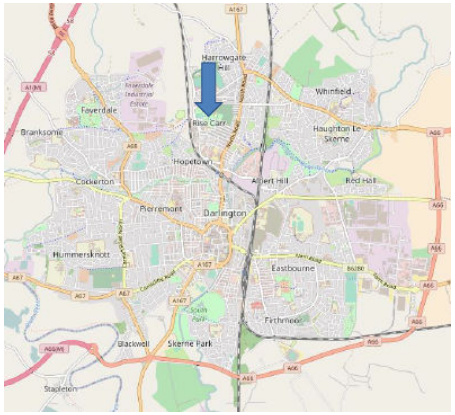
Transition scenarios/ credible futures

- Which energy conversion facilities are actors likely to choose?

downscale

upscale

How will local costs or constraints change transition scenarios or credible futures?



Spatially explicit local model

- Can actors' choices be accommodated locally?
  - At what cost?
- Will development and use be constrained or are choices likely to change?

Break-out discussion

- Why do we need to link models across scales and sectors?
  - What are the relative strengths and weaknesses of whole systems models, local / city models and sectoral models?
- What are the key enablers and barriers to effective model linking across scales (model design, data availability, etc.)?
- What emerging research is being carried out on model linking across scales?
- What represents good practice for model linking across scales?