Model linking across scales

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Multi-scale modelling review

Review criteria:

- Peer reviewed
- Includes hard-linking *and* soft-linking across scales
- Multi-scale analysis of real-world regions
- "Whole system" analysis across multiple supply and-or end-use sectors i.e. not single-sector models

Systematic review (1970-Present), yielded:

- 40 models or multi-model studies that fit all criteria
- 15 studies of interest that do not fit all criteria – (e.g. power sector only; urban energy models which in most cases did not cross scales)

Multi-scale modelling review

Global
(GLO)

Multi-National Region
(MNR)
e.g. European Union

National
(NAT)
e.g. United Kingdom

Sub-National Region
(SNR)
e.g. Scotland

Individual Settlement or
Urban (ISU) area
e.g. Edinburgh

GLO-MNR/NAT

GLO-MNR

MNR-NAT

NAT-SNR

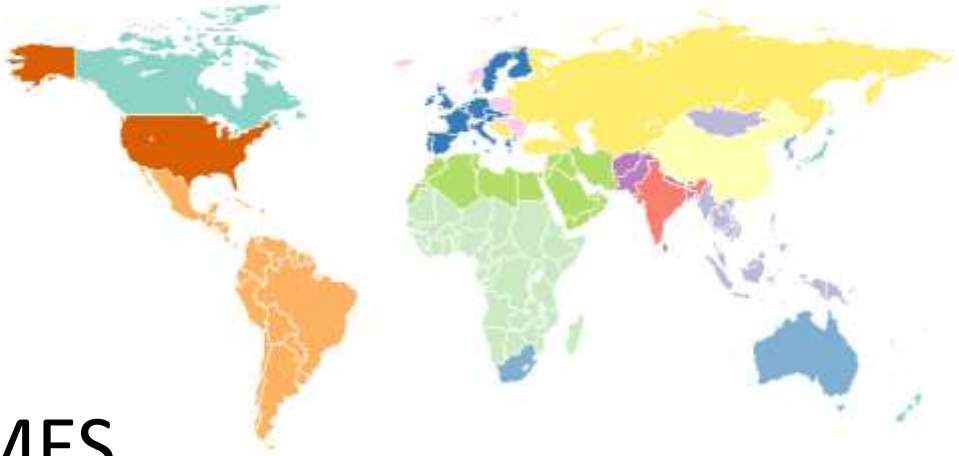
NAT-ISU

Multiple examples

… only a handful of studies

Very few

Examples



- 2-region MARKAL
- US multi-region TIMES
- JRC-EU-TIMES plus NEPLAN

2-Region MARKAL

- Separate-but-linked ‘Scotland’ and ‘Rest of the UK’ Regions
- Analysis of Scottish targets
- Was developed wholly at UCL – not commissioned by government
- Was presented to Scottish government – but not widely used

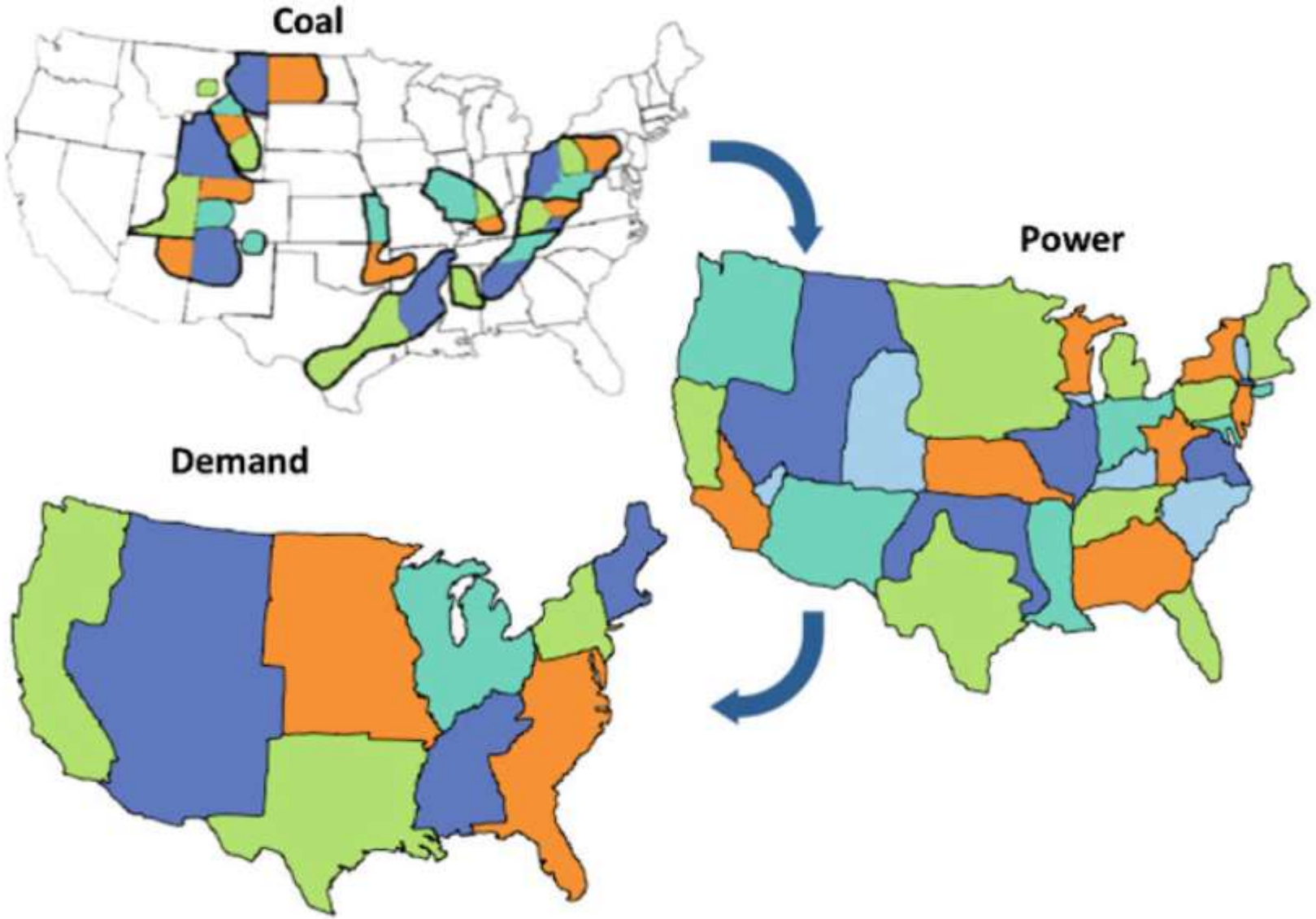
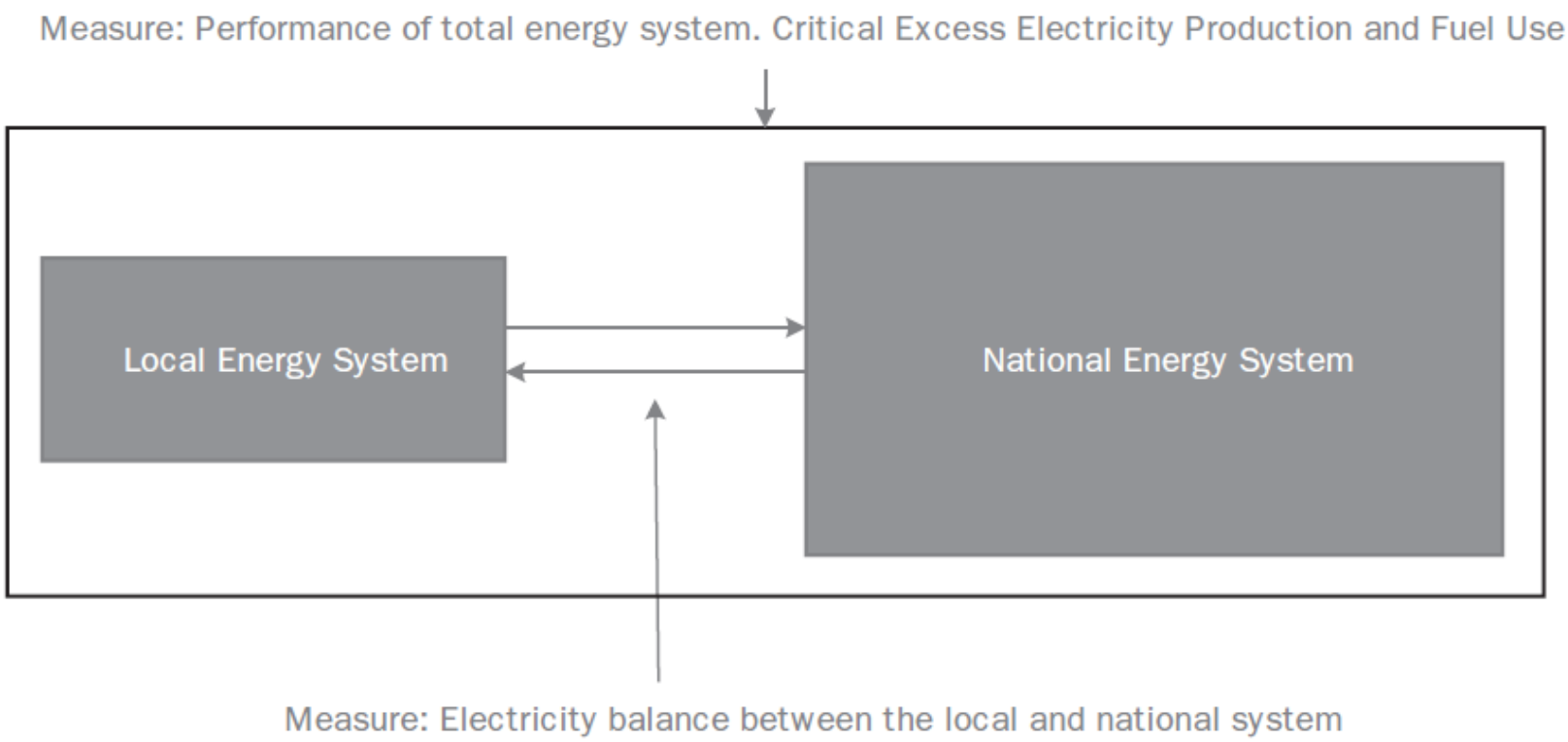


Fig. 1 FACETS coal, power, and demand regions

Nijs et al. 2015 – linking JRC European TIMES with NEPLAN

Fig. 4 Simplified model of European grid at the base year of study

Linking national to urban



Thellufsen & Lund 2016

Rationales & Challenges

Capturing more information & feedback in your model (="better model"?)

- Capturing finer scales: better representing spatially-granular processes (power systems; transport infrastructure)
- Broadening to wider scales: Embedding analysis within consistent boundary conditions: global learning; prices
- Disaggregating/aggregating to match politically-relevant boundaries
  - Capture policy divergence across regions (e.g. EU PRIMES)

Challenges: Not necessarily more helpful for decision-makers at other scales; harder to interpret

Rationales & Challenges

Multi-scale models for shared understanding across scales

- Analysis that simultaneously serves needs of decision-makers across scales? Consistent, integrated perspective
- (Dis)aggregation to relevant decision-scales
- But major challenges:
  - Different relevant decision-rules (perfect-foresight optimisation vs. predictive simulation)
  - Different goals – decentralised optima, c.f WITCH model?
  - Legitimacy and ownership

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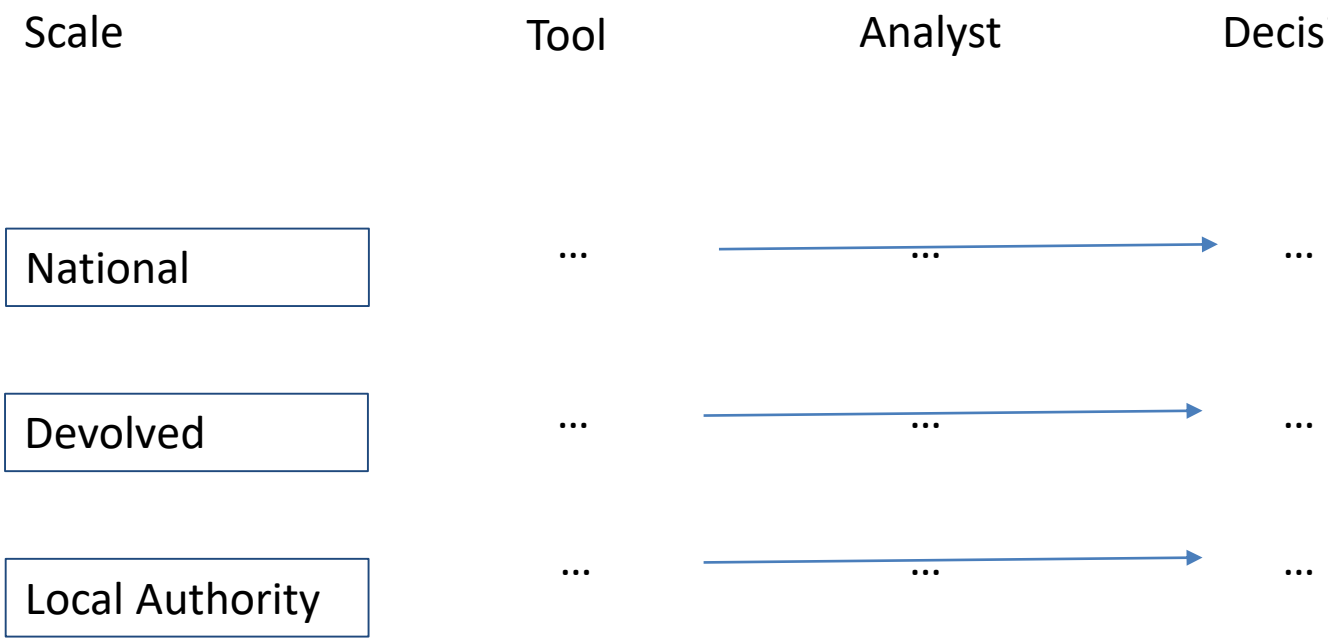
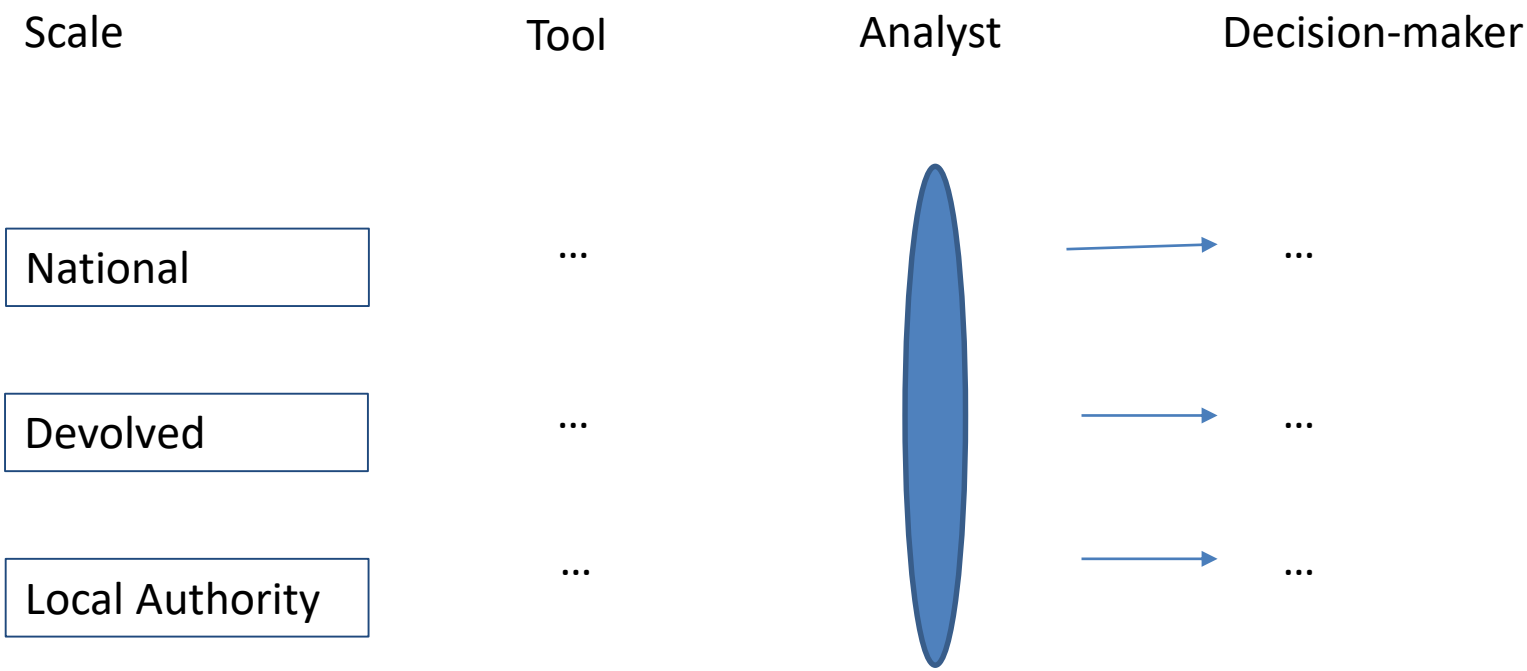
How does national modelling influence local?

- Use of MARKAL-derived tech data
- Input data derived from scenarios: marginal/average carbon intensity of electricity; cost of carbon
- Context: ambition, tech options,
  - E.g. Greater Manchester: 2050 power mix and sector emissions – from PRIMES, MARKAL, ESME

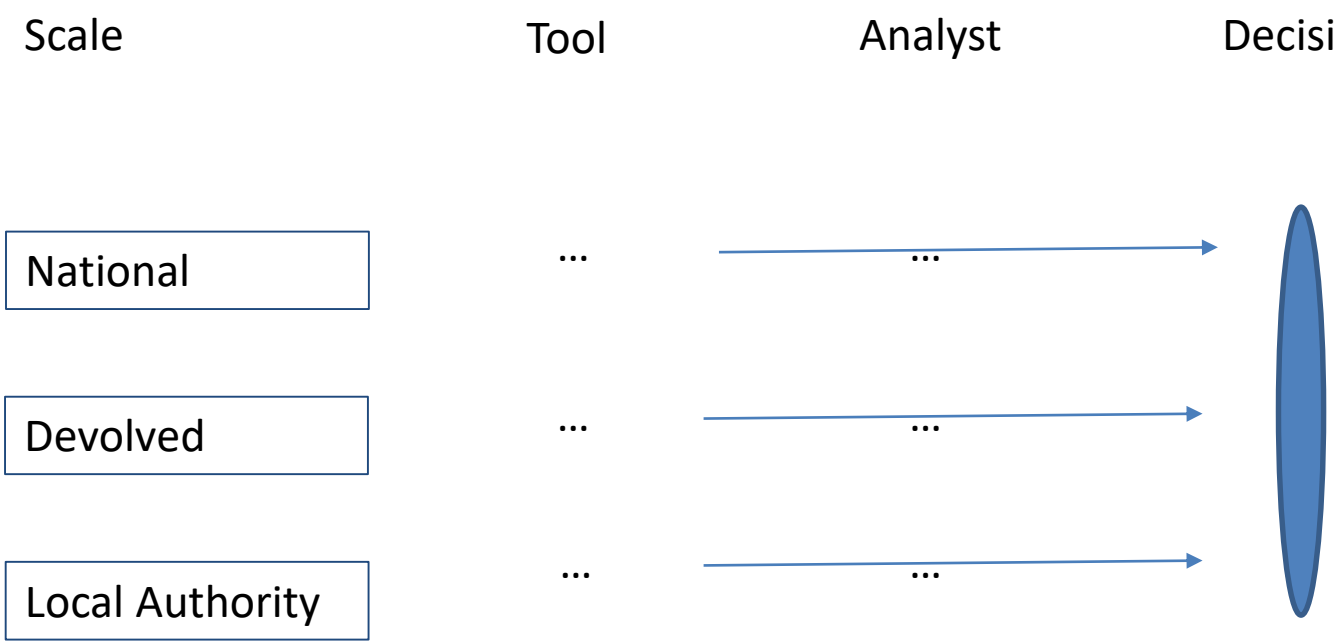
Fragmented: little cross-scale integration



Analyst Integrates



Governance process integrates



Tool integrates