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Decision making under uncertainty in the energy sector

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Multi Actor Adaptive Decision Making

My main argument

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- Energy transitions are subject to a range of uncertainties
- We are getting better at characterising and managing that uncertainty
- We are not good at accommodating uncertainty in decision making
- We need to focus on the processes that support decision making, as well as the models
- The tools that are currently available to support decision making do not reflect the decision environment well
- We need to get better at representing the bounded rationality of decision makers and the complex environment in which they make decisions

Where are we going?

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- What do I mean by uncertainty?
- Uncertainty in energy system modelling
- Using models in decision making
- Approaches to decision making under uncertainty
- The realities of decision making
- How to reflect the realities of decision making in decision support
- Why is local an important scale to focus on?

What do I mean by uncertainty?

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Risk	Knowledge where both the factors of risk and the likelihood of those factor occurring can easily be identified and quantified (Knight 1921)
Endemic uncertainty	*Insufficiency* of models, *necessities* to set boundaries thus exogenising and making invisible certain possibilities, *inaccuracy* of measurements, and other issues that systemically generate *ignorance* as a function of constructing knowledge (Butler et al 2015)
Irreducible uncertainty	Arising from system complexity, where defining cause and effect is impossible and outcomes emerge from the behaviour and interaction of a range of intermediate actors (Wynne 1992)

Uncertainty in models

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Energy Research & Social Science 46 (2018) 332–344

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Assessing qualitative and quantitative dimensions of uncertainty in energy modelling for policy support in the United Kingdom

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Energy Policy 41 (2012) 433–444

Contents lists available at SciVerse ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Critical mid-term uncertainties in long-term decarbonisation pathways

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ARTICLE INFO

Article history:
Received 27 July 2011
Accepted 3 November 2011
Available online 22 November 2011

Keywords:
Energy system modelling
Uncertainty
Stochastic programming

ABSTRACT

Over the next decade, large energy investments are required in the UK to meet growing energy service demands and legally binding emission targets under a pioneering policy agenda. These are necessary despite deep mid-term (2025–2030) uncertainties over which national policy makers have little control. We investigate the effect of two critical mid-term uncertainties on optimal near-term investment decisions using a two-stage stochastic energy system model.

The results show that where future fossil fuel prices are uncertain: (i) the near term hedging strategy to 2030 differs from any one deterministic fuel price scenario and is structurally dissimilar to a simple 'average' of the deterministic scenarios, and (ii) multiple recourse strategies from 2030 are perturbed by path dependencies caused by hedging investments. Evaluating the uncertainty under a decarbonisation agenda shows that fossil fuel price uncertainty is very expensive at around £20 billion. The addition of novel mitigation options reduces the value of fossil fuel price uncertainty to £11 billion. Uncertain biomass import availability shows a much lower value of uncertainty at £300 million.

This paper reveals the complex relationship between the flexibility of the energy system and mitigating the costs of uncertainty due to the path-dependencies caused by the long-life times of both infrastructures and generation technologies.

Energy Strategy Reviews 21 (2018) 204–217

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: www.elsevier.com/locate/esr

A review of approaches to uncertainty assessment in energy system optimization models

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Energy Research & Social Science 37 (2018) 122–132

Contents lists available at ScienceDirect

Energy Research & Social Science

journal homepage: www.elsevier.com/locate/erss

Original research article

Uncertainty, politics, and technology: Expert perceptions on energy transitions in the United Kingdom

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ARTICLE INFO

Keywords:
Climate policy
Energy policy
Uncertainty analysis
Decision-making

ABSTRACT

Energy policy is beset by deep uncertainties, owing to the scale of future transitions, the long-term timescales for action, and numerous stakeholders. This paper provides insights from semi-structured interviews with 31 UK experts from government, industry, academia, and civil society. Participants were asked for their views on the major uncertainties surrounding the ability of the UK to meet its 2050 climate targets. The research reveals a range of views on the most critical uncertainties, how they can be mitigated, and how the research community can develop approaches to better support strategic decision-making. The study finds that the socio-political dimensions of uncertainty are discussed by experts almost as frequently as technological ones, but that there exist divergent perspectives on the role of government in the transition and whether or not there is a requirement for increased societal engagement. Finally, the study finds that decision-makers require a new approach to uncertainty assessment that overcomes analytical limits to existing practice, is more flexible and adaptable, and which better integrates qualitative narratives with quantitative analysis. Policy design must escape from 'caged' thinking concerning what can or cannot be included in models, and therefore what types of uncertainties can or cannot be explored.

Linking models and decision making

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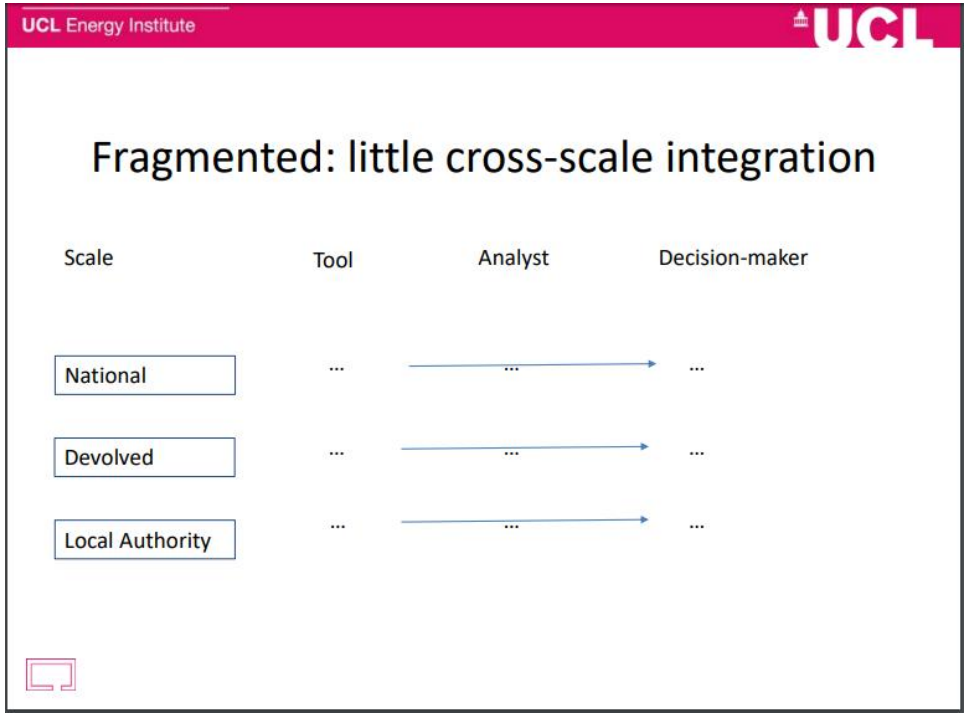

https://www.birmingham.ac.uk/research/activity/energy/research/other-research/ascend/across-scales-in-energy-decision-making-ascend.aspx

Decisions under uncertainty [in energy] are hard

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Because of complexity – uncertainty in speed and scale of change, long-timelines, multiple and interacting uncertainties, numerous stakeholders

Because of high stakes – high investment needs, urgency of change

Because of individuals – bounded rationality – we prioritise certain types of information and draw on emotions, values, gut feelings to make decisions quickly

And because of processes – drive preference for a fixed best answer, preferably with a number attached e.g. cost/benefit ratio, rate of return on investment

Decision making under uncertainty

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"the study finds that decision-makers require a new approach to uncertainty assessment that overcomes analytical limits to existing practice, is more flexible and adaptable, and which better integrates qualitative narratives with quantitative analysis" (Li and Pye 2018)

Approaches to decision making under uncertainty

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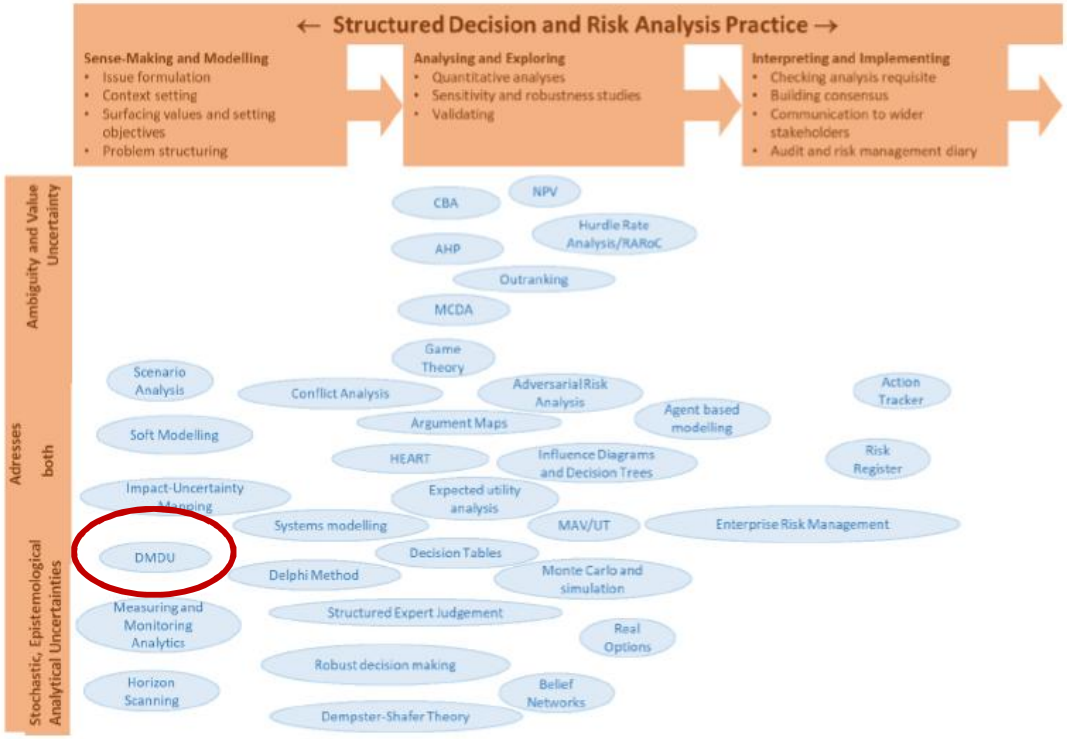
Approaches from operational research:



Source: Analysis under Uncertainty for Decision-Makers Network
Decision Support Tools for Complex Decisions under Uncertainty
Edited by Simon French from contributions from many in the AU4DM network

Approaches to decision making under uncertainty

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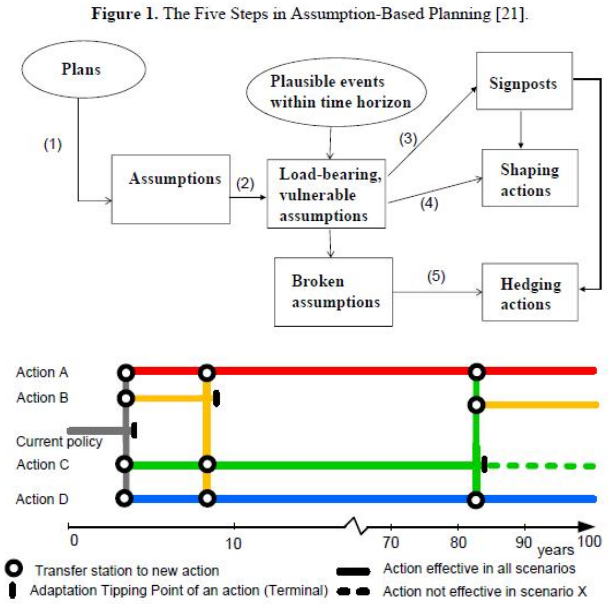
Long-term planning under deep uncertainty (DMDU):

- Assumption-based planning
- Robust Decision Making
- Adaptive policy making
- Adaptation pathways
- Dynamic adaptive policy pathways



More detail in: Walker et al (2013) Adapt or Perish: A Review of Planning Approaches for Adaptation under Deep Uncertainty

Adaptive decision making

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A group of decision support approaches that:

- Explore how to express uncertainties and options in a different way – how do we respond to uncertainties, not ignore or eliminate them?
- Enable foresight about future options– which options do we open up or close down by actions in the short term?
- Build flexibility into decision making – how easily can we move to alternative pathways?

Adaptive decision making

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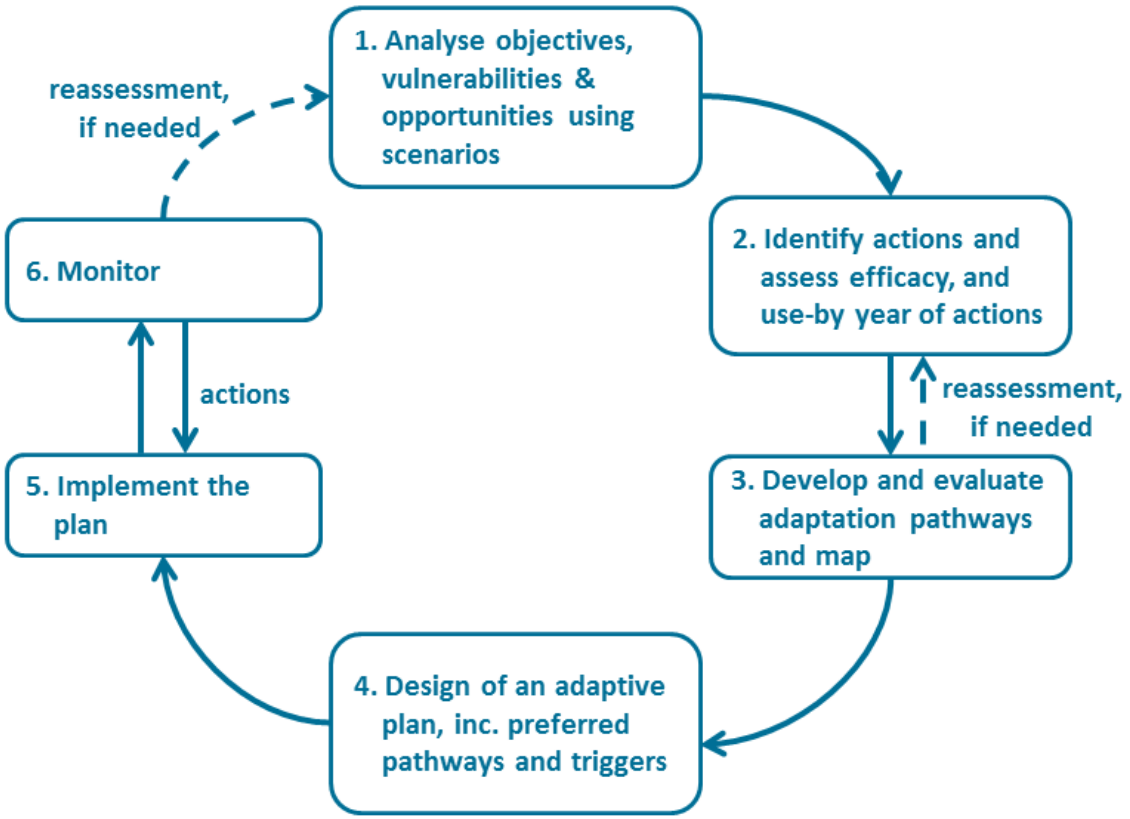

Dynamic adaptive policy pathways (Haasnoot et al 2013)
Source of figure: https://www.deltares.nl/en/adaptive-pathways/

Adaptive decision making

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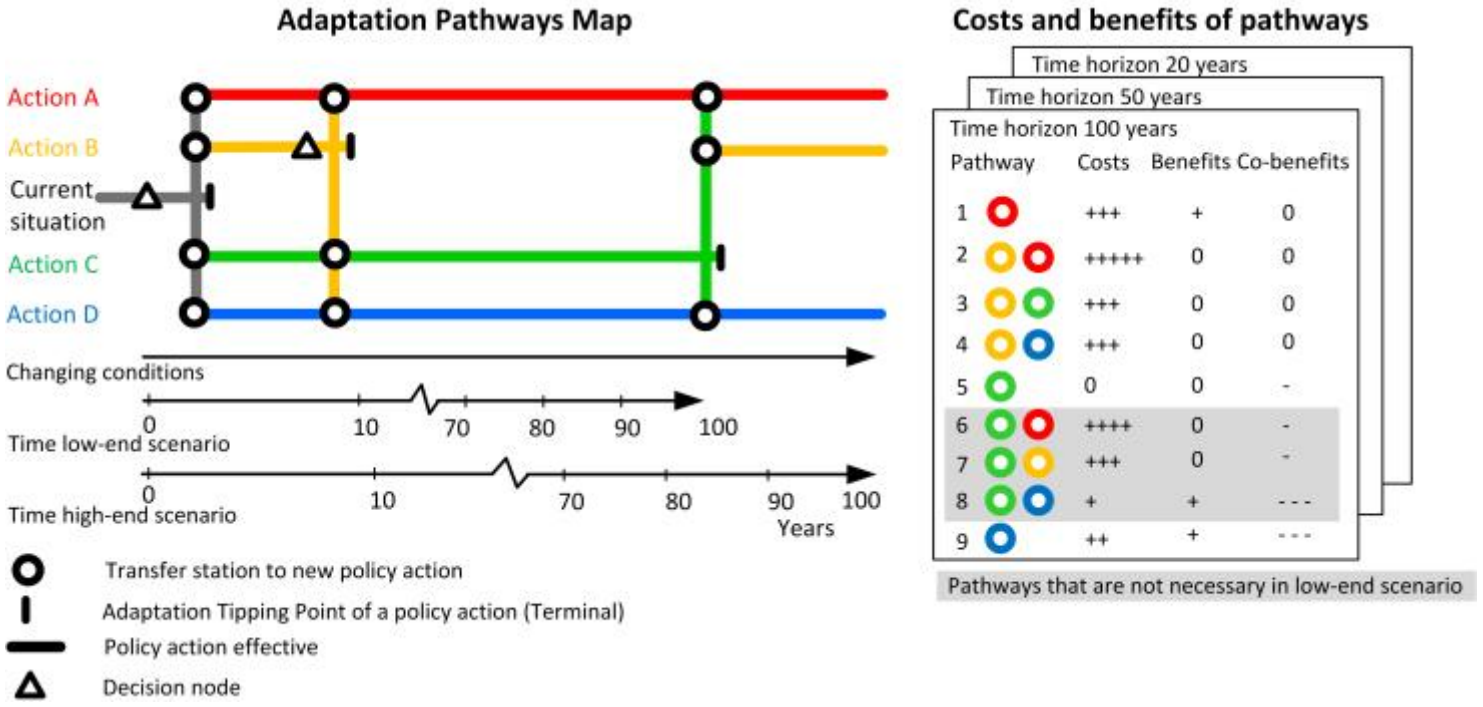

Source: https://www.deltares.nl/en/adaptive-pathways/

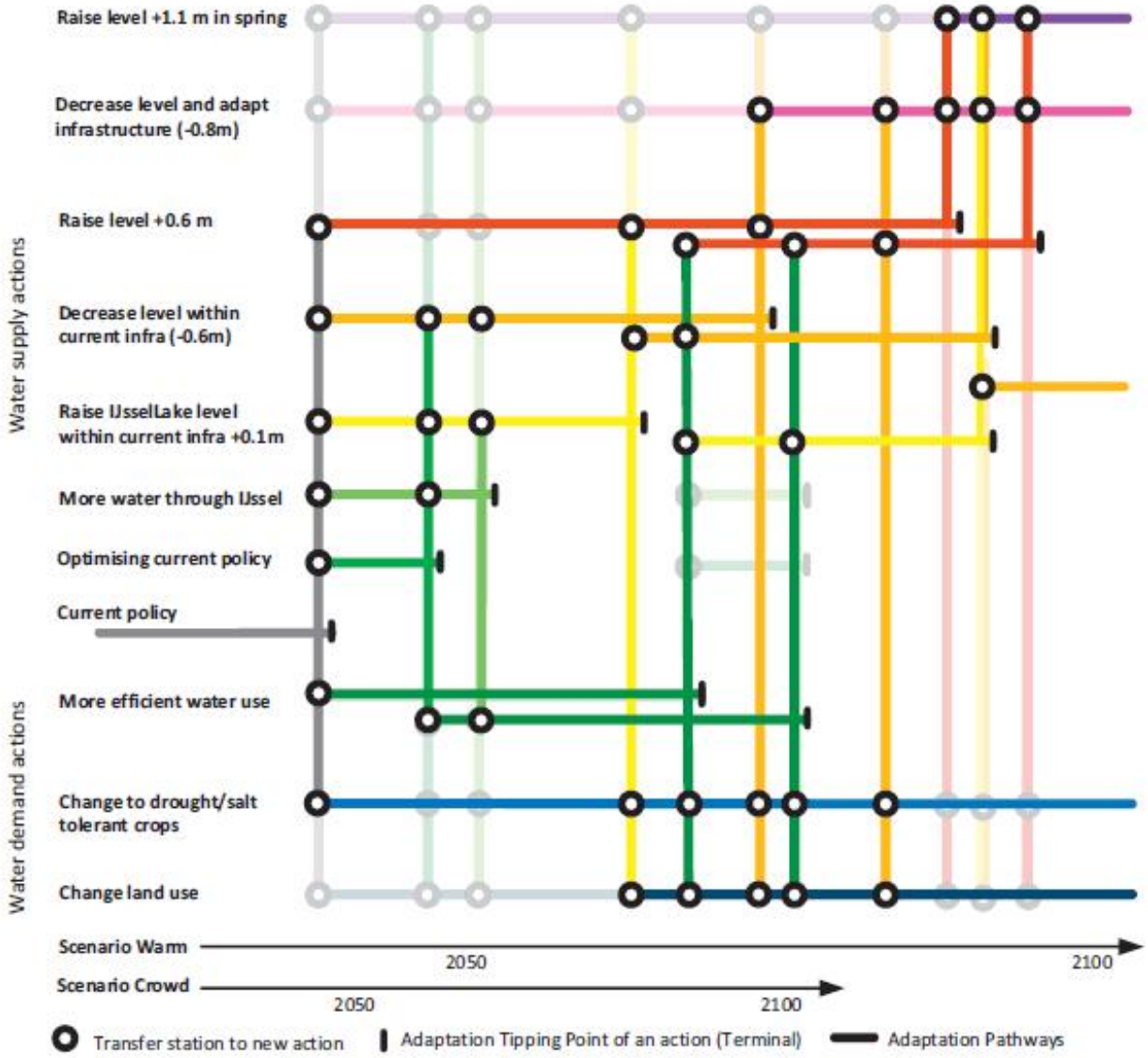

Fig. 6. Adaptation pathways map for fresh water supply from the IJsselmeer area.

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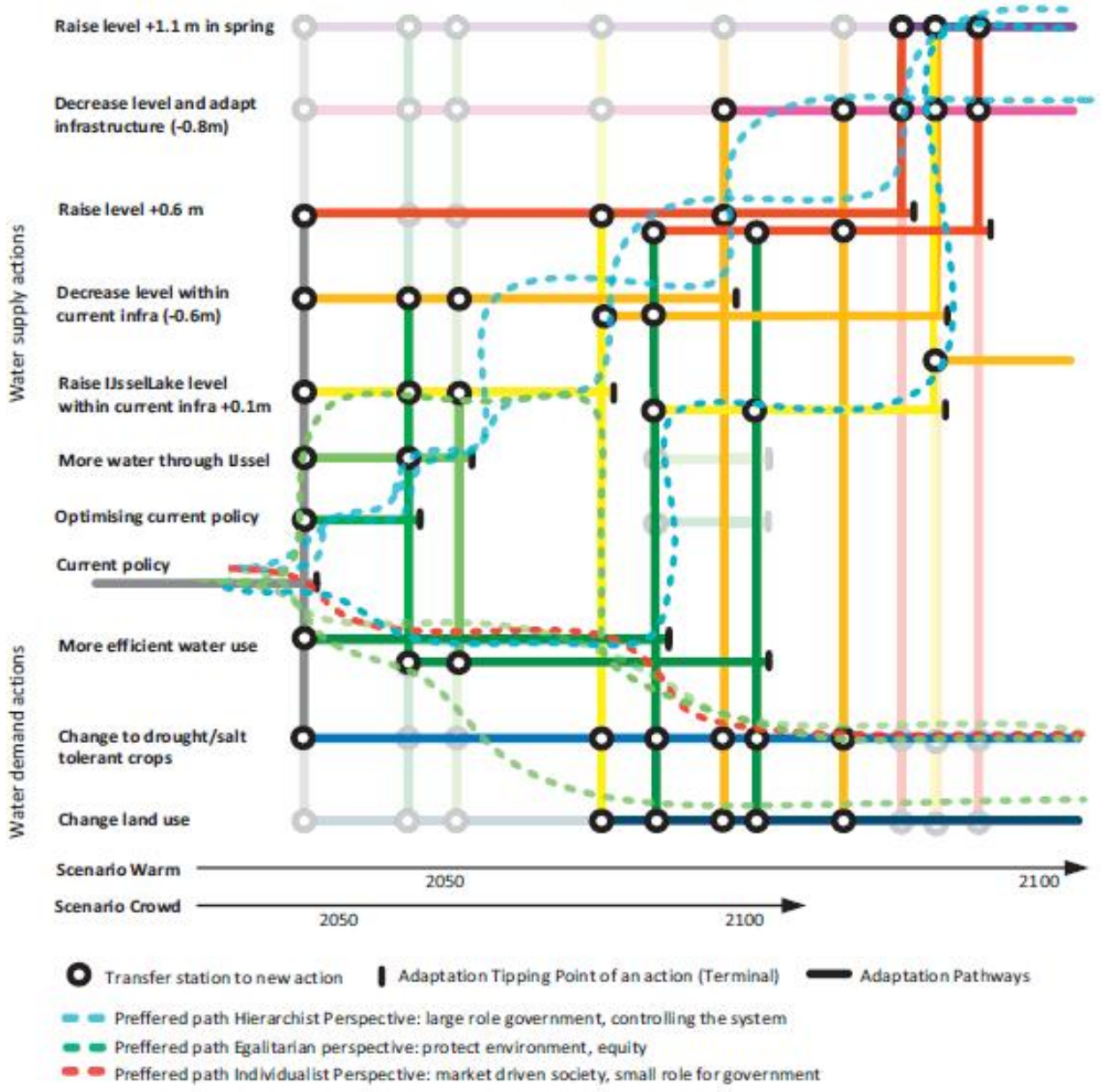
Source: Haasnoot et al (2013)



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Source: Haasnoot et al (2013)

The realities of decision making

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- Multiple actors
- Multiple plans/ objectives
- Processes and context driving decisions
- Different types of decisions
- Decisions at different scales
- Public perceptions

https://paulcairney.wordpress.com/2018/10/25/evidence-based-policymaking-and-the-new-policy-sciences-2/

What am I doing about this?

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Case studies

- Transport
- Energy system

Local Infrastructure Commission (https://maadm.leeds.ac.uk/local-infrastructure-commission/)

Public engagement

Multiple actors

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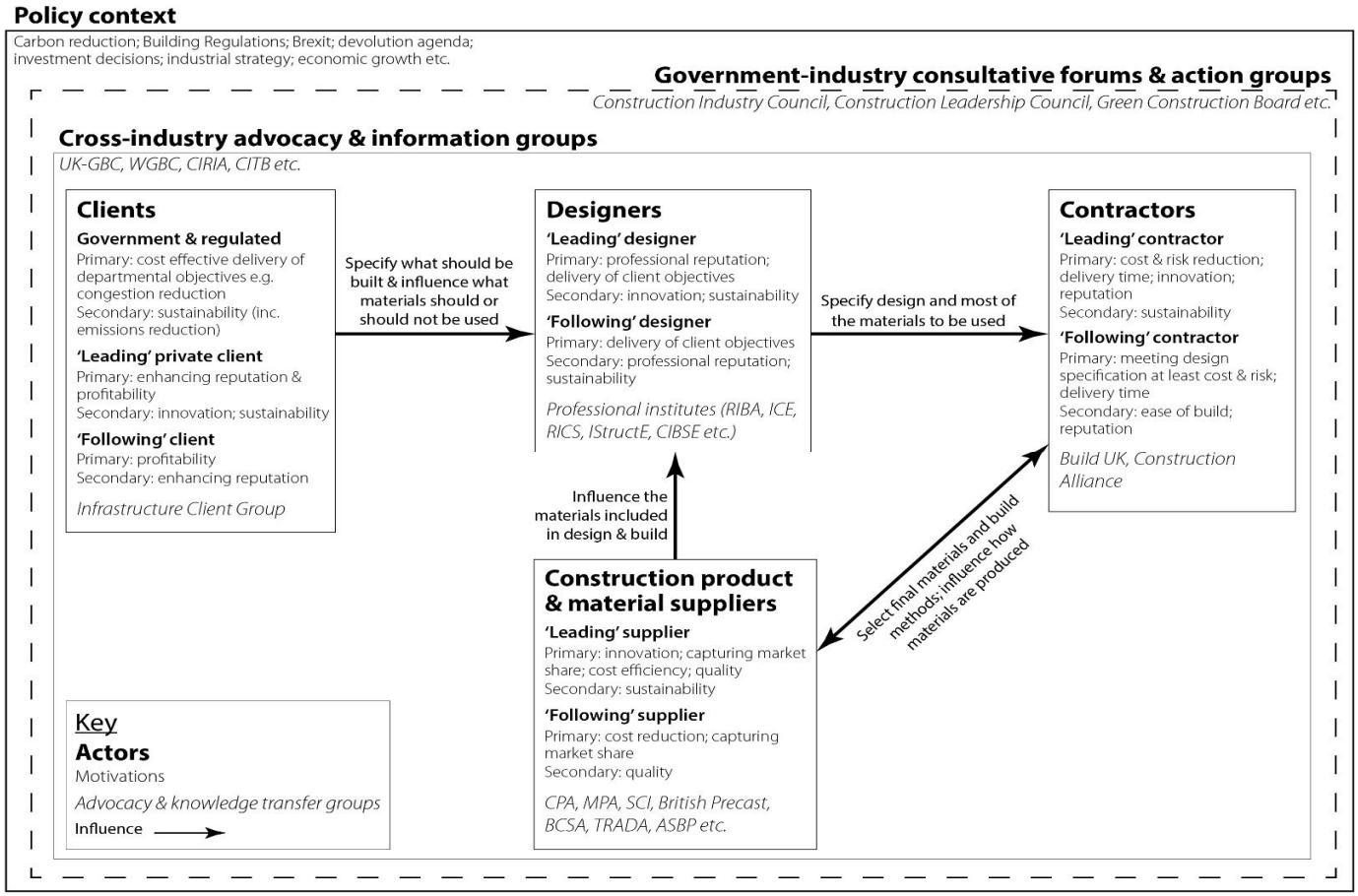
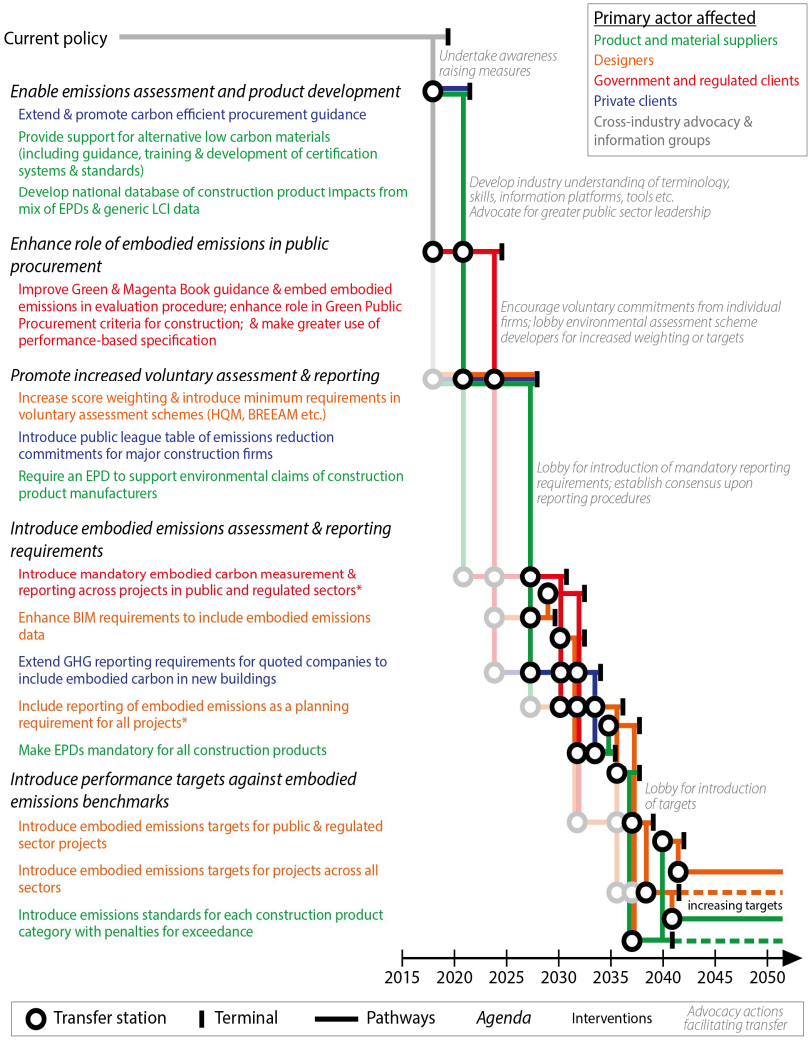


Multiple actors

Roelich and Giesekam (2019)



* All data to be uploaded to common repository to facilitate benchmarking (likely facilitated by organisation such as RICS)

Note: numerous other measures were considered such as the development of a material re-use database & platform; the introduction of material passports; requirements to design for deconstruction; requirements to design for adaptability; and the mandatory labelling of re-usable construction products but these options have been omitted from this figure. Although such measures may deliver emissions savings over multiple product uses, these savings will be delivered over a timeframe that extends beyond this analysis.

Multiple objectives/plans

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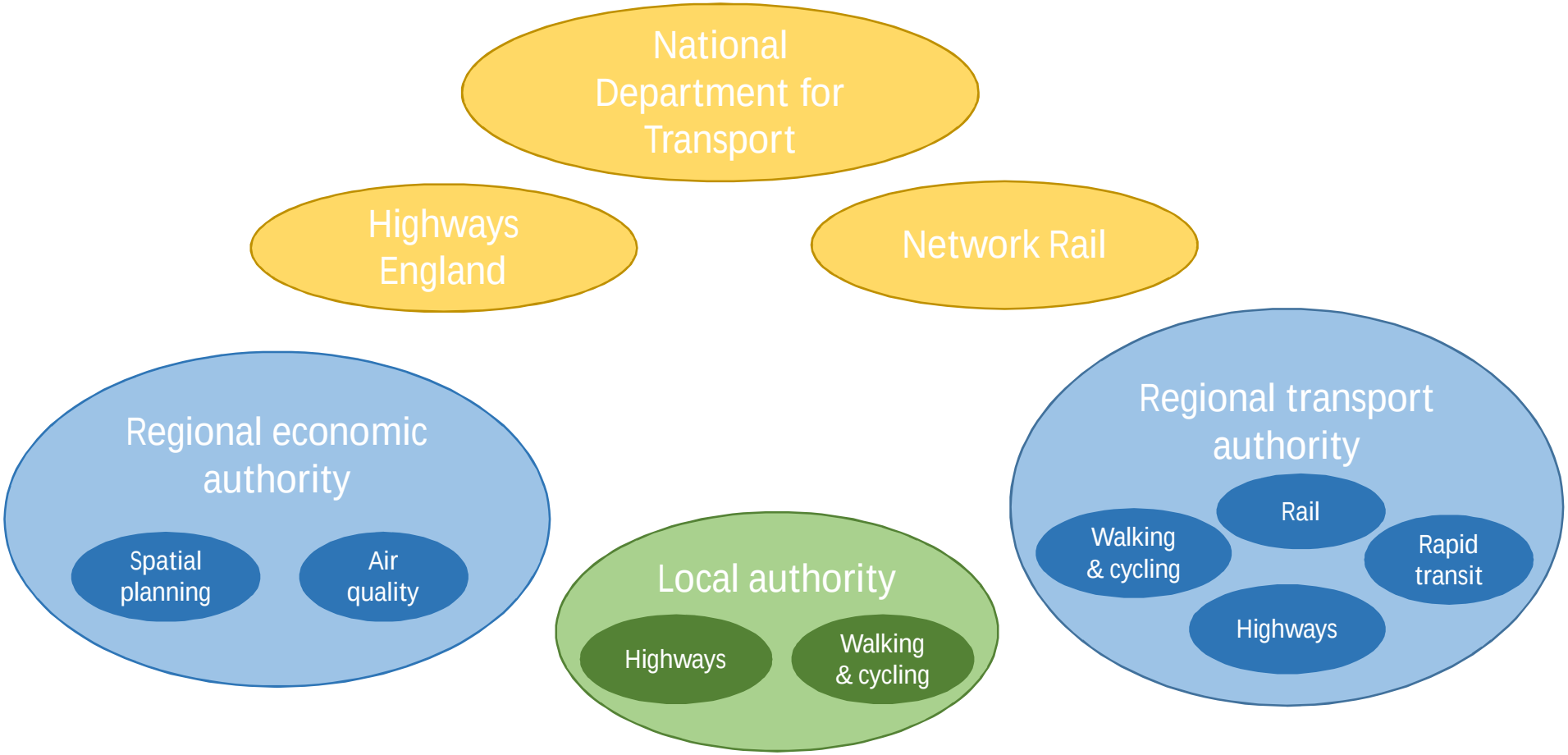

Multiple objectives/plans

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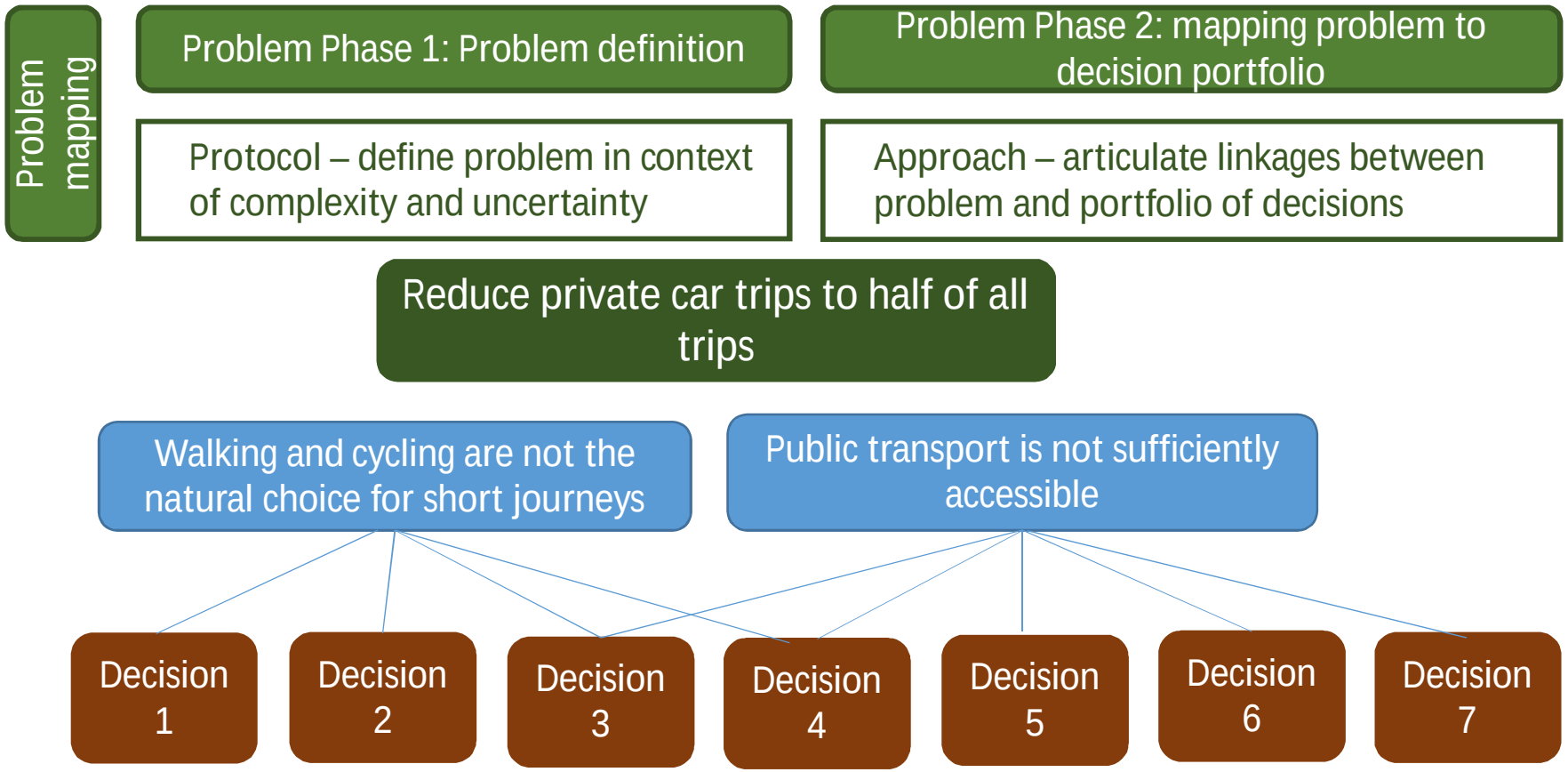

Not all decisions are equal

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A decision about whether to invest in a long-lived asset that might create conditions for systemic change in the future

Or

A decision about a short-lived asset that might create change now

Or

A decision about whether to set a target to encourage others to invest

Not all decisions are equal

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Decision Support

Decision Phase 1: Decision screening

Decision tree – identify decisions in need of adaptive approach and 'type' of decision
- Institutional/investment/innovation?

- Reversibility
- Extent of control
- Type of uncertainty (level or issue?)
- Impact on vision/sensitivity of vision/impact on whole system
- Scale of investment
- Availability of data
- Exposure to political/legal challenge
- Interaction with other targets or problems
- Urgency

Decision Phase 2: decision support identification

Toolkit – map 'type' of decision onto appropriate tool/approach/model with examples of how these tools/ approaches/models have been used

- Adaptive planning
- Robust DM
- Real options
- Multi-Criteria Decision Making
- Decision trees
- .....

The importance of context

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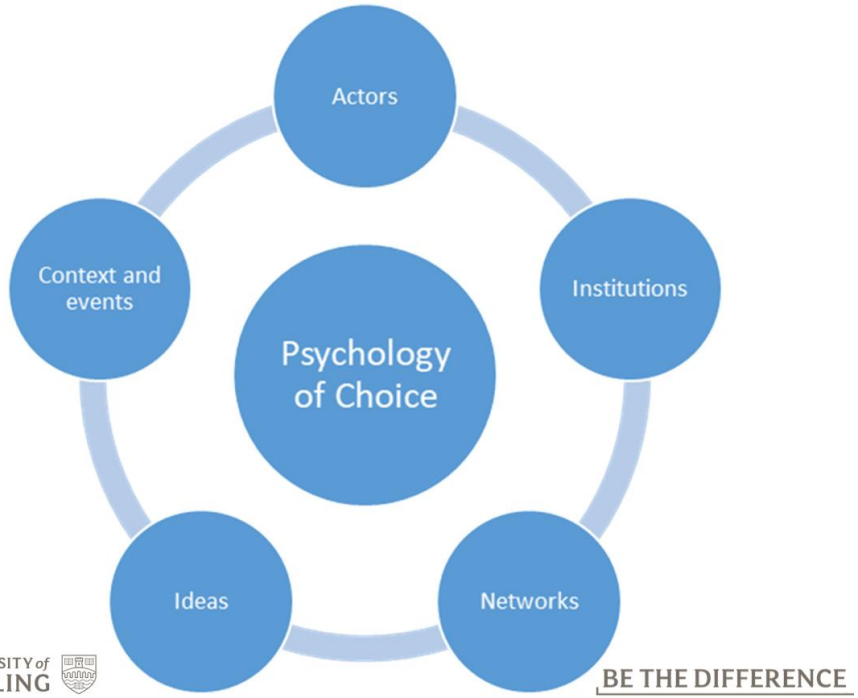

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The importance of context

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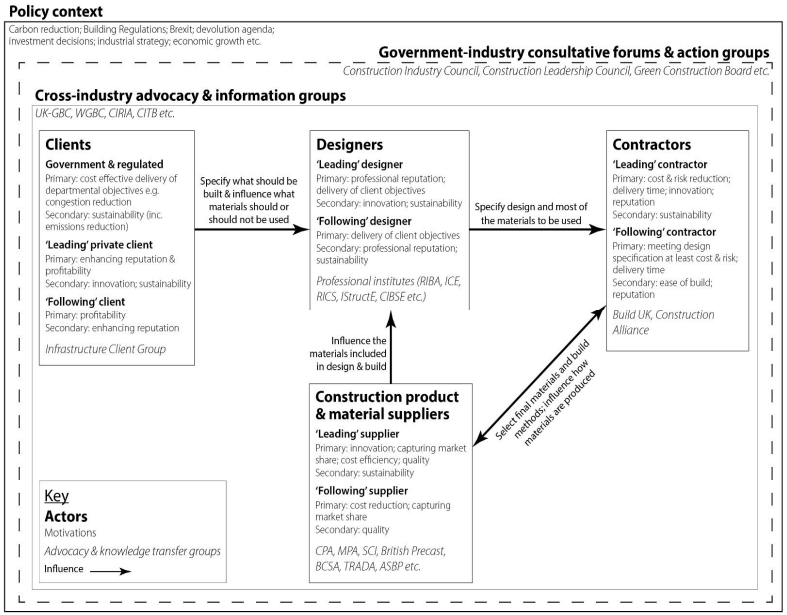
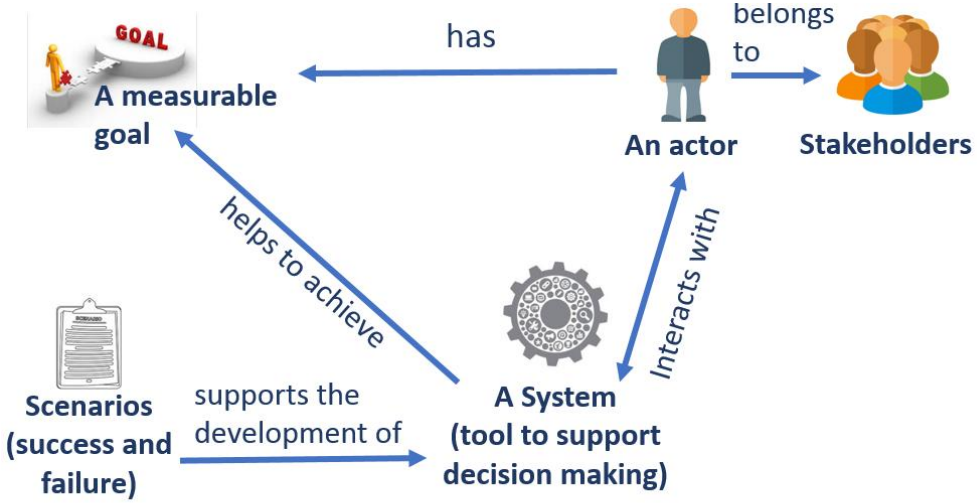
- Stakeholder mapping



- Use cases[1]

A "use case" comprises actor(s), a system, a goal and a scenario.



[1] Approach introduced by Dr Thomas Downing, GCAP (adapted from IT)

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At the local scale:

- The relationship between infrastructure and quality of life is more apparent
- The relationship between national policy and local decisions is crucial
- The evaluation of outcomes is generally poor
- Systemic change needs to happen (compared to siloed decision making)
- The public has (and should have) more of a direct say in decisions

The influence of scale – local decision making

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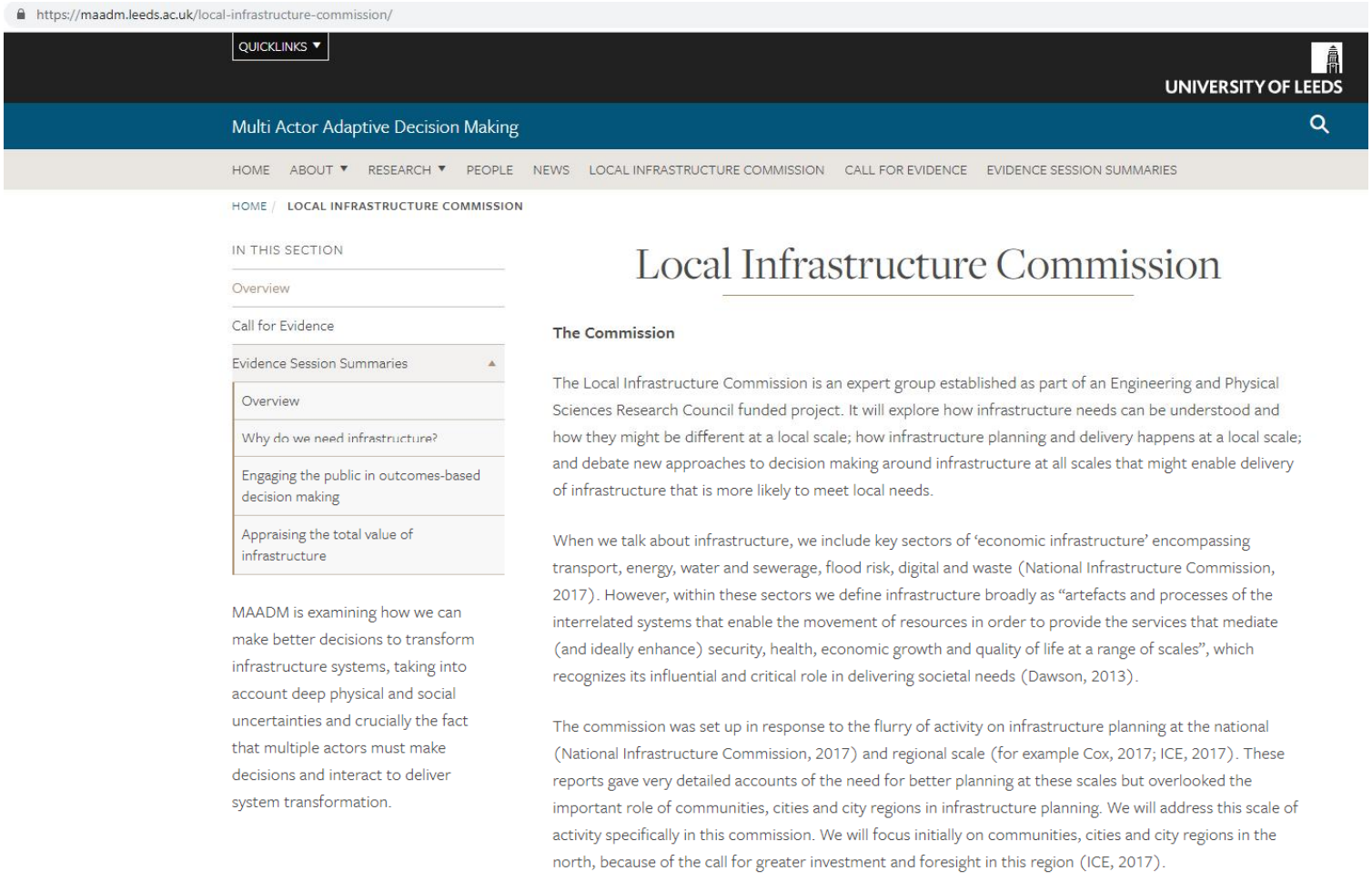

The influence of the public

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- The public is affected by decisions made under uncertainty
- We are quite bad at engaging the public on complex issues
- We quite often engage them once we've decided what the answer is
- This can lead to resistance and slow project but also has implications for the quality of the answer and the wellbeing of the public

The influence of the public

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- Solutions need to align with values that underpin public perceptions

Efficient not wasteful

Environment and nature

Security and Stability

Autonomy and power

Process and change

Social justice and fairness

Reaching the public

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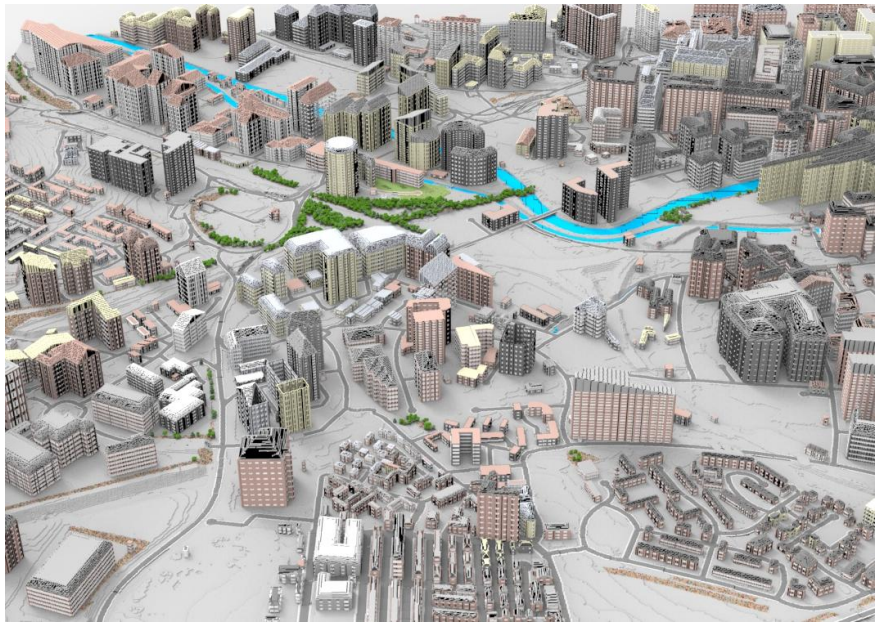
Digital tools for engagement can help to:

- Facilitate visualisation
- Foster collaboration and reduce disagreement
- Provide a platform for multi-stakeholder engagement
- Engage some hard to reach groups



The importance of understanding decisions as well as uncertainty

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- We are making great process in characterising and managing uncertainty
- But there needs to be more focus on accommodating uncertainty in decision making
- To do this we need to understand the realities of decision making and develop tools and approaches appropriate to that context
- This also means thinking about the different scales of decisions
- And how to engage the public in decisions

Get in touch

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