Adaptive regulation and adaptive planning: Issues for economic regulation in water and energy

September 2021

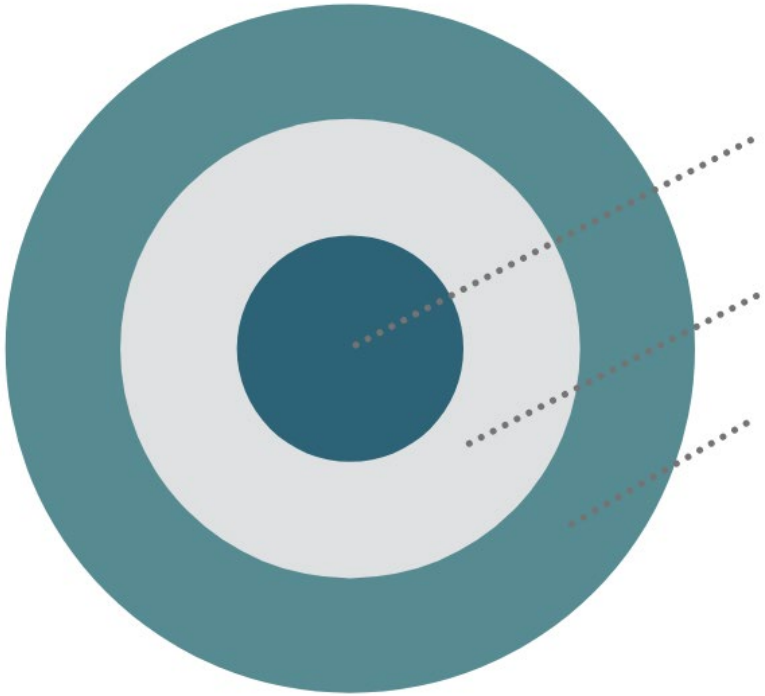
Sustainability *first*

About

Sustainability First

We are a think-tank and charity that works in essential services to promote practical solutions to improve environmental, social and economic well-being. We seek to bring about social and cultural change for a more sustainable future.

Our aims



Shape agendas - bring stakeholders together to drive strategic thinking on key topics

Embed sustainability - push thinking in new directions through informed engagement

Connect, inspire, engage - use creative, collaborative and inclusive approaches to engage broader groups in society on difficult choices and to identify innovative solutions

About

The author

This slide deck has been written by Sustainability First Associate, Martin Hurst, with support from Maxine Frerk, Judith Ward, Zoe McLeod and Sharon Darcy and other members of the Sustainability First team.

This work is based heavily on work conducted during Sustainability First's Fair for the Future project[1], which was set up to help utilities better address the politics around fairness and the environment. Focused on the energy, water and communications sectors, this project explored how companies can maintain a social contract with society through disruptive change and what a focus on corporate purpose means for companies, policy makers and regulators.

The slide deck also benefits from thinking/experience whilst the author was a member of the CCRA3 expert panel/ the Thames Estuary 21000 steering group and as a visiting fellow on major infrastructure appraisal at UCL.

This slide deck

The purpose of this slide deck is to stimulate discussion, and act as a source of reference, on: how best flexibility and uncertainty can be addressed in regulation in the energy and water sectors; and to help ensure that sufficient focus is given to long-term issues in these areas.

Summary

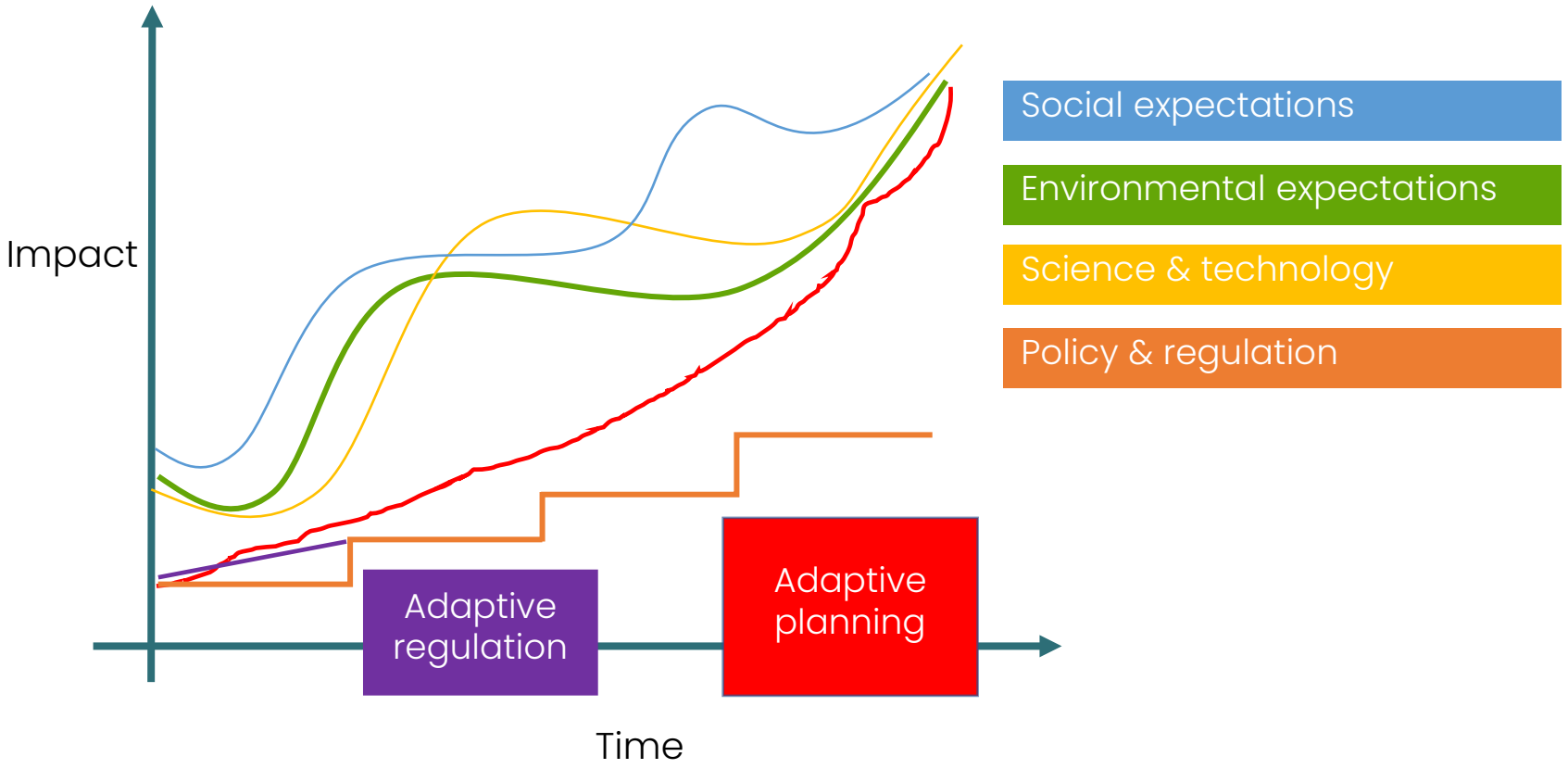
Adaptive regulation and adaptive planning

This slide deck looks briefly at a some of the issues about injecting flexibility into utility regulation between price reviews: '**adaptive regulation**' (Part 1: slides 9-14).

It then considers how to conduct utility regulation for the long term: starting with the desired end points of 2050 net zero and (say) 2065 climate resilience and working back to the required decisions now/in price reviews: '**adaptive planning**'. It explores the nature of uncertainty over these time periods, and how to adjust to this, and asks how far price review approaches are adequate for long term systems changes. It concludes with some unanswered questions (Part 2: slides 15-40).

Summary

Flexibility, uncertainty and adaptive regulation and adaptive planning



- Changes to **policy and regulation** tend to lag behind **changing social and environmental expectations** and **advancements in science and technology**.
- The former are **reactive and linear**, largely depending on **fixed price control processes and/or legislative cycles**; the latter are **non-linear, unpredictable, and disruptive**.
- **Adaptive regulation and adaptive planning** can help policy and regulation keep more instep with changing expectations and science; to flex with events and deal with long-term uncertainty.
- **Note:** There are clearly different timescales of change between sectors: water (slowest), energy transmission, energy distribution, gas - until pathway to decarbonizing heat is established (faster) and energy retail (fastest).

Source: Sustainability First. Please do not circulate without permission

Summary

Why look at adaptive regulation and adaptive planning together?

- Both issues are about how to create more flexible economic regulation.
- Some issues (e.g. net zero) are likely to require both in price review period flexibility and cross price review adaptive planning.
- Others may present choices between the amount of flexibility within a price review period and waiting until the next price review.
- So there is a danger in looking at each approach in isolation.
- The kinds of issues which justify this kind of thinking may also require thought about taking some responses outside the price review framework. Examples include long term systems changes, cross company or cross sector approaches and individual mega projects.

Summary

1. There is already some good thinking by Ofgem about how to introduce flexibility between price reviews – although our analysis suggests that the scale of actual movement has been somewhat oversold. There has been less thinking in water: probably because water has fewer rapidly moving issues.

2. More work is required on how to do this with flexibility/reduced bureaucracy while retaining customer and wider stakeholder buy-in and regulatory assurance, and avoiding unintended consequences (e.g. from supply chain uncertainty). We offer a checklist to judge success.

3. Thinking on how to work back from the end points of net zero, climate resilience and recovering biodiversity to short to medium term actions is less well advanced, despite good (but little known) government guidance. The Rapid workstream in water probably comes closest. Ofgem are perhaps behind the game in this area.

4. This is related to the questions of how to ensure that price reviews are balanced between current and future generations and how to judge actions given the scale of uncertainty around future technologies and the quantum and impact of climate change.

5. Ofwat have raised the question about the extent to which different approaches from fixed term price reviews are required for long term systems investments, but no decision rules have yet been offered. We suggest some tentative options.

Quotes from National Infrastructure Strategy[2]

- ‘Infrastructure is long-term. Decisions taken today on new rail lines, power plants, or road upgrades, will affect lives and livelihoods for decades to come. But infrastructure investment also has an important short-term role to help support jobs and stimulate the economy. This Strategy brings together the government’s long-term goals with the short-term imperative to rebuild the economy following the COVID-19 pandemic.’

- ‘Bold action is needed to transform the UK’s infrastructure to meet net zero and climate change commitments. The government will continue to decarbonise the UK’s power, heat and transport networks – which together account for over two-thirds of UK emissions - and take steps to adapt to the risks posed by climate change’

- ‘Every infrastructure sector could face transformative technological change over the next twenty years. From electric vehicles, to hydrogen heating systems, to 5G and its successors, new technologies have enormous potential to improve the environment and the daily lives of people across the UK. This Strategy will ensure the UK is at the forefront of this technological revolution.’

Part 1

Adaptive regulation

Flexibility within price reviews to adjust to changes which it would be suboptimal to wait to take on board until the next price review.

Examples include:

- Policy developments: e.g. on the future of heat, EV charging networks, legislation.
- Shocks: e.g. Covid 19, major floods.
- Sometimes, technology developments.
- Volume changes.

Part 1

The current position

- Large majority of allowed expenditure determined in 5 year price reviews, themselves conducted on basis of methodology set 2 years before end of price review. So by last year of price review key policies/assumptions etc can be 7 years out of date.

- In water, companies can apply for Interim Determinations (IDOCs) and substantial effects determinations, but there is a high bar and a perception that these can also be frowned on by regulator. The right to propose changes lies mainly with the companies. There are also some uncertainty mechanisms.

- In energy transmission and gas distribution wider use of uncertainty mechanisms – include UIOLI (use it or lose it allowances) and in some cases volume drivers (perhaps 20% of investment).

The current position (continued)

- Increased proposed use of reopeners by Ofgem around net zero, with the right to trigger lying with the regulator, adds to this armoury.

- When there are systemic hits, or policy pressures such as covid, green recovery etc, regulators can relax performance requirements (e.g. ODIs), and can with government help seek to bring expenditure forward – even from future price review periods.

- Tendency in both water and energy for spend to become back end loaded through price review period. Function both of regulatory model and cash flow management. Issue on how to equalise this, or even front end load to allow room for future flex.

Part 1

Good practice/challenges from existing Uncertainty Mechanisms in energy

- Approaches to ensure companies can gear up, and can create supply chains which can respond quickly, without entailing potentially unnecessary cost include:
  - Call off contracts;
  - Long term supply relationships: and joint modelling of possible demands with supply chain;
  - Profiling of work to ensure some spare capacity in later parts of price review (but this is countercultural and cash flow negative, so may need some incentive).

- Role of innovation funds: but need for symmetric incentives. Link between reopeners and innovation?

- Pre-engagement with customers/stakeholders: don't wait until reopeners are triggered, engage customers in advance on likely schemes.

Part 1

Big open questions

- Is adaptive regulation a positive for investors (with care needed by regulator to avoid excess returns), or does it require additional return? (NB Ofgem allow indexation of WACC). How far can good design of mechanisms ensure investor participation?
- Is the balance between Uncertainty Mechanisms (UMs)/reopeners and pre-set investment right? – e.g. National Grid east coast. How to ensure reopeners/UMs aren't a convenient way to avoid tough decisions/visible bill increases?
- What capability do Ofgem/Ofwat, Customer Engagement Groups, Challenge Groups etc need for adaptive regulation?
- Is adaptive regulation more than a sticking plaster over an inflexible outdated system of fixed period price controls? There is a case for wider alignment of regulatory cycles with industry investment cycles. HMT would cheerfully do a full new spending review if things changed, why not regulators?
- What is the role of pilots here?

Part 1

Potential checklist of adaptive regulation: when/how to reopen

1. Have things changed substantively from price review settlement?
2. Can automatic mechanisms cope, or is there a prima facie case for reopening?
3. Where should 'right to propose' sit? Ideally either 'side' can ask to reopen.
4. How are customers and citizens/stakeholders involved? What types of changes should they be consulted on? Is there a danger of the totality of bill increases being of concern even if each individual element of adaptative regulation is not?
5. Has risk changed and/or are call off contracts going to increase unit costs? In which case does the marginal cost of capital need re-examination?
6. How can a bureaucracy light and agile approach provide sufficient assurance that excess profits will not result? What mechanisms – e.g. true ups – could be used?

Part 2

Adaptive planning

How to work from future desired outcomes to current actions.

Examples include:

- Net zero
- Drought resilience in the face of climate change
- Wider climate resilience: floods, heat
- Improving biodiversity – e.g. 75 % of water bodies in good ecological condition
- And also, how to take account of uncertainty with regard to 'within' issues such as how fast the climate changes and 'without' issues such as technological change and social change.

Part 2

Summary of the problem

- Very long term 'wicked issues': climate change, net zero, biodiversity.
- Multiple dimensions of uncertainty –e.g. uncertainty about scale of global warming compounded by uncertainty about consequences of given amount of global warming.
- Non linearities/ tipping points - e.g. habitat condition, critical mass on technology adoption/costs, Greenland ice shelf, technology unit costs.
- Backdrop of external disruptors: 4th industrial revolution, ways of working (peak/average demand and local patterns), social change, openness of global economy – so comparative static analysis wont work.
- Need for multiple solutions: behaviour change, conventional infrastructure, mega projects, systems re-engineering.
- Many solutions work across regions/companies; some work across sectors.
- Measure of redundancy required, some stranding likely.
- Government advice that conventional economic appraisal is insufficient.

Part 2

e.g. climate change: UKCP 18 summary[3]

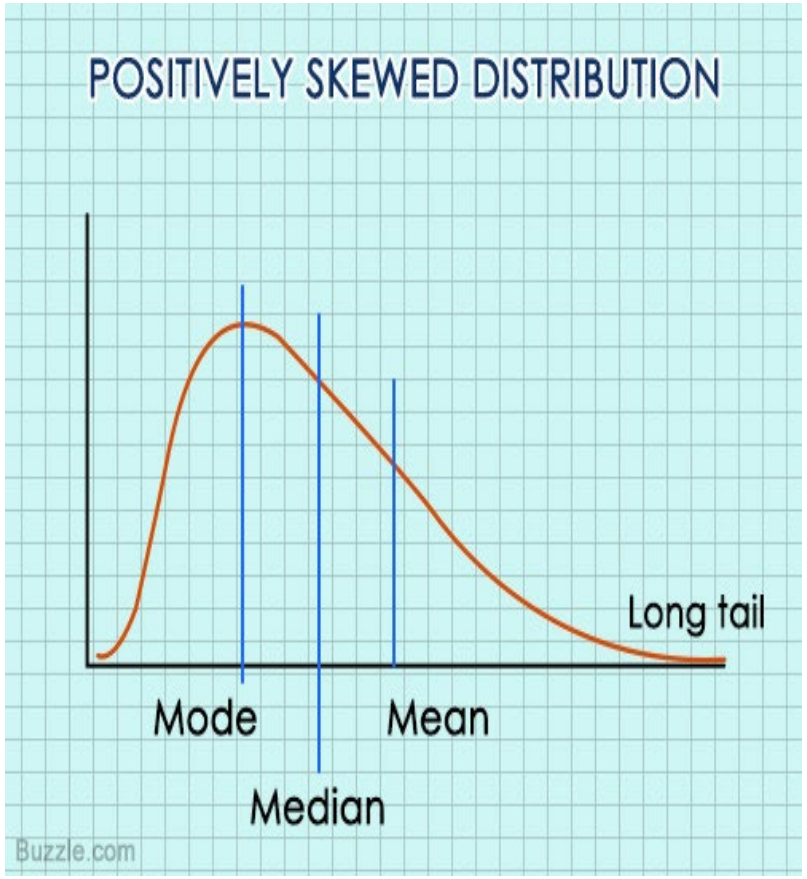
10-90% probability ranges for 2070:

- Summer temperature 0.9- 5.6 degrees increase
- Hottest summer day 3.7- 6.7 degrees
- Winter temperature 0.7 – 4.2 degrees
- Summer rainfall -49% - +2%
- Winter rainfall -1% - +35%
- Heaviest summer rain per hour +25%

Part 2

Skewed distributions (e.g. climate change, major project costs)

- Asymmetric non-normal distribution
- Probability of high impact events markedly greater than conventional modelling. We know this is the case with major projects and with climate change
- Technology change may impart some negative skew – e.g. solar
- Consequences also asymmetric: 2m sea level rise c10x cost of 1m
- 0.1% on normal distribution can easily become 1 or 5% probability.
- Conventional NPV doesn't work NPV(E) does not equal E(NPV)
- P50/90 (old green book approach) misleading as indicator of risk
- Backward regression/comparative static analysis is wrong



Part 2

Some water issues (note: interrelated, e.g. if more abstraction, biodiversity and carbon gets worse)

- Water resources: significant deficit in resource availability 2045 and beyond: caused by climate change, population growth and need to reduce abstractions in sensitive ecosystems (notably chalk streams).

- Aquatic biodiversity. UK has world important aquatic biodiversity 130 out of only 200 world wide chalk streams, overwintering waders, sea kelp etc. Only 14% of water bodies in good condition, down from a decade ago and relative to 70% target by 2027.

- Net zero. Industry reliant on energy for pumping water etc, concrete/steel high embedded carbon, sewage releases methane.

Part 2

Second order impacts for water

- Increase in water demand with summer heat waves
- Increased CSO overflows and agricultural run off from flash flooding ('UKCP18 predicts more intense 'summer convective rainfall')
- Heat may lead to greater evaporation, more algal blooms;
- Low flow reduces dilution of pollution and may trigger habitat tipping points/non recoverability
- Increased flood risk, sea level rise means need for significant capital spend on coastal assets (e.g. waste water)
- Greater storminess may knock out/trip electricity to water treatment (e.g. St Jude's storm)

Part 2

UK 2021 Climate Change Risk Assessment (CCRA3)[5]: Water key messages

- Water infrastructure, such as reservoirs, dams, pipelines, water treatment plants and sewage treatment plants, are all at risk from the impacts of climate change, especially increases in the frequency and intensity of surface water and coastal flooding.

- Water infrastructure assets represent a key element of the UK infrastructure system and could affect, or be affected by, failures of other assets due to extreme weather, such as energy systems, transport and information and communications technology (ICT).

- There are also risks to buried infrastructure, such as water pipelines, with damage potentially becoming more frequent in future due to flooding and subsidence.

Part 2

UK 2021 Climate Change Risk Assessment (CCRA3)[5]: Water key messages (continued)

- More frequent flooding could also impact on water treatment facilities leading to potential reductions in water quality, in turn impacting upon health.
- Future projections of more frequent and intense dry periods lead to concerns around the availability of public water supplies in future, especially in England and parts of Wales. Private water supplies are also at risk.
- Aquifers near the coast could be at greater risk from saltwater intrusion due to sea level rise, though the risk is thought to be low in places where aquifers are important water sources.

Part 2

Energy Issues

- Net zero: electricity demand likely to rise from decarbonisation of transport and gas; future technologies for household heat, currently dominated by gas, yet to be determined.

- Energy singled out as under prepared for resilience to climate change in recent risk assessment from climate change adaptation committee: issues include resilience to floods, wind, sea level rise and intersectoral impacts.

- Energy sector needs more fully developed approach to biodiversity, include issues in supply chain – e.g. with regard to biofuels.

Part 2

Relevance to net zero

- Net zero presents a number of adaptive planning elements:
  - Long term aim, need to understand what to do in short to medium term;
  - In some areas high degree of uncertainty – e.g. around technological solution;
  - Some things have long lead in times so delay can in effect rule out options/entail excessive future costs;
  - Element of redundancy probably inescapable.

- Science based targets and trajectories to net zero in RIIO2 part of an adaptive prescription.

- More work needed to identify: options for spending to gain time (note this requires willingness to touch the network multiple times); options for building in flex to future tech change.

- Question: how to cope with likely fall in unit price of technology: e.g. storage.

Part 2

2021 Climate Change Risk Assessment (CCRA3)[6]: Key messages for energy

- All energy-related infrastructure is at risk from the impacts of climate change, especially due to the changing frequency and intensity of surface water and coastal flooding.
- High and low temperatures, snow and ice, high winds and lightning can all cause disruption to the energy network. The future risks from wind and lightning are more uncertain than for other hazards.
- Energy infrastructure assets represent a key element of the UK infrastructure system and could affect, or be affected by, failures of other assets due to extreme weather such as transport, information and communications technology (ICT) and water infrastructure including reservoirs, pipelines, water treatment plants and sewage treatment plants.
- There are also risks to buried infrastructure such as gas pipelines, with damage potentially becoming more frequent in future due to flooding (affecting bridges that carry pipelines) and subsidence.

2021 Climate Change Risk Assessment (CCRA3)[6]: Key messages for energy (continued)

- Hydroelectric power output can be affected by high and low river flows, which may be affected to a greater extent in future due to expected changes in rainfall patterns. Impacts have been seen in recent years, including reduced generation in 2018 due to the very dry summer.
- The potential for reduced water availability in future could reduce output of thermal power generators and potentially biomass and gas power output.
- The risk of more frequent destabilisation or degradation of offshore infrastructure due to sea level rise and more extreme weather could also occur in future, though this is difficult to quantify.
- Household heating demand is very likely to decrease due to warmer winters, and cooling demand is likely to increase in hotter summers if air conditioning uptake increases. These changes may alter the pattern of peak electricity demand for energy companies.

Part 2

Cross sectoral issues

- Similar requirements for behaviour change: e.g. water and energy efficiency – and indeed hot water saving straddles both;
- Risk of unintended consequences from siloed approach: e.g. insulation in buildings will help reduce CO2, but could reduce ventilation, required to adapt to hotter summers;
- Direct impact of, e.g. energy outages for water supply and waste water treatment; water requirements for fracking, carbon capture and storage, cooling of electricity generation;
- Need to avoid inefficient duplication of work on, e.g. trends in biodiversity, vulnerability, flood risk etc.

Part 2

Adaptive planning for climate resilience: New Green Book guidance[4] and beyond

- Helps understand which projects may be affected by climate.
- Supports design of adaptation measures – relevant to issues wider than simply climate change adaptation: arguably to any long term disruptive change
- Also relevant to technology and policy uncertainty – e.g. decarbonisation of heat
- Buy time for key decisions to allow for more understanding.
- Provide for money to be spent on ensuring options aren't ruled out and areas where avoiding spend could entail excessive future cost: e.g. on capacity to retrofit/inbuilt flexibility and element of redundancy
- But possibly delay investment where future evidence/decisions will be clearer in a few years time and delay could avoid stranding
- Need range of techniques to complement standard NPV

Example 1

Adaptive planning: a ‘simple’ example (only £4-30bn!) Replacing the Thames Barrier

- Current engineering and resilience life of barrier ends c 2040. Replacement would mean starting work now.
- Asymmetric risks – central case 1m sea level rise by 2100, but high case (probability c 5%?) over 2m. Costs of 1m rise £4bn. Costs of high scenario £10-30bn.
- Decision now might involve placing replacement barrier in wrong place.
- But reserving land in both sites quite cheap.
- Also can invest in buying time for decision, to understand better what scenario will emerge: e.g. washlands, over-rotation. Has extended life to 2070.

Example 2

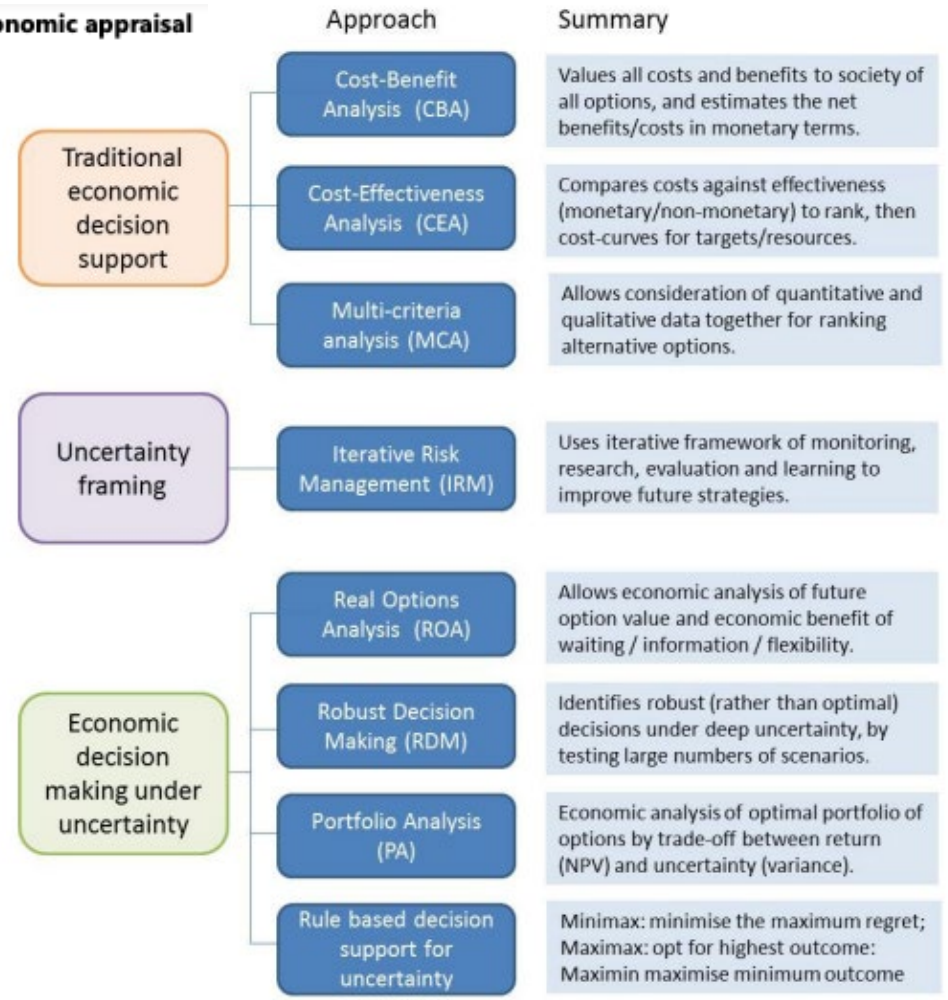
Gas and hydrogen (NB ad hoc, rather than fully adaptive)

- Net zero will require decarbonisation of heat (e.g. most homes currently heated by natural gas).
- Number of possibilities: hydrogen with CCS; heat pumps and other local solutions; green gas (e.g. from landfill/sewage/biomethane); electricity. No policy decisions and technological uncertainty.
- So demand for gas uncertain, and yet to be confirmed how far gas network – repurposed with full PE pipe coverage – can safely transport hydrogen.
- Hynet: production scale hydrogen with CCS pilot.
- Increased depreciation rate allowed for assets, given risk of stranding.
- Ofgem reluctant to allow non mandatory mains replacement (PE pipe replacing iron mains) with pay back beyond 10 years in case of stranding. Not fully evidenced.

Part 2

Approaches: From Green Book supplementary guidance

Figure 2: Decision support tools for adaptation economic appraisal



Source: Watkiss (2015), Watkiss et al. (2014).

Part 2

How to incorporate in economic regulation – some ideas?

- Common scenarios – not just for sector specific issues, but also for external environment (e.g. technology, ways of working, social change/deprivation).
- Case for real options analysis/portfolio analysis/MCA (see annex 1 for more on real options theory)
- Identify where a case for 'buying time', for conscious delay, and issues where delay will incur excessive costs/lack of flex.
- Identify whether and where flexibility within 5 year periods may be needed (cf Ofgem RIIO2 reopeners).
- Set out tests for agreeing to proposals for redundancy, and to stranding risk.

Part 2

How to incorporate in economic regulation – some ideas? (continued)

- Think very hard about where new approaches are needed, outside 5 year settlements: mega projects, systems issues, industry wide approaches etc.
- How to get customer buy in to difficult issues such as standards of service (and what does 1:100 years actually mean in a highly uncertain world): role of deliberative fora, bequest motive?
- Clarify role of production scale pilots and route to mainstreaming;
- Work through how to involve stakeholders and NIC. Ensure NAO understand approach.
- Techniques to ascertain vfm in adaptive world?

Part 2

Water actions already in play

- Number of medium to long term approaches under preparation; Ofwat PR 24 documents demonstrate major commitment to thinking through long term issues
- Regional water resource management plans, RAPID;
- Company specific drainage and waste water management plan
- WINEP, CSOs initiatives aiming at medium to long term aquatic biodiversity
- 4 likely Environment Bill targets

Part 2

Water resources methodology – approach to date

- EA's National framework for water resources
- RAPID: EA, OFWAT, DWI
- Regional groups: WRSE, WRE, WRN, WRW, WRSW
- Company WRMPs
- Use of scenarios etc. And genuinely long term analysis
- But no systematic adaptive approach or guidance: buying time, appraisal for redundancy etc.
- Gap also with regard to systems solutions and relationship with company business plans, and how to co-ordinate behavioural change initiatives across companies

Part 2

Historic work on investment under uncertainty in energy

- RIIO1 GD1 Ofgem thinking around real options and investment decision making: based around a probabilistic decision tree (as recommended in Green book!)
- National grid NAO methodology: least worst regrets methodology using future energy scenarios
- Imperial college work for BEIS on value of flexibility. Case for small investments in flexibility to delay decision making (Comment: classic adaptive planning)
- ENWL real options project: criticises ED1 for basis on NPV with no account taken for uncertainty (see asymmetric probabilities diagram). Proposes use of tipping points to define investment strategies.

Part 2

Ofgem additional thinking (e.g. forward work programme, RIIO ED2 methodology)

- Some incremental/individual pieces of thinking, but less systematic than in water to date
- EV demand and charging infrastructure;
- Heat and ED2;
- Flexibility mechanisms;
- RIIO2 and gas repex;
- Endorse work on NEA scenarios
- ESO, digital twins etc

Part 2

Long term system issues

- Solution to many long term issues will require systems thinking, not series of individual projects determined on company by company basis.
- Even if there are individual company projects they may have dependences on other companies/vertical parts of network
- Role for system operator, as government have identified with ESO? Rapid +?
- Role for cross sector production scale pilots as providing evidence – e.g. Hynet?
- How to approach demand management, and uncertain outcomes from this, in determining infrastructure choices. Might buying time to see how demand management succeeds be optimal.
- How to identify separable projects from ones where portfolio/systems approach is unavoidable.

Part 2

Where might things be best taken outside price review framework altogether?

- Systems issues, notably between companies
- Cross sectoral issues: e.g. flood resilience, water and energy efficiency/behaviour change
- Mega projects – e.g. Thames Tideway Tunnel.

Part 2

Options for doing this

- Direct procurement: First Economics work suggests need a strong 'operate' component – e.g. DBFO – for efficiencies to offset greater financing costs from moving outside RAB model
- Special purpose vehicles, potentially within RAB model: e.g. Nuclear RAB, Thames Tideway tunnel.
- Long term systems decision maker: e.g. RAPID
- More thinking needed about how to join up between sectors under economic regulation
- Multi period settlements: thought needed about WACC settlement?
- Need to ask: Who owns which risks, and how is risk rewarded?

Discussion

Some summary questions

- How to formalise economic methodologies for adaptive planning: real options analysis/portfolio analysis/MCA based on asymmetric distributions? Bayesian learning – mixes current experience and future expectation with analysis of past: as opposed to traditional backward looking regression analysis.

- Need wider debate about how to approach stranding risk and need for potentially redundant assets before starting next price reviews - and 'safe space' for discussion

- How far can demand management (PCC reduction in water) be done by companies, or is national approach better?

Some summary questions (continued)

- Role for pilots/production scale innovation? But ‘more pilots than British Airways’: how to mainstream successful pilots
- Triangle of regulator, government, customer may all have different pressures to undervalue future generations. Role for NIC, or similar champion of long term to reduce short term pressures?
- Case for expanding coverage of issues which can span price reviews from one off projects to wider programmes. And also perhaps for greater automatic mechanisms e.g. for capital maintenance?

Annex 1

Real Options Theory - Overview

- Origins with financial options (option to buy or sell shares)
- Key insight: value of an option is higher the greater the volatility in the market
- Black-Scholes-Merton formula for valuing options – need a probability distribution for key unknown variable – not practical
- But concept is valuable – how to give yourself more options?
- Real option - wait, do a trial to learn, expand, abandon
- Example – buy the land you would need to develop a sub-station
- Example – flexibility solutions as a way to defer decision
- Some options problematic for politicians and regulators? (Alleman)

Further Reading

- Sustainability First (2021) Regulation for the future: The implications of public purpose for policy and regulation in utilities - https://sustainabilityfirst.org.uk/publications-project-research-reports/242-regulation-for-the-future

- DEFRA (2020) Accounting for the effect of climate change – Supplementary green book - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/934339/Accounting_for_the_Effects_Of_Climate_Change_-_Supplementary_Green_Book_..._.pdf

- Hurst (forthcoming) Fat tailed distributions, climate change and major projects - Journal of Major Infrastructure and Sustainable Development

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2. National Infrastructure Strategy (2020) – Fairer, faster, greener
3. The Met Office (2018) – UKC18 Key Results
4. DEFRA (2020) Accounting for the effects of climate change: Supplmentary Green Book guidance
5. UK Climate Change Risk Assessment (CCRA3) Evidence Report 2021 (Water Briefing)
6. UK Climate Change Risk Assessment (CCRA3) Evidence Report 2021 (Energy Briefing)

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