Net Zero, Uncertainty and the Implications for Regulation

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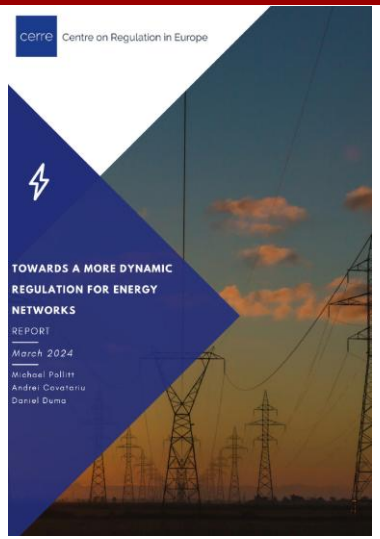
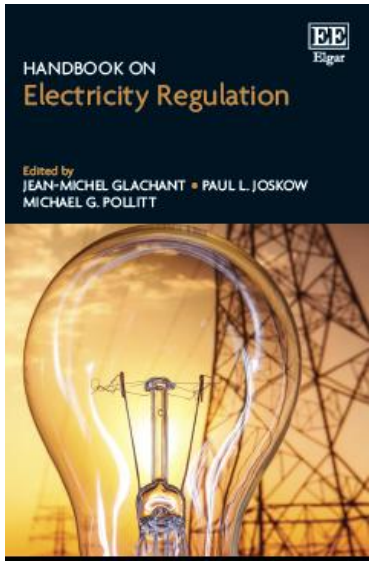
Outline

- With thanks to Andrei Covatariu and Daniel Duma and CERRE



- Uncertainty facing regulators
- Regulation on the path to net zero
- Governance and institutions
- Beyond RIIO?

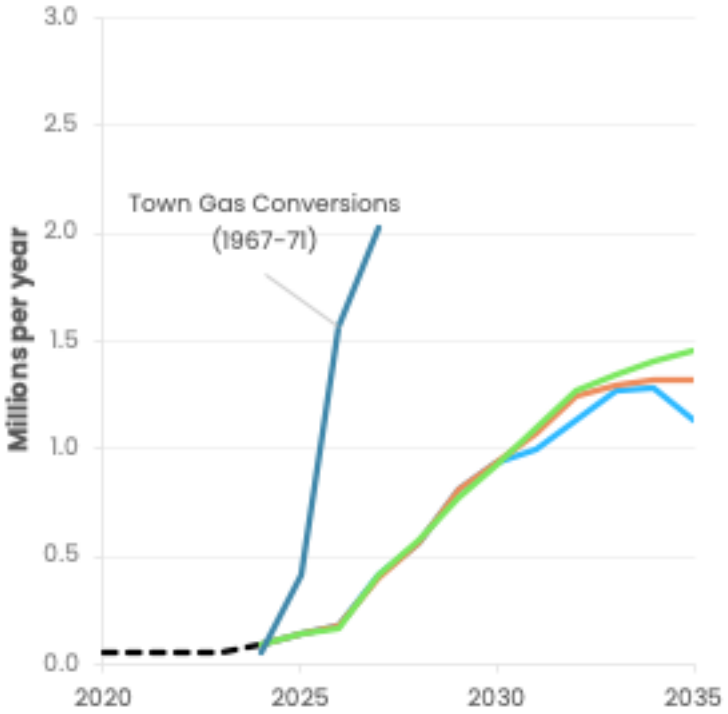
- Based on chapter in new book:



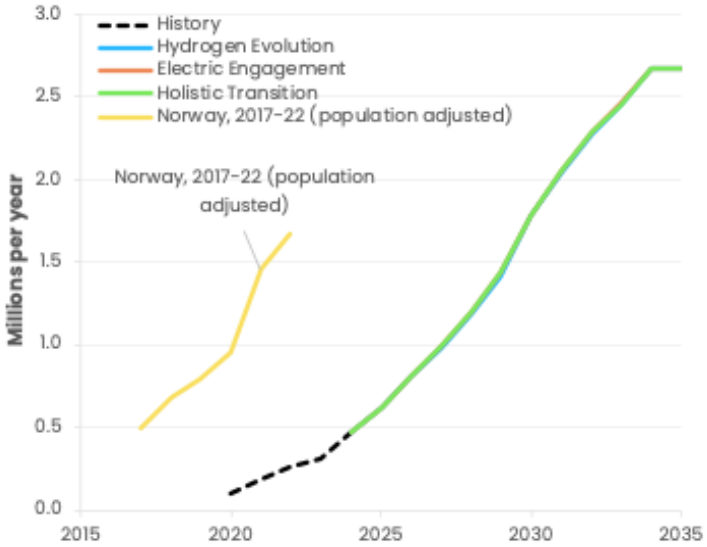
UNCERTAINTIES WHICH REGULATORS NEED TO LIVE WITH

Uncertainty 1: Technological wishful thinking

F.08: Annual heat pump uptake rates



F.08: Annual electric vehicle uptake rates



Source: NESO Future Energy Scenarios, 2025, 2024 Data Workbook.

2050 energy demand

Holistic Transition

Net zero met through a mix of electrification and hydrogen, with hydrogen mainly around industrial clusters. Consumer engagement in the transition is very strong with demand shifting, with smart homes and electric vehicles providing flexibility to the grid.

Total energy supply
1218 TWh

Electric Engagement

Net zero met through mainly electrified demand. Consumers are highly engaged in the energy transition through smart technologies that reduce energy demands, utilising technologies such as electric heat pumps and electric vehicles.

Total energy supply
1222 TWh

Hydrogen Evolution

Net zero met through fast progress for hydrogen in industry and heat. Many consumers will have hydrogen boilers, though energy efficiency will be key to reducing cost. There are low levels of consumer engagement. Hydrogen will be prevalent for heavy goods vehicles but electric car uptake is strong.

Total energy supply
1292 TWh

Counterfactual

Net zero missed, though some progress is made for decarbonisation compared to today. While home insulation improves, there is still a heavy reliance on gas across all sectors, particularly power and space heating. Electric vehicle uptake is slower than the net zero pathways, but still displaces petrol and diesel.

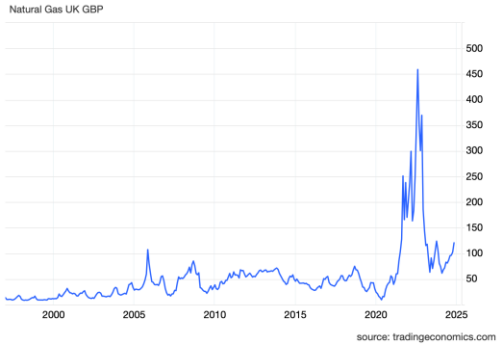
Total energy supply
1423 TWh

Uncertainty 2: The impact of War and net zero

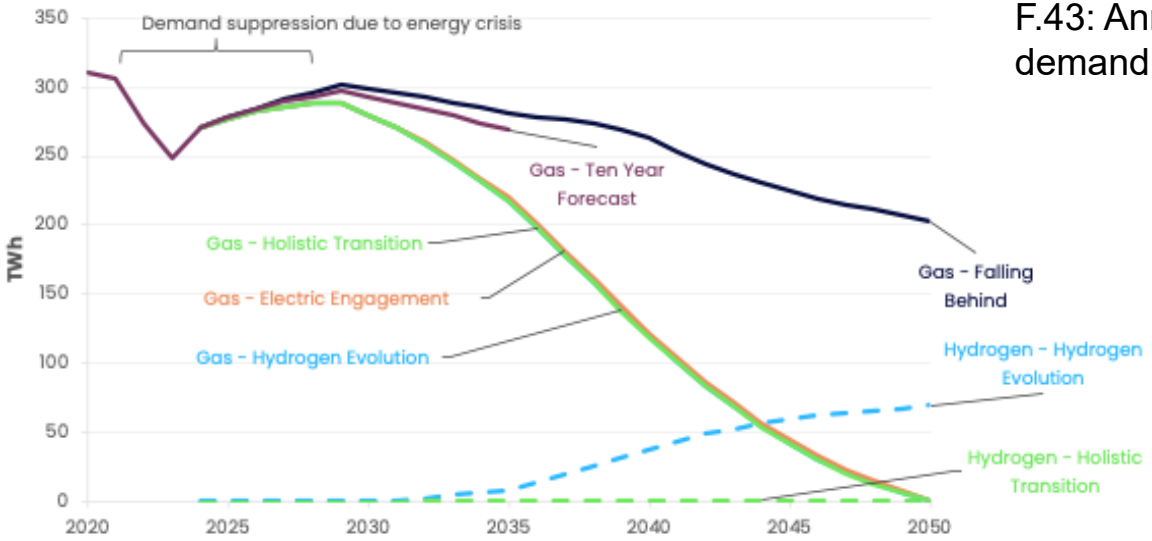
Birmingham Civic Centre Scheme 1939

- Birmingham if there had been no WW2.
- Energy security back as a key issue
- Wind is unreliable and European single market necessary.
- How quickly will market be repaired.
- GDP and net zero?
- Higher price of gas probably bad for net zero.

Impact of war on UK gas price:

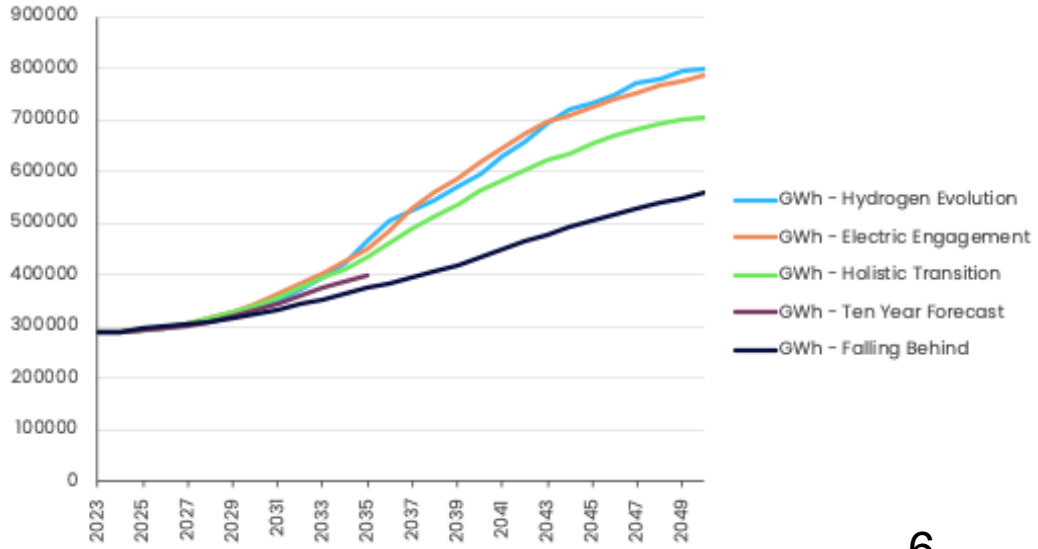


Uncertainty 3: Gas vs Electricity Policy



F.43: Annual natural gas and low carbon hydrogen demand for residential heat

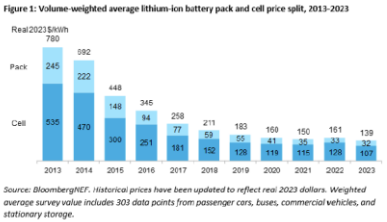
DB.ED1: Electricity Demand



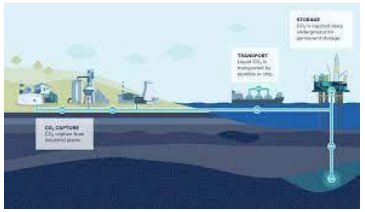
Source:
NG ESO Future Energy Scenarios 2025, Data Workbook

Uncertainty 4: Technological surprises

- *Good (so far):*
- Wind offshore and onshore, PV and Li batteries



- *Bad so far:*
- CCS, nuclear, hydrogen, synfuel



- *Unknown:*
- Fusion?

Uncertainty 5: The size of the economy

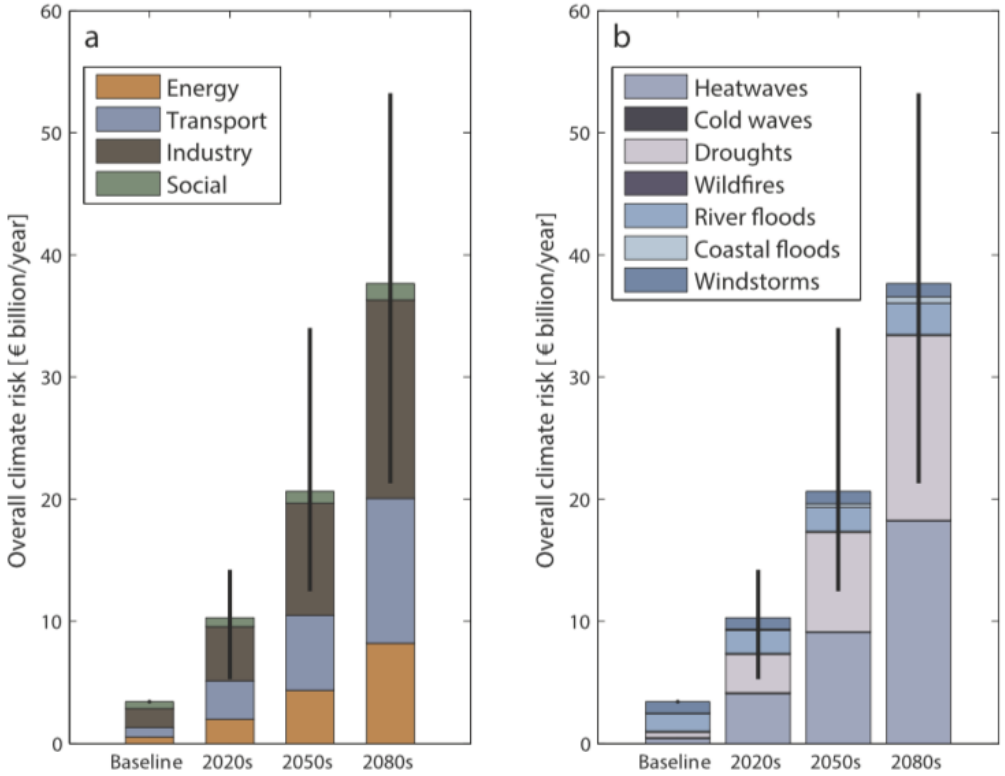
UK Figures

	2022	2042	2042	Relative difference
	(est)	(2012 est)	(2022 est)	2022 vs 2012
Population	67.6m	74.7m	75.3m	*1% higher*
Average fertility	1.56	1.89	1.43	*14% lower*
Life expectancy male	79	84	80.9	*4% lower*
		(2036/7)	(2036)	
Life expectancy female	82.9	87.3	84.3	*3% lower*
		(2036/7)	(2036)	
Net migration	c.435k	200k p.a.	340k p.a.	*70% higher*
Productivity	1	1.15	1.09	*5% lower*
(per hour worked)		0.7% p.a.	0.45% p.a.	
		France est.	UK est.	

Sources: ONS National Population Projections 2025
ONS National Population Projections 2012 – based Reference Volume Series PP2;
ONS Long-term international migration provisional, year ending June 2022;
https://www.niesr.ac.uk/blog/why-uk-productivity-low-and-how-can-it-improve

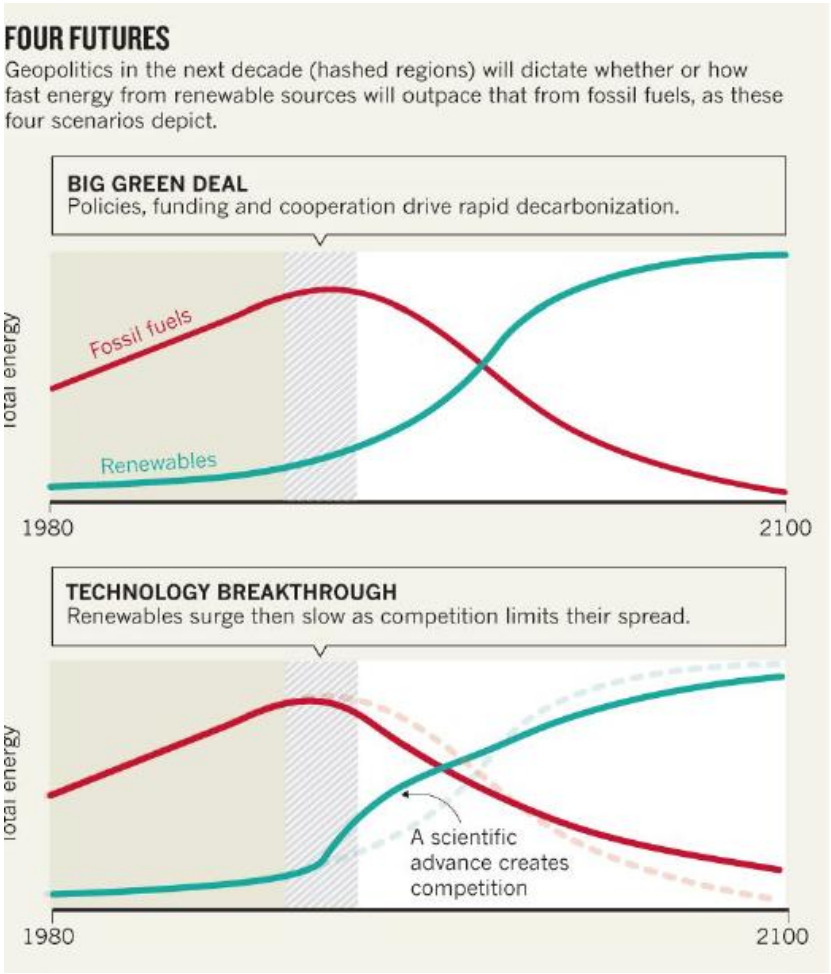
Uncertainty 6: The impact of extreme weather and climate change…

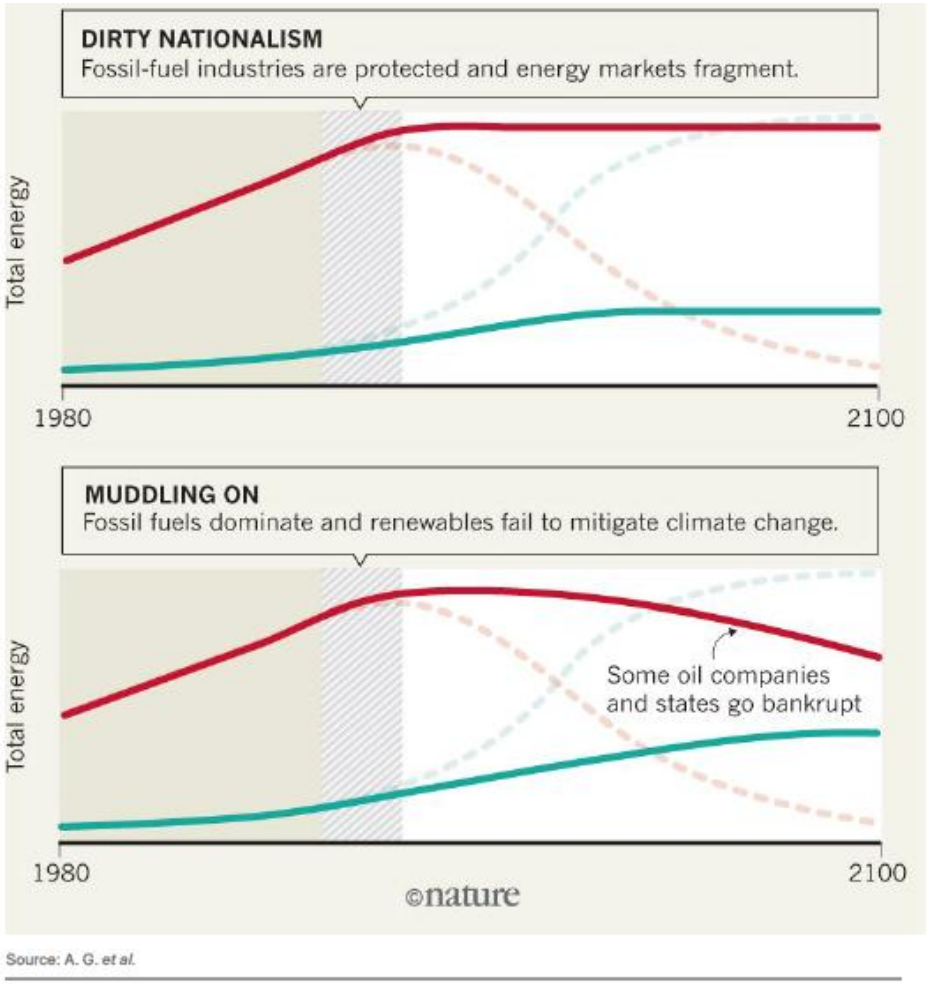
An increase in the frequency of extreme-weather events will lead to more frequent damage to power supply infrastructure, **raising the value of Expected Annual Damage (EAD)** to asset operators and insurers.



Source: Forzieri et al. (2018)

Uncertainty 7: Geo-politics and climate policy





Source: Goldthau et al. (2019, p.30), https://www.nature.com/articles/d41586-019-01312-5

ECONOMIC REGULATION OF ENERGY UNDER NET ZERO

What does Net Zero Policy mean for a regulator?

- We were not on track to deliver 80%, so we are definitely not on track to deliver net zero.
- Net zero requires massive change and policy support, which cannot be delivered by regulators alone.
- Indeed regulators need to stand ready to change if necessary if societal preferences change.

- The energy regulator needs to focus on:
  - Security of supply under rising renewables and electrification
  - Control of average prices and price discrimination
  - 'Supporting' sensible decarbonization.

Do day job.

General regulatory reality check

- Regulation should involve regulatory innovation, rising effectiveness and better matching with expectations over time.
- Richer, better-informed citizens expect a regulator to respond quickly to available information and intervene effectively or to explain why not etc.
- Distributional issues remain the central reason for regulation and this requires both regulation of total regulated company revenue and tariff schedules.
- Regulators should treat inflated claims about the impact of innovation with suitable scepticism and subject them to fact-checking and proof-testing.
- We need more utility regulation not less. The internet and several big tech platforms are under-regulated at massive social cost to mental health, competition and our democracy.

Source: Copilot

Key elements of net zero

(see Chyong et al., 2021)

- Lower energy consumption compared to business as usual

- Final electricity demand will increase
- Electricity will additionally be required for hydrogen, synthetic fuel
- More variable renewable electricity (VRE)
- More investment in electricity grids

- Decarbonising heating via electrification,hydrogen,biomethane,synthetic fuel
- Decarbonising transport via electrification, hydrogen and synthetic fuel

- Higher carbon prices

- More international trade in electricity (not just in Europe and North America)

- Negative emissions required via bio-energy with carbon capture and storage

Key elements of net zero

(see Banet et al., 2021)

- Higher unit energy and carbon prices underlie all sensible net zero policy
- More use of pricing and/or control in electricity to match supply and demand in real time
- Locational price signals for around energy networks can help manage local congestion issues
- Public acceptability of solutions will be challenging in heating (and transport)
- In transport, smart charging and pricing will be important, and distributional issues of who pays for private transport will need to be addressed
- National energy regulators do need to pay attention to local preferences in order to increase options and help with national policy goals.

Net zero makes 'good' economics more important not less…

- If targets were cheap, willingness to pay would cover up overpayment/negative distributional effects.

- Net zero will be expensive therefore only attention to economic cost and equity will deliver it.

- The pathway to net zero is more not less important, so scope for learning, behaviour change and long dated planned transitions important (e.g. switching off natural gas network).

- Co-benefits more important to justify costs, so wider assessments of benefits (and costs) important.

- Impartial advice will be at a premium, given the scope for 'group think'.

Some energy costs are energy policy costs in GB
Breakdown of annual household energy bill

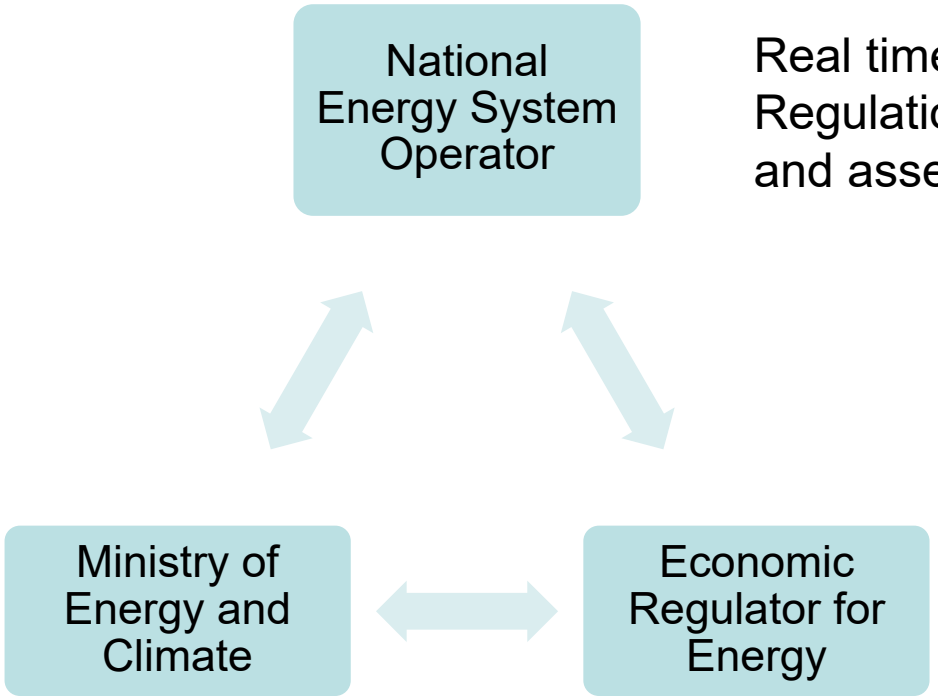
January - March 2025 £		Electricity	Gas	Per MWh	Per Household
Total bill pre-VAT		906	857		
Typical Consumption Values					
RO	Renewables Obligation	85.81		x	
CP	Carbon Pricing	20.37		x	
ECO	Energy Efficiency	23.46	34.39	x	
FIT	Feed in Tariff	19.76		x	
DCC	Data Communications Co.	14.53	10.92		x
WHD	Warm Homes Discount	10.91	10.91		x
CFD	Contract for Differences	26.85		x	
AAHEDC	Distribution network subsidy	1.13		x	
GGL	Green Gas Levy		0.38		x
Total policy		202.82	56.60		
	% of bill	22%	7%		
Network costs		211.52	158.42		
	% of bill	23%	18%		

Source: Ofgem Price Cap Data (Annex 9),
Typical consumption: 2700 kWh electricity; 11500 kWh Gas, Standard Credit

1. *Policies significant in electricity*
2. *How they are charged for varies*: variable vs fixed
3. *Mistakes material*
   e.g. FIT (2%+),
   DCC (1%+)
4. *Regulated charges high*
   e.g. overbuilding grid. Every £10bn of over-build adds c.1% to the household bill (at 8% annual capital cost)

GOVERNANCE AND INSTITUTIONS: REGULATORS IN CONTEXT

Where the regulator fits in: regulator needs to work with other parties



Real time monitoring and Regulation; expert planning and assessment

Source: Pollitt et al., 2024

Legislation; big distributional Decisions; offering political leadership

Balancing consumer and producer interests; monitoring NESO; Keeping politicians honest

Ownership and regulation tradeoffs

- Europe, North America and Australia have pursued a separation and regulate model consistent with privately owned profit motivated network companies. This is not representative of global network companies (e.g. ESB).

- Public ownership of networks continues in many countries, with weak regulation.

- Consumer Trust and Common Ownership models can be experimented with e.g. Competitive Joint Venture model of Keisling.
- It would be odd if net zero did not require ownership reorganisations, given the scale of the challenge.
- The reorganization of ownership, especially of gas and electricity assets, to achieve net zero remains a viable alternative to regulatory solutions.

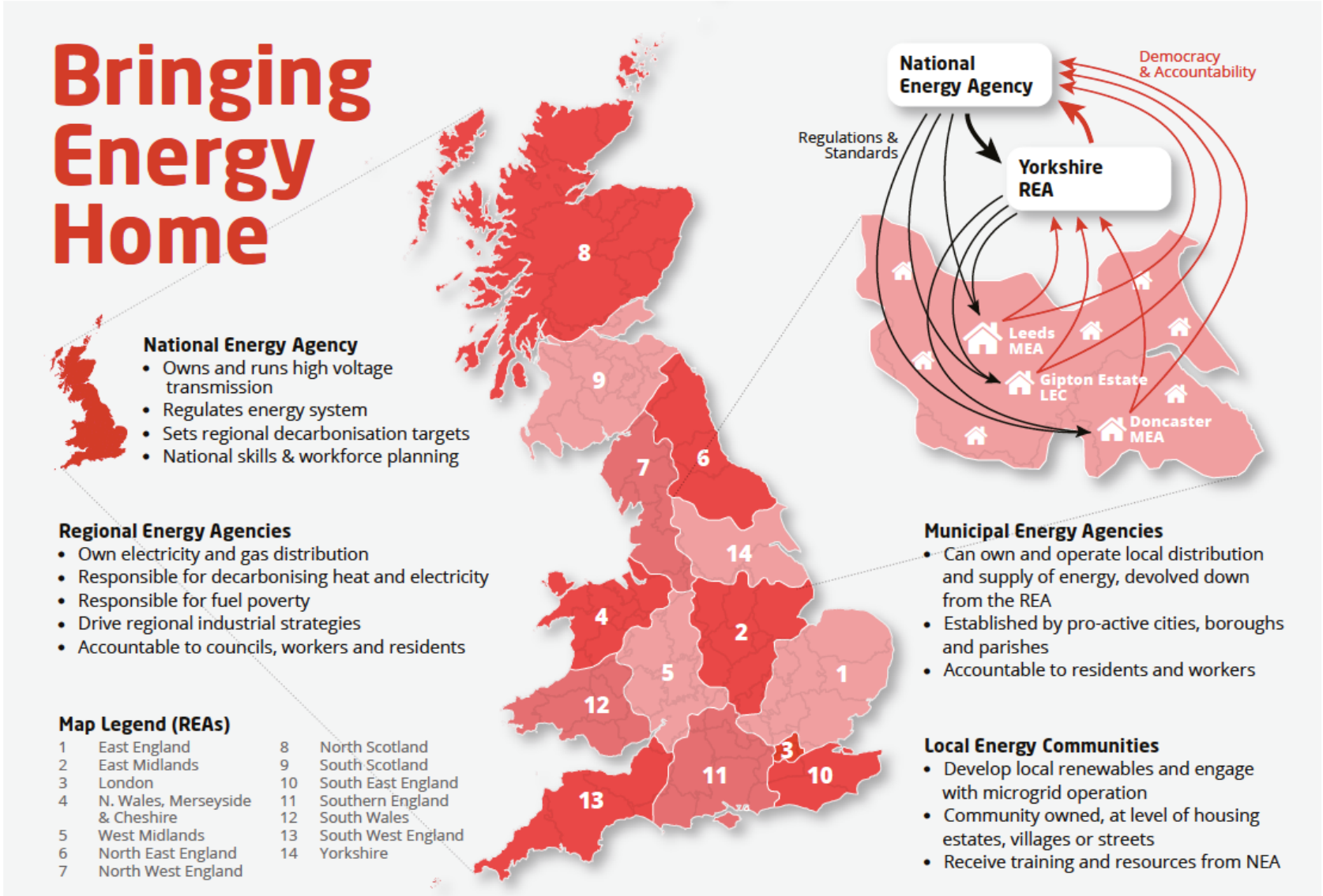
Looking across the world: a lot of organizational variety of electricity distribution utilities

Legal Structure	Ownership *Public*	*Private*	*Mixed*	*Total*	*Example*	
T D	1	1	2	4	Japan	
G D R	6	2	1	9	Philippines	
T D R	8	0	2	10	Kenya	
D	12	18	4	34	UK	
D R	23	13	2	38	Nigeria	
G T D R	67	5	5	77	Indonesia	
Total	117	39	16	172		

T=Transmission, D=Distribution, G=Generation, R=Retail
172 countries: Largest DSO in each country.
Type of ownership is categorised as "mixed" only if the private or public shares represent less than 85% of the total

Source: Anaya, Arroyo and Pollitt, 2020, with inspiration from Trimble et al., 2016.

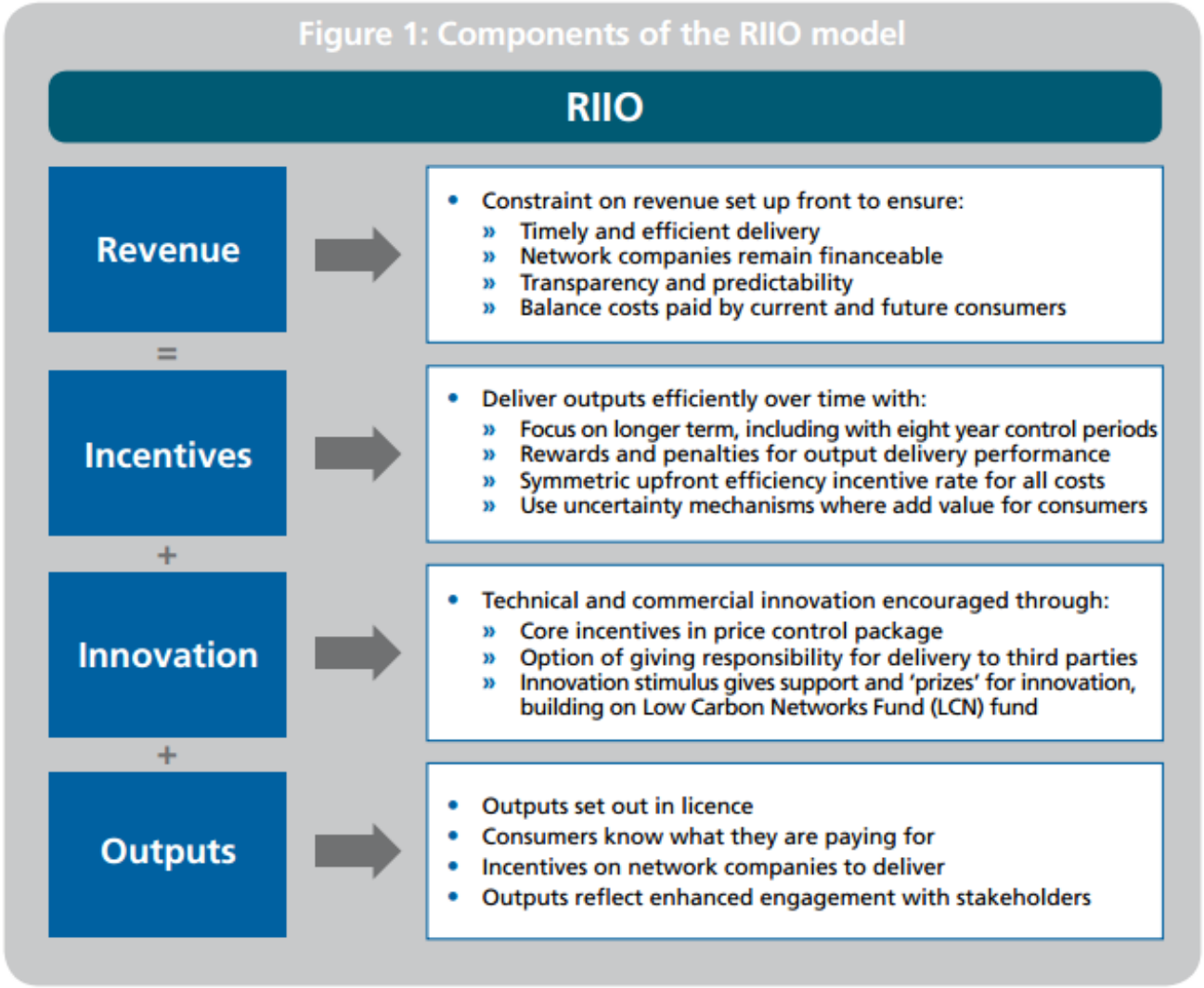
Asset reorganization to improve governance?



Source: Bringing Energy Home, 2019, p.9.

POST RIIO?
(TO RIIO AND BEYOND)

RIIO – Recap: GB energy network regulation from 2010



Source: Ofgem

Post RIIO?

Ofgem, the Great Britain energy regulator, issued an open letter on future of the price controls from 2026 (in September 2022) which explicitly asks this and related questions. The context is a discussion whether Great Britain's regulatory regime for networks based on RIIO – Revenue = Incentives + Innovation + Outputs – and itself a development of RPI-X incentive regulation remains fit for purpose.

Ofgem raised the following questions, inter alia:

1. Should there be a continued use of a periodic price control?

2. Is there an alternative to the current ex ante price control regime?

3. Is there scope for greater stakeholder participation in the regulation of networks?

4. Is it possible to have an ex post regulatory regime?

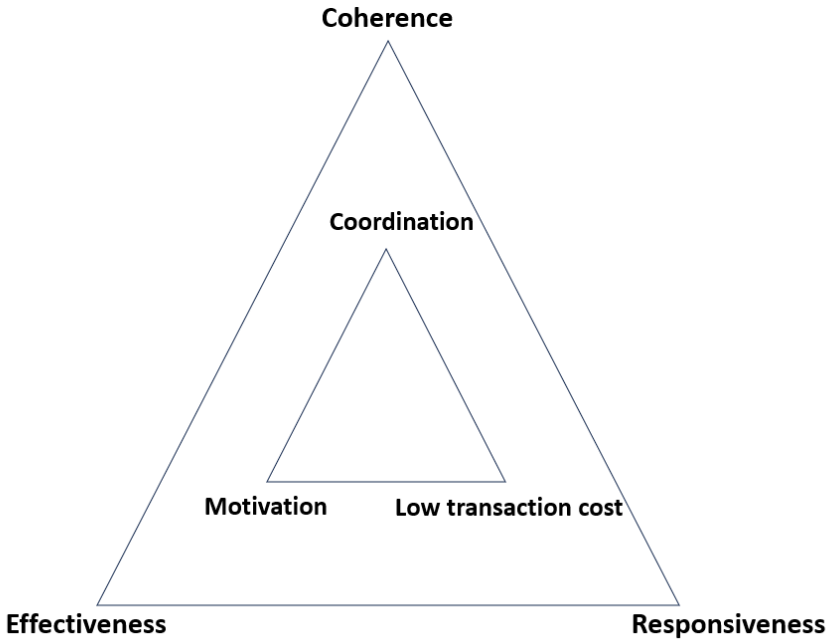
Dynamic Regulation?
Regulatory Trilemmas to overcome (Pollitt et al., 2024)

First regulatory trilemma
(Parker and Braithwaite, 2005; Teubner, 1986)

- Effectiveness
- Responsiveness
- Coherence

Second regulatory trilemma
(Eskesen, 2021)

- Motivation
- Coordination
- Low transaction costs



Uncertainty of Net Zero pathways may exacerbate trilemmas

- The need for anticipatory investment becomes more significant but the exact amount required is not known (otherwise it would not be anticipatory). A greater level of uncertainty and potential of overinvestment will have to be tolerated.
- The credibility of ex-ante controls can be undermined by the frequent use of reopeners, needed to adapt to changing circumstances.
- The risks associated with ex-post rulings – which may affect remuneration of assets outside of plan – may translate into higher cost of capital demanded by investors.
- As decentralization continues, more numerous and diverse stakeholders may emerge but the cost of managing them rises, ensuring they are representative and informed enough to make choices on complex issues will be high.
- Innovation may become more consequential but also more difficult to manage. For instance, the temptation to reward only the one that is successful will discourage future attempts, while too much freedom may induce wasteful innovation spend.

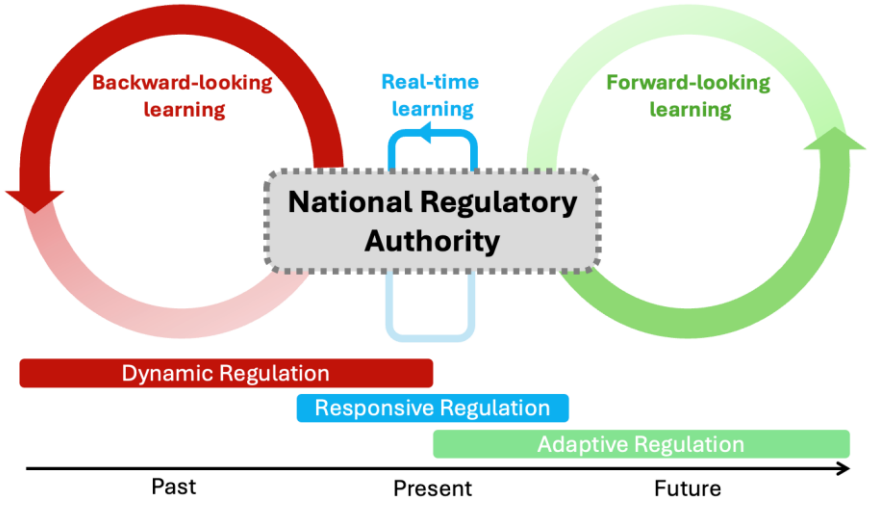
Regulation may need to change

- Firstly, there may be need for changing the mandate of regulatory authorities. For example, under new Energy Act statutory responsibility for Ofgem to support the Government in achieving net zero by 2050.
- On **planning [1]**, regulators currently ask networks companies for business plans for a specific period of time, which are subsequently negotiated and then settled.
- Relatedly, **uncertainty mechanisms [2]** will need improvement. At present, reopeners are seen as burdensome even in the most advanced regulatory regimes.
- **Incentive [3]** based regulation will also need to be adapted. This is potentially expensive under net zero!
- The large investment and higher uncertainty will impact **financing [4]** conditions.
- The emergence of DERs but also the high stakes of net zero will mean that networks companies will have to deal with a larger and more diverse set of **stakeholders [5]**.
- Funding and adopting technological and business model **innovation [6]** is more important than ever.
- At the **governance [7]** level, there may be several directions of potential change.

The Learning Regulator

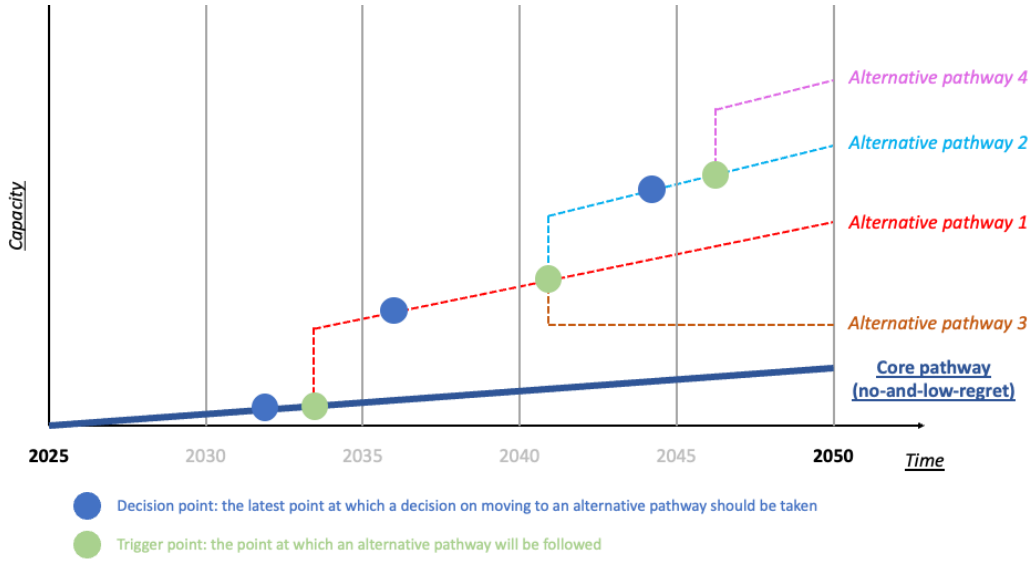
- **Dynamic regulation** (Agrell and Bogetoft, 2003)
- **Responsive regulation** (Ayres and Braithwaite, 1995)
- **Adaptive regulation** (Bennear and Wiener, 2019)

•All of these 'dynamic' approaches to regulation emphasise the need for regulatory learning.



The 'Learning' Regulator

Adaptive Regulation in practice
Role for longer-term planning



Example core and alternative adaptive pathways (Source: Ofwat (2022, p.7))

Ofwat, the water regulator in England and Wales, has chosen:

- **Adaptive pathways planning;**
- Companies adopt an adaptive pathways method to their business plans, **being prepared for changes to meet the challenges of the future;**
- **Business plans** are meant to cover **five years** but need to be presented within **25 years strategies + core pathway for 25 years;**
- Relevant **indicators** and **thresholds** for triggering alternative pathways that deviate from the core.

What we learnt in the 2021-23 European Energy Crisis

- **High prices have encouraged retailer experimentation with targeted payments for reducing consumption at specific times of grid stress**. In GB Octopus Energy and NG ESO designed a Demand Flexibility Product which notifies consumers a day ahead of stress periods during which reductions in their normal consumption is rewarded with high per kWh payments. 1-2 hour response windows, with payments of £2 to £4 per kW response.

- **Do introduce a short-term profits tax to windfall additional generator profits.** The Energy Profits Levy from May 2022 on companies extracting UK oil and gas. It was initially set at 25%, now 38% and extended to 2030. Electricity Generator Levy applies to profits of larger low-carbon electricity generator firms in the UK, earned above £75 / MWh, at 45% and in place to 2028.

What we learnt in the 2021-23 European Energy Crisis

Safely through the Winter

- The German Heating and Warmth Commission (2022) proposed **giving a discount on the first 80% of baseline household gas consumption and maintaining the market price on the last 20%.** This was an excellent idea which was implemented by the German government. EU have now a similar emergency scheme in place for future crises.

Two-way CfD

LOW CARBON CONTRACTS COMPANY

- **Two-way government backed CfDs for new low carbon power lock in fixed prices for the initial period of the life of a renewables project.** This would follow the Low Carbon Contracts Company set up in the UK, where CfD contracts are currently reducing the calculated price cap price.

Innovative thinking required: Solutions can be spectacularly innovative

Refrigeration: Ice harvesting

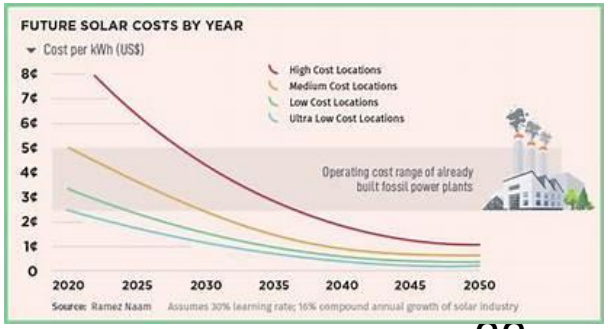
Better use of road Space?

Ammonia: Guano harvesting

Autonomous Vehicle?

First solar Panel (1884)

Solar Economy?



Innovative thinking required: universal basic income (UBI) ideas?

- Most of what we understand about efficient prices probably needs to be challenged when it comes to utility pricing for residential consumers:
  - MC vs AC; fixed vs variable; time/place varying vs flat.
  - Behavioural economics tells us psychology and risk attitudes important.
  - Memo: Google AI search (energy) 0.006p; Cup of water 0.03p.
- The (long-term) economic future lies in universal basic income (even Elon Musk thinks that!), but this is in a long tradition from Utopia to Star Trek.
- A simple current manifestation of this lies in the rising block tariff for utilities.
  - A basic allocation of cheaper utility output.
  - The block size could be related to household characteristics.
  - More units are then subject to a rising block tariff.
  - The size of the lower block could be related to cheaper CfD contracts for electricity.

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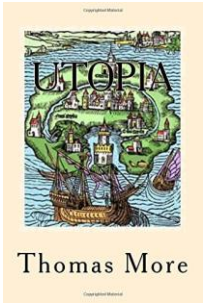
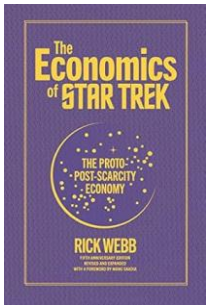
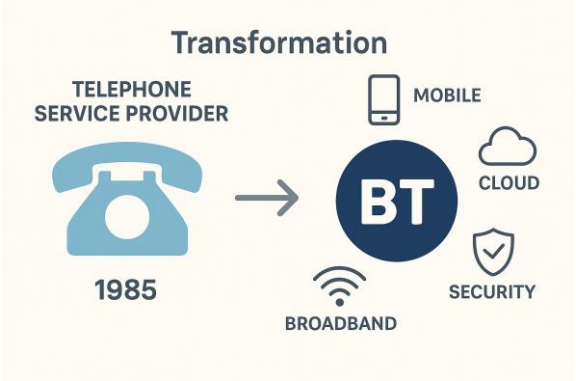


23rd Century



Innovative thinking required: Inspiration from Telecoms

- In 40 years, the telecoms sector has transitioned from provision of a single telephone service to a comprehensive range of data services (Thanks to Ian White). Phones and all internal wiring used to be owned by utility.
- Driven by end user needs, open access and standardization we now have:
- Totally new applications (driven by customers)
- Ease of access (via standards)
- Greatly reduced cost (via standards)
- Strong resilience (via standards)
- Stable accessible core network (via regulation)



- Much of the infrastructure now customer-owned, competitively provided and subject to open access arrangements. Equipment provided subjected to simplifying universal standards.

Concluding thoughts

- Uncertainty facing regulators – regulators face uncertainty on the path to net zero which they can only partially manage.
- Regulation on the path to net zero – it is important to be clear what net zero implies for the scale of the challenge and the continuing role of good economic regulation. However, the fundamentals of good regulation are not changed by net zero.
- Governance and institutions – regulators need complementary institutional structures with which to work. These wider institutional arrangements in government and industry will need to work with regulators to achieve net zero.
- Beyond RIIO? – Best practice regulation continues to evolve. Theories of 'dynamic' regulation suggest a key role for both learning and for tradeoffs in regulation. The best regulators develop the capacity to reduce the size of the tradeoffs and to achieve better outcomes at less cost.

- There are still good lessons to learn from other contexts and other sectors.

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