Oxford Energy Network

Inescapable Obligations: an examination of the consequences of the Government's energy security announcements

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Chair

Nuclear Industry Association

22nd November 2022

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Agenda

- Some context – UK energy challenge
- Inescapable Obligations
- Great British Nuclear – what is it and the outcomes
- Final Thoughts

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UK Energy Challenge

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A Stuttering Revival

Blair presses the nuclear button

· New generation of atomic stations endorsed by PM
· Failure to act would be 'a dereliction of my duty'

Brown calls for eight new nuclear plants

· New stations to be part of 'nuclear renaissance'
· Oil price fears and climate change push agenda

Britain must build "at least" eight new nuclear power stations during the next 15 years to replace its ageing plants and contribute to a "post-oil economy" that is cleaner and much more efficient than in the era of "cheap energy and careless pollution", Gordon Brown signalled last night. The first new reactors could feed electricity into the national grid by 2017.

Boris Johnson says it is 'time to make big new bets on nuclear power' to end the UK's 'addiction' to Russian oil and gas as he also signals the Government will increase North Sea energy production

- Boris Johnson said 'now is the time to make a series of big new bets on nuclear'
- The Prime Minister said that the UK must end its 'addiction' to Russian oil and gas
- He also signalled Government will boost domestic North Sea energy production

Energy

PM: UK plans eight new nuclear reactors to boost energy independence - video

Thu 7 Apr 2022 13.38 BST

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Why did it take 15 years?

- Labour Government had targeted 16 GW new build by 2025 in 2008-9
- Coalition Government in 2010 did not produce a financing model to generate revenue for developers during pre-construction and construction
- Chris Huhne: no taxpayer subsidy for nuclear
- CfD put all construction risk on private companies who struggle to bear £20 billion on balance sheets
- Hinkley Point C = EDF (French state-owned) and CGN (Chinese state-owned)
- E.On, RWE, SSE, Iberdrola, and ENGIE gradually withdrew from NuGen (Cumbria) and Horizon (Anglesey)
- Toshiba and Hitachi then withdrew from projects in 2018-2020, Hitachi writing off £2.1 billion

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Some Energy Security issues

The Times

Blackouts fear forces power alarm at National Grid

National Grid last night sent out an urgent call for more power stations to fire up to keep Britain's lights on today after plant outages and low ...

3 weeks ago

The Times

Blackout alert from National Grid as Britain sails close to wind

Barely a week after Boris Johnson had backed a huge expansion of offshore wind farms to power every home in Britain, National Grid was ...

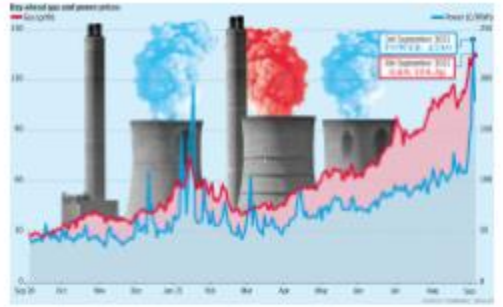
2 weeks ago

LCP Energy
@LcpEnergy

Loss of Load Warning

Loss of Load Probability (LOLP) forecast on the GB system:
25/11/2020 18:30 PM: 0.3472184
#LcpEnact #Enact #LCP #System #LOLP #LossOfLoad

12:06 PM · Nov 24, 2020 · LcpEnergyApp



Britain forced to fire up coal plant amid record power prices and winter squeeze

Two coal facilities taken off standby as the amount of electricity coming from wind farms falls dramatically

By Rachel Millard

6 Sep 2021, 8:14pm

National Grid ESO
@ng_eso

We're forecasting tight margins on the #electricity system tomorrow owing to a number of factors including low renewable output and the availability of generators over periods of the day with higher demand [1/2]

6:43 PM · Nov 3, 2020 · Twitter Web App

39 Retweets **45** Quote Tweets **44** Likes

ELECTRIC POWER | NATURAL GAS — 04 Nov 2020 | 09:17 UTC — London

UK system operator National Grid issues electricity margin warning

Forbes

Nov 5, 2020, 02:21pm EST

A Warning From The United Kingdom: Renewable Energy May Not Suffice

Ellen R. Wald Senior Contributor

Markets

Blow to Britain's winter blackout plan as delayed repairs limit power imports from France

National Grid has warned of blackouts risk this winter if it cannot import electricity from Europe

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UK Energy Today

- “Dirty, pricey and insecure”
- UK energy approximately 80-85% fossil fuels
- Electricity is 17% of total energy demand, and is about half decarbonised
- Gas is the leading source of UK heating and electricity: half is imported at spiralling prices
- Electricity market is broken: all power is sold at the price of the most expensive watt
- Gas is the marginal fuel in the grid, so gas price also sets the electricity price
- There is no “energy system”, just a series of *ad hoc* decisions on individual technologies
- Planning system obstructs major infrastructure

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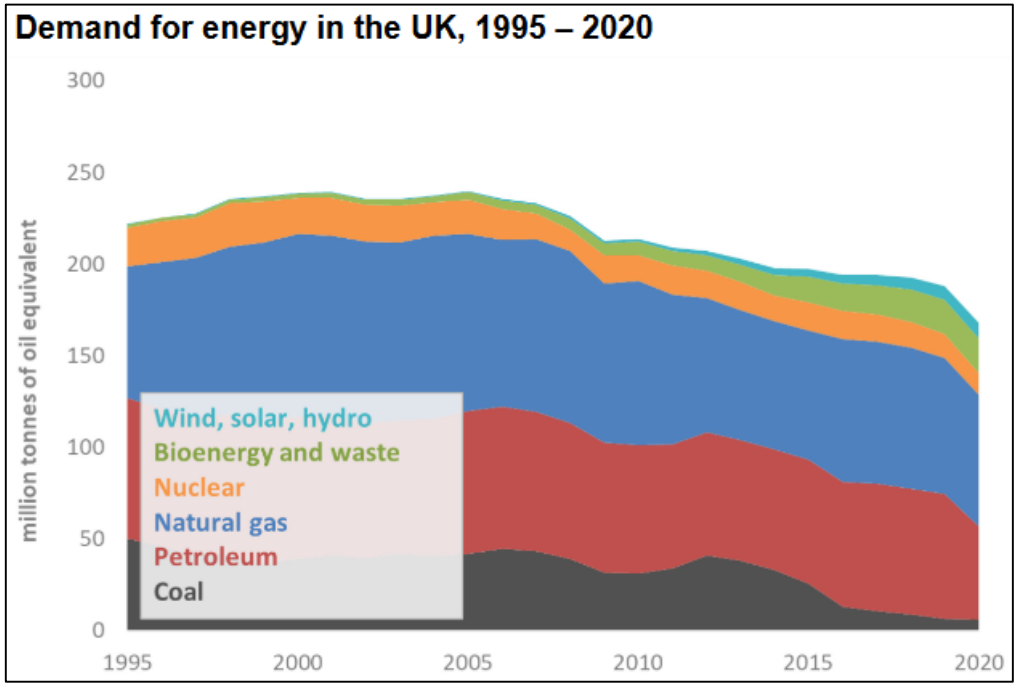
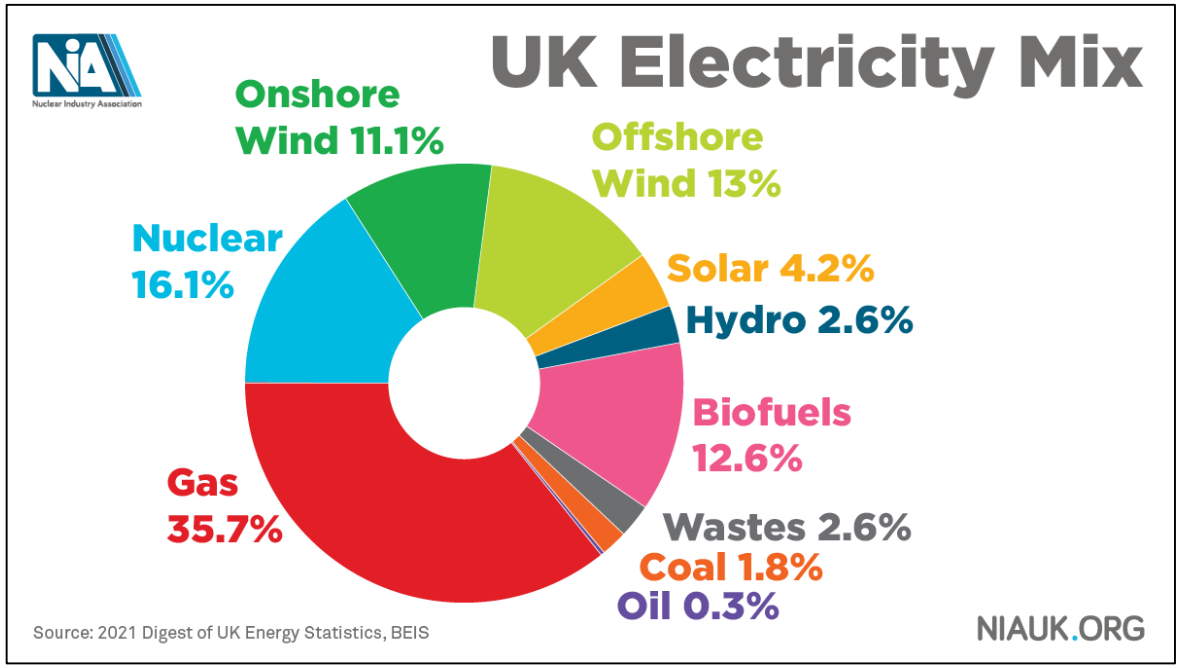
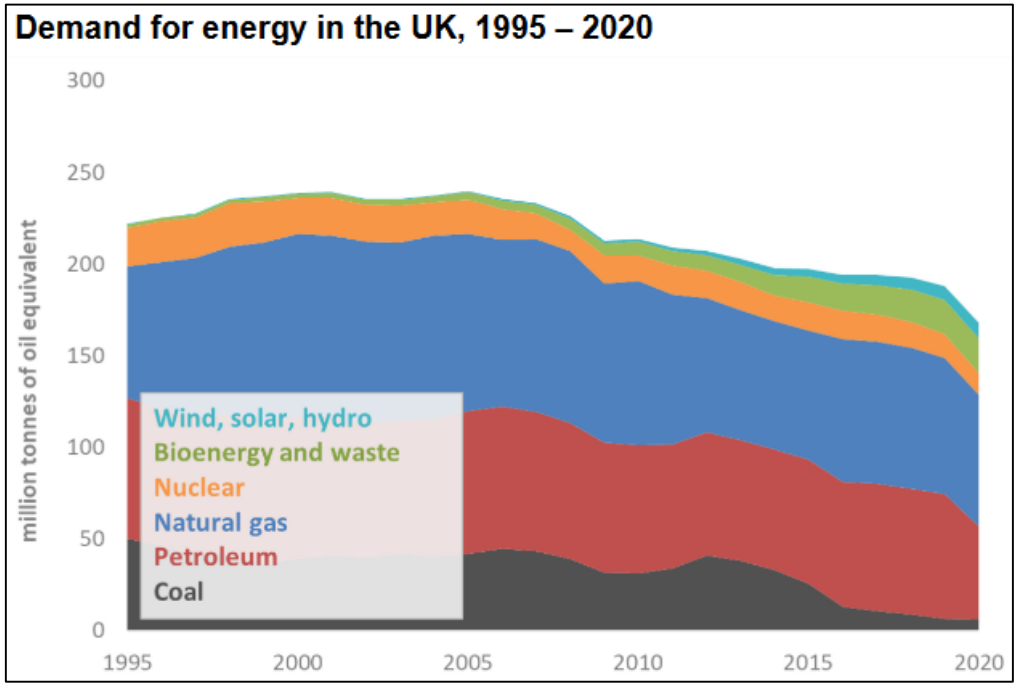
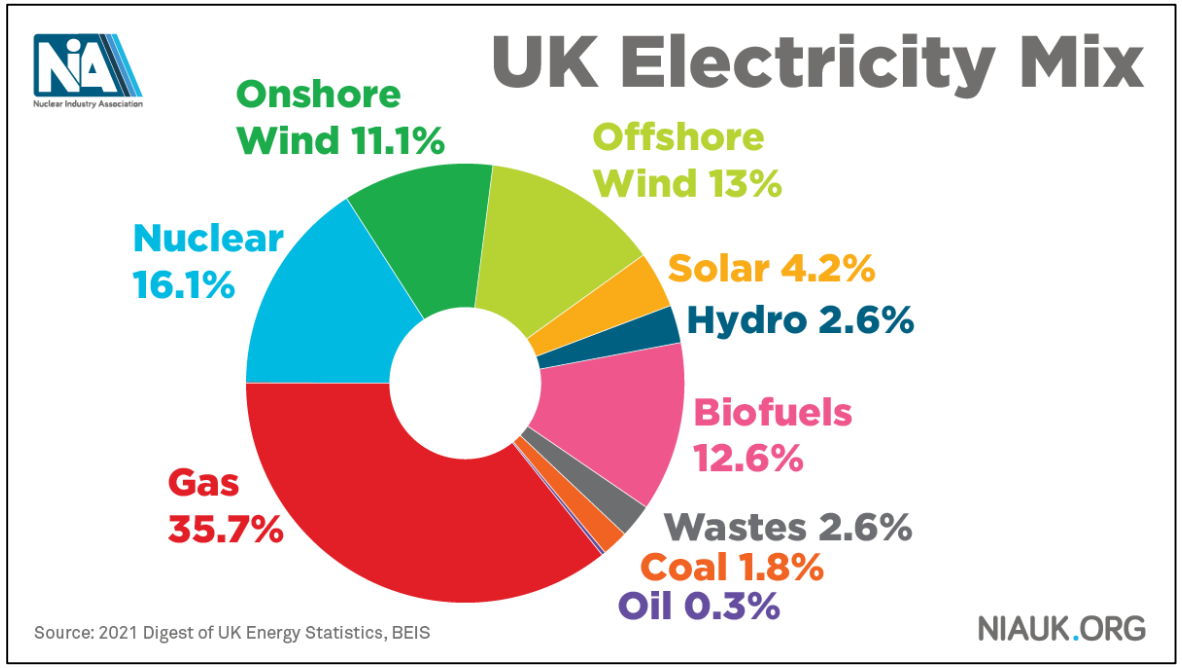




UK Energy Problems

- Not enough clean power deployment
- No commercial solutions for high-grade heat for industry
- No functioning markets to drive down prices and incentivise investment
- No sovereignty: high import dependency for primary energy resources
- No long term planning
- No “guiding mind” to shape the system – advice to Select Committee on Science & Technology





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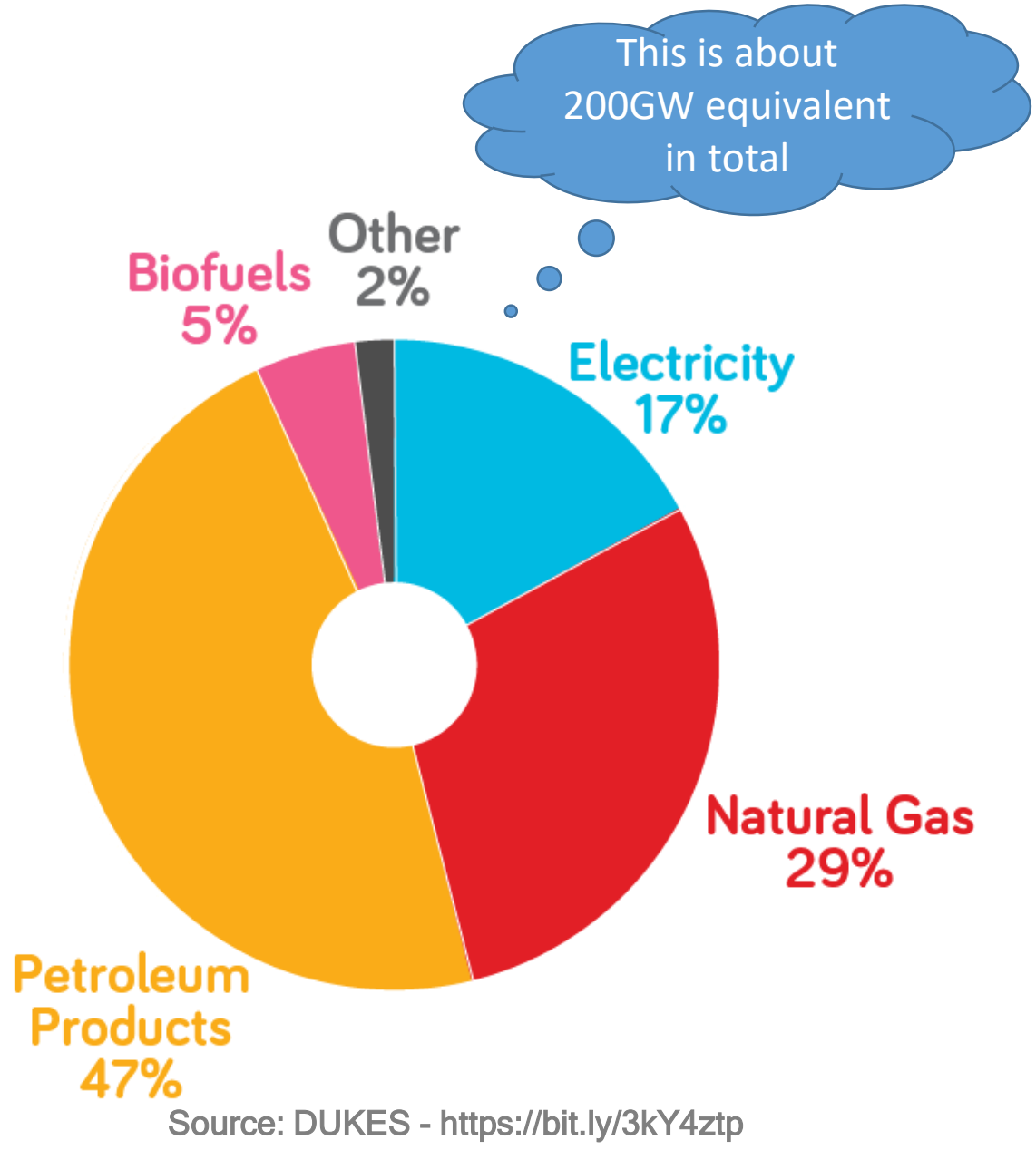
It really *is not* a trivial problem…

We haven't even decarbonised electricity yet

We must replace all the fossil sources by another primary energy source by 2050 to hit Net Zero

Hydrogen will be generated from electricity (and high-temp. nuclear - Cu-Cl or S-I) or Steam Reforming with CCUS…

But **NONE** of the current energy sources will be working in 2050. It ***all*** needs (re)building – unprecedented pace & scale.



Source: DUKES - https://bit.ly/3kY4ztp

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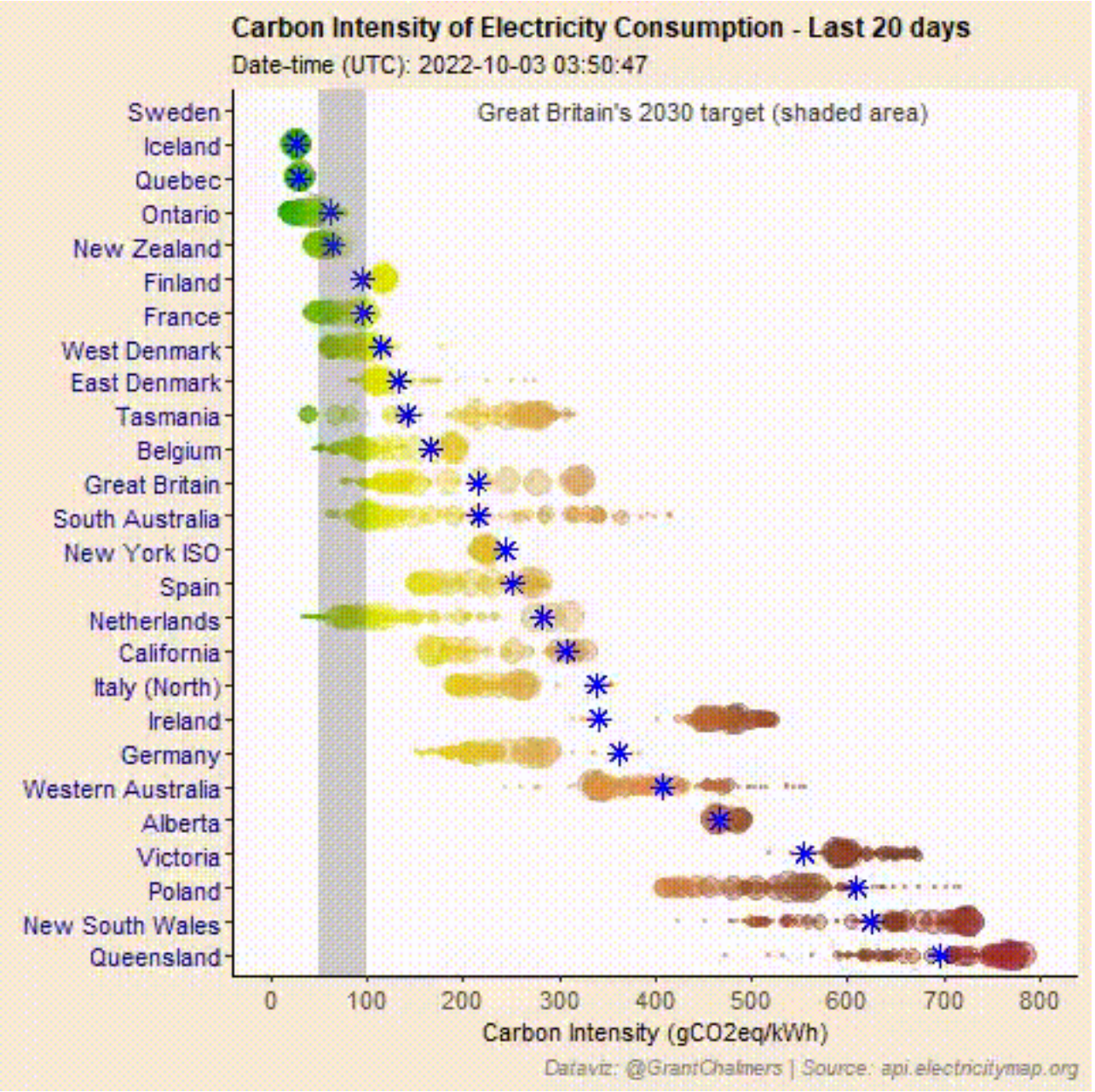
Carbon Intensity

- Which countries have more nuclear?
- Which countries have less – or less than in previous years?
- What do you note about California, Netherlands and Germany (and Queensland…)
- … and France, Ontario and Sweden?
- Any deductions?



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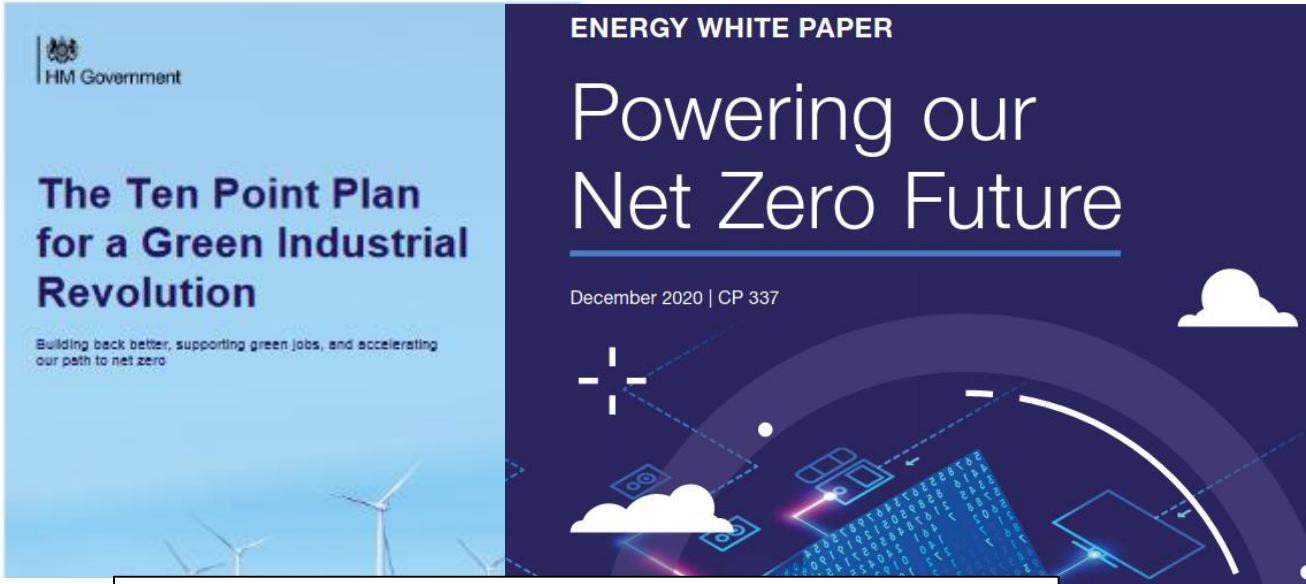
What changed?

- Net Zero target in 2019 versus previous 80% target
- Last 20% makes it *clearly* impossible to model a net zero system without nuclear
- UK, even with successful wind deployments, was not able to eliminate price spikes and gas use
- German and Japanese 2010s nuclear phase-outs resulted in more coal and gas dependency, and higher prices
- Prime Minister's 10 Point Plan and Energy White Paper (2020) set out high-level support for nuclear and ambition to take 1 more project to FID by 2024 – delivered with Sizewell C
- Onset of energy crisis in August-September 2021 necessary to prompt rapid passage of Regulated Asset Base legislation for nuclear financing



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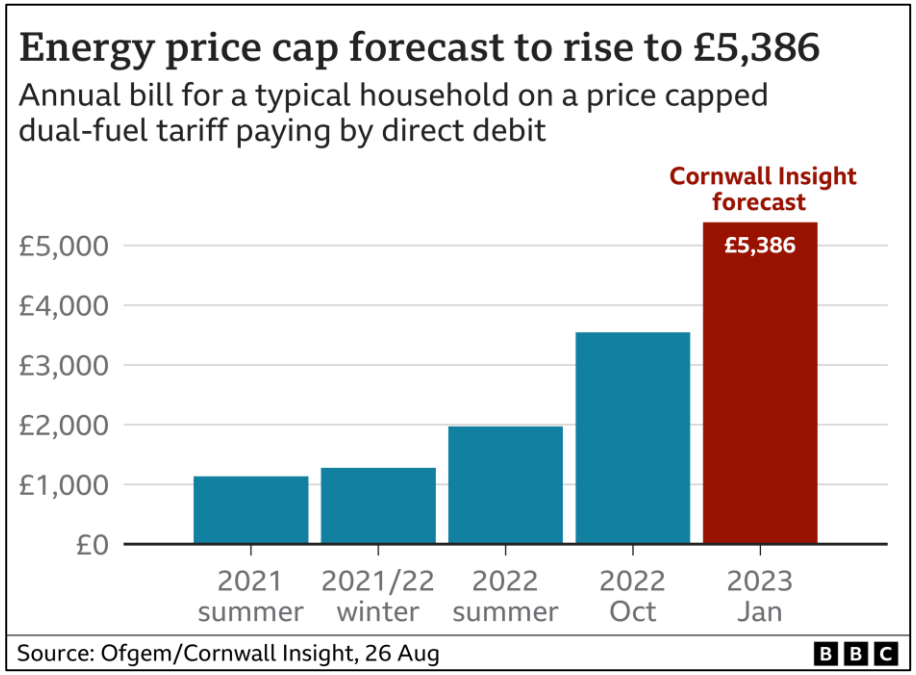
What changed?

- This is what ***really*** changed things.
- Energy security and sovereignty are the top issue as part of the whopping cost of living crisis across Europe and the UK
- Potentially ***40%*** of UK households in fuel poverty – ***"heating or eating"***



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Net Zero needs Nuclear

- Committee on Climate Change says we need four times as much clean electricity in 2050
- 38% of this should be ‘firm’, of which nuclear is only commercially viable option
- All but one of current fleet going offline by 2030, and only one new plant in construction (Hinkley Point C) – but at least Sizewell C is now going to happen…
- Wylfa and Bradwell B are also potential GW-scale build sites
- Immediate need to invest in new nuclear – low running costs, long-term and high-skilled jobs, lowest carbon footprint with wind, and best use of UK’s limited geographical space

No nuclear, no Net Zero

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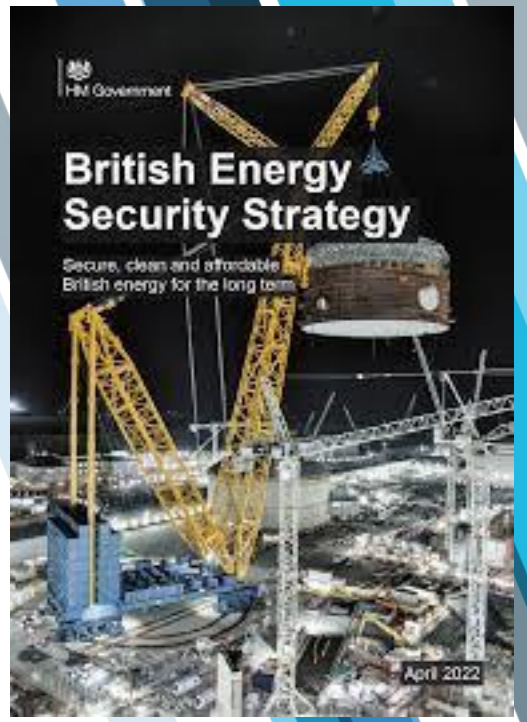
Energy Security Strategy

- 24 GW nuclear capacity by 2050, 25% of electricity demand.
- Approve up to eight new reactors by 2030.
- Take one project to Final Investment Decision this Parliament and at least two in the next Parliament. This is hopelessly slow, but Sizewell C ***seems*** on track
- Launch the £120m Future Nuclear Enabling Fund. (A trifling amount)
- Establish a Great British Nuclear delivery vehicle (see later)
- Competitive selection process for the next new nuclear projects to be deployed, including considering the role of UK Government financing.
- Simon Bowen appointed as GBN Industry Adviser
- Updated National Policy Statement.
- Streamline consenting and licensing regimes, including possibly harmonising international regulations.
- Collaborate with other countries to accelerate work/licencing on GW-scale, SMR and advanced nuclear



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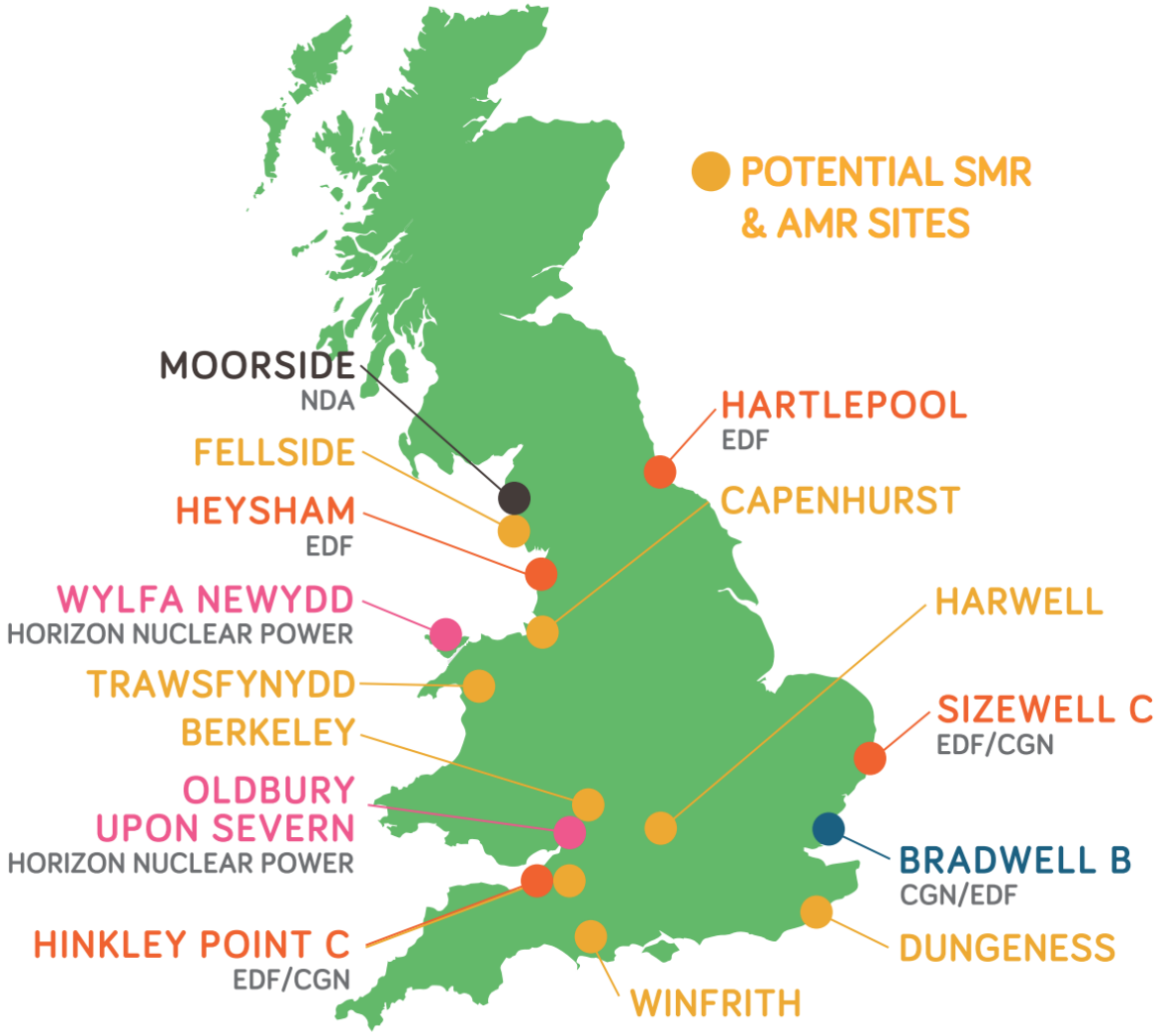
From Sites to Plants

Barriers need to be addressed:

- Financing: how to raise long-term capital at competitive rates
- Licensing: how to reduce enormous pre-FID spending on reactor design evaluations
- Consenting: how to speed up planning process
- Siting: how to unlock more land
- Capability: how the UK can “do more nuclear” itself, e.g. make a Reactor Pressure Vessel
- Skills: how to make sure we have the people
- Leadership: how to get the right people who can manage and deliver colossal projects

Figure 6 *Nuclear new build sites*



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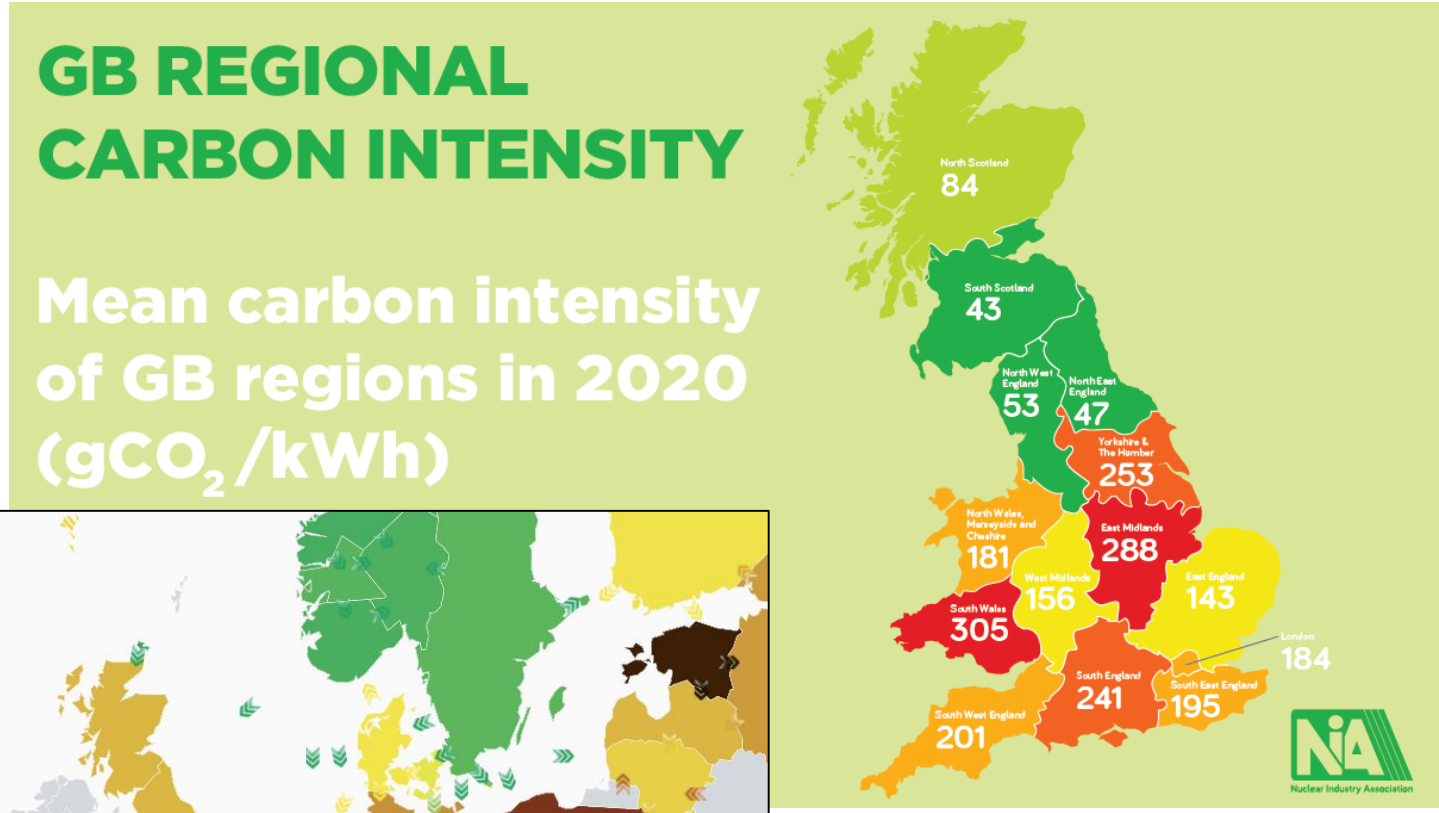
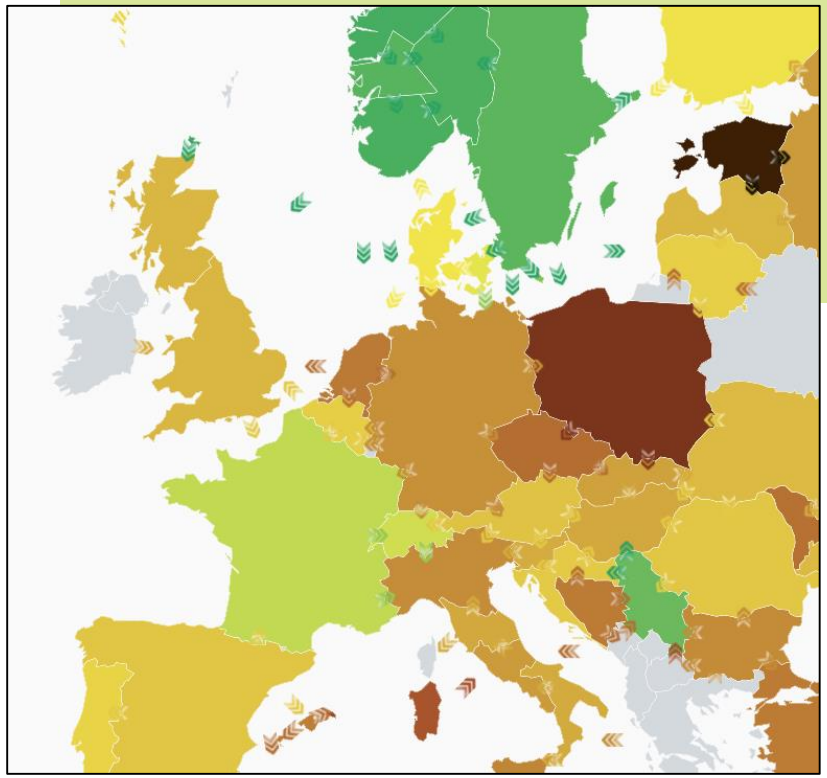
Net Zero Needs Nuclear

- UK regions with variable renewables plus firm nuclear already perform better than average.
- Countries with nuclear and renewables (e.g. France and Sweden) have lower emissions than countries that are turning off nuclear (e.g. Germany – look at their politics)
- Nuclear provides firm power substitute for gas, cutting strategic dependency
- Nuclear is also able to ramp output up and down to match renewables (as in France), but it only makes sense with enough low-carbon capacity





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As of 22nd November 2022, we've wasted …

10.81%

of the time to Net Zero

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Nuclear Finance

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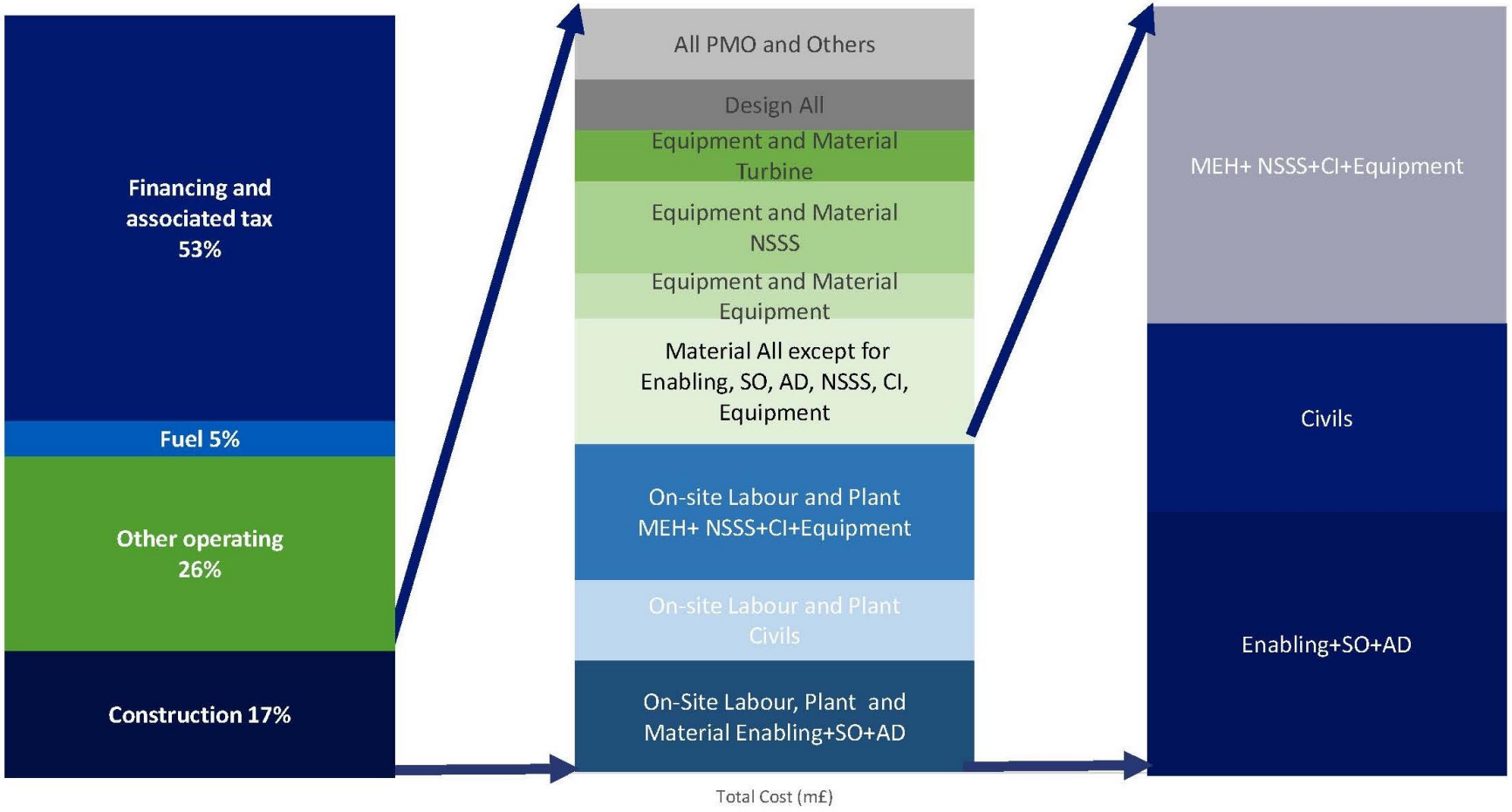
Costs breakdown for the Sizewell C project



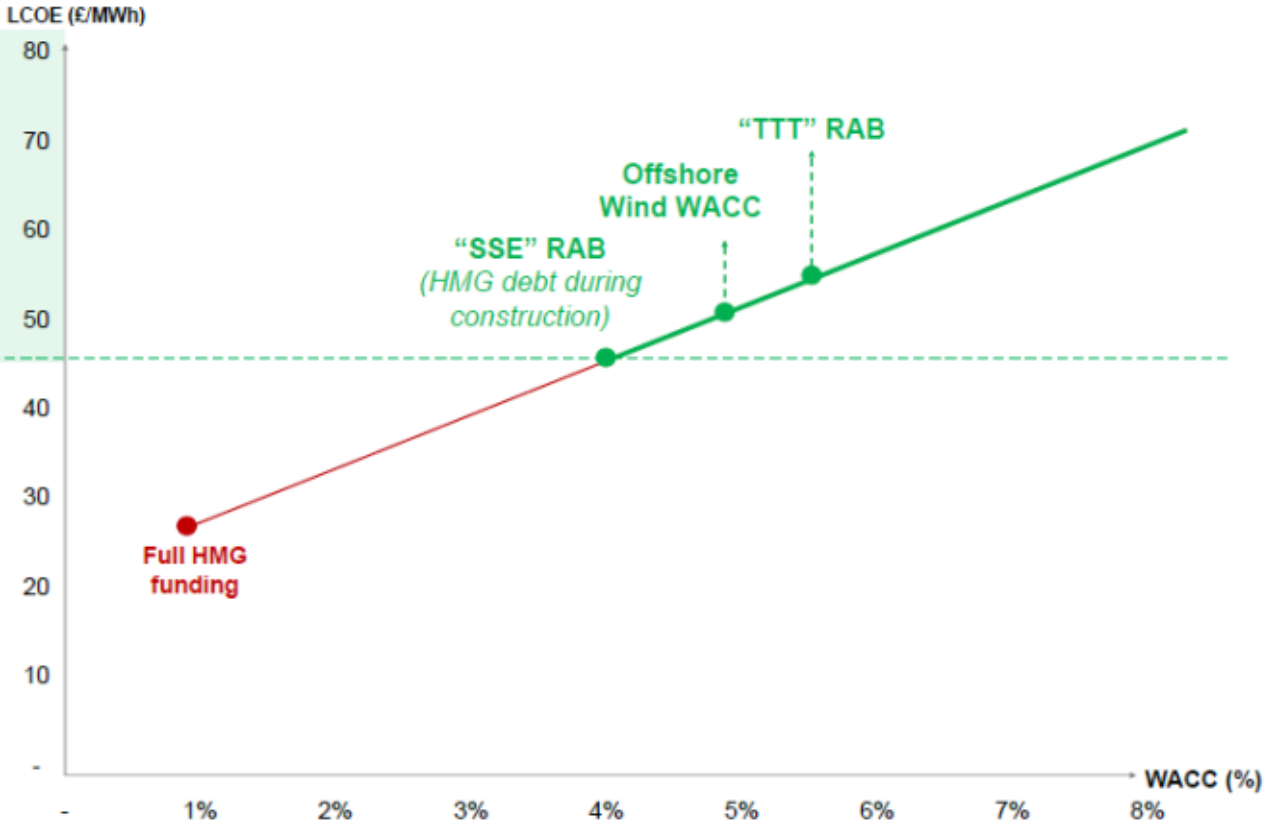
Source: EDF Energy

Effect of WACC on the Sizewell C project

Sizewell C: £30-60/MWh

LCOE driven by HMG decision on financing model

- ✓ Private capital takes material construction risk
- ✓ HMG off-balance sheet during operations
- ✓ Easy replication of HPC supply chain



Source: EDF Energy

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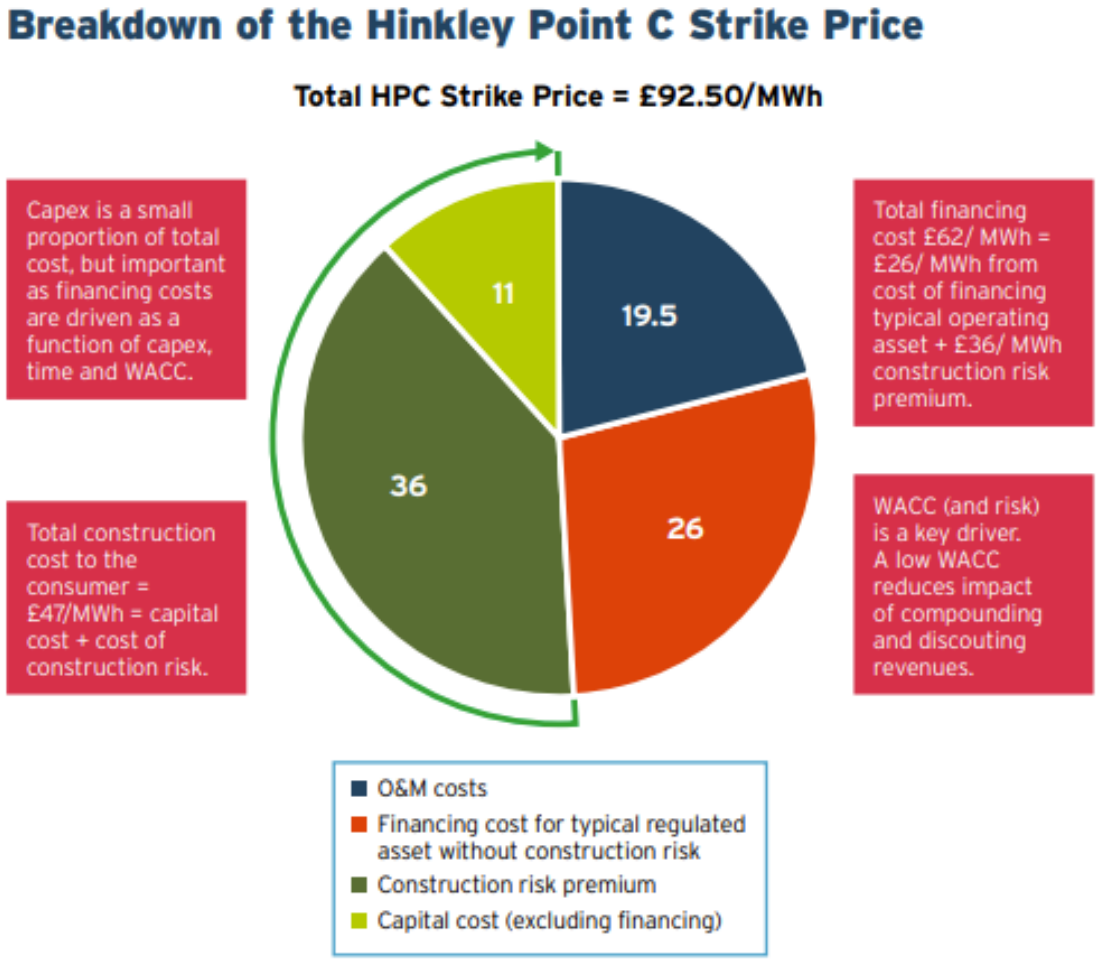
Cost Reduction

- Sector Deal: 30% new build reduction by 2030
- Financing is about 2/3 of lifetime cost: 1%-point reduction in the cost of capital worth up to £13/MWh
- Simple designs and construction methodology, repeating designs, and transferring a skilled workforce to new projects can all reduce costs
- Addressing construction and financing makes c£60/MWh, achievable for the next wave of plants, reducing to c£40/MWh for further units – or even lower
- Continuous investment ***will*** see costs fall – as with renewables



WACC (weighted average cost of capital) is the financing cost which for HPC was 9.2% on a post-tax nominal basis at time of final investment decision in 2016.

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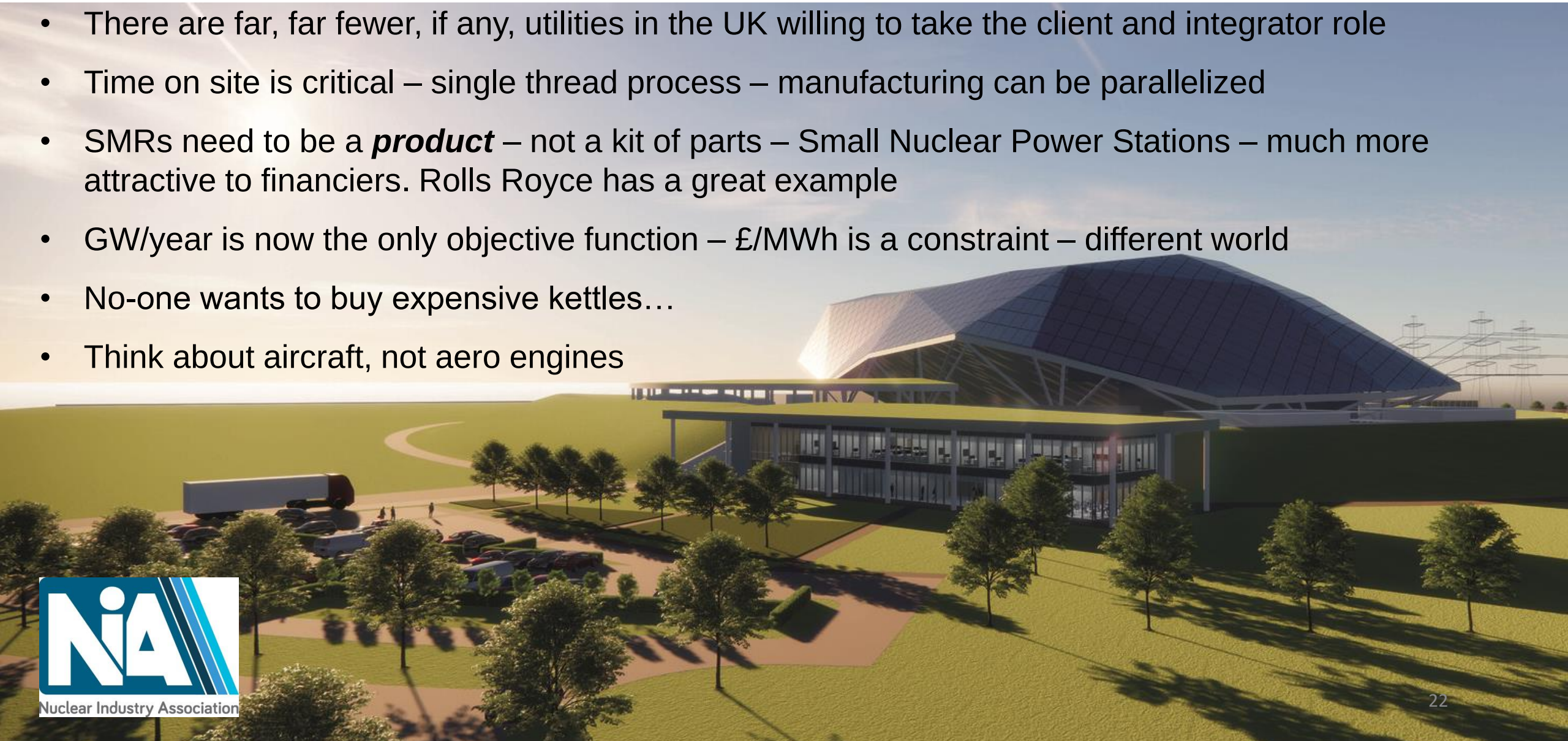
SMR Challenge

- There are far, far fewer, if any, utilities in the UK willing to take the client and integrator role
- Time on site is critical – single thread process – manufacturing can be parallelized
- SMRs need to be a ***product*** – not a kit of parts – Small Nuclear Power Stations – much more attractive to financiers. Rolls Royce has a great example
- GW/year is now the only objective function – £/MWh is a constraint – different world
- No-one wants to buy expensive kettles…
- Think about aircraft, not aero engines



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Inescapable Obligations

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Infrastructure Commissioning & Provision

Mixed economy – privatised or public provision

Privatised

- Water (heavily regulated)
- Energy (mixed regulation)
- Air traffic control (heavily regulated)

Public Provision

- Road and rail (despite rail franchising & PFI Roads…)

But in all cases, the state ***ultimately*** controls to some extent

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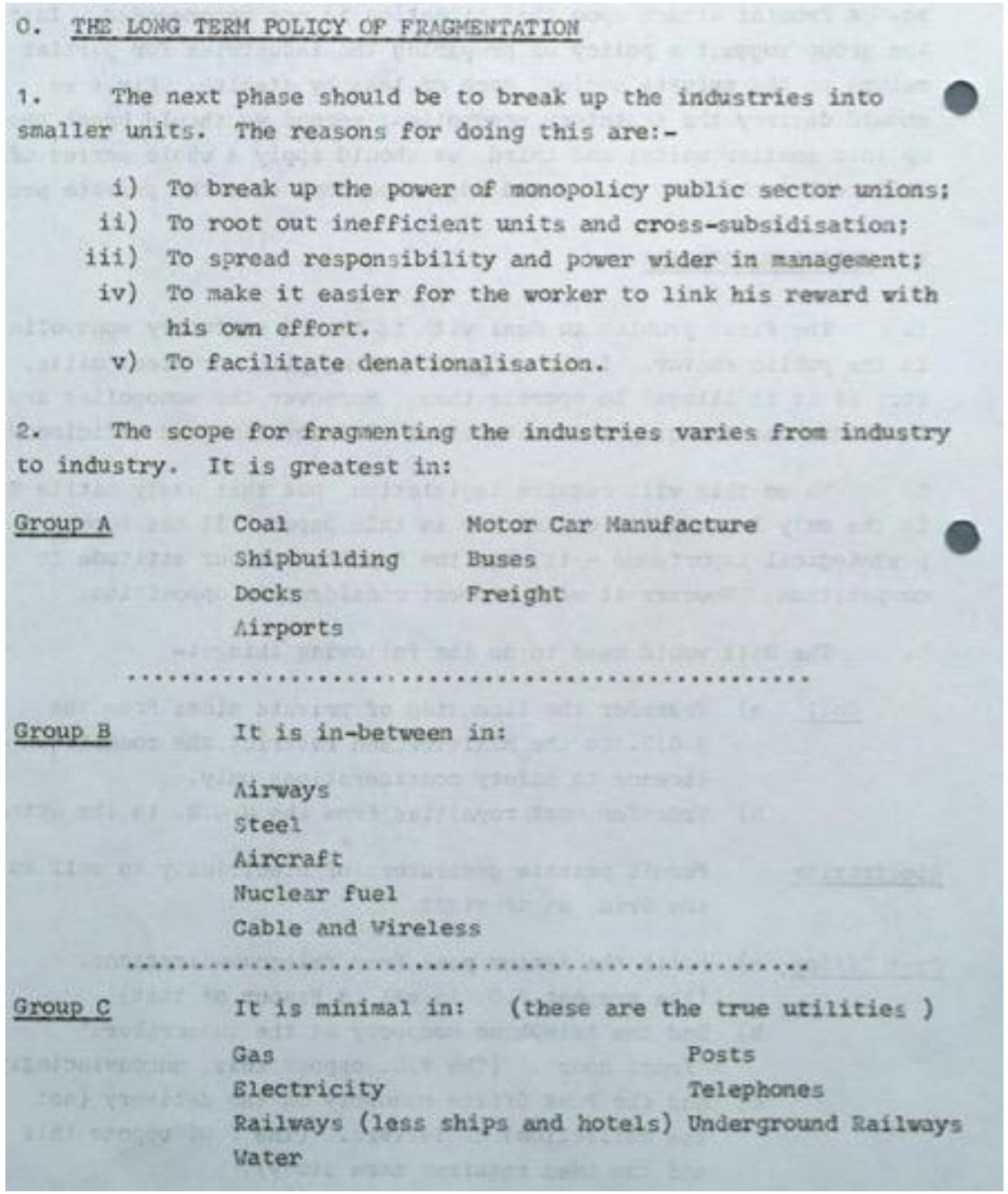
Privatisation – not quite to plan



0. THE LONG TERM POLICY OF FRAGMENTATION

1. The next phase should be to break up the industries into smaller units. The reasons for doing this are:-

i) To break up the power of monopolicy public sector unions;
ii) To root out inefficient units and cross-subsidisation;
iii) To spread responsibility and power wider in management;
iv) To make it easier for the worker to link his reward with his own effort.
v) To facilitate denationalisation.

2. The scope for fragmenting the industries varies from industry to industry. It is greatest in:

Group A	Coal	Motor Car Manufacture
	Shipbuilding	Buses
	Docks	Freight
	Airports	

Group B — It is in-between in:

Airways
Steel
Aircraft
Nuclear fuel
Cable and Wireless

Group C — It is minimal in: (these are the true utilities)

Gas	Posts
Electricity	Telephones
Railways (less ships and hotels)	Underground Railways
Water	

Source:
Conservative Research Dept.
Economic Reconstruction Group
Nationalised Industries Policy Group Report
(PG/10/77/38) – page 18
Hon. Nick Ridley
30th June 1977

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Simple truths

In nationally significant infrastructure, Governments “own” failure

Irrespective of apparent contractual protections, *force majeure* means ultimate failure ***cannot*** be outsourced - the `"L" in plc

If resilience isn’t at the heart of government policy and planning, it becomes a shorter-odds wager on the health and prosperity of citizens

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Scale of need

- Current UK energy usage is around an equivalent of 200GW at 100% capacity factor
- ***Hypothetical*** example below of a possible scale of each primary energy source is still vast
- Physical challenges are paramount, followed by people, sites and permitting
- Assumes can still move about ⅓ of energy down gas pipes…

Primary Energy	Assumed Capacity Factor	Total Needed	Actual power
Nuclear	0.92	67.39	62
Wind	0.5	120	60
Solar	0.15	120	18
H_2 from methane		60	60
		367.39	**200**

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Scale of need

- But what about resilience – how much more capacity needs to be on the system to preserve stability? Maybe another 10-15% - as extra generation or storage?
- Where's the overall system model?
- CarbonFreeEurope.org – with the David McKay book ("Sustainable Energy without the Hot Air") – are required reading

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Economic Regulation

But what about intergenerational obligations and consequences of decisions?

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Outlived its usefulness in its current form?

- Created to solve a problem of the 1980s
- Original idea was a “stopgap”
  - *RPI-X regulation was first proposed as “a means of ‘holding the fort’ until competition arrives” [Littlechild S C (1983), The Regulation of British Telecommunications’ Profitability, London, Department of Industry, para 4.11]*
  - *Regulation is essentially a means of preventing the worst excesses of monopoly; it is not a substitute for competition.*
- Duties now anachronistic in the time of climate change & energy security & sovereignty

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Outlived its usefulness in its current form?

- How should regulation work in an era of climate change and the need for ***massive*** pace & scale of change?
- Most adaptation of regulators to climate change (not thought about energy security yet…) is to stick a BandAid on their duties – no proper "zero-based" review – yet, anyway…
- But how to manage trust in regulators when they're reformed? Esp in financial markets….
- Trust & confidence are vital – a consistently recurring theme
  - Question for discussion is how to embed a ***duty*** of resilience as part of a very different approach to regulation

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Common failures

Bank of England has a second-order control on inflation – they can't control underlying prices (eg energy & food) from systemic shocks

Ofgem reminds Radio 4 *(16 May '22)* that they only regulate the ***retail*** market… they don't control underlying costs

> Bank of England governor says he is unable to stop inflation hitting 10%

Neither regulator actually controls the variable for which they are, supposedly, accountable. This appears to work fine in stable, slow-moving times. Not in general.

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Outlived its usefulness in its current form?

- Pure markets are essentially Darwinian Evolutionary mechanisms
- Are they appropriate for slow, heavy infrastructure?
- Are they appropriate for consequences of climate change – e.g. energy where we need to build something in the order of 8-10GW of low-carbon, primary energy generation ***every year*** from 2025-2050?
- What's a market in low-carbon energy when most forms of primary energy creation have low or zero marginal cost?
- What's the role of a market in forward cost discovery if the objective function is *max(GW/year)* subject to a price constraint?

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Imperfect Information

Where are the assets?

- Law-makers and the public/media don't have easy access to asset condition information
- Post-privatisation it's hard to garner a clear understanding of asset condition
- Managing asset condition and durability is not a central regulatory duty

Where are the liabilities?

- Public accounts have too many liabilities off-balance sheet
- Privately held assets are measured for the shareholders, not citizens
- How are regulators held to account?
- …and the liabilities from the way decisions are taken?

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But what's a balance sheet for anyway? Isn't quantisation pointless?

Cyclical Policy Changes

Government's corporate memory

- Increasingly diluted and lost in the civil service / administration
- Electoral timescale and frequent job reassignment means limited political institutional memory
- With a post-privatisation mindset, assumes that markets are managed by regulators
- Serious resistance to "Industrial Policy" and "picking winners"
- Increasing loss of sector expertise in civil service /administration – increasing number of "Rumsfelds"
- …all aggravated by glacial timescale of decay of infrastructure

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Ideal Markets - 1

Condition	Infrastructure?
A large number of buyers and sellers— A large number of consumers with the willingness and ability to buy the product at a certain price, and a large number of producers with the willingness and ability to supply the product at a certain price	✗
Perfect information— All consumers and producers know all prices of products and utilities each person would get from owning each product	✗
Homogeneous product— The products are perfect substitutes for each other, (i.e., the qualities and characteristics of a market good or service do not vary between different suppliers)	✗
Well defined Property Rights— These determine what may be sold, as well as what rights are conferred on the buyer	✓

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Ideal Markets - 2

Condition	Infrastructure?
No barriers to entry or exit	✗
Every participant is a price taker— No participant with market power to set prices	✗
Perfect factor mobility— In the long run factors of production are perfectly mobile, allowing free long term adjustments to changing market conditions	? ? ?
Profit maximization of sellers— Firms sell where the most profit is generated, where marginal costs meet marginal revenue	✓ ? ?

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Ideal Markets - 3

Condition	Infrastructure?
Rational buyers— Buyers make all trades that increase their economic utility and make no trades that do not increase their utility	✕
No externalities— Costs or benefits of an activity do not affect third parties. This criteria also excludes any government intervention	✕✕
Zero transaction costs— Buyers and sellers do not incur costs in making an exchange of goods in a perfectly competitive market	✕✕✕
Non-increasing returns to scale and no network effects— The lack of economies of scale or network effects ensures that there will always be a sufficient number of firms in the industry	✕

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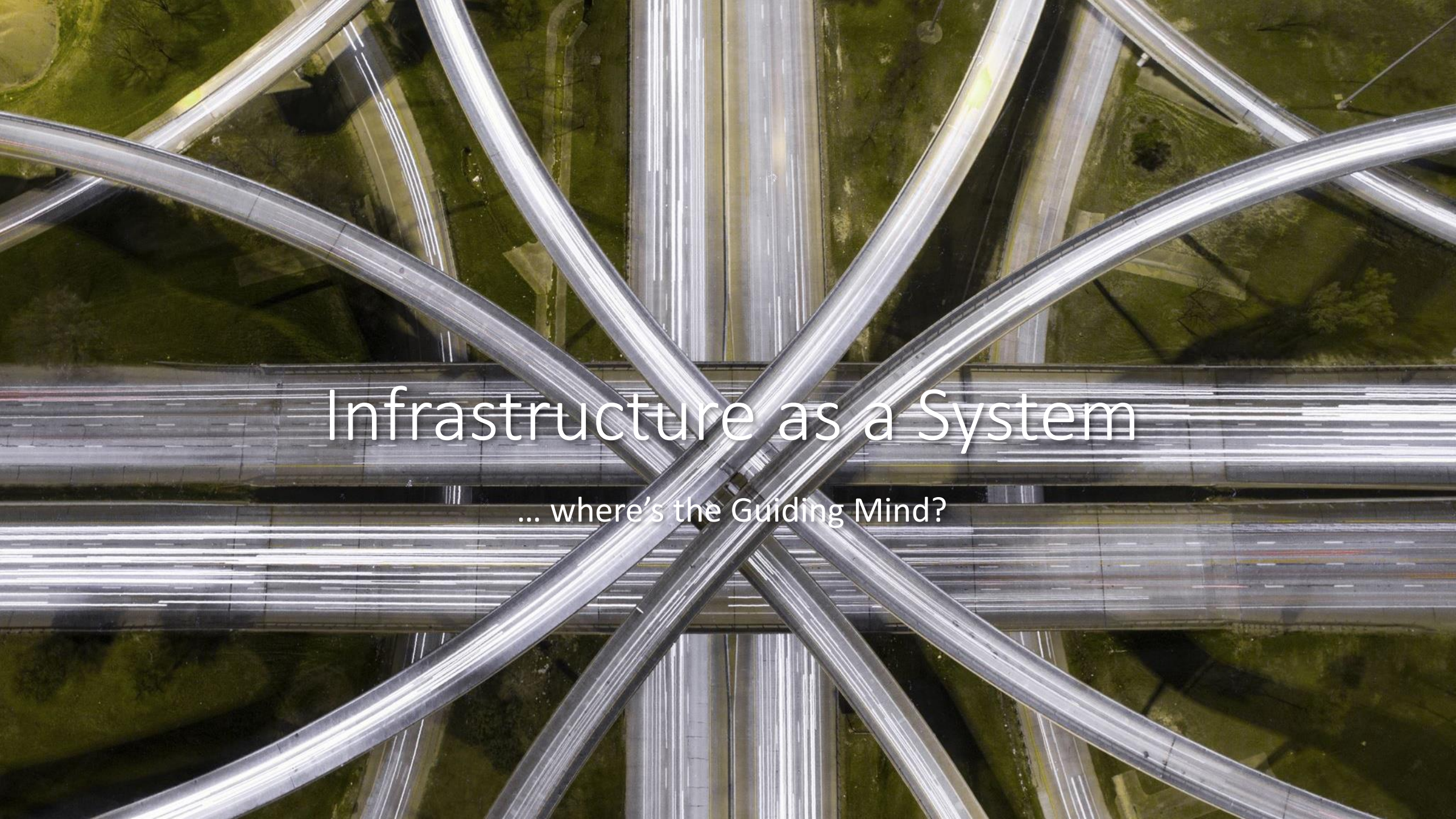
Does this sound like infrastructure?

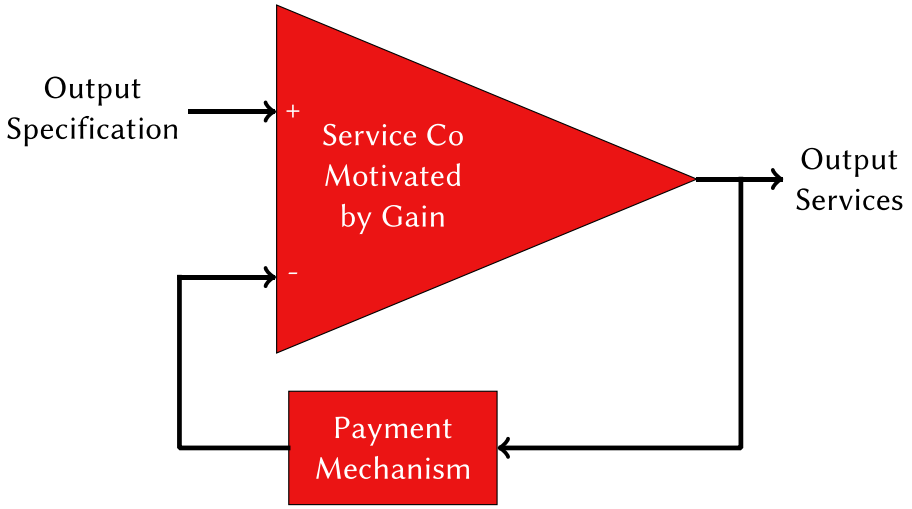


Infrastructure as a System

… where’s the Guiding Mind?

Infrastructure as a System

- P3 deals – the good ones – look like this
- Infrastructure is ***inherently*** a system – ***cannot*** be (re-)implemented as ad-hoc collection of bits
- Systems thinking completely forgotten in national energy policy post liberalized markets



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Infrastructure as a System

- In the absence of an effective Darwinian evolutionary process, there has to be some sort of plan
- No, not "*5-year tractor plans*"….
- For some aspects of climate change response, there is only time for a programmatic response
- Interdependencies mean systems thinking as consequences of decisions inherently last for many generations (see Bazalgette….)
- Needs some sort of "Guiding Mind" or "Convening Mind" (see Prof. Brian Collins)

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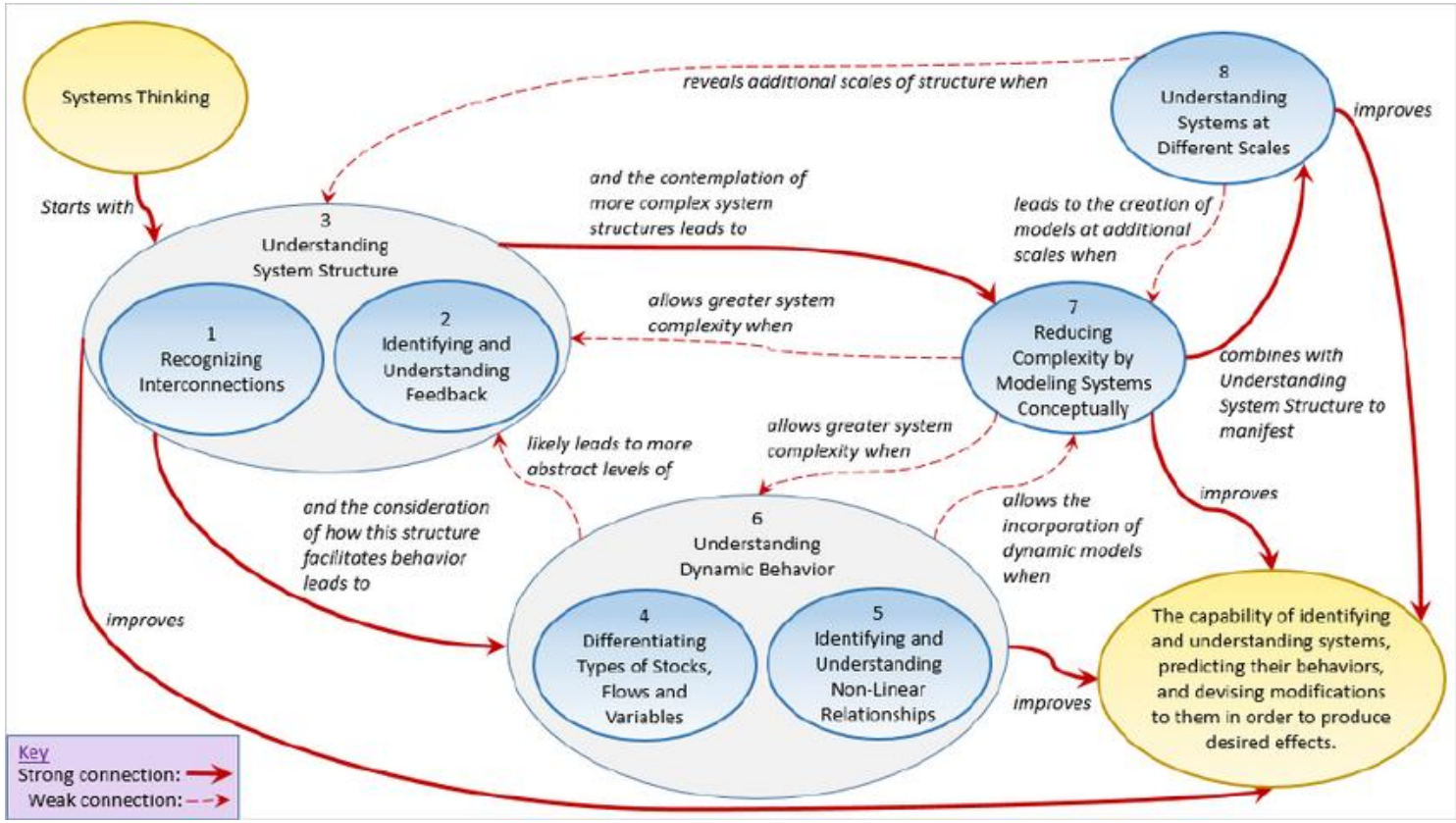
Infrastructure as a System

Because of limits to markets, the systems approach & guiding mind has to focus on best known solutions today with off-ramp scenarios for possible major technology changes

Energy costs will determine national competitiveness in 2050

Government simply cannot abrogate responsibility for ensuring this happens

And there's currently no competent body to whom they could, anyway.



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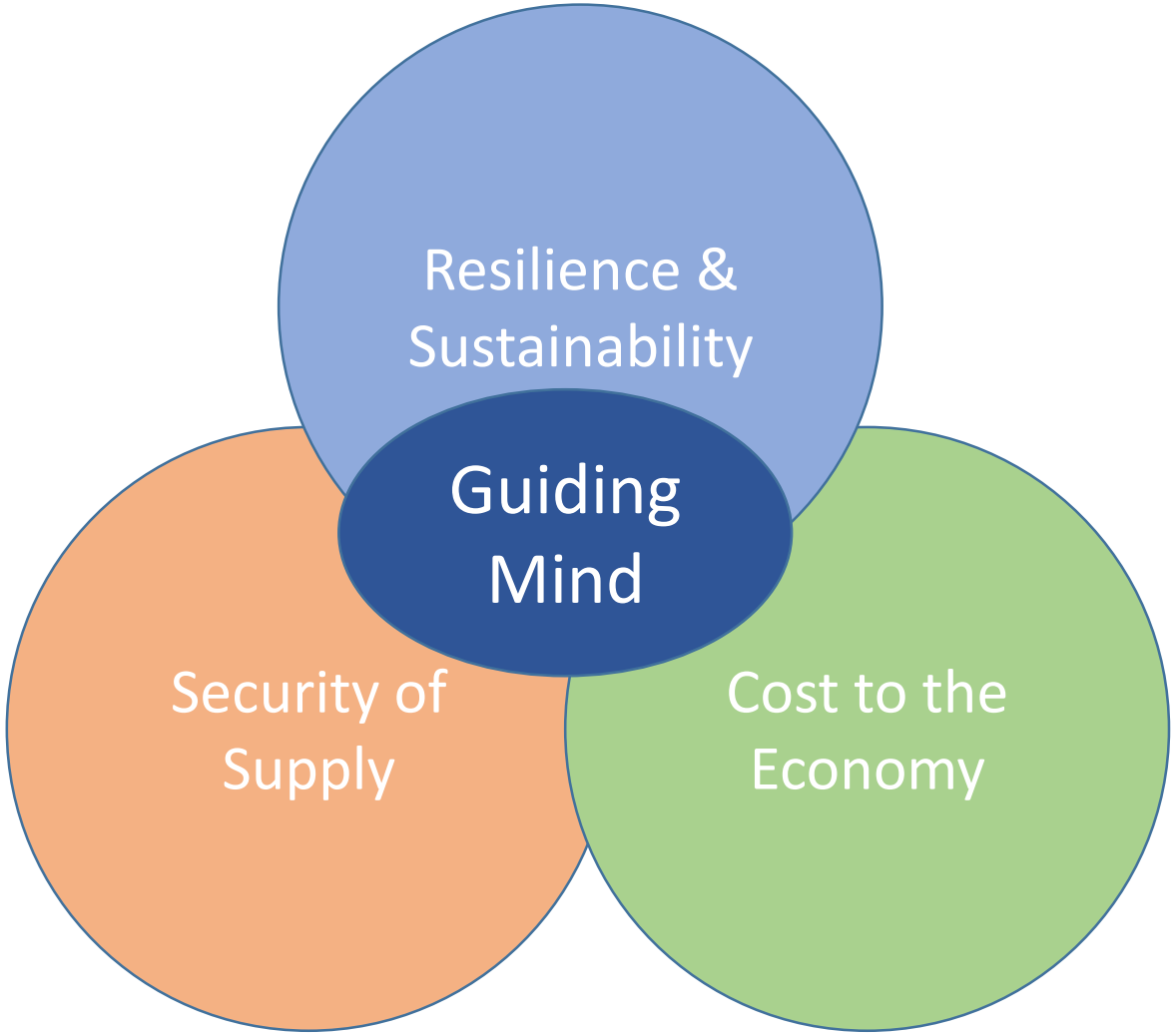
Systems Thinking – Energy Policy

- One image of how a Guiding Mind in energy might be structured
- Similar example is needed around wider infrastructure and housing
- All in the context of proper stewardship



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Great British Nuclear

What is it and what will be the outcomes?

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Final Thoughts

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Biggest change in a decade

- Net Zero provided the backdrop
- Really, triggered by Ukraine and realisation that UK does not have energy security (and hasn't, truthfully, for more than a decade)
- System plan needed – not fragmented loopholes joined by elastic
- Great British Nuclear has the clear attention of Whitehall
  - Full report submitted (on time and on budget….) on 2nd September
  - Chancellor said in Budget Speech, along with announcing Sizewell C, that GBN would be announced "before Christmas"
- But it's the *last chance* for another decade if not gripped – GW **&** SMR

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