Policy Brief

The importance of managing political and societal factors in the UK's energy transition

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Overview

- Political and societal factors play critical roles in energy transition, and their influence may increase in future, but they are difficult to understand and manage.
- Most energy system models used in energy planning analyse the technological and economic aspects of energy transition, making broad assumptions about policy making and policy outcomes.
- A new model, [TEMPEST](), includes political ("political capital for energy transition") and societal ("public willingness to participate") factors in its simulation of the UK's energy transition.
- The design of TEMPEST was based on a review of historical evidence about how and why changes in the energy system occur and informed by academic theories on socio-technical transition.
- TEMPEST was used to explore uncertainty about the future of UK's energy transition.
  a) Uncertainty was modelled by varying key influences on the energy system, including household income, drivers and barriers that influence political capital, technological development, and population.
  b) 58% of uncertainty cases reached net zero before 2080, but only 20% achieved cumulative emissions below the CCC budget to 2050.
  c) The uncertainty analysis highlighted the importance of demand for energy services, which rose steadily in most sectors between 1980 and 2019. It will likely need to decrease in future to achieve the required rates of emissions reductions.
  d) Two major uncertainties in how the energy system might respond in future are the level of societal pushback to policies, and the success of delivering the expected large emissions savings from new, complex technologies.
- Broad recommendations are made to inform governance of the energy transition.
  a) Ensure sufficient political capital is available to fuel the energy transition, especially up to 2030.
  b) Ensure there is sufficient public willingness to participate in the energy transition, through well designed policies and supported by social movements and technology innovation.
  c) Reduce the likelihood of pushback or policy failures, including assessing the importance of non-economic issues to societal actors, such as culture, fairness, convenience, and control.
  d) Look for opportunities to pilot whole system energy transition in specific regions, making use of unique local culture, geography, industry, and infrastructure, while providing benefits to local households and businesses.
  e) Manage the energy transition from a whole system viewpoint by regularly observing the strength of the five feedbacks and interactions between them.

Image 1

The Problem:

Political and societal factors play critical roles in energy transition, but they are difficult to understand and manage

Deep and structural changes in the energy system can take many years, sometimes decades, to happen. Power plants, buildings and infrastructure networks have long lives, while patterns of energy use in industry, commerce and households are well established and critical for everyday life.

The timescale available for the UK to achieve its legislated net zero emissions target is short, from now to 2050. There is little spare time to respond to policies that perform poorly or adapt plans that prove too difficult to achieve. To successfully meet this huge challenge, we need both swift and effective policy action from government, and broad societal responses that support and reinforce energy transition policy actions.

Looking back over the past few decades, it is clear that political and societal factors have play critical roles during system-wide changes in the energy system, in tandem with technologies and fuel supplies; however, not enough is known about this phenomenon to be able to manage it well. This policy brief describes a new approach to modelling energy transition, along with initial findings and their implications.

Image 2

A New Approach:

Energy transition modelling that includes political and societal factors

Conventional energy systems models used in energy planning, such as UK-TIMES[i], use optimisation to find the best potential pathways to net zero. This approach is vital, since we need pathways that will be technologically feasible and have manageable costs, but it is not the full story.

Experience from the past 40 years – in energy planning, energy market regulation, emissions reductions targets, and policies for reducing emissions – shows there are almost always differences between expected policy outcomes and what is actually achieved. These discrepancies must be accounted for in our planning if we are to create pathways with a high likelihood of succeeding.

A new model, TEMPEST, provides a more holistic view of the energy system and how it changes. Its design was based partly on historical evidence from the past few decades of UK energy system changes and energy policies, and partly on expectations about the remainder of the energy transition, up to 2050 and beyond. In TEMPEST, policy making, and policy ambition are part of the model calculations, rather than inputs.

To explain the model, we must first define four key terms:

1. **Mitigation measures** are any changes that reduce emissions and/or energy consumption. They work by: providing new low-carbon energy supplies, or improving equipment energy efficiency, or enabling fuel switching from high-carbon to low-carbon fuels, or reducing demand for energy services such as heating and transport.
2. **Political capital** is the potential political power that can be invested in policy ambition by governments [1]. It is a kind of "fuel" which can be used to set targets and launch policy programmes. It is gained both through elections and positive responses to policies. It can be spent on ambitious policies or lost through poor policy outcomes or wider changes such as economic downturns.
3. **Public willingness to participate** indicates the likelihood that the expected outcomes of policies will be achieved. It is a combination of the agency (ability) of actors in society to take action [2], and their motivation to carry out these actions. Motivation is sometimes intrinsic, arising from personal choices-based ethics. Motivation can also be extrinsic, arising from government mandates, regulation, incentives, or taxes. There is often a difference in what people say they would do/support versus what they actually do/support, as seen in the "attitude-behaviour gap" [3] and "intention-behaviour gap" [4]. At least some extrinsic motivation is usually needed.
4. **Pushback** arises if policies are badly received by society or badly run, and it can reduce political capital. For example, the fall of the Northern Ireland government was partly due a badly run renewable heat incentive scheme [5]; there has been public anger at car manufacturers who circumvented EU vehicle emissions reduction targets through dishonest vehicle emissions testing; and there have been direct protests against energy policies that are seen as unfair (e.g., fuel strikes against increased road fuel taxes).

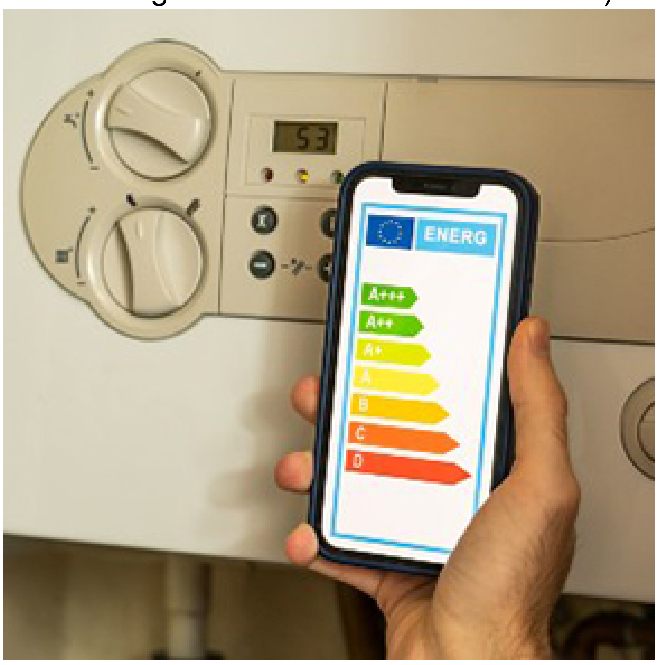

Image 3

The model:

Feedbacks and their influence on energy transition

TEMPEST captures the role of political and societal factors in energy transition within a structure of five system feedbacks. Feedbacks are either reinforcing (grow indefinitely until interrupted) or balancing (goal seeking, active until a goal or limit is reached). They are illustrated as a causal loop diagram below[ii]. The five feedbacks are explained as follows.

Loop 1. Balancing: mitigate until target is reached.

Emissions savings must be achieved until the target reaches zero. Once the target is reached, the balancing loop ceases.

Loop 2. Balancing: the mix of measures are more difficult as target is approached.

Much of the easiest potential for emissions savings, such as efficient light bulbs and shifting from coal to natural gas in the power sector, has been used. The remaining potential generally rests with more difficult measures: those that are more novel and technologically complex such as hydrogen as an energy carrier; those that require equipment changes that can cause disruption such as domestic heat pumps; or those that require a change to patterns of consumption of energy services such as the way we travel or do business.

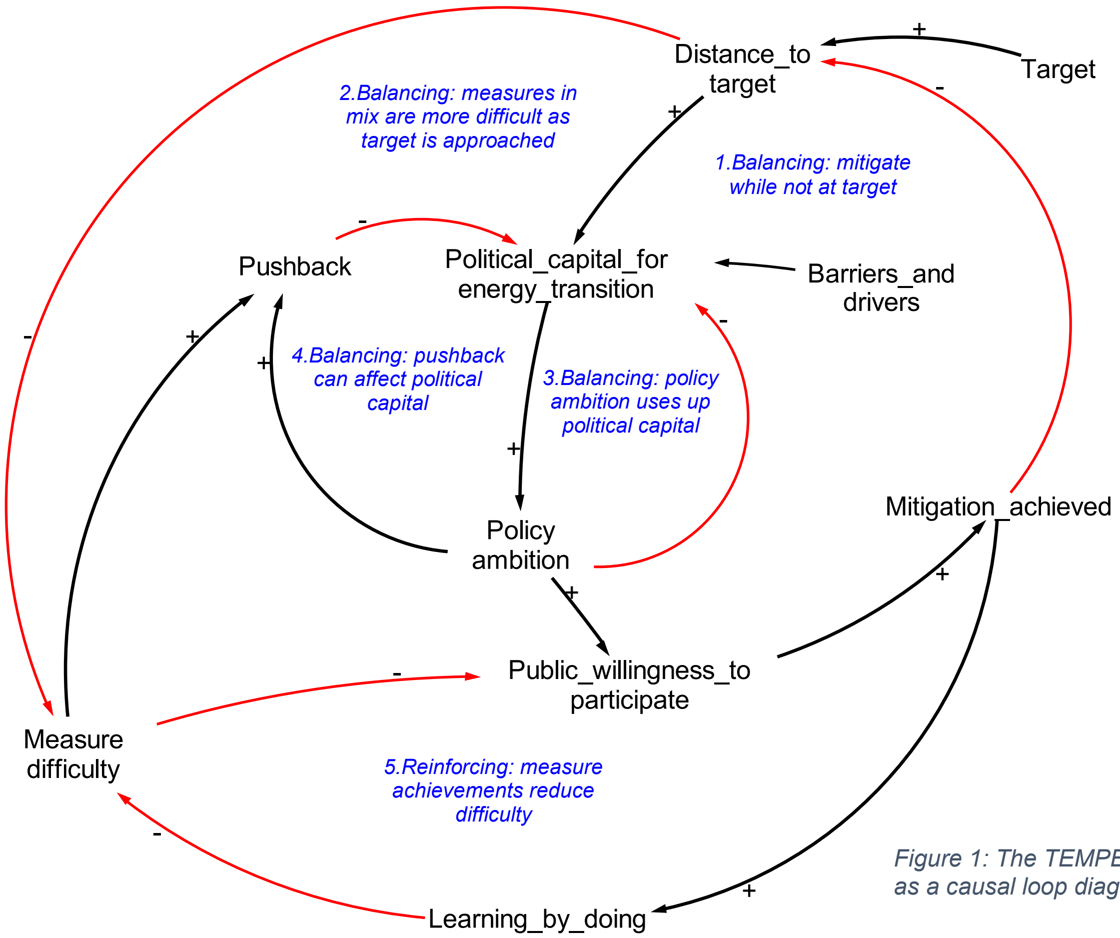

Figure 1: The TEMPEST model as a causal loop diagram

Loop 3. Balancing: policy ambition uses up political capital.

As policies are launched, available political capital is used. The amount of political capital available limits the ambition of policies. The supply of political capital is influenced by the distance to the final target, and by drivers and barriers such as economy and elections.

Loop 4. Balancing: pushback can affect political capital.

Pushback (negative public responses) to policies can happen when there is a combination of high measure difficulty (behavioural or technological) and high policy ambition. It tends to reduce political capital.

Loop 5. Reinforcing: measure achievements reduce difficulty.

Loop 5 represents learning by doing: *'the more something is made, the better it can be made*' [6]. Learning by doing enables early-stage development of mitigation measures (pre-commercialisation), and the reduction of technology costs and user impacts after commercialisation – making them more attractive to adopt, and (eventually) not policy dependent.

Loop combinations

Three loop combinations may become important on our route to net zero:

- The combination of loops 4 and 5 forms a reinforcing loop that can run in two directions. If loop 5 strongly reduces measure difficulty, then "negative pushback" could actually increase political capital and adoption of measures. For example, the popular feed in tariff programme for building-mounted solar PV increased public support for solar PV and also reduced prices. A weak loop 5 makes pushback more likely, as high measure difficulty combines with the high policy ambition needed to meet the target.
- Loop 2 is counterbalanced by loop 5. If loop 5 can reduce mitigation measure difficulty faster than the rate at which more difficult measures are required, then loop 2 will become insignificant.
- Loop 5's growth rate would be limited by unavailability of sufficient policy ambition through loop 3. This may occur if political capital is reduced due to barriers such as economic downturns.

Uncertainty testing

TEMPEST was used to explore uncertainty in the future of the UK's energy transition, based on variations in key influences on the energy system – disposable income, political capital drivers and barriers, and population.

Figure 2 (overleaf, top) shows a histogram of future (2020 to 2080) cumulative emissions across 1000 uncertainty cases. The distribution is positively skewed, indicating the most likely emissions are at the lower end of the scale, but with a system propensity towards much higher emissions under more uncertain conditions.

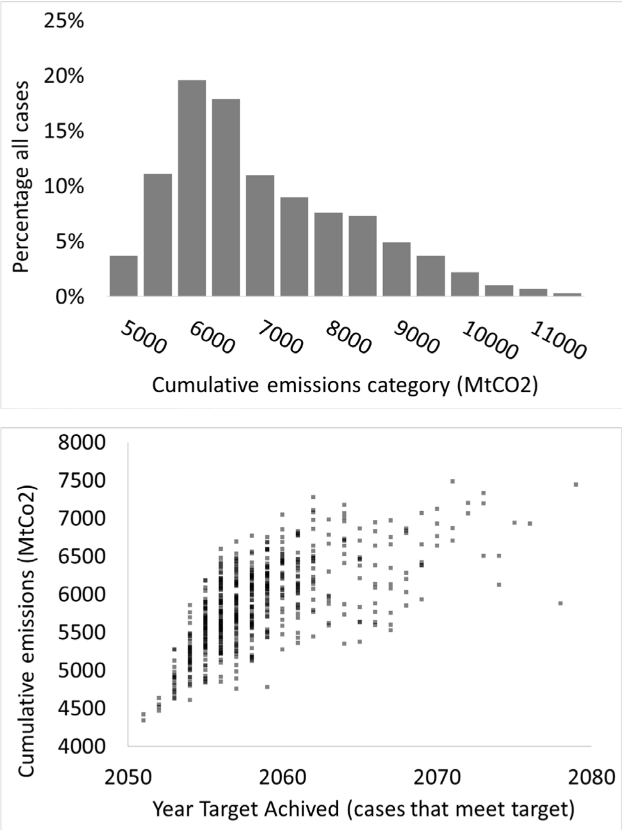

Figure 2: Histogram of cases according to future cumulative emissions (top), and plot of emissions against year that target is met for those cases that do achieve the target (bottom).

Analysis by groups of cases

Four groups of cases were derived from the uncertainty analysis based on their success in reducing emissions. Group 1 (20% of cases) is the best. It stays within the $MtCO_2$ budget in the Committee on Climate Change's (CCC's) 6th Carbon Budget [7], and reaches the net zero target by 2056. Group 4 (20% of cases) is the worst. Its emissions are 70% higher than Group 1 and it fails to reach the target before 2080.

Figure 3 (overleaf, top) illustrates emissions over time for the four groups. While groups 1 and 2 achieve steady reductions in emissions and net zero by 2060, groups 3 and 4 achieve reductions much more slowly, emissions begin to rise again after 2060, and the net zero target is not met.

Figure 3 (bottom) shows percentage differences in the key indicators of energy transition for groups 2 to 4, as a percentage change against group 1. Political capital, policy ambition, and public willingness all decline significantly from group 2 to group 4, although there is a much smaller change in learning by doing.

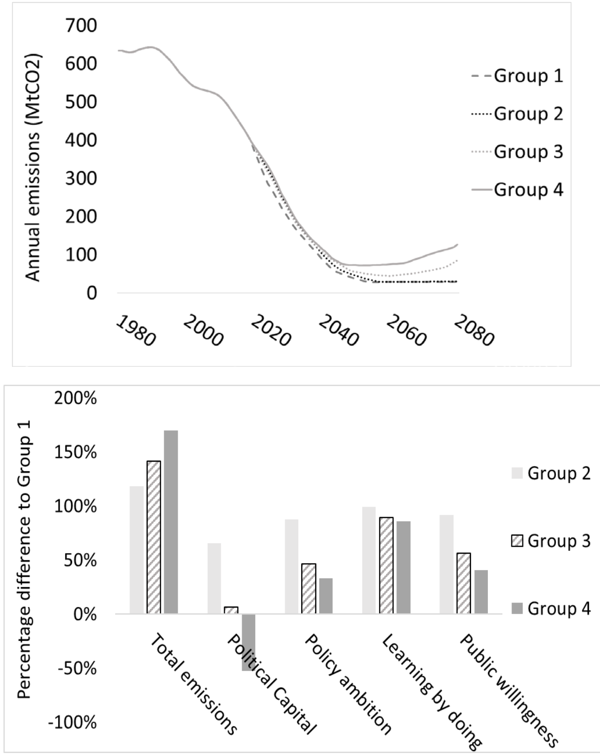

Figure 3: Comparison of four groups of cases from the uncertainty analysis. Annual emissions over time (top) and percentage differences in key indicators compared to the most successful group (bottom).

The importance of political capital availability

The uncertainty analysis shows the importance of having sufficient political capital available for energy transition from now up to

2030. The more available early on, the lower the total emissions reductions needed to get to net zero.

While spending a lot of political capital early on could be risky for politicians, the rewards for society would be seen in shortening the length of the energy transition and reducing its overall cost.

The importance of behavioural measures

Between 1980 and 2012, energy service demand in air and surface transport, residential, and services increased steadily, starting to decrease slowly after 2012. The uncertainty analysis showed how important behavioural measures are for the whole energy transition. Behavioural issues have also been flagged as important by the CCC: 59% of planned emissions reductions require at least some behavioural changes [8].

Figure 4 shows energy savings from changes in per capita service demand in residential, air transport and surface transport sectors.

Groups 1 and 2 achieve net reductions in service demand after the peak demand in 2012, by the time they reach net zero. Groups 3 and 4 see a net increase in service demand by 2080. A lack of policy ambition, due to a lack of political capital, means there is not enough impetus to reverse existing behavioural patterns.

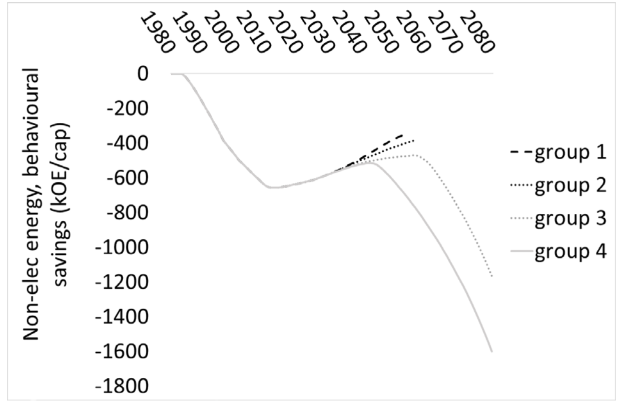

Figure 4: Energy savings for non-electric fuels by groups of uncertainty cases.

What would the pattern of service demand in groups 1 and 2 look like in practice? Energy service demand would be reduced to levels last seen in the mid-1990s by 2060. If achieved solely through changes such as traveling less or reducing indoor temperatures in winter, this would feel like a step back in progress for many. However, this level of reductions can be avoided.

Firstly, changes to service demand may only be needed for a period of a decade or so, while low-carbon technologies are ramped up.

Secondly, achieving changes to energy services could be possible without strongly negative effects on lifestyle, through new smart and flexible ways of delivering services.

Thirdly, if energy efficiency and reducing the carbon intensity of fuels is achieved much faster than expected, then large reductions in service demand would not be needed.

Differences in system responses

Uncertainties exist not only in external influences on the energy system, but also in assumptions about changes within the energy system. TEMPEST was calibrated to approximately reproduce the behaviour of the energy system from 1980 to 2019, and then extended into the future, yet we don't know how much the future will look like the past.

Two assumptions about the energy system are likely to be particularly influential in future:

1. How much policy pushback will occur, compared to the past, if more rapid and deeper changes are seen in the energy system that have potential to impact many aspects of daily life across society.
2. How successful will be plans be to commercialise and build capacity of new, complex technologies, like hydrogen as an energy carrier and carbon capture and storage. These could be required to deliver significant amounts of emissions reductions in future.

To test the possible impacts of these uncertainties, conditions for Group 1 were tested under worse (higher) pushback and more difficult new technologies, and the conditions for Group 4 were tested with better (negative) pushback and less difficult new technologies.

Group 1 cumulative emissions rose by 27% and the net zero target was not reached, while Group 4's cumulative emissions fell by 5% with the target not reached as before.

This test illustrates the importance of loops 4 and 5 for achieving targets. An unexpected pattern of much better or much worse responses, from the energy system and society, could mean missing the target even under good general conditions or could improve results even in poor conditions.

Reducing uncertainty

We are now entering relatively unchartered waters. There is little experience of rapid, system-wide transformation in a critical and highly complex infrastructure. There are several approaches to reducing the risk of missing targets. These are options that could weaken loop 4 and/or strengthen loop 5. For example:

Social innovation: Social movements that support climate action could increase public willingness and reduce pushback by supporting actors across society to implement mitigation measures and finding new solutions that work in diverse end-use situations.

Innovation in service delivery: Smart technologies, intelligent controls, and fast end-use technology development could enable service demand to be reduced without negatively impacting societal wellbeing.

Measure development: Policies could be targeted to increase the speed at which new technologies are brought to market, and to support transformation of supply chains to enable faster adoption of mitigation measures.

Solutions: Achieving a good glide path to net zero emissions

An ideal glide path to net zero emissions would be neither too fast, risking damage to the economy and poor policy outcomes, nor too slow, risking increased cost of energy transition and missing the net zero target. The following recommendations are made in this aim.

Ensure sufficient political capital

Communicate the full benefits of the energy transition to the public, to put any transitory economic and disruption costs into perspective. Find and utilise co-benefits with energy transition actions, to align with other strategic priorities. This is particularly important from now up to 2030.

Ensure sufficient public willingness through social innovation

Aim to mix incentives, regulation, educational programmes, and taxes in a balance that ensures consumers and firms have sufficient support to act, sufficient motivation to act, and sufficient information feedback to see the results of their actions. Social movements that support climate action could increase public willingness by supporting actors across society to implement mitigation measures where needed and finding new solutions that work in diverse situations.

Reduce the likelihood of pushback or policy failures

Aim to balance levels of policy ambition, and the types of policies being run, with public willingness, to reduce the likelihood of pushback to policies. Where needed, design policies specifically to reduce disruptions to households and businesses from implementing climate actions. Pay attention to non-economic issues that are important to people, such as culture, fairness, convenience, and control.

Look for regional opportunities to pilot whole system energy transition

A regional approach to decarbonisation could be aligned with the government’s Ten Point Plan for a Green Industrial Revolution and its overall levelling up agenda. It could make use of city-focused initiatives, unique local culture, geography, industry, and infrastructure, while providing benefits to local households and businesses.

Manage the energy transition from a whole system viewpoint

Regularly observe the strength of the five feedbacks, and interactions between them, to identify key trends influencing the transition. Improve the strength of learning by doing through policies that support rapid technology research and development in industry along with responsive supply chains that enable widespread adoption of mitigation measures.

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Image credits

Image 1. UK Parliament / Jessica Taylor
Image 2. Marc Olivier
Image 3. Uswitch.com

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[i] UK-TIMES is an energy system model of the UK that has been developed by UCL and the UK Department of Business, Energy and Industrial Strategy: www.ucl.ac.uk/energy-models/models/uk-times

[ii] Causal Loop Diagrams are 'visual representations of the dynamic influences and inter-relationships that exist among a collection of variables' [9]. They can help to quickly capture hypotheses about the causes of system dynamics, and communicate important feedbacks believed to be responsible for a system's behaviour [10]. Causal Loop Diagrams consist of variables connected by arrows, which represent causal links between the variables. Each causal link is either positive (indicated by a "+" sign) or negative (indicated by a "-" sign) to indicate how the dependent variable changes due to a change of the independent variable [11].