

O-STET: Heat decarbonisation branching points

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The Challenge:

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- Net Zero targets focus attention on decarbonisation and promote engagement of policy and political roles.
- Across the economy, there's need for transformation of existing systems to deliver zero carbon services as alternatives.
- Socio-Technical Energy Transitions (STET) research offers learning on how wide-reaching radical innovations happen.
 - STET often applied to historical developments and/or to structuring scenarios of future development
 - But how do future pathways come to be shaped and enacted? How do past stories of grand arcs of change appear from within them and part way through the process?

How can STET be used to facilitate policy decisions and developments for transition in progress?

- Consider the issue of **heat decarbonisation** - Live, unresolved and challenging setting (for policy and for industry alike)
- Use STET concepts of **pathways & branching points**

UK Heat Decarbonisation

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Policy attention and the need to decarbonise heating:

- Net Zero carbon emission target for 2050 (2019)
- > a third of greenhouse gas emissions
- Featured in the UK Clean Growth Strategy (2017); work from Committee on Climate Change (CCC) (2016; 2018; 2020); important area of activity in BEIS (including policy roadmap).

Domestic heating:

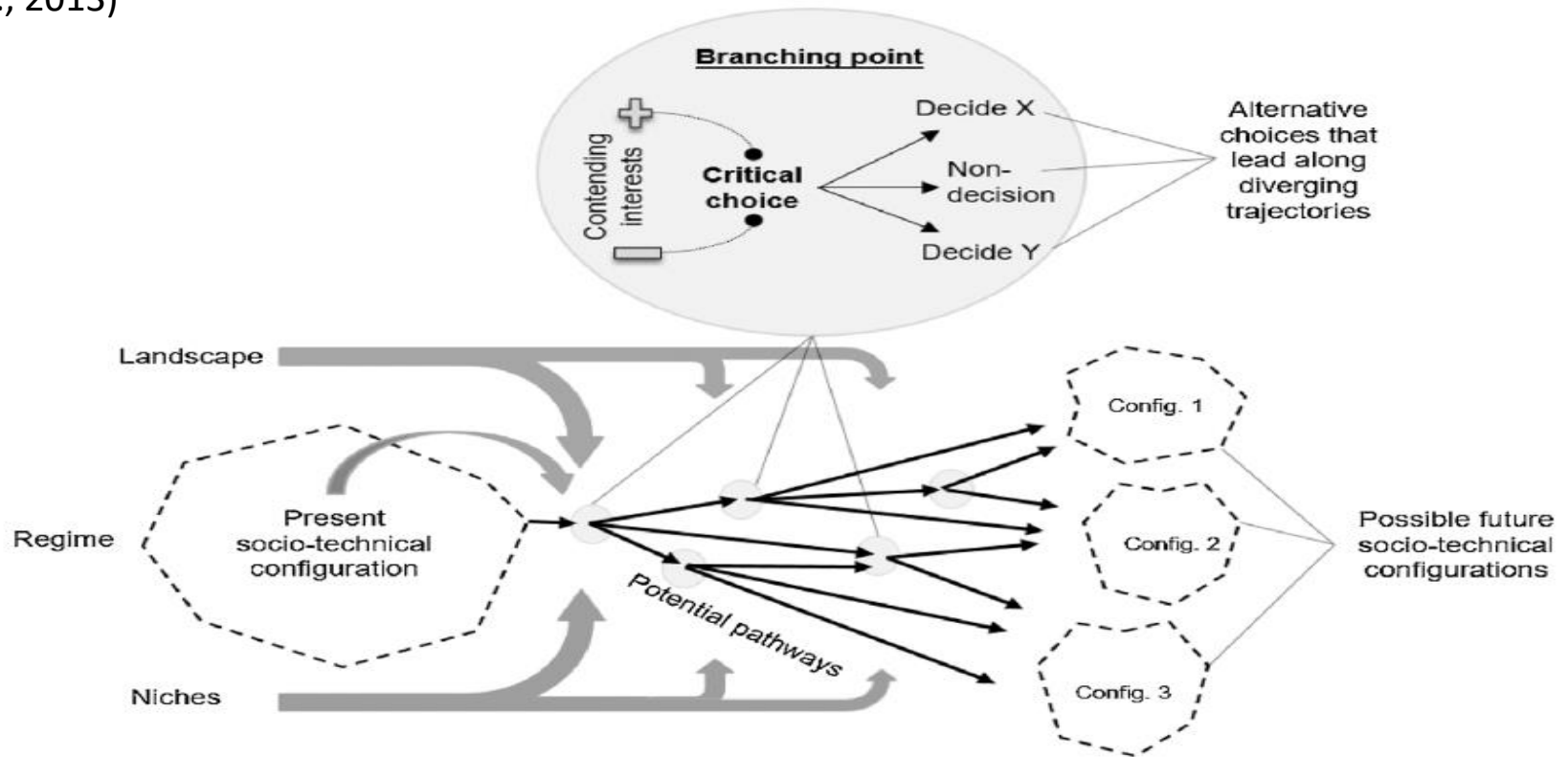
- Dominated by natural gas (combined space & water heating); ~24 million connections to the gas grid
- Exiting housing stock varied and with poor thermal efficiency (Guertler et al., 2015)
- Heating is personal – expectations over usage patterns and within the home

Addressing heat decarbonisation:

- Heat sector has high importance for decarbonisation and increasing attention
- **Range of technology options** developing but not a single solution hasn't emerged
- Not a simple technology substitution – people's **behaviour and lifestyles involved**
- **Future of the gas grid** has become an important framing/step across the sector
- **Change will need to cover all usage** - buildings/users/areas/demographics

Pathways & Branching Points

Branching Points: “key decision points at which choices made by actors, in response to internal or external stresses or triggers, determine whether and in what ways the pathway is followed” (Foxon et al., 2013)



Mapping transition pathways for change: 3 steps

Stage	Focus	Findings	Methods
Identify socio-technical pathways of development for low carbon heating	Areas of innovation and development activity for alternative low carbon approaches to heating. Knowledge & system development and implementation steps.	4 separate socio-technical pathways identified <ul style="list-style-type: none"> - Different actors - Decisions around implementation being made at different scales 	Review of policy documents Analysis of interviews with industry actors
Map potential pathway connection points	Socio-technical pathways come together and are influenced by each other. Points and spaces where connections known/anticipated.	Identify a wide variety of connection points between pathways. Including decision-points situated in existing technology, new business models and policy activities.	Analysis of interviews with industry actors; Check with policy documents; Workshop feedback
Unpack the position, potential and needs of pathway connection points.	Pathway connection points as spaces of co-ordination between pathways. Could be sites of experimentation and growing alternative approaches. Used two examples: Hybrid heat pumps and local area energy planning	Can enable consideration of state and potential of sites. Potential as pragmatic intervention points. Reflect on how fit together to span sector.	Workshop to trial and unpack further. Draws on interview data and industry reports.

Step 1: Pathway(s)

- Separate pathways:
 - different actors, focus and mechanisms
 - decisions for development and for implementation sit at different scales
- Approach needed to go beyond single selection point between pathways
 - Future of the gas grid
 - Diffusion of retrofit
- Bringing together pathways:
 - A combination of these socio-technical areas will be needed
 - How to co-ordinate between pathways in decisions and in development is yet to emerge

	Networked, coordinated joined up change	Distributed change is possible
System adaptation	Hydrogen through gas networks <ul style="list-style-type: none"> • Technological response centred on existing actors and assets • Coordinating to national (GB) scale • Purposeful pathway, co-ordinated around shared vision • Key decision-points within the pathway include research projects set up, regulatory changes etc 	Demand reduction measures for space and water heating <ul style="list-style-type: none"> • Often framed by individual dwelling/consumer and diffusion issues but also represented in co-ordinated retrofit projects (by region, by building type...) • Policy tends to be adoption/diffusion based • Potentially complementary to all of the other pathways
System reconfiguration	Heat networks <ul style="list-style-type: none"> • Development of knowledge and expertise is built through projects and as part of localised/place-based approaches • Individual projects can add to a broader pathway - building knowledge and altering the context for future projects • Close connection between HN performance and demand reduction measures 	Electrification (low-carbon) of heat <ul style="list-style-type: none"> • Framed and treated in a variety of ways throughout the data • There are dwelling by dwelling viewpoints; project perspectives and approaches involving regional/national considerations • Some configurations have necessary co-ordination connections with demand reduction. • This pathway also links to considerations of other uses of electricity (e.g. transport).

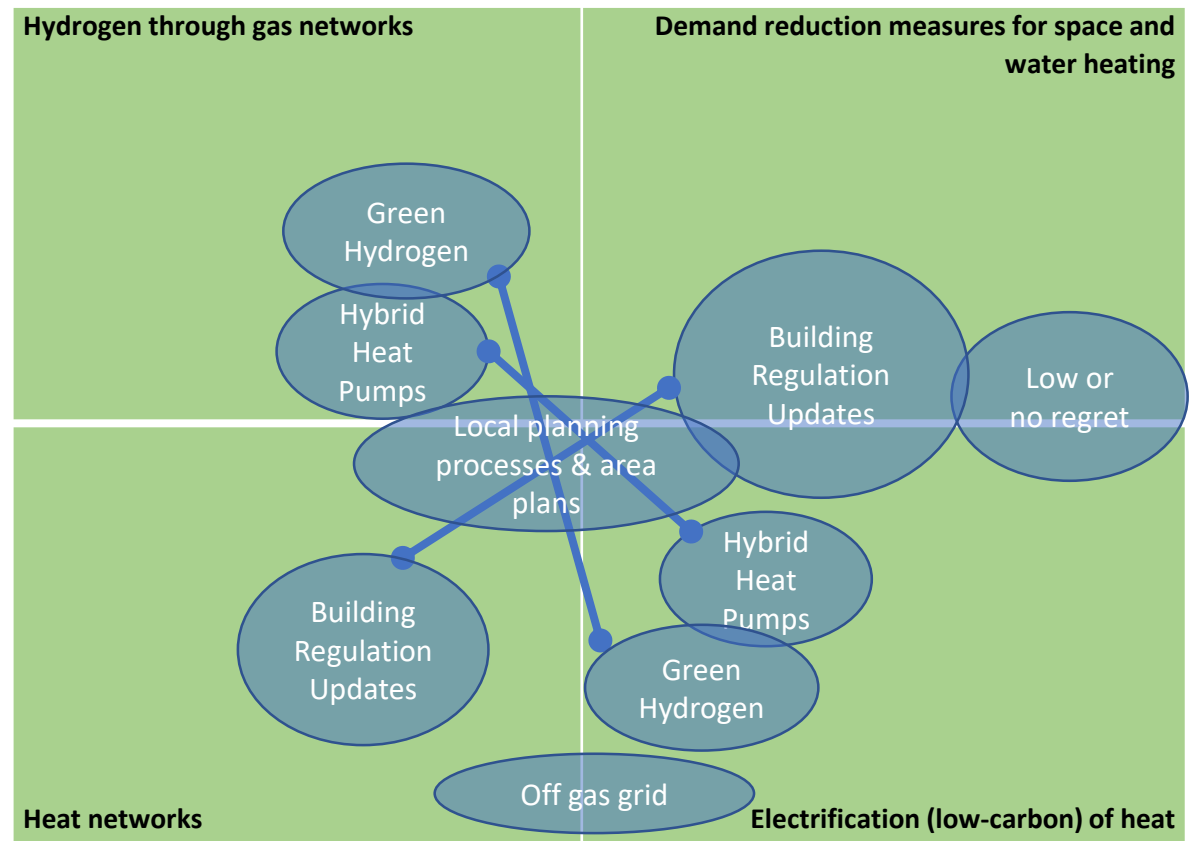
Step 2: Pathway connections

Identified connections

- Building regulations
- Green hydrogen
- Hybrid heat pumps
- Low or no regret
- Off gas grid
- Place-based local planning (including zoning & local area plans)

Open connections

- Built environment projects
- Heat as a Service
- National level futures approach
- R&D or Innovation funds
- Replacement decision



Step 3: Understanding potential connection point

- Case study material and a workshop with ESC used to consider two examples in more detail: Hybrid heat pumps & **Place-based local energy planning**
- To understand underpinnings of connection point and consider its potential developments
- Potential for strategic overview considering decision-points within the 4 pathways alongside cross-cutting decisions
- Potential to consider alternative development options, potential impacts and opportunities from points of connection already emerging
- Could also to look across pathways and connection points to see potential alignments and tensions

	Techno-economic	Socio-technical	Political
Drivers for connection point development	-Energy system characteristics are local and areas differ. Solutions/responses need to be adapted to local conditions. (demand/resources/infrastructure)	-Help with supply chain/skills. Local plans can serve to help identify solutions for an area and bring relevant education institutions to help with skills	-All areas are different so solutions must be appropriate for local situations. - The process of generating local plans, can bring citizen engagement in what net zero may mean to their area – supporting behavioural change
Needed to develop this connection space	- National to local infrastructure connections. Boundaries and how to co-ordinate	-Pathfinder areas - some local areas to lead and learn, then share with others / act as exemplars - Capacity building for planning at local level - in terms of resources/skills etc.	-Sit within a national framework – Need encouragement for LAs to develop place-based plans -Socialisation of costs (linked to area size) – How to serve the range of different users – has implications for household costs, access, fairness/justice
Potential to aid co-ordination of development towards net zero	Gives all users the agency to contribute to the energy transition solution helps to show the scale of local markets for different solutions Can help to attract investment into local areas by providing certainty over developments Helps network operators understand what changes might occur across their 'patch' Social housing is an area where it could be easier to act and address decarbonisation (some Local Authorities (LA) using as a starting point) Possible tensions between national government and LA (who gets to do - resources & responsibilities) National planning framework review - Funds & planning framework could be the basis for supporting local plans and connecting back into national policy		

Strategic learning for developing pathways

- Conducting this kind of mapping process with stakeholders holds potential to support further steps to address cross-sector co-ordination and assess strategic sites of learning and experimentation
- For example, strategically linking together pathway connection points
 - Hybrid heat pumps and Heat as a Service approach
 - Deep retrofit, heat pumps and particular setting (e.g. social housing)
 - Local area plans/zoning with connecting networks (considering different types of heat network and gas distribution projects)
- Could nurture sites of connection that allow for learning and experimentation to:
 - Support pathways of development (what steps needed in technology, business models, users etc.)
 - Co-ordinate between pathways (aligning/contesting)
 - Facilitate policy interventions (build evidence and legitimacy)
- Follow up with evaluations, reassessments and further steps to steer and support decarbonization development

Conclusions

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“People are going to have different perspectives on what’s right and what’s wrong in this space, so it’s not just hydrogen versus electricity but it’s the nature of the consumer rights, the amount of continuity or disruption we think consumers are willing to accept in return for change that’s going to cost money and it’s going to be difficult to legislate for and to implement practice.”

(Policy actor interview)

- Net Zero requires co-ordination of decarbonization across heat delivery
- Branching points and pathways process
 - Identifying development patterns and characteristics
 - Map openings for pathway interactions and new directions of change
 - Critical engagement with framing and connections between policy and different modes of system development
 - Offers a basis for ongoing processes of learning and co-ordination



Science Funding

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Thank you for your attention!

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Socio-technical Systems Transitions Food

Poverty Low Carbon Infrastructure In

Inclusive Growth

Creative Industries

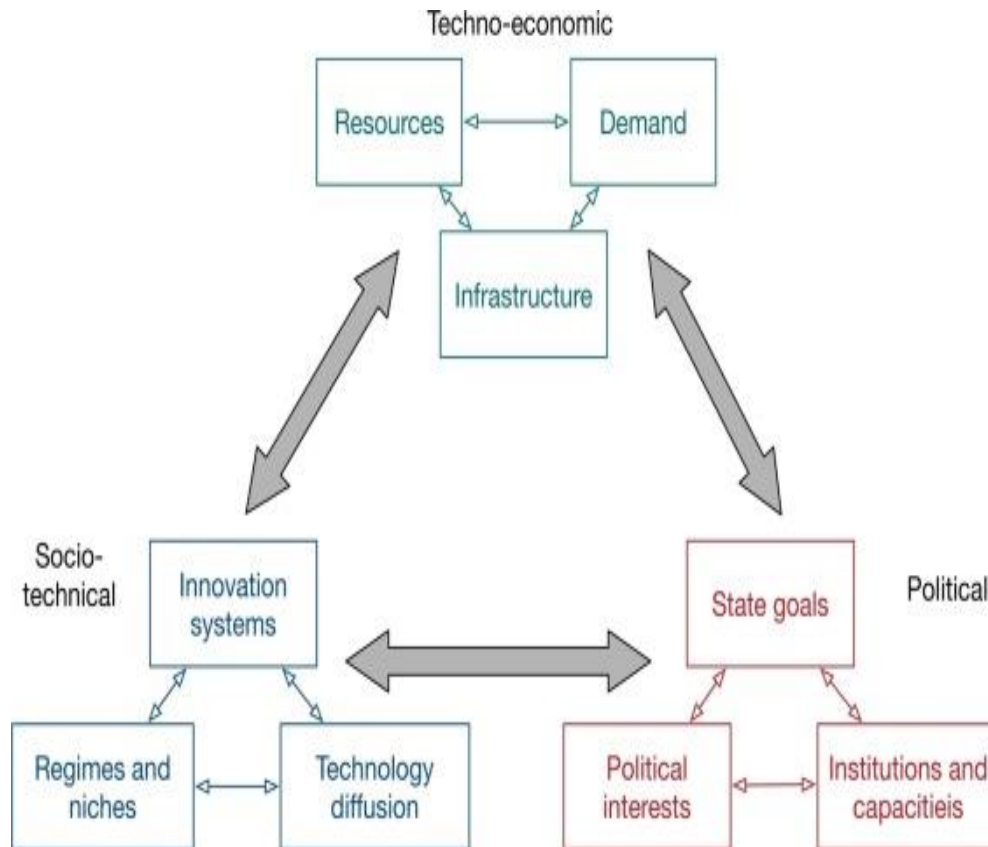
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Analytical Framework



Techno-economic: focused on energy flows associated with energy extraction, conversion and use processes involved in energy production and consumption as coordinated by energy markets

Socio-technical: focused on knowledge, practices and networks associated with energy technologies

Political: political activities influencing energy-related policies and developments

Adapted from Cherp et al. (2018)

Hybrid Heat Pumps

	Techno-economic: focused on energy flows associated with energy extraction, conversion and use processes involved in energy production and consumption as coordinated by energy markets	Socio-technical: focused on knowledge, practices and networks associated with energy technologies	Political: political activities influencing energy-related policies and developments
Drivers for connection point development	<ul style="list-style-type: none"> -Reducing peak demand for electricity, immediate demand for gas and maintaining a high temperature system. -While new low-carbon markets develop, HHPs can start reducing emissions before key decisions/ developments are made. 	<ul style="list-style-type: none"> -Potential to get people more comfortable with heat pumps without demanding shift to low temperatures and it's a way to trial some of the practicalities of heat pumps. -Building up skills and market formation in heat pumps, installation, building fabric, smart controls etc. (and still possible in hydrogen and heat networks) 	<ul style="list-style-type: none"> -Responds to an idea of consumer disruption and perceived dislike for low temp heat -Keeps powerful players (of gas and electric spaces) in the game -'buys time' for potentially disruptive decision
Needed to develop this connection space	<ul style="list-style-type: none"> -Smart controls that suit people and homes; installation; demand for decarbonised heat/subsidy? -Maintenance of 2 infrastructures (And additional needs to co-ordinate them?) 	<ul style="list-style-type: none"> Maintenance and installation skills and services -Learning ...how people and homes respond and use patterns... -From research by Parrish et al. (2021): Indication that hybrid heat pumps could have the perverse impact of convincing people that heat pumps on their own are not sufficient to provide heating and hot water at cold external temperatures. 	<ul style="list-style-type: none"> -Leaves decision over gas grid unresolved and potentially shifts demand (and demand patterns) for natural gas/low-carbon alternative gas -Managing powerful actors by bringing in vested interests in electric & hydrogen pathways
Potential to aid co-ordination of development towards net zero	<p>An interim measure that is a stepping stone but leaves further questions to resolve whilst changing the context for those decisions.</p> <p>Risks of duplication of resources and skills development with high investments in interim complex systems</p> <p>Maintains consumer use patterns whilst potentially getting used to aspects of heat pumps and starting to develop market for installation and maintenance etc.</p> <p>Leaves future of gas grid open (whilst changing context)</p> <p>Diffusion could limit alternative zone based responses...</p> <p>As a high temperature system - Potentially leaves building fabric and behaviour changes needed unaddressed (opening the door for hydrogen?)</p>		