Public attitudes towards energy infrastructure and technologies

Dr Christina Demski, University of Bath

cd2076@bath.ac.uk

Climate risks & impacts

- Perceptions and experiences of climate impacts
- Adaptation and resilience (Global North and South)

Energy technologies & transitions

UKERC UK Energy Research Centre

- Responses to low-carbon energy technology innovations
- Public perspectives on energy transitions

Low-carbon lifestyles & policies

Centre for Climate Change and Social Transformations

- Feasible and desirable low-carbon futures
- Diet, Mobility, Heat, Material Consumption
- Public perceptions and societal discourse

UK Research and Innovation

Outline

- Public engagement with energy – why this matters (and a bit on how/what, when, who)
- Understanding public engagement and acceptance of energy transitions and infrastructure
- Deep dive: Mapping public attitudes towards heat decarbonisation

Public engagement with energy

Why engage?

Scientific literacy paradigm (1960+) – deficit model of public understanding of science: people don't know enough to have positive attitudes. Rationalist approach to decision making.

Public understanding of science (1985+) – people are not positive enough. Need to address negative attitudes. Still a focus on education but also persuasion.

Science and society (1990s+) – constructivist view of public understanding of science: regaining public trust and improving two-way interactions between stakeholders and communities/publics.

Bauer et al. (2007) *Public Understanding of Science*

Why engage?

Instrumental rationale

Engagement as a means to improve perceptions of fairness and legitimacy, improve trust

- Signal commitment to action and value people's perspective, needs and concerns
- Improve transparency of decisions

Substantive rationale

Engagement as a means to improve decision-making, design fairer and more effective policies

- People as active agents to solve problems and engage in trade-offs
- Consider perspectives from diverse groups, information on (local) concerns etc.

Normative rationale

Engagement as a democratic right

- It's the right thing to do because people are affected by decisions

Stirling, 2008; Fiorino, 1990; Berry et al., 2019; Demski, 2021

Public engagement with climate and energy

Deep and rapid emission reductions require societal wide transformations:

- People are at the heart of those changes

Demski, C. (2021). Net Zero Public Engagement and Participation: a Research Note. BEIS.

Pixabay

Unsplash

Unsplash

People are deeply implicated in how energy systems are configured, e.g.,

- They are citizens with voting powers
- They are active (and passive) proponents and/or opponents
- They are energy users and producers

Public engagement with climate and energy

Deep and rapid emission reductions require societal wide transformations:

- People are at the heart of those changes

Demski, C. (2021). Net Zero Public Engagement and Participation: a Research Note. BEIS.

Public engagement with climate and energy

Deep and rapid emission reductions require societal wide transformations:

- People are at the heart of those changes
- Importance of early and meaningful public engagement

DELIVERY DECISION-MAKING

Demski, C. (2021). Net Zero Public Engagement and Participation: a Research Note. BEIS.

Rationales for engaging people

- Develop technologies, interventions, policies, communications etc. that take into account public values and perspectives
- Foster legitimacy, trust and a sense of collective action

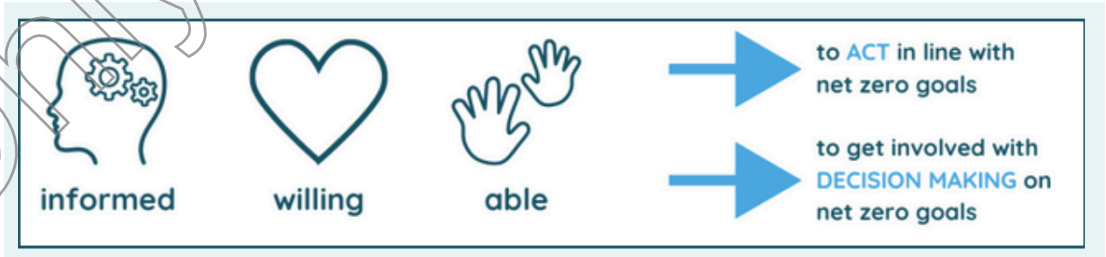
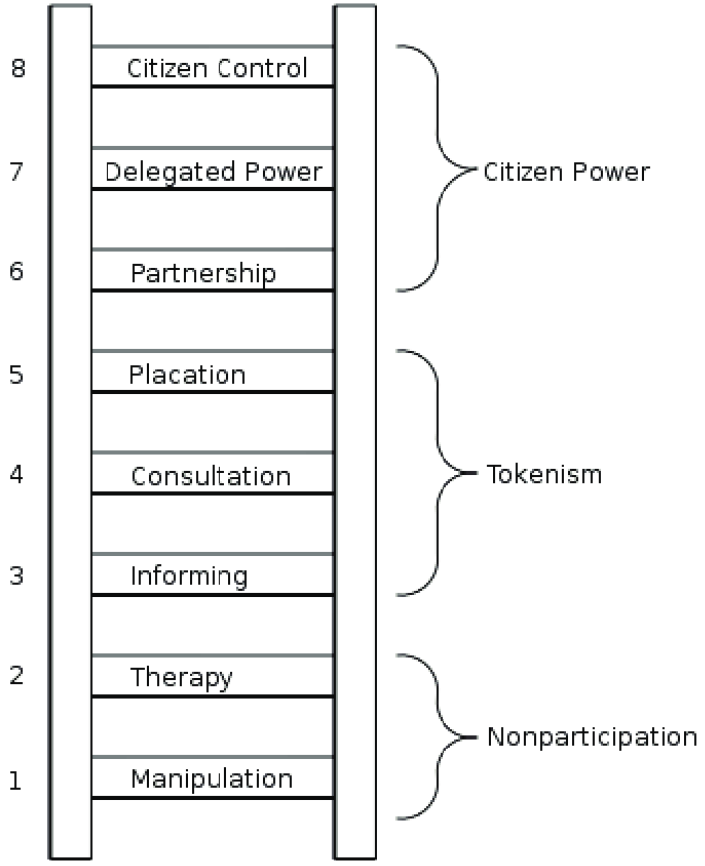


Fig 1. How an engaged public should feel (Zanin et al., 2024), CAST Briefing 29.

= strong social mandate and support for changes
= successful delivery of energy transition and carbon reduction targets

What do we mean by public engagement?



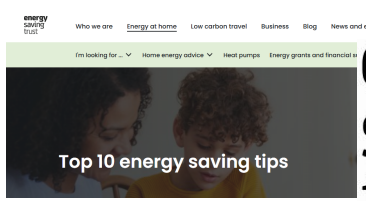
Arnstein's ladder (1969)

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

The ‘how’ and ‘who’ of engagement

- One-way engagement



energy saving trust

ACT ON CO2

- Two-way engagement

Climate Assembly
THE PATH TO NET ZERO

- Emergent/created engagement

OUR STREETS CHORLTON

GLOBAL ECOVILLAGE NETWORK

-> Inclusivity and diversity: Who participates and where? Bespoke spaces for underserved or marginalised communities? What does it mean to be ‘representative’? Role of existing and new voices, gatekeepers and champions?

When to engage

Early and continuous engagement is important

- During innovation/design process and implementation/delivery
- To **open-up discussions** about motivations, visions, purpose and implementation of new technologies **beyond scientific and technical features**.
- Low-carbon energy technologies often have a favourable starting position in terms of public attitudes, but people still have concerns. This requires an **anticipatory rather reactive approach** to development and implementation.

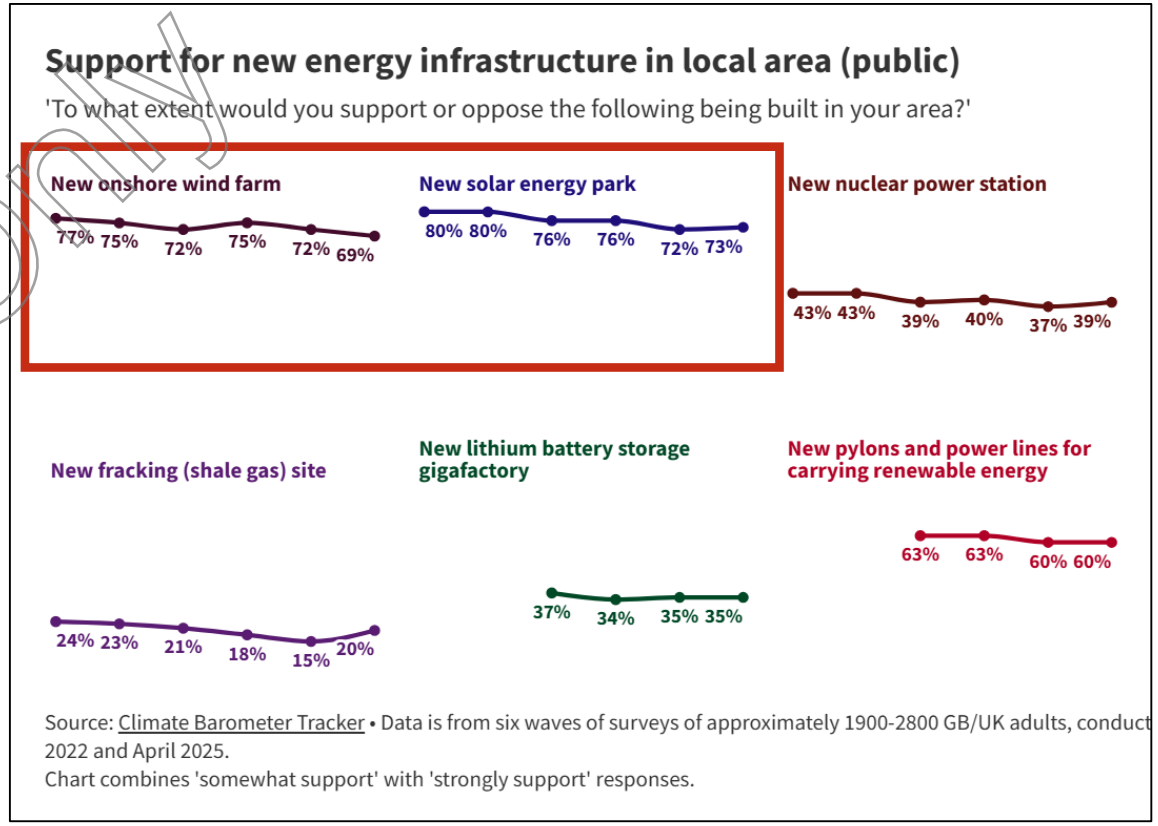
e.g., Stirling (2008), Lai et al (2024) *IDRIC*

Understanding public engagement and acceptance of energy transitions and technologies

Public preferences for energy transitions

Public preferences and acceptability are complex and diverse:

- Views can shift and evolve over time
- Even if support is high for the general idea (e.g. renewable energy, wind farms) -> acceptance not guaranteed
- Importance to understand qualifications, concerns or conditions (‘conditional support’)



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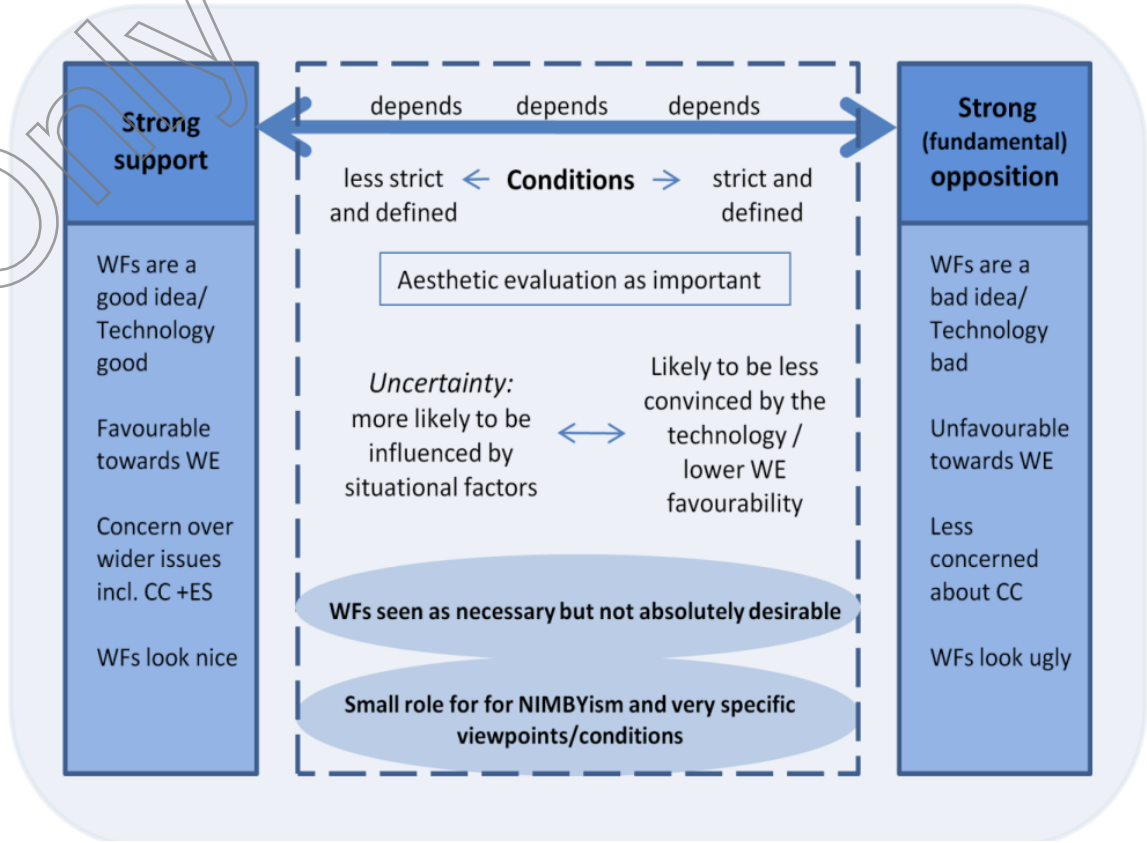

Demski (2011)

Public preferences for energy transitions

Topics may be uncertain, new, emergent and of low-salience:

- Preferences are not fully formed, dependent on context and framing
- Importance of understanding existing values and experiences that inform preferences (now and in the future)

Demski et al. (2015) *Global Environmental Change*

Public values for energy system change

Demski et al. (2015) *Global Environmental Change*

Public values for energy system change

Avoiding waste

Efficient

Capturing opportunities

Environmental protection

Naturalness and Nature

Availability and Affordability

Reliability

Safety

Social Justice

Fairness, Honesty & Transparency

Long-term trajectories

Interconnected

Improvement and quality

Autonomy and Freedom

Choice and Control

Demski et al. (2015) *Global Environmental Change*

Public values and principles – Justice and fairness

Perceived fairness as important

Distributive justice: Who bears the costs? Who benefits?

Procedural justice: Transparency; having a voice in decision-making

Public values and principles – Justice and fairness

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Climate Assembly
THE PATH TO NET ZERO

"Fairness within the UK, including for the most vulnerable (affordability, jobs, UK regions, incentives and rewards) in actions, not just words"

(Second principle prioritised and endorsed by over half of the assembly)

Public values and principles – Justice and fairness

Perceived fairness as important

Distributive justice: Who bears the costs? Who benefits?

Procedural justice: Transparency; having a voice in decision-making

Energy justice discourses in citizen deliberations on system flexibility and energy storage

Thomas et al. (2020) *ERSS*

Table 4
Summary of Energy Justice discourses relating to capacities and vulnerability.

Key discourses	Distributive	Procedural
Concern for vulnerable groups	Differences in financial and social capacities may lead to some groups being further disadvantaged under community and domestic forms of flexibility pro[86]vision.	Some sections of community may lack time or social resources required to become involved in community or municipal energy governance.

Acceptance of costs (on energy bills) associated with low-carbon energy policies:

✗ <u>Personal financial circumstances</u>
- Income
- Energy bill/costs
- Concerns about cost

✓ <u>Fairness and justice beliefs</u>
- Distributive justice
- Procedural justice
- Trust indicators

n=3150, nationally representative UK survey

Evensen et al. (2018) *Applied Energy*

Distrust in energy companies (and their profits):

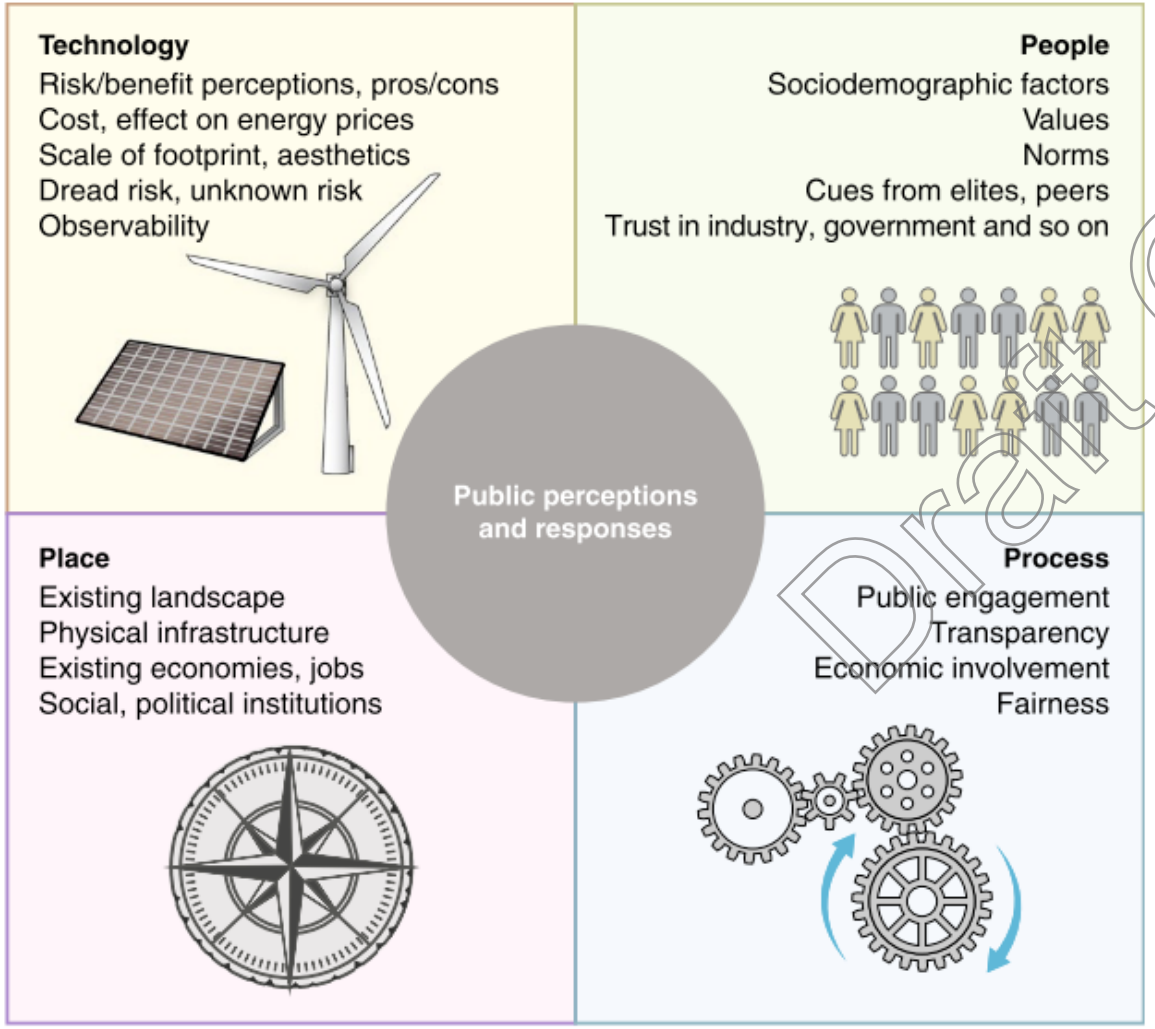
"They could have 50% profit if I could afford my bill…And I know people that are elderly….[…]and he is sitting there struggling to get heat"

"It's called having a good accountant, isn't it?"

5 focus group in Wales, Scotland and England

Becker et al. (2019) *ERSS*

Public perceptions of and responses to new energy technologies (Boudet, 2019, *Nature Energy*)

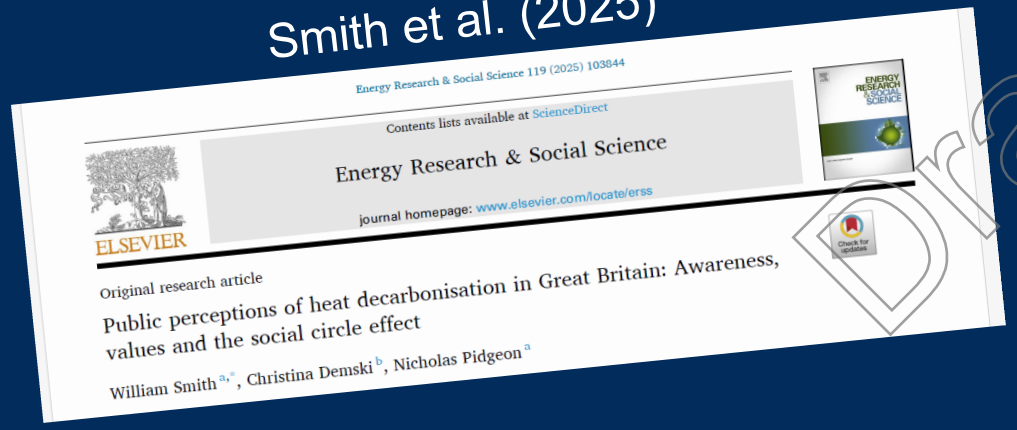


Considered a broader set of theories:

- Theory of Planned Behaviour, Norm-Activation Model – individual level
- Diffusion of innovation theory – social system and group based
- Social practice theory – practice of everyday life
- Risk perceptions of technologies
- Social representation theory – broader worldviews and social ‘representations’ guiding responses

Mapping the landscape of public attitudes towards low-carbon heating technologies

Smith et al. (2025)



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Original research article

Public perceptions of heat decarbonisation in Great Britain: Awareness, values and the social circle effect

William Smith [a,*], Christina Demski [b], Nicholas Pidgeon [a]

UKERC
UK Energy Research Centre

Decarbonising domestic heat

- The decarbonisation of domestic heating is a vital part of achieving net zero emissions.
- It relies now on significant demand-side change.
- Public choice will play an important role in the shape and success of the transition.
- Mixed success across Europe

Decarbonising domestic heat

- UK heat policy has so far emphasised ‘going with the grain of consumer behaviour’ (BEIS, 2021)
- Subsidies available for heat pumps (£5000 at time of this research, recently increased)
- Low awareness of low-carbon heating technologies, high satisfaction for current gas heating (Becker et al., 2023; Sovacool et al., 2022; Demski et al., 2022)

Approach and methodology

- Nationally representative online survey of the general public in Great Britain.
- **Understanding the landscape of public attitudes towards decarbonized heat** technologies in the UK – what do people know, how do they feel, what do they believe, what do they want?
- Data was collected February – March 2023, during a period of unprecedentedly high energy bills.
- Exploring attitudes to three decarbonised heating technologies

  – **heat pumps**, **hydrogen heating** and **district heating**

Survey Design

- Exploring **support and willingness** to adopt decarbonised heating technologies.
- **Informed choice and 'decision pathway' element** - challenging implicit expectations and assessing the conditions underlying willingness to adopt decarbonised heating.
- Capturing a variety of **contextual variables** related to heat use and the system transition to decarbonisation more generally.
    - *Individual and situational demographics, heating system use, climate concern, existing knowledge, financial context, perceptions of trust, responsibility and fairness, environmental values and energy security concerns*

Informed choice element:

- **Information provision for each technology**
- Following information, **assess support, perceived benefits and risks, comparison with current heating system**, and most important aspects
- Initial **willingness to adopt** given a hypothetical opportunity (e.g., boiler breaks – what to replace it with?)
- Reflect on willingness through a series of **possible policy / technological scenarios with positive and negative implications (e.g., subsidies available, additional work needed)**

Hydrogen

Hydrogen boilers work similarly to a gas boiler, except that the source of fuel is different. Instead of running on fossil gas (also known as natural gas) they run on hydrogen gas.

Level of disruption for installation: The installation process would be similar to installing a new fossil gas boiler. However, there is the possibility that new hydrogen compatible pipes would need installing as well. Connecting or upgrading to a hydrogen network may cause some disruption on your street for several days/weeks and mean that heating and hot water would not be available in that time.

Installation cost: Hydrogen boilers are not yet available to buy and install on the market, so it is unclear how much a hydrogen boiler will cost. Estimates have suggested that the cost will be similar to current gas boilers at around £2,500 to buy and £1,000 to install. The cost will also depend on the government grants available at the time.

Running cost: It is not yet known how much it will cost to run a hydrogen boiler for heating. It will depend on how much it will cost to produce hydrogen and which type of hydrogen is used. It is not yet clear how many hydrogen suppliers there will be and therefore how much competition there will be (potentially affecting prices on the market).

How to use: Hydrogen boilers will be similar to use as current gas boilers. You will have control over the temperature in your home and which rooms to heat by adjusting the setting on your radiators.

Technological readiness: Hydrogen boilers are not available to buy or install. However, manufacturers have developed working prototypes. The current gas network will need to be fully converted to be ready for 100% hydrogen gas. Part of the network has already been converted.

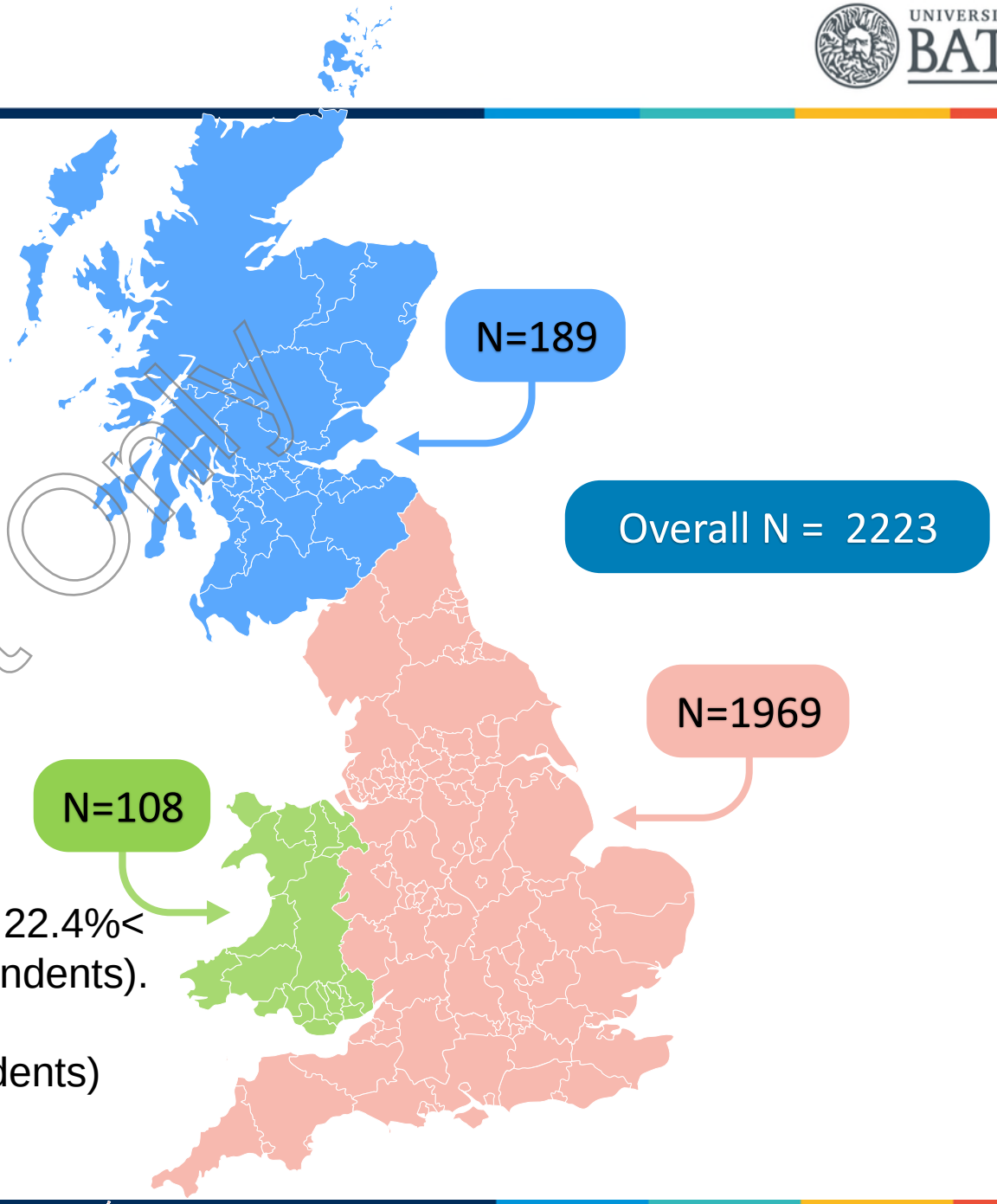
Environmental impact: Hydrogen's environmental impact will depend on which kind of hydrogen is produced. Hydrogen gas can be produced either from water using renewable electricity (e.g., wind farms) or from fossil gas (the gas we currently use for heating). If fossil gas is used it will have to be combined with carbon capture and storage. This technology captures carbon emissions and stores them under ground when producing the hydrogen.

Core Representative GB Sample Summary

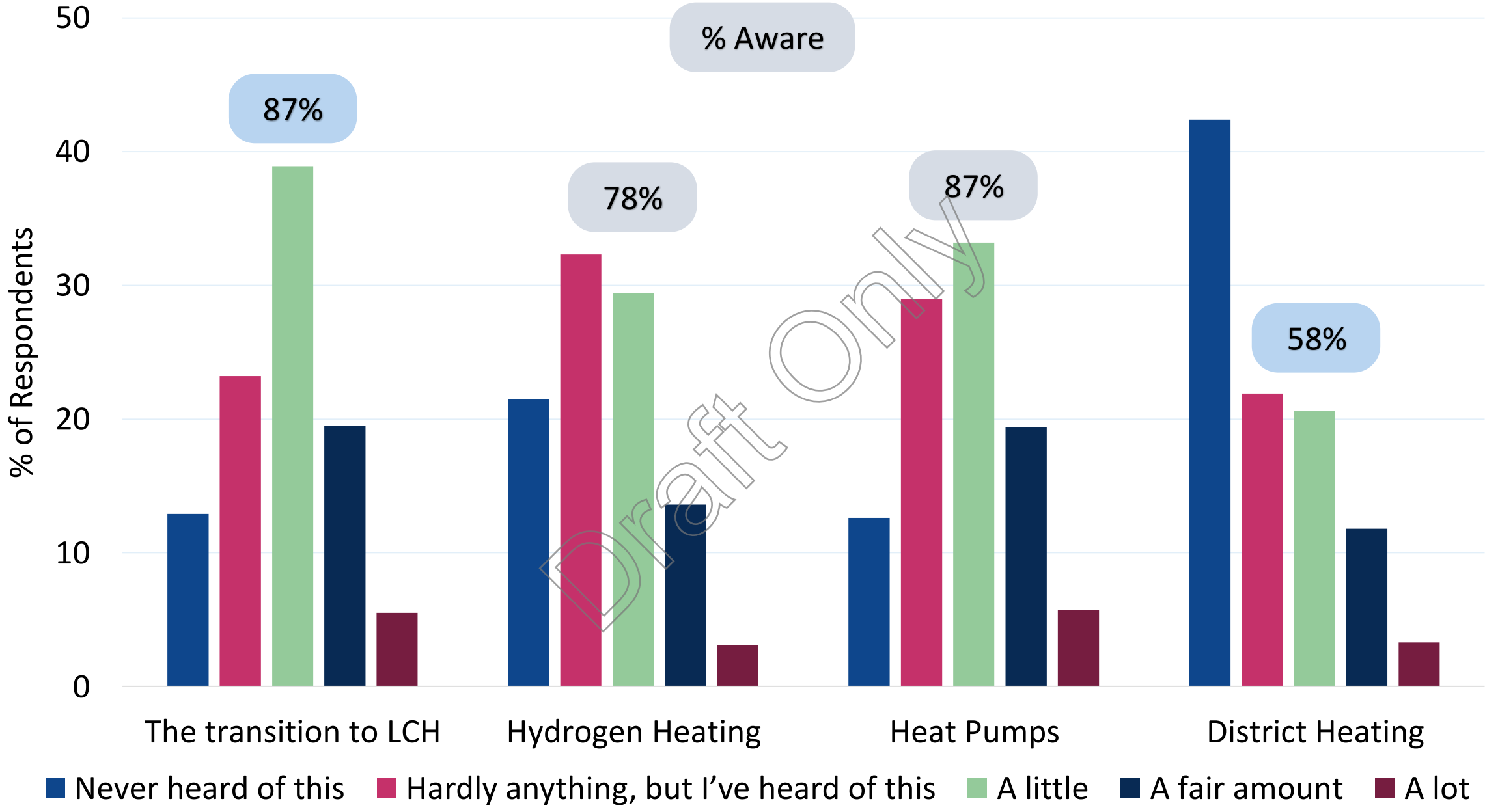
- **Home Owner:** 56.4%, **Renter:** 41.4%
- **House:** 78.6%, **Flat:** 21.2
- **EPC A-C:** 34.1%, **D+:** 14.6%, **???:** 51.2%
- **Home Age:** *M*=1970

- **Age:** Nationally representative.
- **Education:** Nationally representative.
- **Employed:** 66.6%, **Student:** 4.4%
- **Female:** 47.8%, **Male:** 51.8%

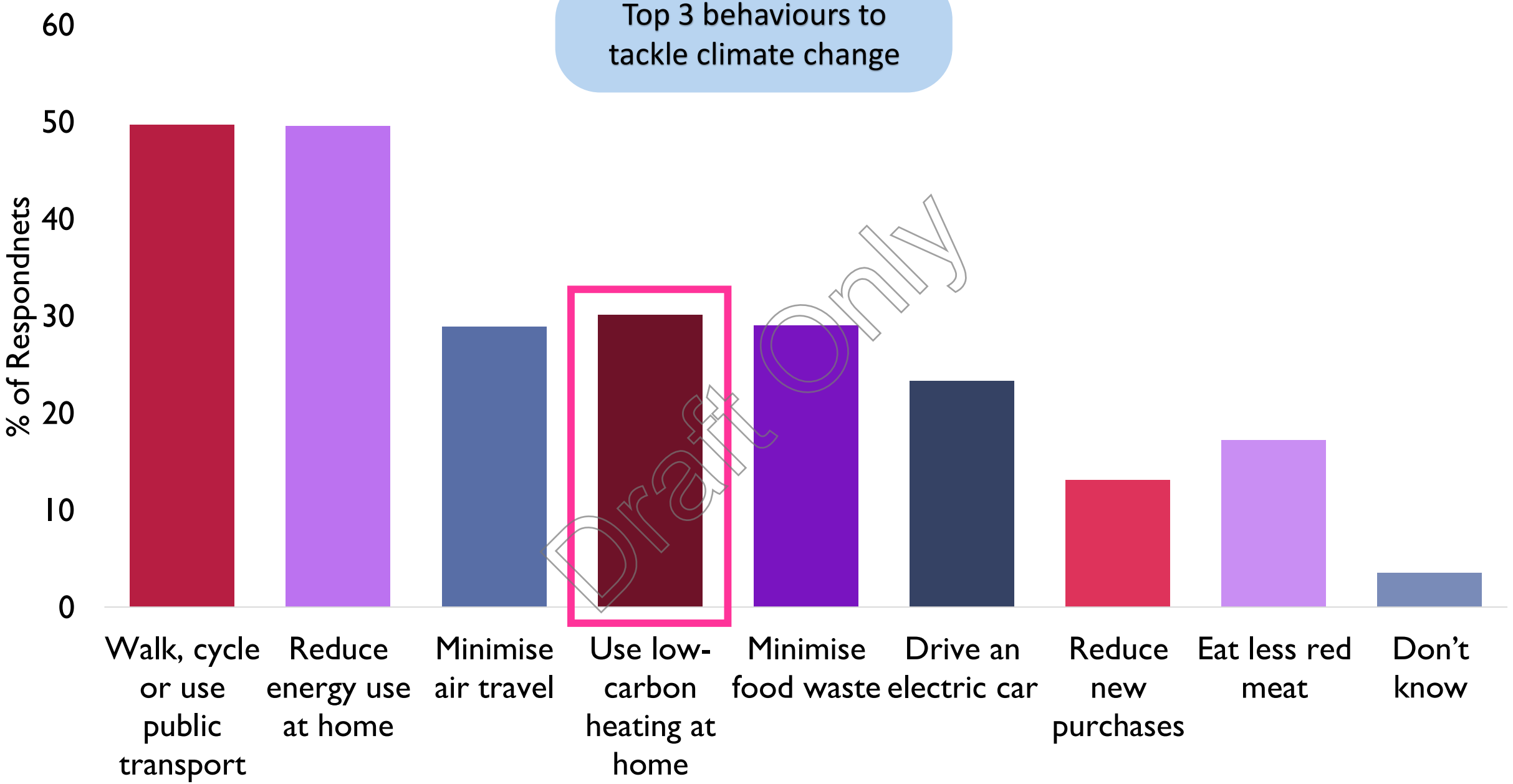
- **Income:** 62.1% (£20k - £59k), 15%>, 22.4%<
- **Reduced Spending:** 73.4% (of respondents).
- **Energy Vulnerable:** 33%
- **Reduced Heating:** 63.5% (of respondents) likely.



Awareness and Knowledge


% Aware
87%
78%
87%
58%
% of Respondents
50
40
30
20
10
0
The transition to LCH
Hydrogen Heating
Heat Pumps
District Heating
Never heard of this
Hardly anything, but I've heard of this
A little
A fair amount
A lot

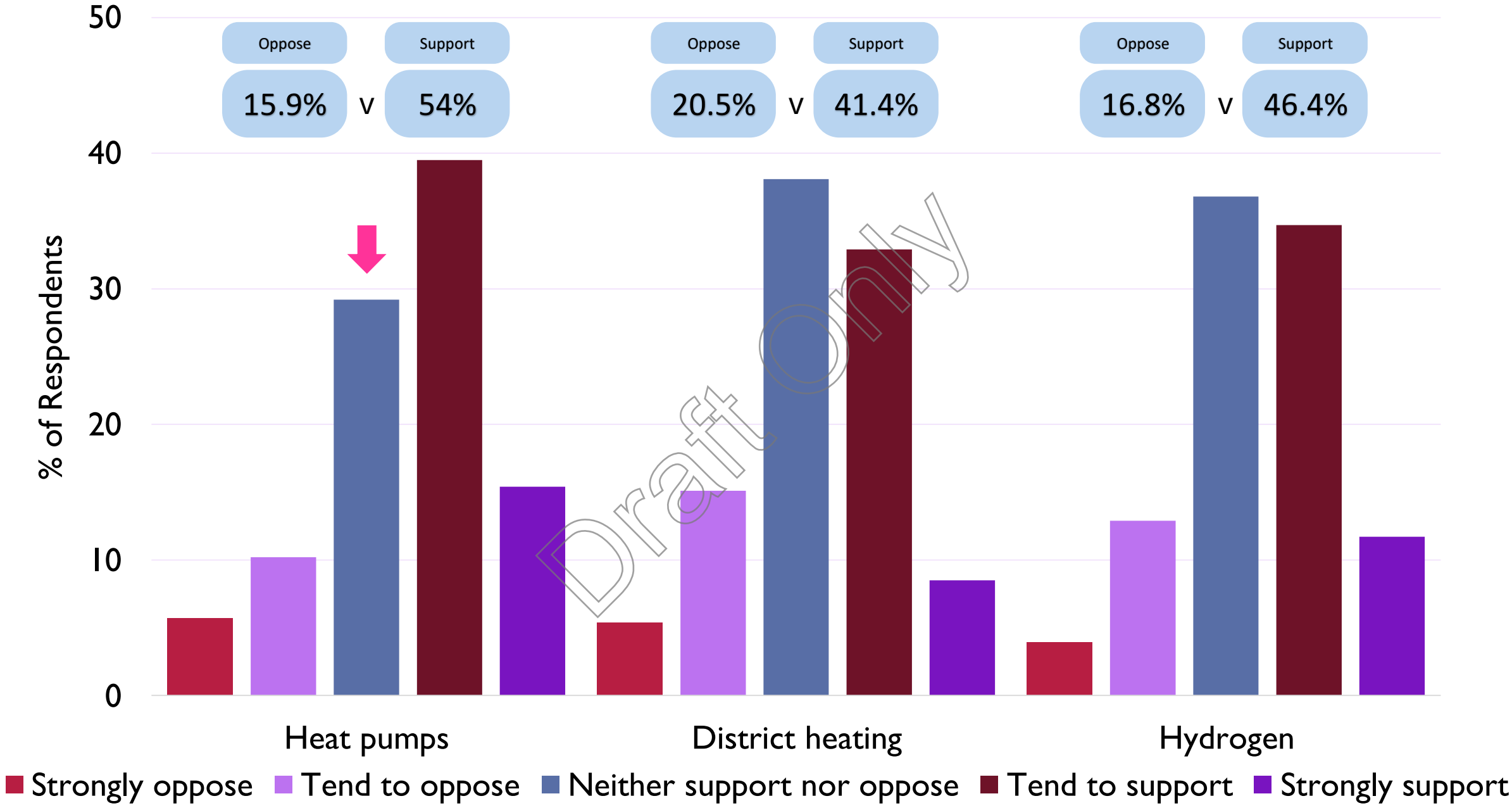
Top 3 behaviours to tackle climate change



Awareness and knowledge

- The **majority** of respondents know at least **something** about low-carbon heating.
  - Most knowledge of heat pumps, and least for district heating.
  - In-depth knowledge (“fair”/“a lot”) is **present, but limited**.
- Low-carbon heating is seen as **less important** versus other behaviours for tackling climate change.

Support


Oppose
Support
15.9%
v
54%
Oppose
Support
20.5%
v
41.4%
Oppose
Support
16.8%
v
46.4%
50
40
30
20
10
0
% of Respondents
Heat pumps
District heating
Hydrogen
Strongly oppose
Tend to oppose
Neither support nor oppose
Tend to support
Strongly support

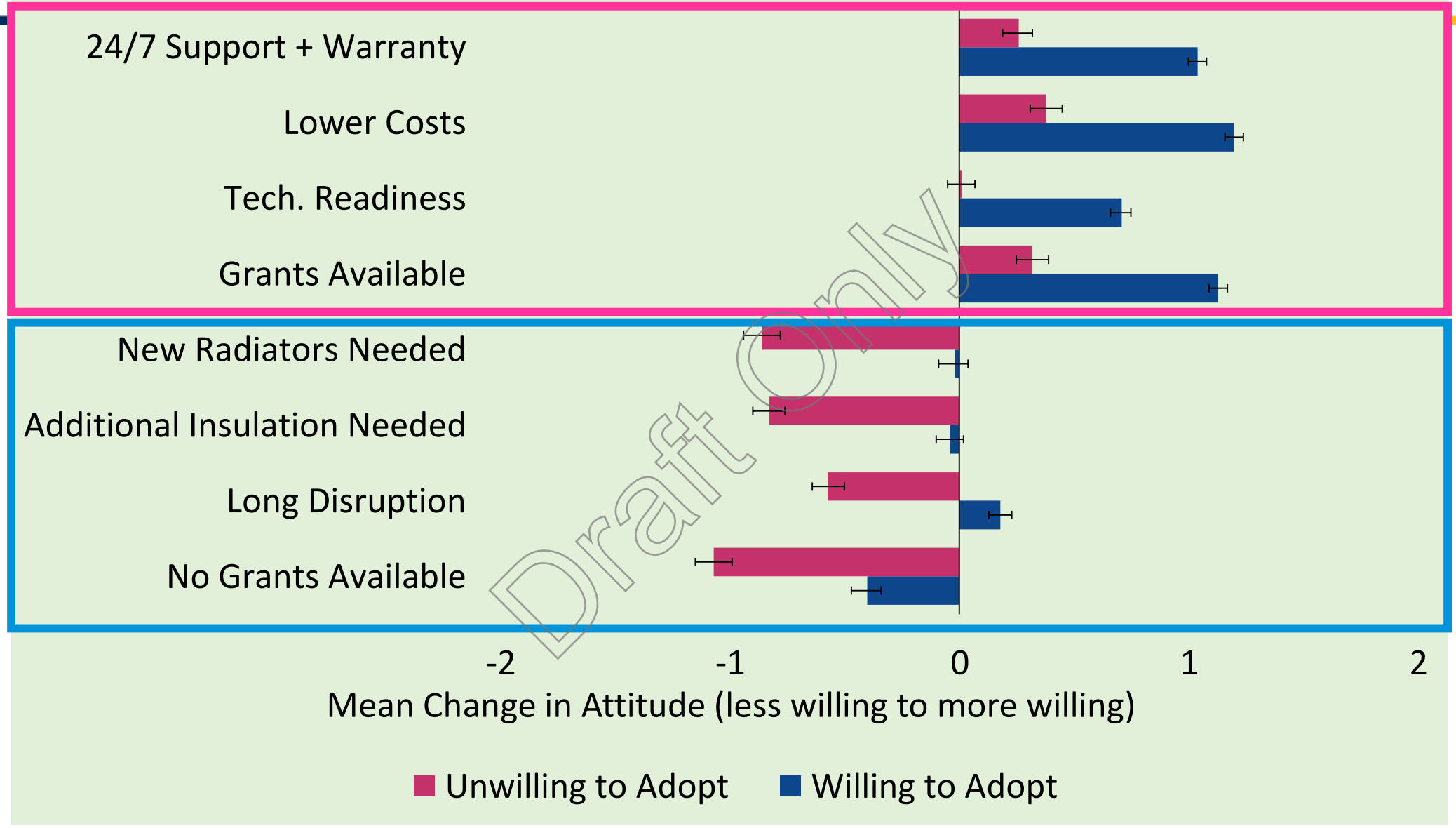
Support for low-carbon heating technologies

- Following the provision of information, respondents **clearly support** each LCH technology, in particular heat pumps.
- **Ambivalence** is more prominent than opposition.
  - Respondents reported a somewhat positive affective response, perceived somewhat more benefits than risks, and were somewhat willing to adopt each technology.

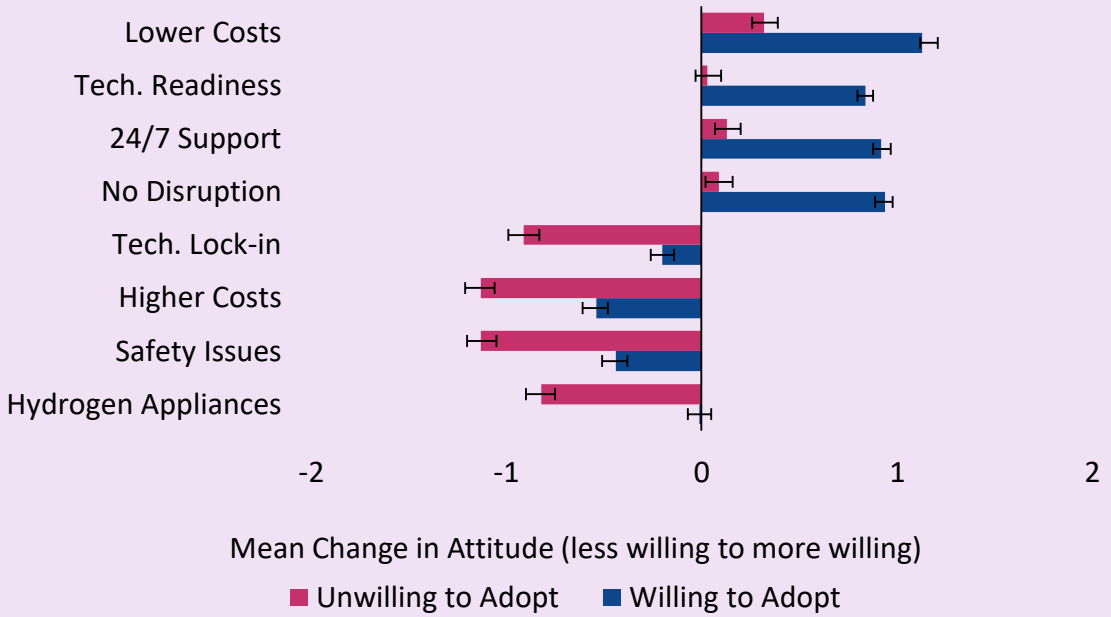
Heat pumps: 62% willing vs. 37% unwilling, 1% did not answer
Hydrogen trial: 65% willing vs. 34% unwilling, 1% did not answer
District heat: 56% willing vs. 36% unwilling, 8% did not answer

Informed choice results

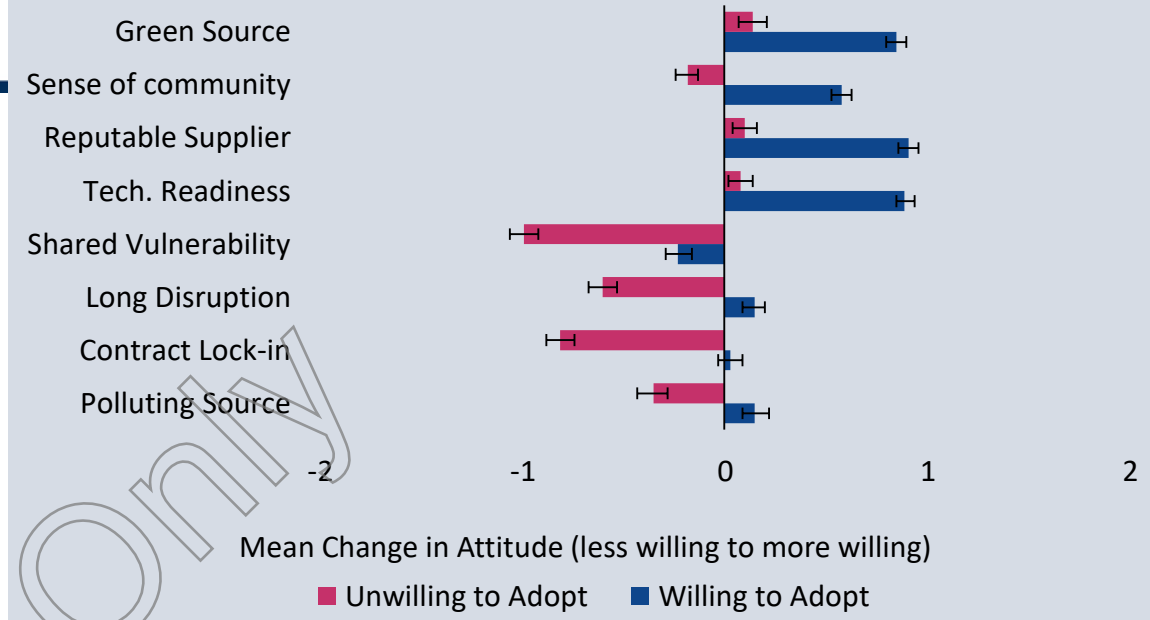
HEAT PUMPS



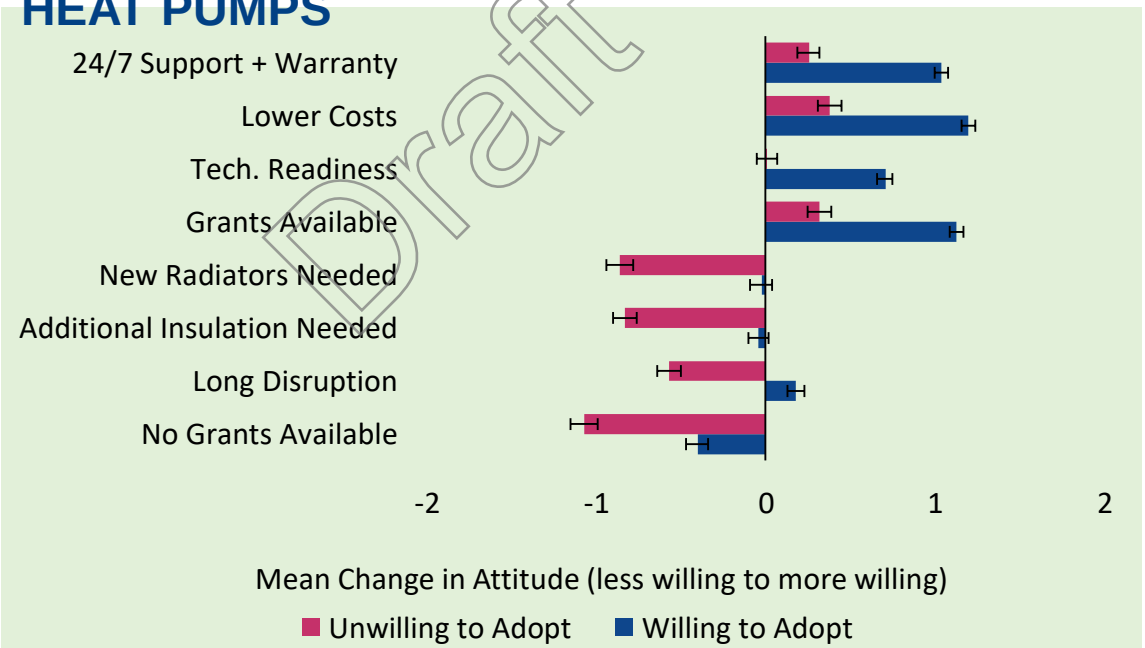
HYDROGEN HEATING



DISTRICT HEATING



HEAT PUMPS



Hypothetical scenarios - effects on (un)willingness

- When asked to review willingness to adopt each technology, given a set of scenarios…
- Clear effect of belief bias – initial willingness only **increases**, whereas initial unwillingness only **decreases**.
- What are the key drivers influencing willingness?

Factors that increase willingness

+ Energy security – dependence on fossil fuels, fear of power cuts, concerns over foreign energy import dependence.

+ Environmental values – preventing pollution, protecting natural resources.

+ Social circle effect – knowing one or more friend or colleague.

Psychometric network modelling

- Deeper exploration of the structural and dynamic properties of attitudes to decarbonised heat
- '**Social circle**' effect emerges as a key factor exerting largely positive influence across the network.

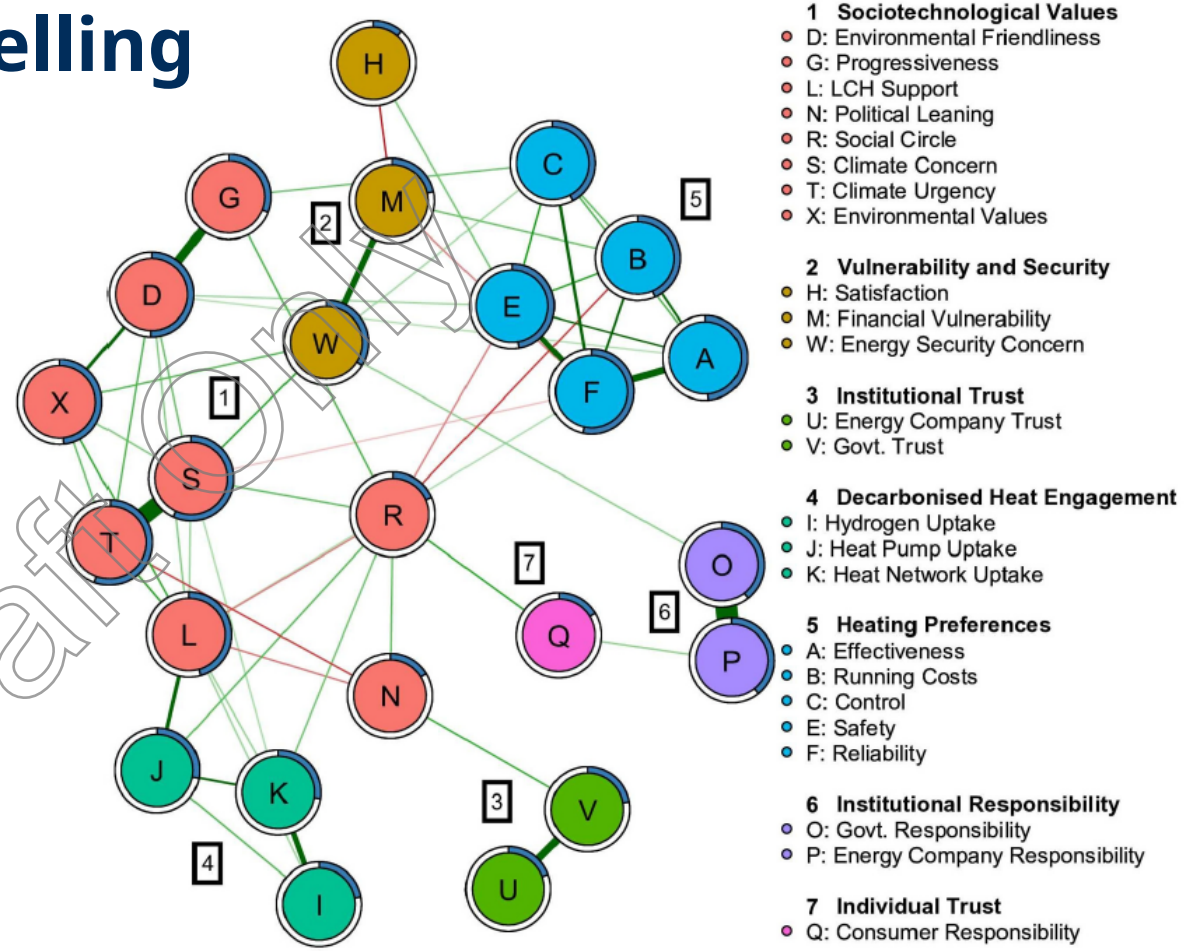
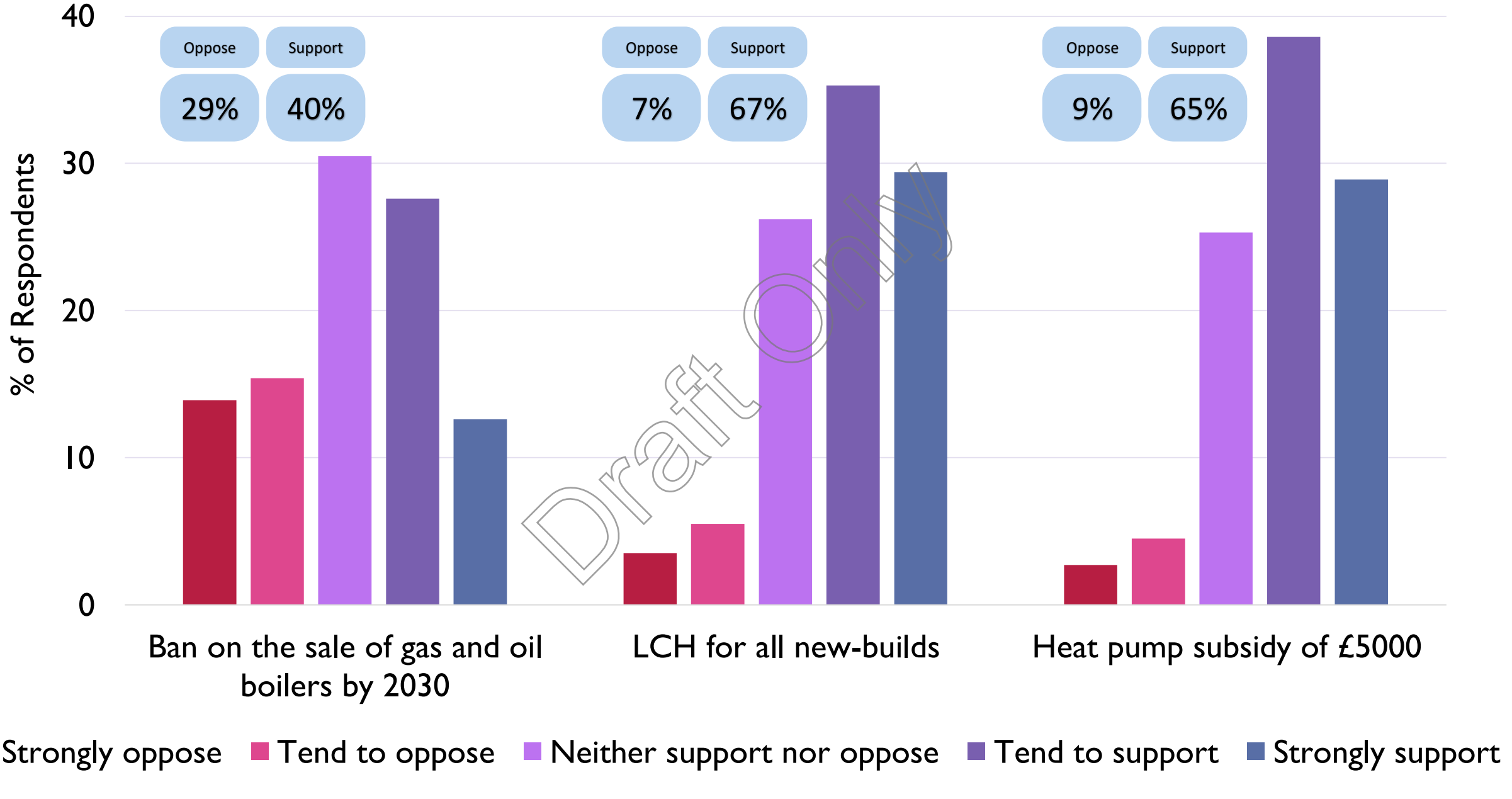


Fig. 2. Estimated undirected network. Connections (edges) between nodes highlight conditional relationships between specific variables, whereas the overall arrangement and connectivity of all nodes in the network highlight structural and dynamic features of attitudes towards decarbonised heating as a whole. Edge colour indicates the direction of the relationship between nodes (green – positive, red – negative). Edge thickness denotes the strength of the relationship between nodes. The ring segments surrounding nodes indicate the variance explained by all connections with neighbouring nodes. Node colours indicate community clusters, described by the key provided. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Trust, responsibility and fairness

- Government and energy companies more frequently viewed as bearing most or all **responsibility** to pay, and consumers the least.
- Lower **trust** for government and energy suppliers to **make decisions or provide information** – more trust in researchers, scientists, engineers, family and friends, and most of all the respondents themselves.
- Respondents believed they **should be** involved in the choice of how the UK decarbonises heating, but believe they **won't be** in practice, and don't expect decision-making processes to be **fair** and **transparent**.

Policy support



Conclusions

- Awareness is **present but limited**.
- When informed, the public show **clear support** for the transition to low-carbon heating.
- Energy security concerns, pro-environmental attitudes, and ‘social circle’ effects are **influential in increasing willingness** to adopt LCH technology.
- A successful transition is seen as featuring **strong financial support**.
- A **foundation of trust** will facilitate public engagement.
- The public expects **clear involvement** from the government and other actors, suggests space for a more proactive top-down strategy.

Thank you for listening!

Dr Christina Demski, University of Bath

cd2076@bath.ac.uk

Table 1

Binary logistic regression results for the hydrogen decision pathway element analysis. The exact wording of each hypothetical scenario presented to respondents is shown (scenarios 1–4 are positive, 5–8 are negative).

	B	S.E.	Sig.	Exp (B)	95 % C.I.for Exp (B)	
					Lower	Upper
Running costs are cheaper than your current heating system.	0.709	0.080	0.000	2.032	1.737	2.376
Other neighbourhoods have already completed trials successfully.	0.404	0.078	0.000	1.497	1.284	1.746
A 24 h support team is available to help with any issues.	0.297	0.077	0.000	1.345	1.156	1.565
Your home could be made compatible with hydrogen with only minimal disruption.	0.456	0.072	0.000	1.578	1.369	1.818
You are not able to switch back to your old heating system after the trial finishes.	0.155	0.067	0.021	1.168	1.024	1.333
Running costs are NOT cheaper than your current system.	0.217	0.075	0.004	1.243	1.073	1.440
A previous trial found some safety issues.	0.343	0.076	0.000	1.409	1.214	1.636
All heating appliances in your home have to be switched to hydrogen ready appliances.	0.170	0.063	0.007	1.185	1.046	1.341

Table 2
Binary logistic regression results for the heat pump decision pathway element analysis. The exact wording of each hypothetical scenario presented to respondents is shown (scenarios 1–4 are positive, 5–8 are negative).

	B	S.E.	Sig.	Exp (B)	95 % C.I.for Exp (B)	
					Lower	Upper
The government would help with some of the installation costs.	0.392	0.074	0.000	1.480	1.279	1.712
Many people in your neighbourhood already have a heat pump.	0.215	0.078	0.006	1.240	1.065	1.445
The heat pump is cheaper to run than your current system.	0.606	0.076	0.000	1.833	1.580	2.126
Full warranty and a 24 h support team is provided to help with any issues.	0.369	0.078	0.000	1.447	1.241	1.687
There are no grants available to help with installation costs.	0.278	0.062	0.000	1.320	1.169	1.490
The heat pump will take 5 days to install.	0.190	0.065	0.003	1.210	1.065	1.374
You find out your home needs additional insulation and/or a water tank installed to make the heat pump efficient.	0.241	0.068	0.000	1.273	1.114	1.454
It is necessary to change radiators to underfloor heating or change radiators to larger ones.	0.198	0.063	0.002	1.218	1.076	1.380

Table 3
Binary logistic regression results for the district heating decision pathway element analysis. The exact wording of each hypothetical scenario presented to respondents is shown (scenarios 1–4 are positive, 5–8 are negative).

	B	S.E.	Sig.	Exp (B)	95 % C.I.for Exp (B)	
					Lower	Upper
New heat networks have been successfully set up in many other neighbourhoods.	0.561	0.081	0.000	1.753	1.497	2.054
The supplier providing your heat network has an excellent reputation amongst their customers.	0.589	0.082	0.000	1.802	1.536	2.115
Joining the heat network would noticeably increase the sense of community between you and your neighbours.	0.354	0.083	0.000	1.425	1.212	1.676
The heat supplied to the network is waste heat provided by an environmentally friendly industry.	0.186	0.069	0.007	1.204	1.052	1.378
The heat supplied to the network is waste heat from an environmentally damaging industry.	−0.090	0.053	0.091	0.914	0.824	1.015
You have to sign up to a 24 months contract with the heat supplier.	0.236	0.067	0.000	1.266	1.109	1.445
Setting up the heat network would cause a few days of disruption to you and your neighbours.	0.203	0.073	0.005	1.225	1.061	1.413
A maintenance issue in a neighbouring property could cause disruption to your heating.	0.405	0.069	0.000	1.500	1.309	1.718