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Factors associated with Public Acceptance of Hydrogen and Ammonia in the United Kingdom (Ocean-REFuel)

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April 30, 2026

Social Acceptance of Hydrogen and Alternative Liquid Fuels: UK Symposium

University of Portsmouth, Portsmouth, UK.

Why Public Perceptions / Acceptance?



Essence of Democracy

- Policy making and change influenced by numerous drivers and follow several pathways (Weible & Sabatier, 2017).
- However, the essence of democracy is that citizens should collectively wield the agency to shape what their governments chose to do (Erikson, Wright, & McIver, 1993).
- Governments need to actively engage with and respond to the will of the people (Dahl, 1971; Young, 2000).
- Traditionalist vs Revisionist views of Public Opinion
 - Lippmann's 'phantom public' in the early 20th century (1922, 1925, 1955) Phillip Converse (1964)
 - Well structured (Jenkins-Smith, Mitchell, & Herron, 2004) and stable (Shapiro & Page, 1988, 1994); rely on heuristics (e.g., Sniderman, Brody, & Tetlock, 1991) based on reasonably well-defined belief systems
- John Dewey's *The Public and Its Problems*
- Timothy Mitchell's *Rule of Experts*

Why Public Perceptions / Acceptance?



Policy change mechanisms

- Selection (D. S. Lee, Moretti, & Butler, 2004; Levitt, 1996; Poole, 2007)
- Adaptation (Caughey & Warshaw, 2018; Kousser, Lewis, & Masket, 2007)
- When public knowledge diverges from that of the experts, policymakers tend to reflect public views (Stoutenborough & Vedlitz 2014)
- Effectively harnessing responsiveness to public perceptions necessitates exploring factors shaping public preferences.

Social Acceptance, engagement, and Adoption

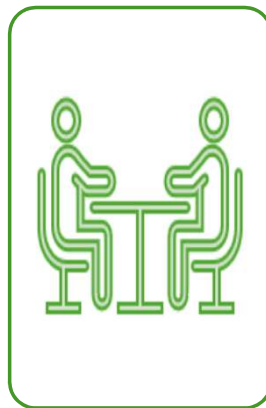
- Success of any new technology depends on its acceptance by the community
- Drive market demand needed for sustainable innovations
- Attract investment as stakeholders and investors tend to back initiatives that have broad societal approval
- Secure necessary funding or face delays due to protests and legal challenges

Fairness, environmental justice, and inclusivity

- Helps ensure projects are aligned with societal values and address broader challenges with fairness
- Projects perceived to exacerbate inequality or harm the environment may face backlash

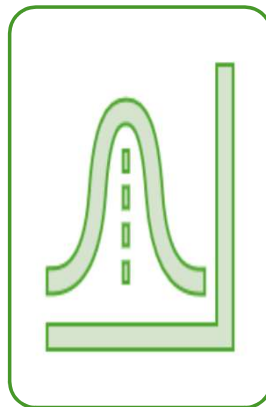


Ocean REFuel



Deliberative Workshops

- Qualitative
- Shetland Islands
- 2 Rounds of workshops
- 4 Workshops 47 participants
- March / April 2025 & 2026



Survey

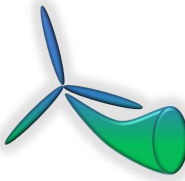
- Quantitative
- N = 1511
- Nationwide
- October 27th – November 04th 2025



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Deliberative Workshop



Session 1: Hydrogen & Ammonia: First Impressions, Feelings, Benefits, Concerns

Session 2: Hydrogen & Ammonia Applications

Session 3: Envisioning Shetland's Future: What Matters Most?

Session 4: Energy Projects in Shetland

Session 5: Economic Impacts of Energy Development

Session 6: Community Benefits – Priorities & Concerns

Survey



- Demographics
- Factors associated with Social acceptance & policy support
 - Climate change and environmental concerns
 - Energy concerns
 - Energy policy orientation
 - Information seeking behaviors, source frequency, trust
 - Conspiracy mentality, misinformation
 - Procedural fairness, institutional trust
 - Affect / attitude / personal norms
 - Risk/Benefit perceptions
 - Technology optimism, Place attachment
- Conjoint Experiments

Survey Response Bias



Demographic Variable		Survey Sample (n= 1511)	Census Estimates ²	+/-
Gender ¹	Male	48.51 %	48.39 %	0.12 %
	Female	50.76 %	51.61 %	-0.85 %
	Prefer to self- describe	0.40 %	--	
	Prefer not to say	0.33 %	--	
Age ¹	18-24	10.66 %	10.53 %	0.13 %
	25-34	17.21 %	16.99 %	0.22 %
	35-44	16.35 %	16.91 %	- 0.56 %
	45-54	16.94 %	15.47 %	1.47 %
	55+	38.85 %	40.11 %	-1.26 %

Survey Response Bias



Demographic Variable		Survey Sample	Census Estimates ²	+/-			
			UK ⁶		England and Wales ³	Scotland ⁴	Northern Ireland ⁵
Ethnicity	White	85.31	82.88%	2.43	81.74	95.38	96.55
	Asian	7.68	8.53%	-0.85	9.30	2.66	1.06
	Black	3.64	3.47%	0.17	4.04	0.73	0.32
	Mixed	2.12	2.65%	-0.53	2.94	0.57	0.41
	Other	1.99	2.47%	-0.48	2.09	0.65	1.66

Survey Response Bias



Demographic Variable		Survey Sample	Census Estimates ²	+/-
NUTS1 ¹ Regions	North East	3.31	4.03	-0.72
	North West	12.78	11.10	1.68
	Yorkshire and The Humber	9.07	8.16	0.91
	East Midlands	7.75	7.33	0.42
	West Midlands	9.74	8.79	0.95
	East of England	9.6	9.42	0.18
	London	8.74	13.04	-4.30
	South East	16.42	13.85	2.57
	South West	7.95	8.68	-0.73
	Wales	4.57	4.66	-0.09
	Northern Ireland	2.05	2.71	-0.66
	Scotland	8.01	8.23	-0.22
	England	85.36	84.40	0.96



Smell

Fertiliser

Corrosive

Toxic

Gas

Dangerous

Poisonous

Bad Smell

Strong Smell

Refrigerant

Cleaning

Not Sure

Smelly

Transportable

Wee

Hair Products

Poisonous Gases

Stinks

Waste

Sulphur

Bleach

Unsuitable In Energy Use

Lethal Greenhouse Gas

Fertilizer

School Science Lessons

Bad Idea

Greenhouse Gas Emissions

Nitrogen

Noxious



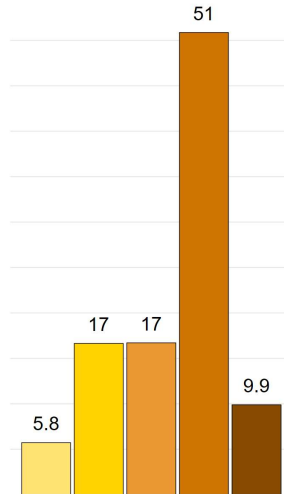
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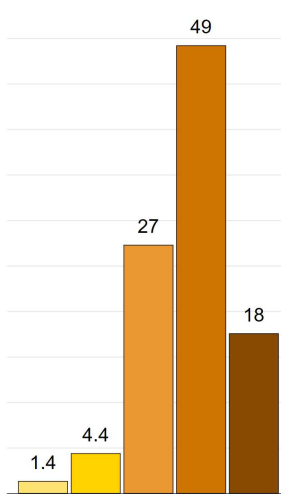
Social Acceptance (H2)



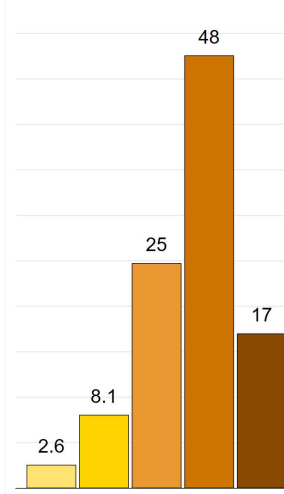
Safe and well regulated



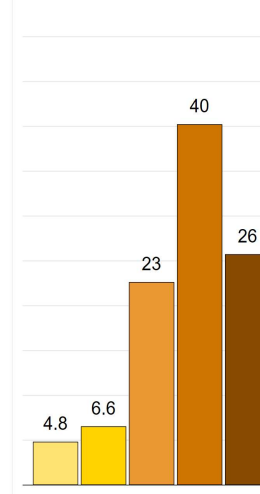
Heavy industry



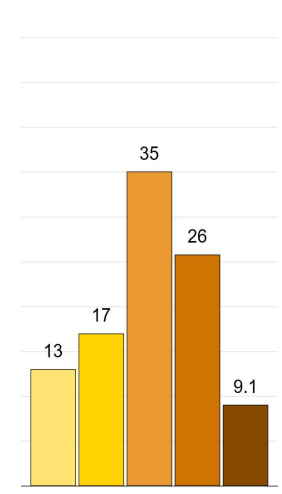
Transportation



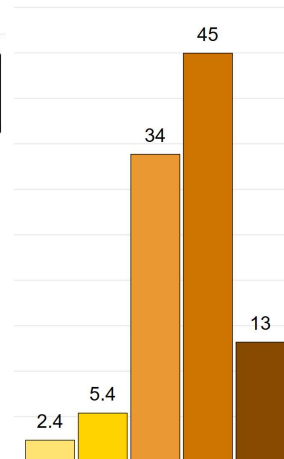
Use public transport



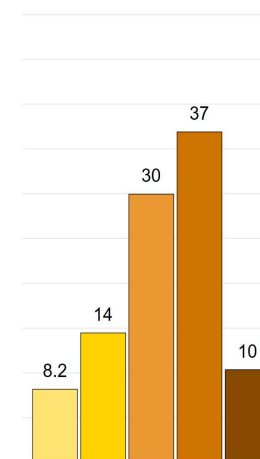
Buying Car



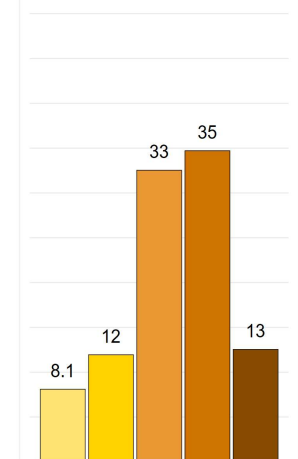
Blending in gas network



Storage facility in local area

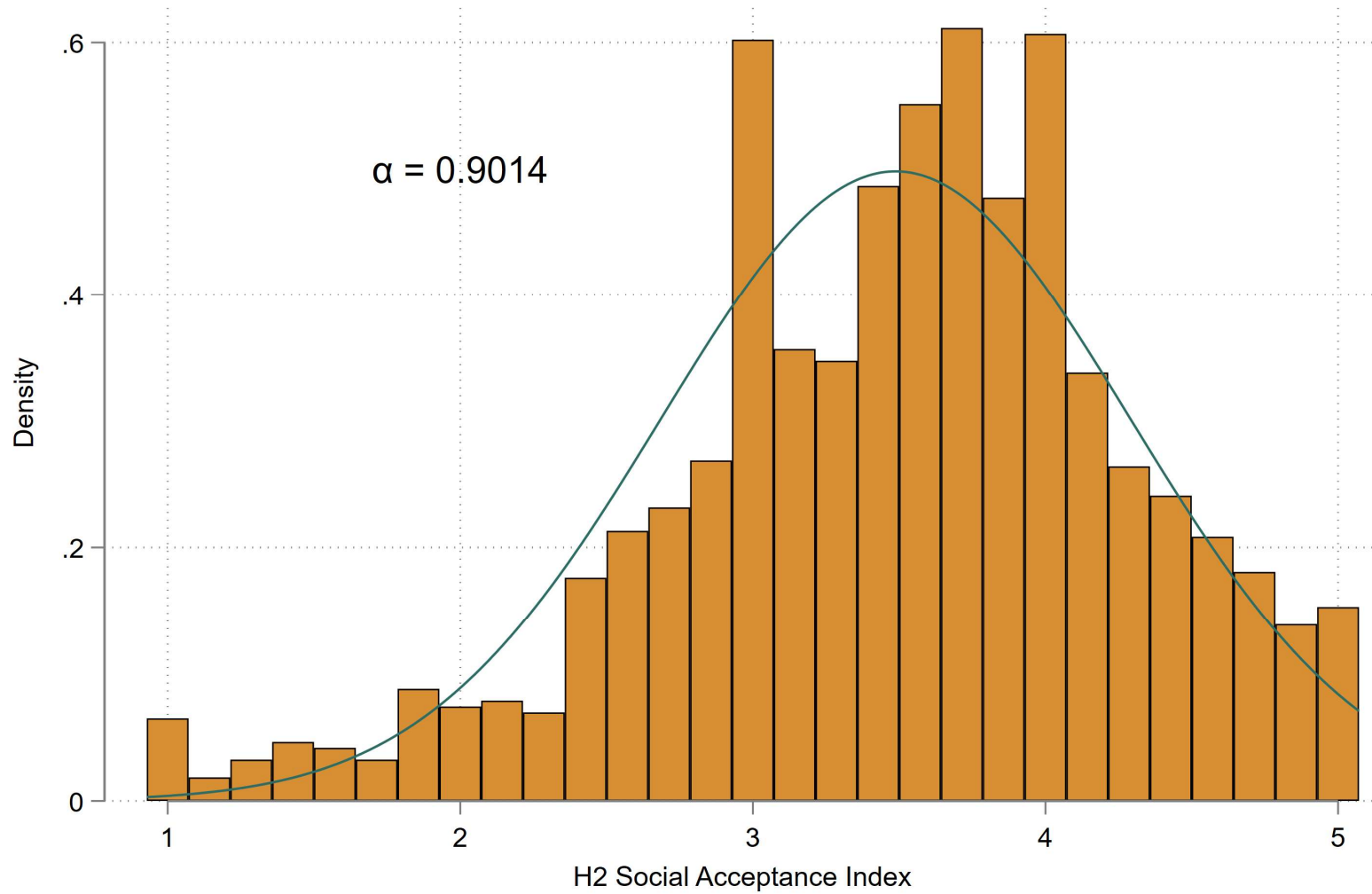


Switch to heating and cooking





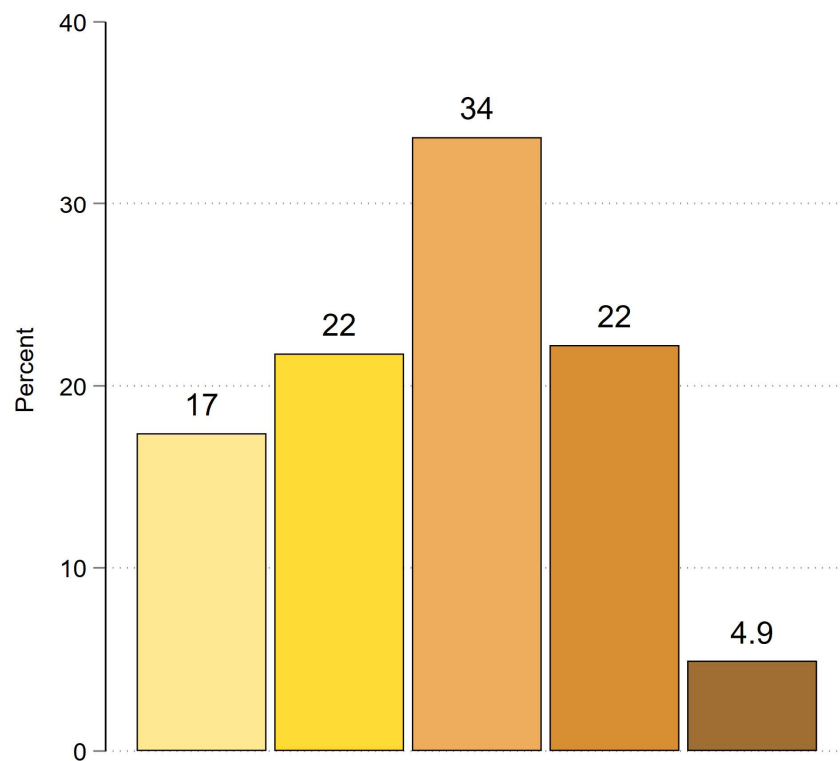
Social Acceptance



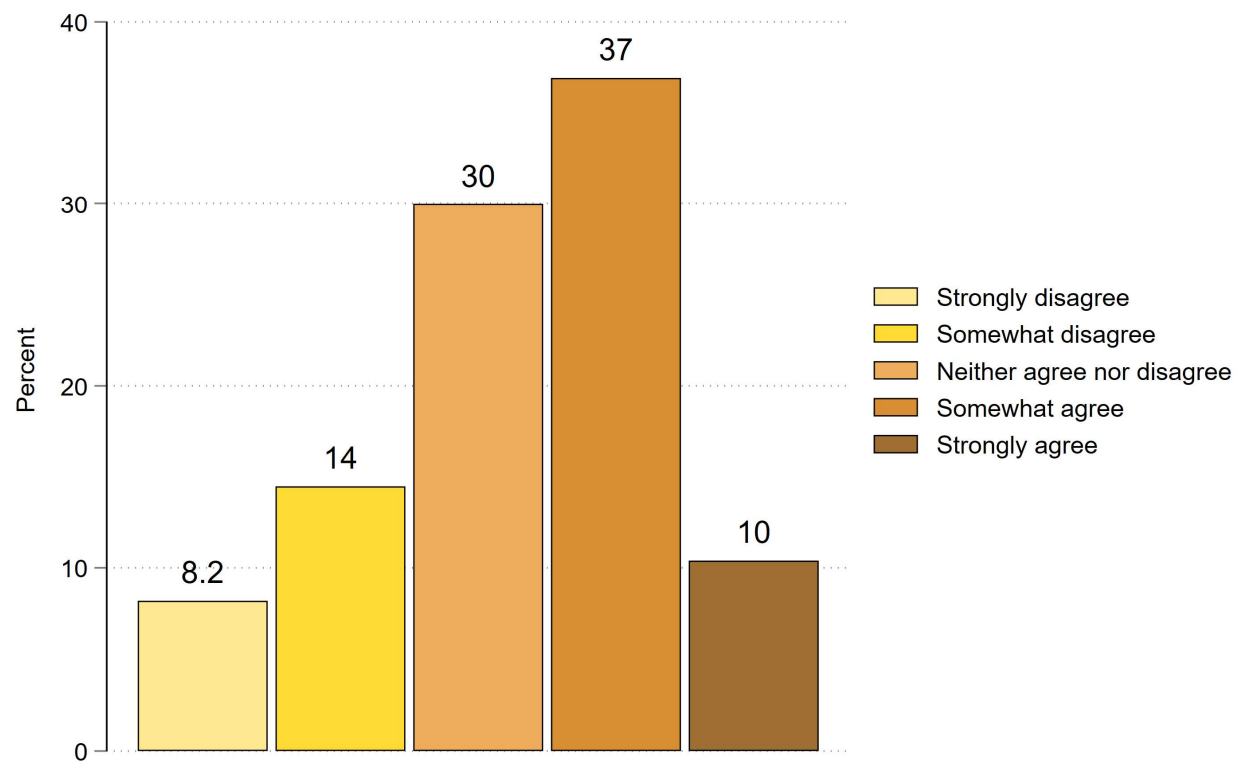
Hydrogen & Ammonia Acceptance



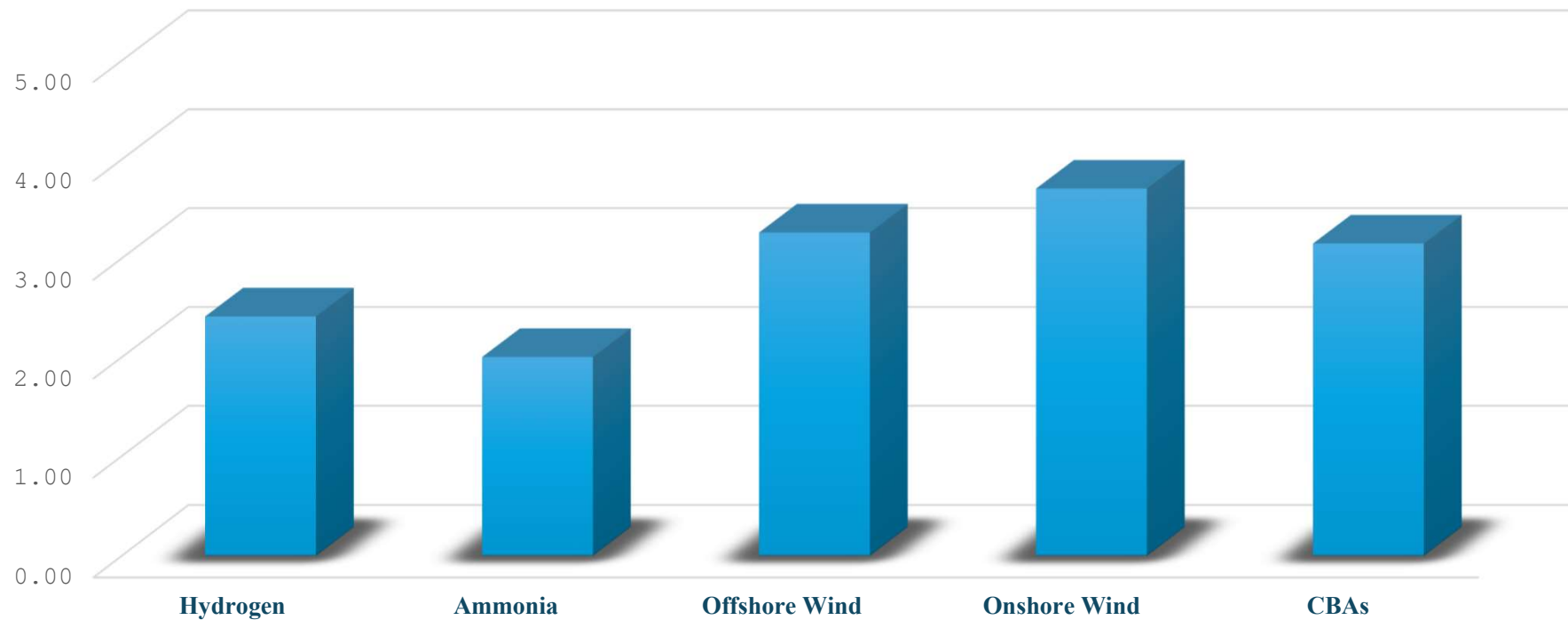
Ammonia Acceptance



Hydrogen Acceptance



Familiarity

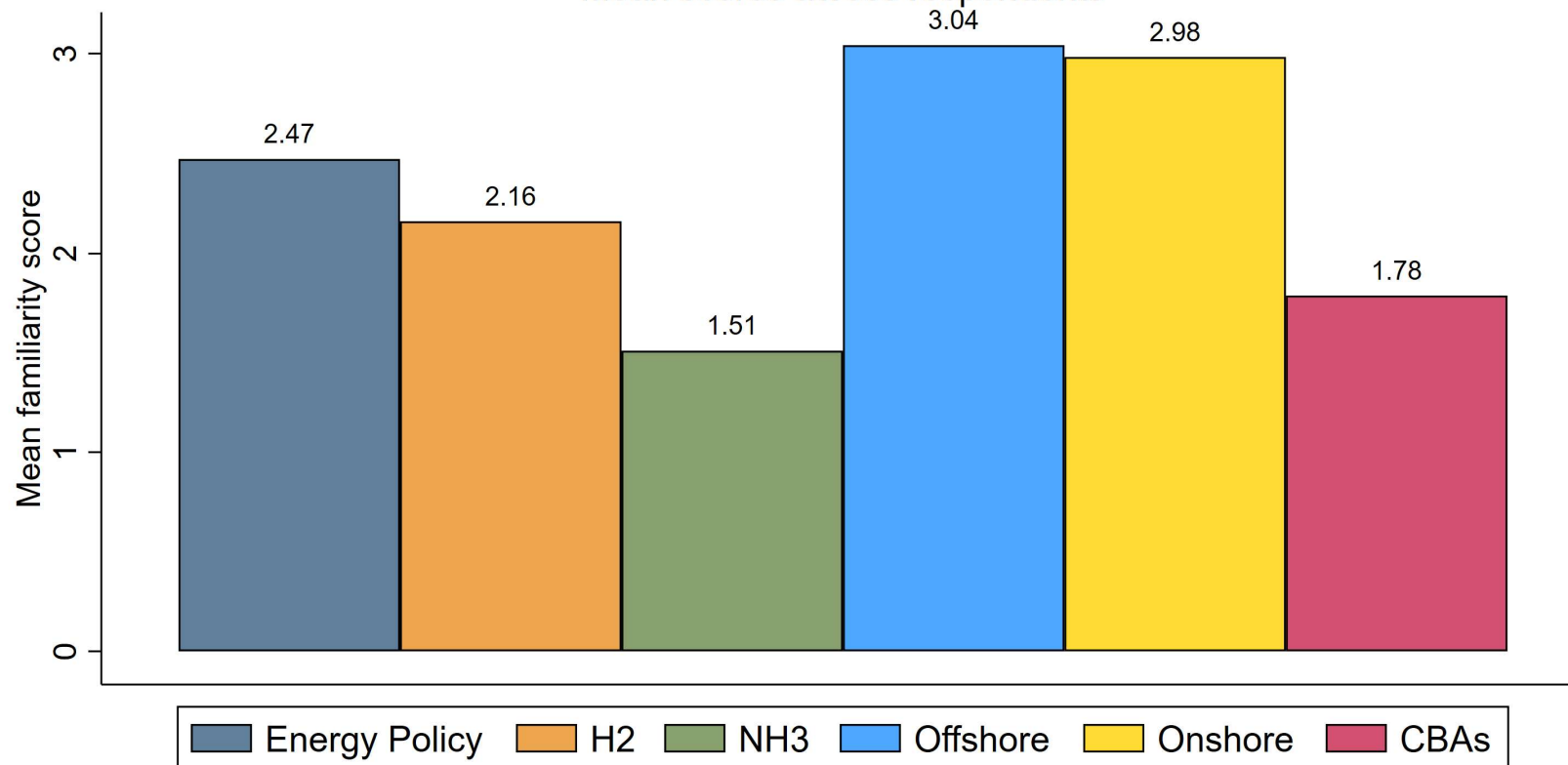


1. Not at all familiar (I've never heard of it before)
2. Slightly familiar (I've heard of it but don't know much)
3. Somewhat familiar (I know the basics)
4. Fairly familiar (I have a good understanding)
5. Very familiar (I am very well-informed)



Familiarity with UK Energy Policy Areas

Mean scores across respondents



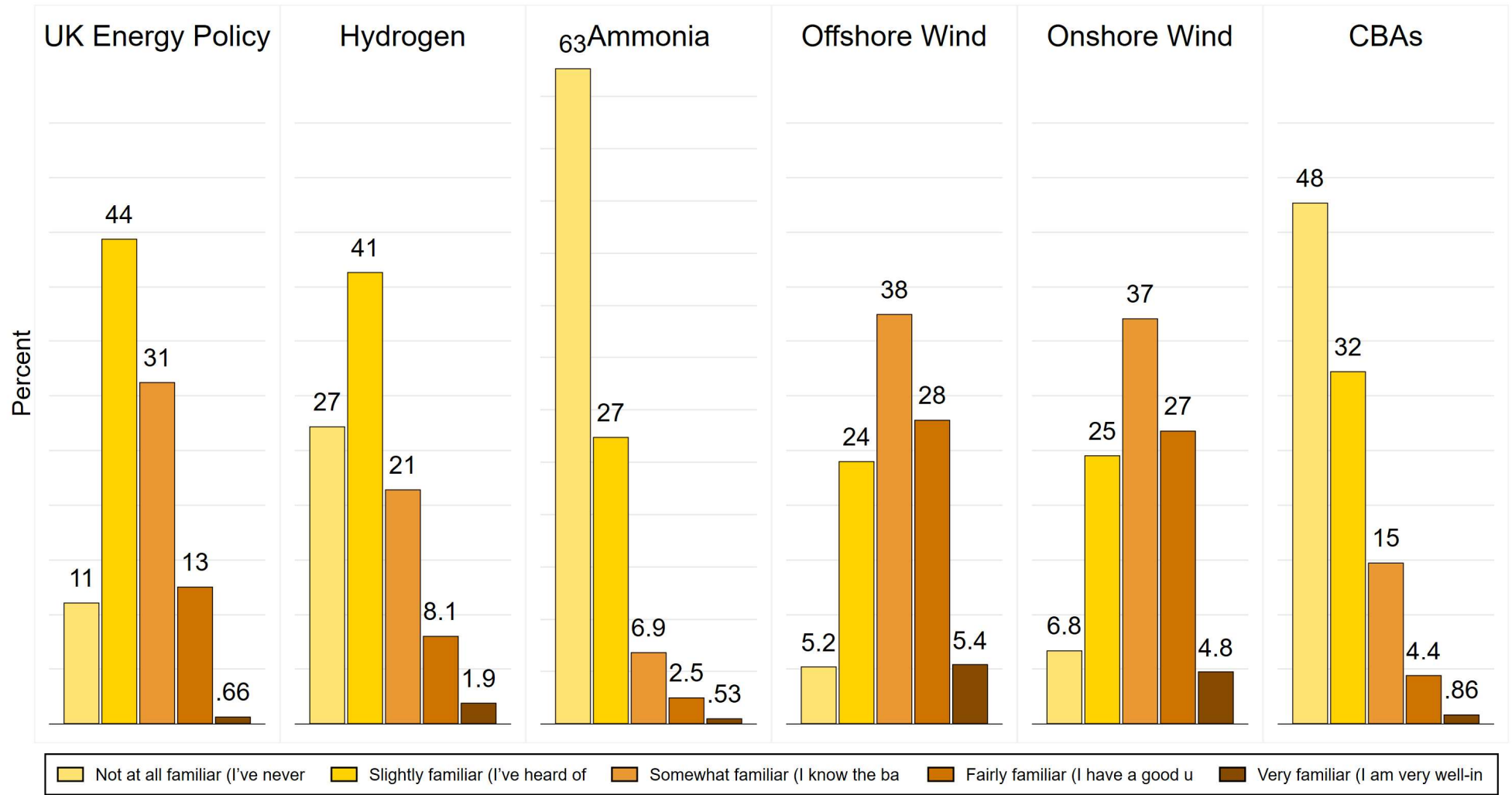
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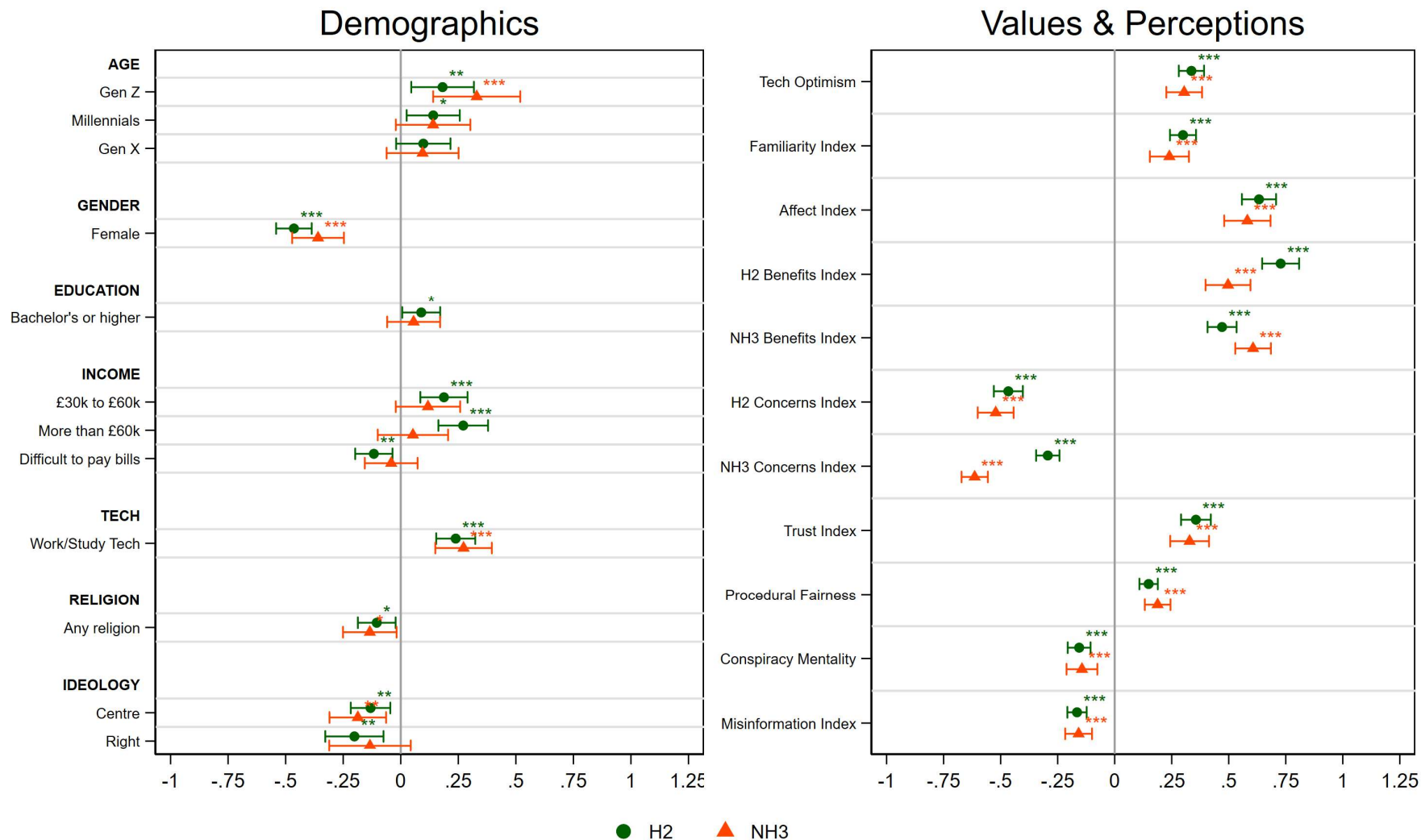
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Familiarity

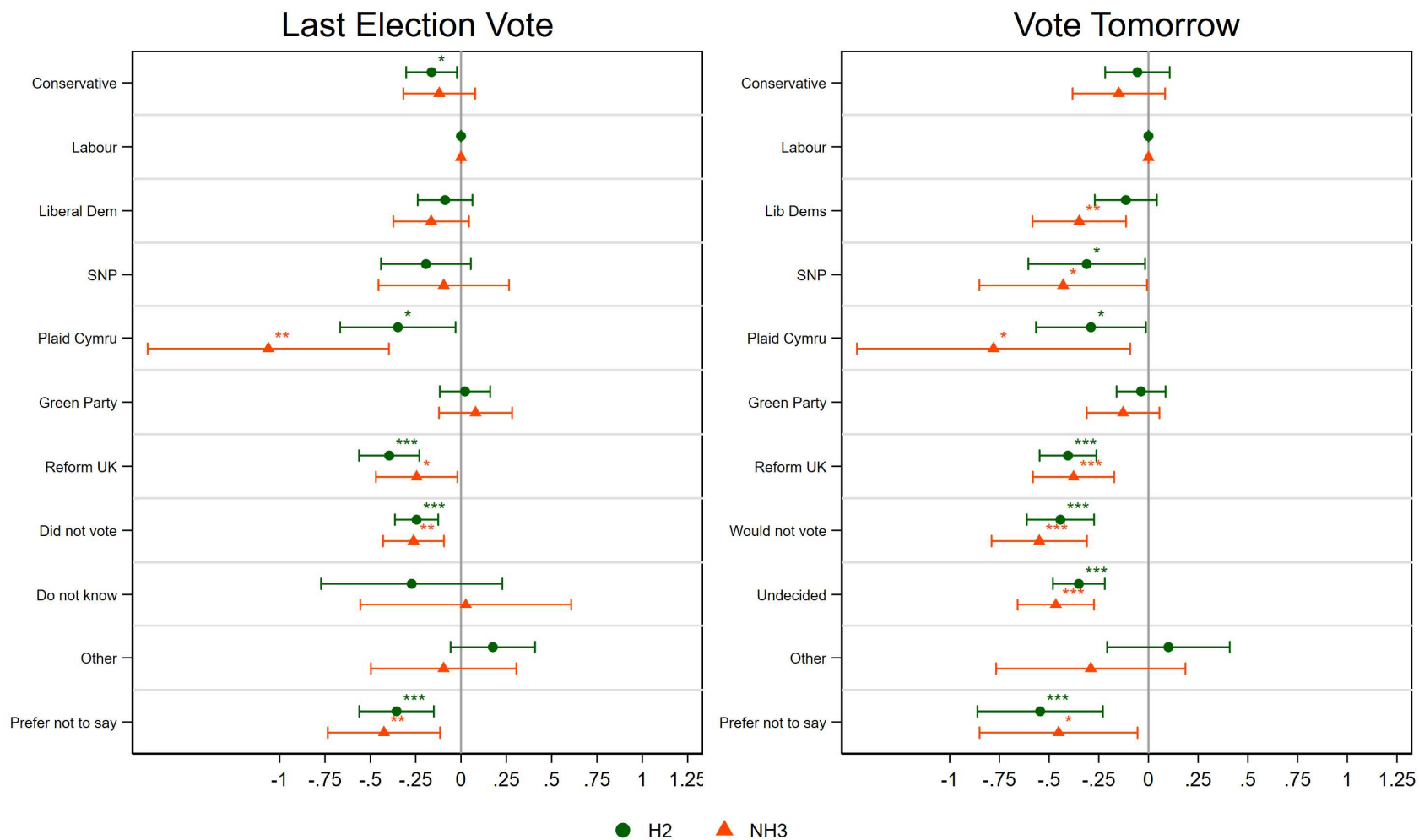


H2 & NH3 Acceptance: Bivariate Associations



Each coefficient comes from a separate regression with robust SEs. Capped lines represent 95% CIs. Stars: * p < .05, ** p < .01, *** p < .001

H2 & NH3 Acceptance: Bivariate Associations

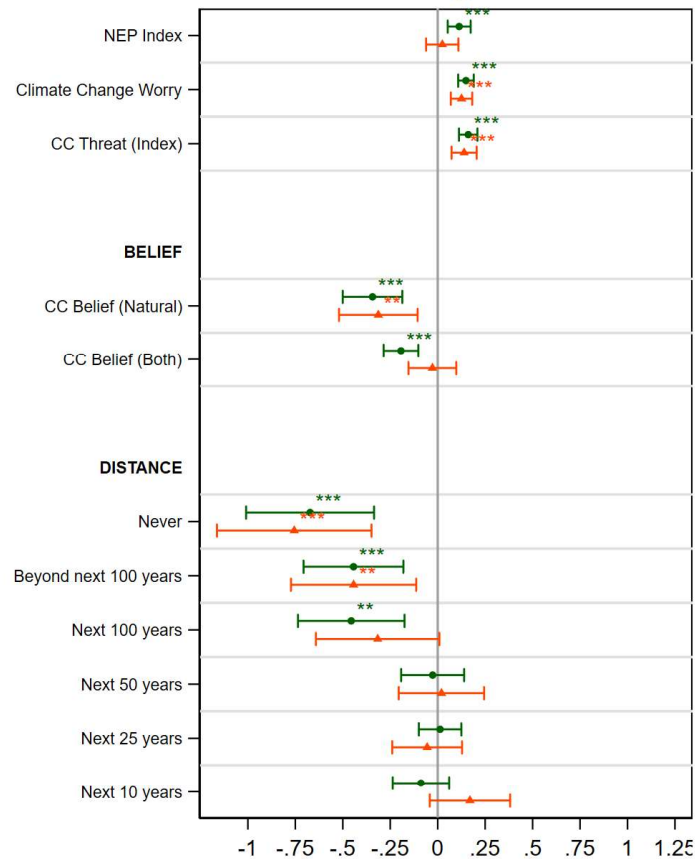


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H2 & NH3 Acceptance: Bivariate Associations



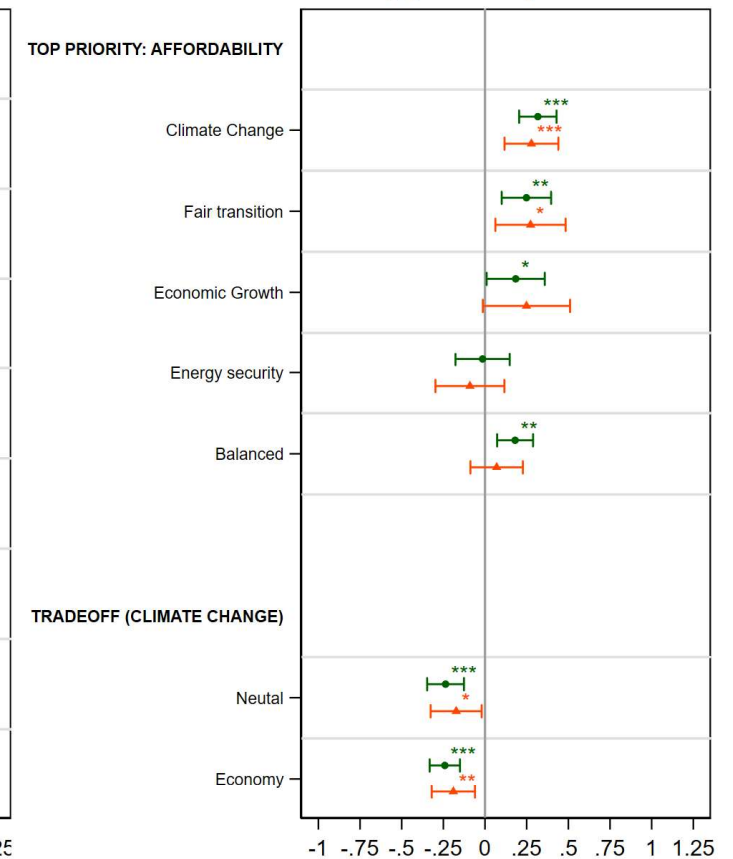
Climate Change Concerns



Energy Concerns



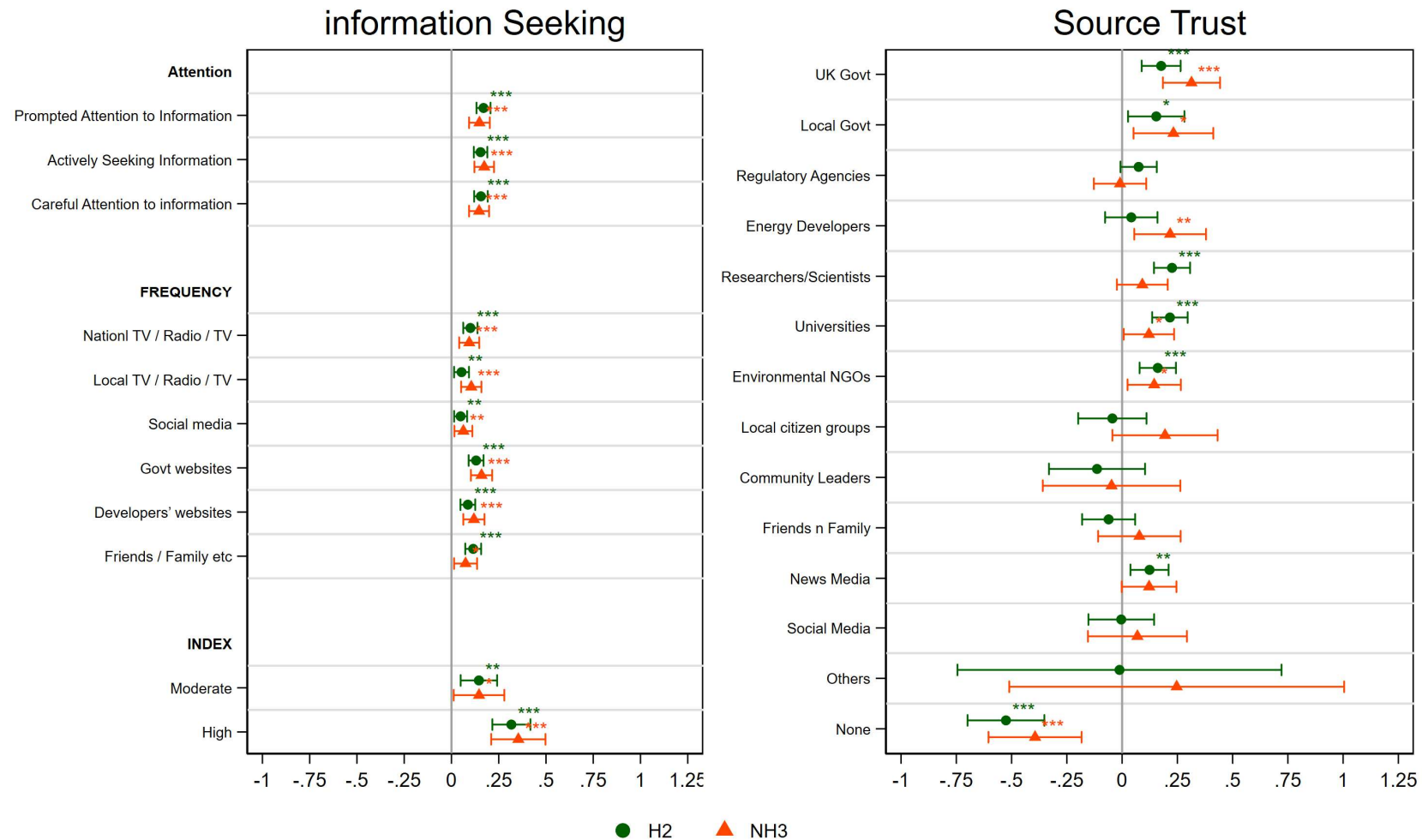
Energy Policy Priorities



● H2 ▲ NH3

Each coefficient comes from a separate regression with robust SEs. Capped lines represent 95% CIs. Stars: * $p < .05$, ** $p < .01$, *** $p < .001$

H2 & NH3 Acceptance: Bivariate Associations

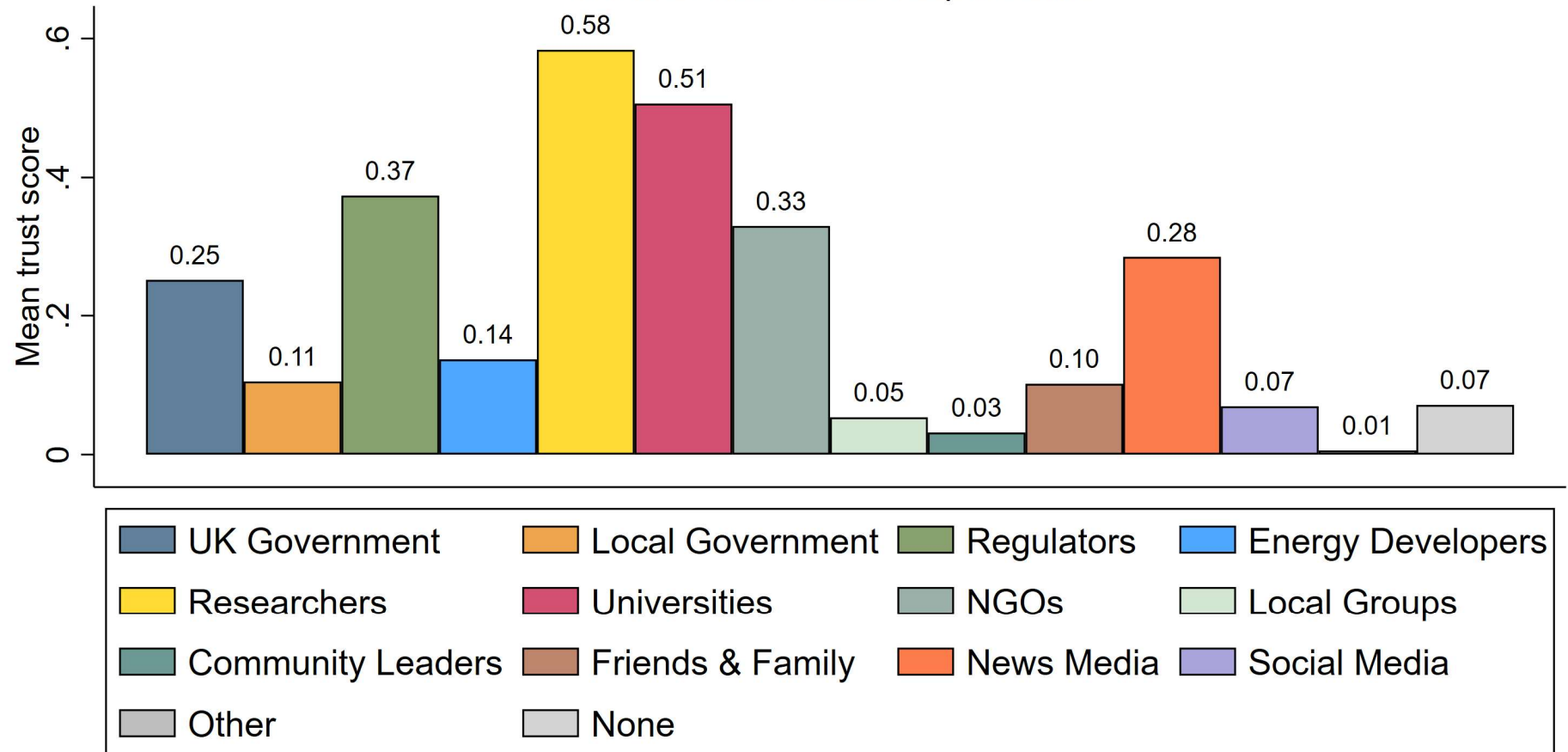


Each coefficient comes from a separate regression with robust SEs. Capped lines represent 95% CIs. Stars: * p < .05, ** p < .01, *** p < .001



Trust in Information Sources

Mean scores across respondents





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H2 & NH3 Project Priorities

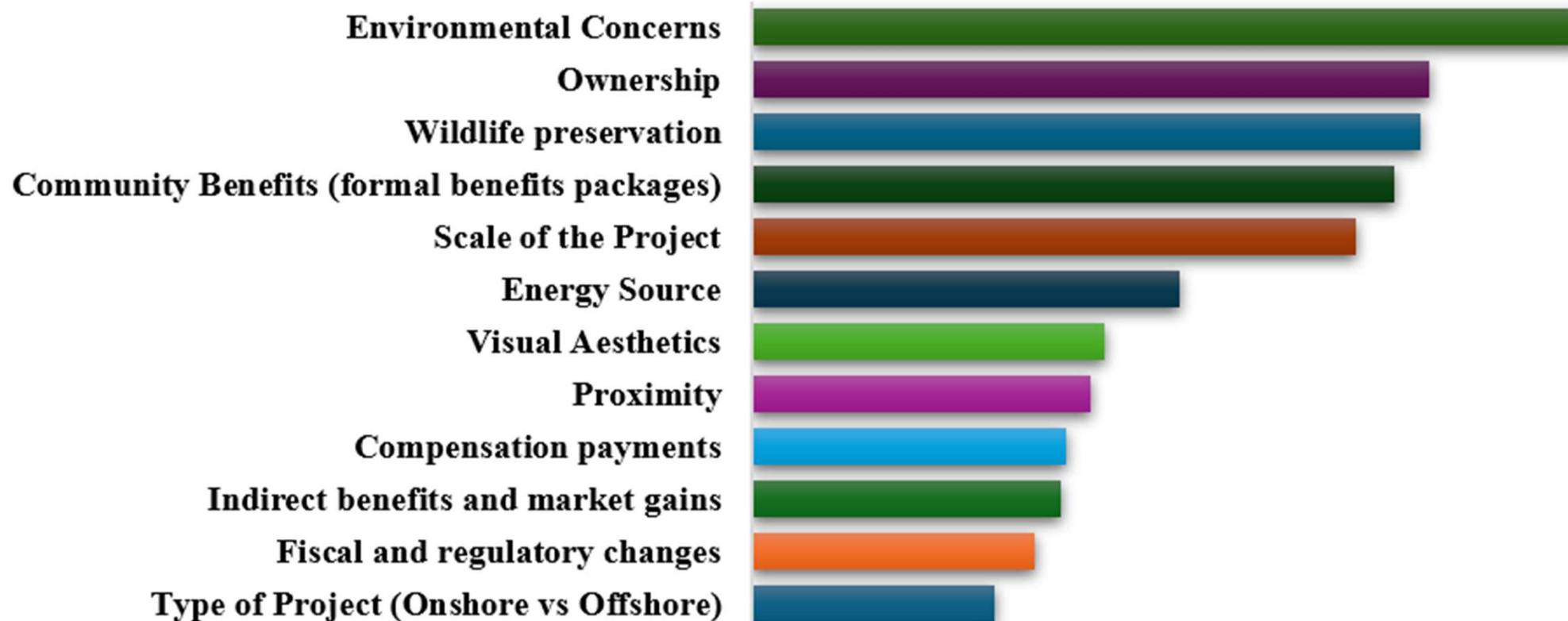


Priorities

Type of project	Scale of the project	Energy Source	Ownership
Proximity	Community Benefits	Indirect benefits and market gains	Compensation payments
Specific Communities and their livelihoods	Fiscal and regulatory changes	Environmental Concerns	Wildlife preservation
Visual Aesthetics			



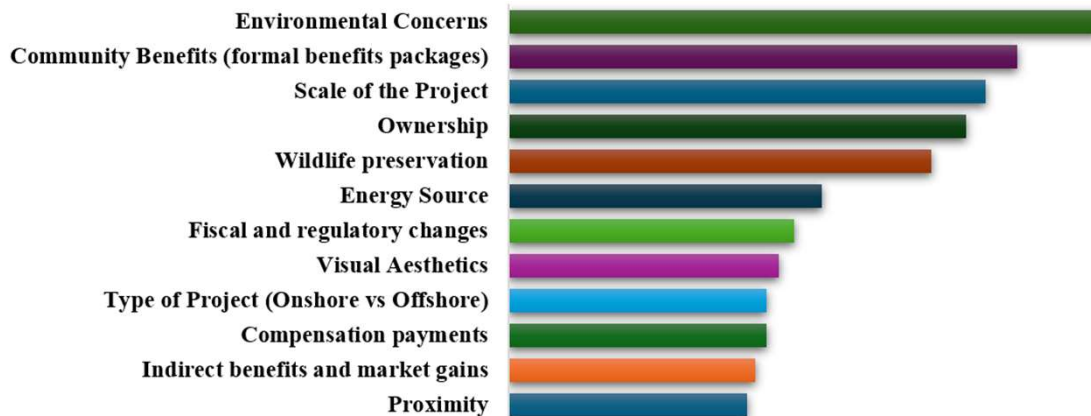
Project Priorities



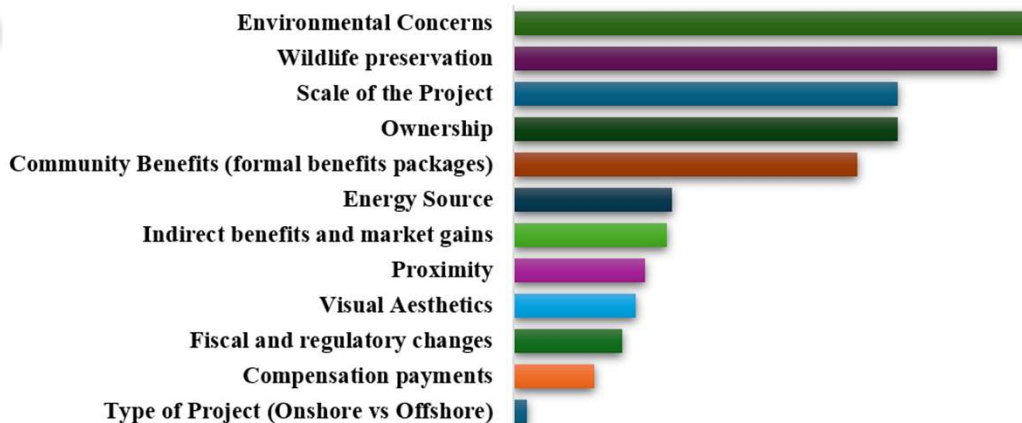
Project Priorities



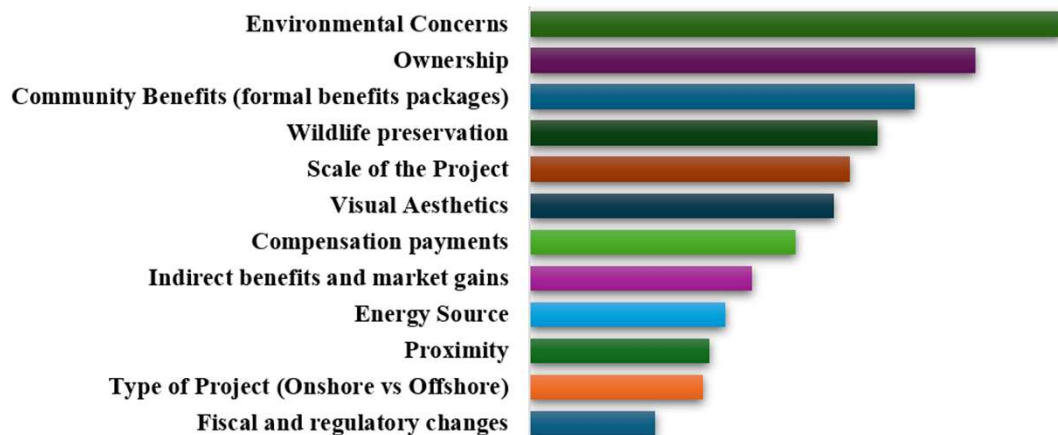
Day 1



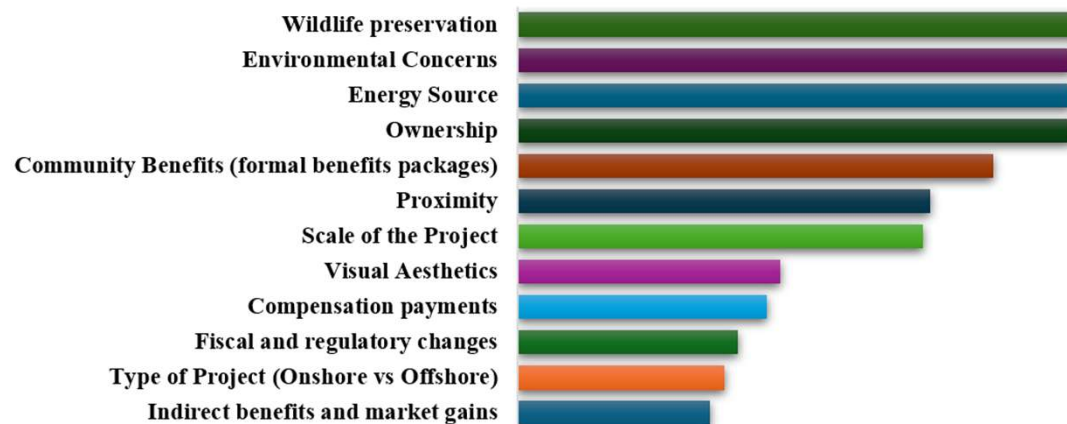
Day 2



Day 3



Day 4



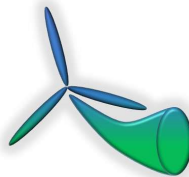


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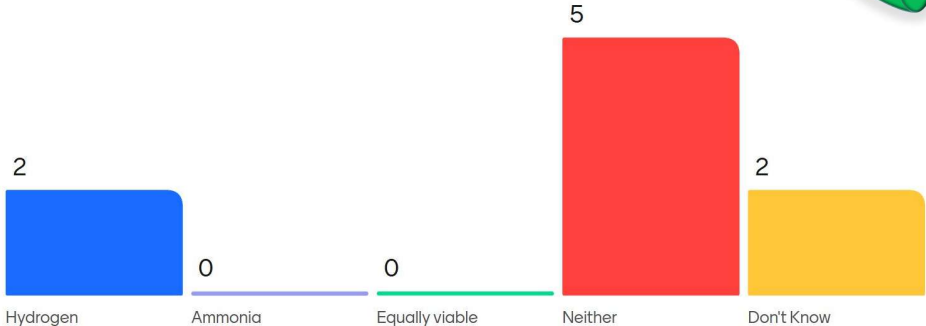
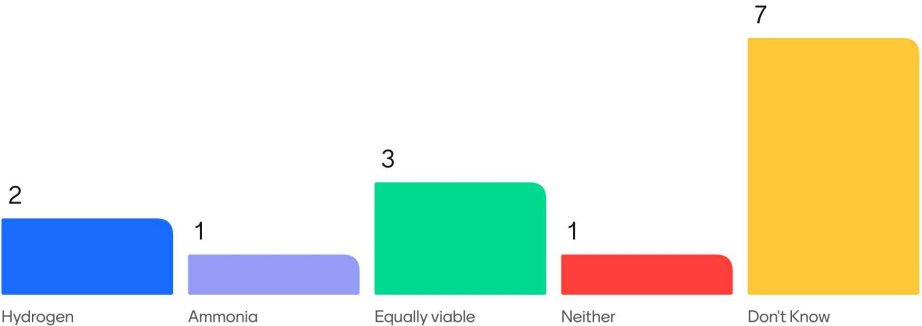


Day 1

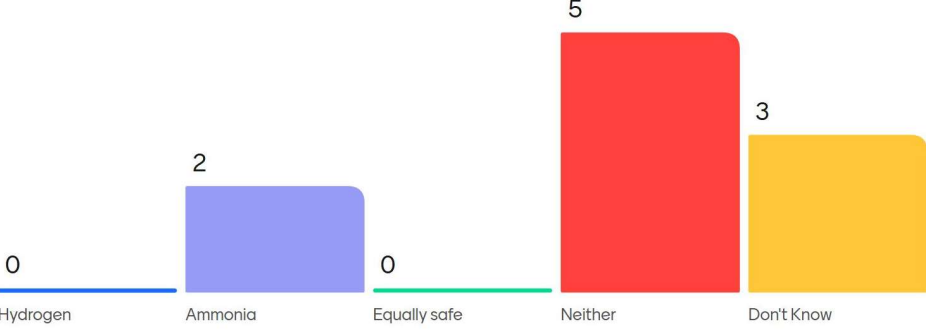
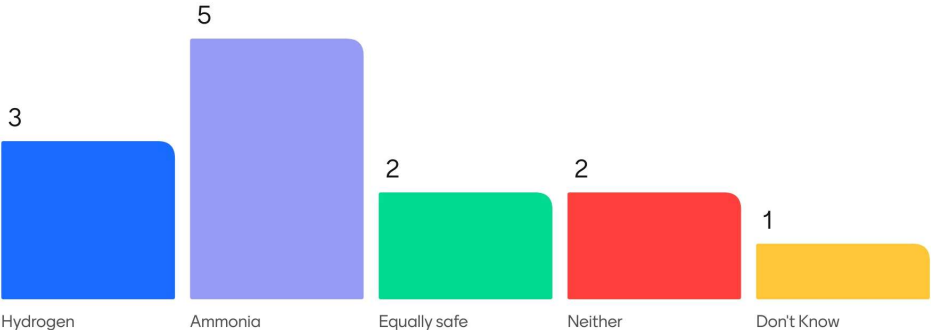
Day 2



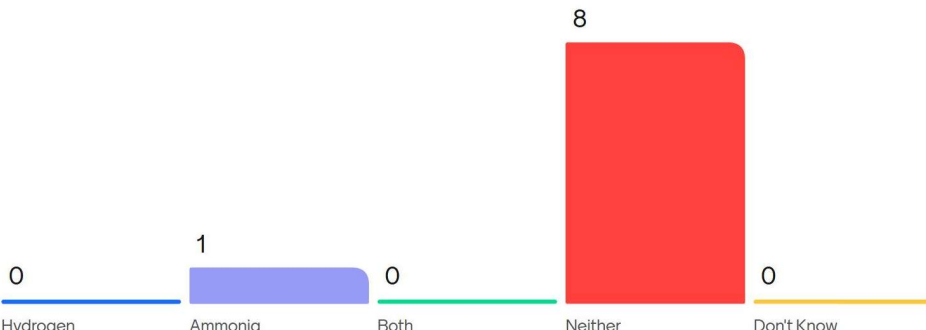
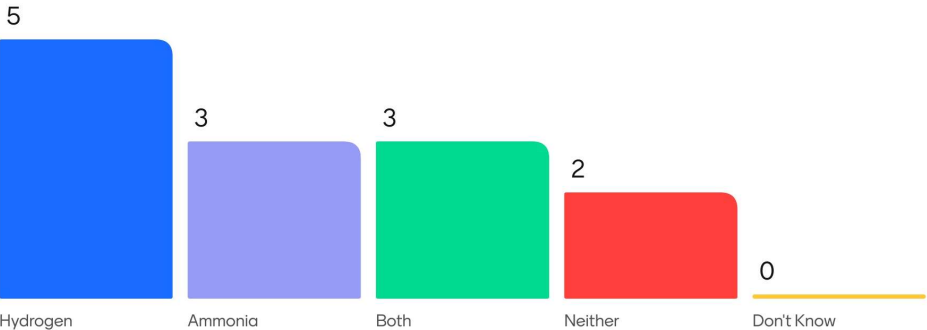
Viable



Safer



Prefer



CEA Allocation



Communities

- Health and social care
- schools, colleges, etc.

Housing

- Affordable housing

a. Environment

- Environmental restoration
- Climate change resilience

a. Jobs

- Skills,
- Targeted workforce development
- Hiring programs

New local facilities

- Recreational facilities
- Daycare centres

a. Infrastructure

- Port facilities
- Roads
- Ferries, etc.

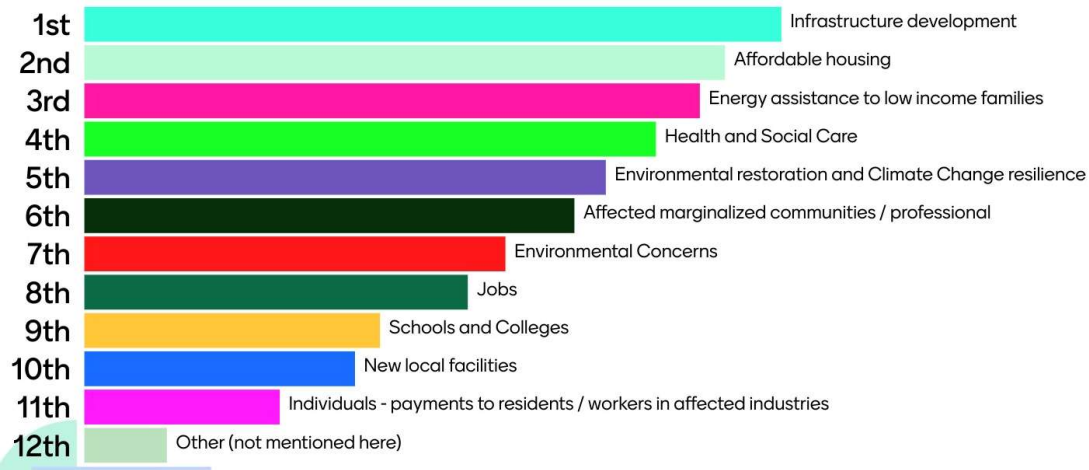
a. Individuals

- Payments to residents
- Workers in affected industries
- Energy assistance to low-income households

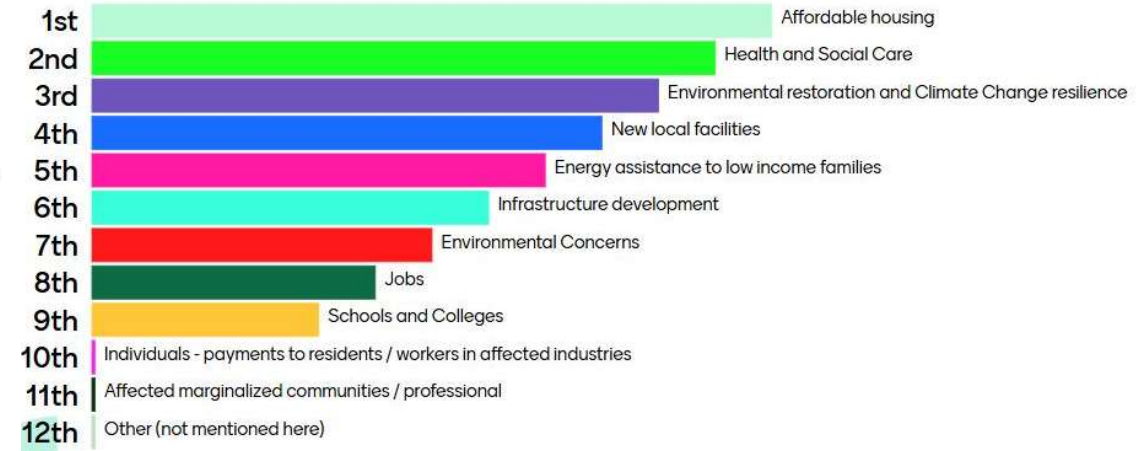
Marginalized communities

varies area to area
e.g.,
Fishing
Crofting

Day 1



Day 2



Conjoint Experiment: Project Preferences



Features	Levels					
Project Type	Hydrogen	Ammonia				
Energy Source	Offshore renewable (wind / wave / hybrid)	Onshore renewable (wind / solar)	Nuclear	Natural Gas	Coal	
Management / ownership	UK Government	Devolved Governments (Wales, Scotland, Northern Ireland)	Local Council	Community / shared ownership	Private developers (UK based)	Foreign developers
Proximity / visibility	1-5 miles (likely visible from your home/workplace)	5-20 miles (potentially visible while commuting to and from home/workplace)	Beyond 20 miles (not likely visible from your home/workplace)			
Environmental / ecological impact	Some impact with effective mitigation measures in place	Significant impact on environment or ecosystem				
Community Benefits	Utility bill cuts / Subsidized gas or electricity	Job share (quota) for the local population	Communities (schools, healthcare parks)	Affordable housing and local infrastructure	Environmental restoration	
Energy Distribution	Mostly used in your local area	Used both locally and elsewhere in UK	Mostly used in UK outside your area	Mostly exported to other countries		
Community Engagement	No consultation, decisions made by experts only	Basic consultation with local leaders and council	Public <u>consulted</u> , input considered	Community had strong <u>say</u> in decisions		

Project Preferences: Example Task



Please select the project you would prefer the government to support.

Step 1 of 5

Project type

Ammonia

Ammonia

Energy Source

Natural Gas

Coal

Management / ownership

Community / shared ownership

Devolved Governments (Wales, Scotland, Northern Ireland)

Proximity / visibility

5-20 miles (potentially visible while commuting to and from home/workplace)

1-5 miles (likely visible from your home/workplace)

Environmental / ecological impact

Significant impact on environment or ecosystem

Some impact with effective mitigation measures in place

Community Benefits

Job share (quota) for the local population

Environmental restoration

Energy Distribution

Mostly exported to other countries

Mostly used in your local area

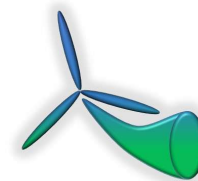
Community Engagement

Basic consultation with local leaders and council

Basic consultation with local leaders and council



Public Preferences for H2 and NH3 Project Characteristics (Conjoint Experiment)



Project type

Ammonia
Hydrogen

Source of Energy

Coal
Nuclear
Natural gas
Onshore renewable
Offshore renewable

Management / Ownership

Foreign developers
Private developers (UK based)
Local Council
Devolved Governments
UK Government
Community / shared ownership

Proximity / Visibility

1–5 miles
2.5–20 miles
Beyond 20 miles

Environmental Impact

Significant impact
Impact with mitigation measures

Benefits

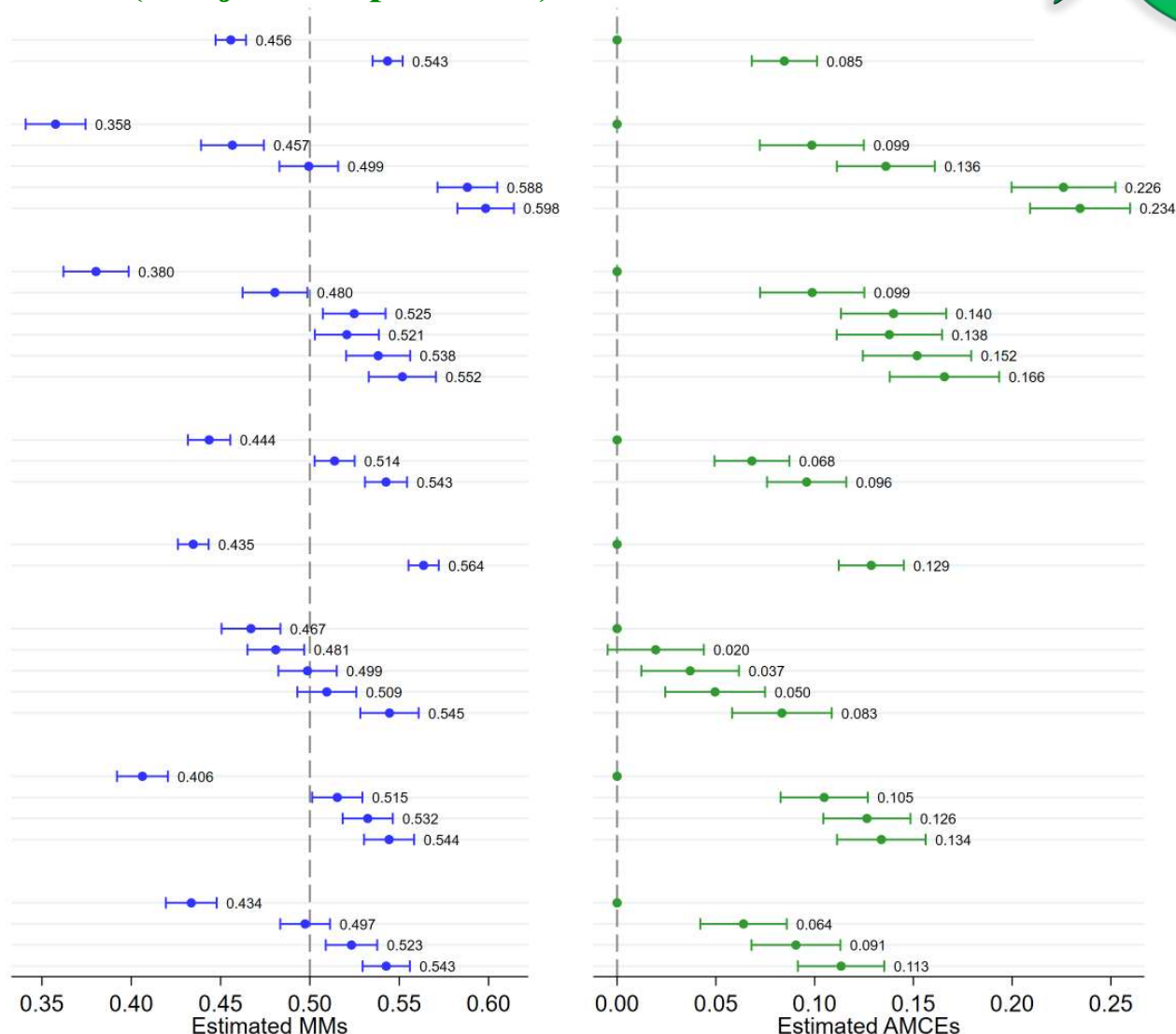
Communities (schools, healthcare)
Job share (quota)
Environmental restoration
Housing / infrastructure
Utility bill cuts / subsidies

Distribution

Exported outside UK
UK (outside local area)
Used locally
Locally & elsewhere in UK

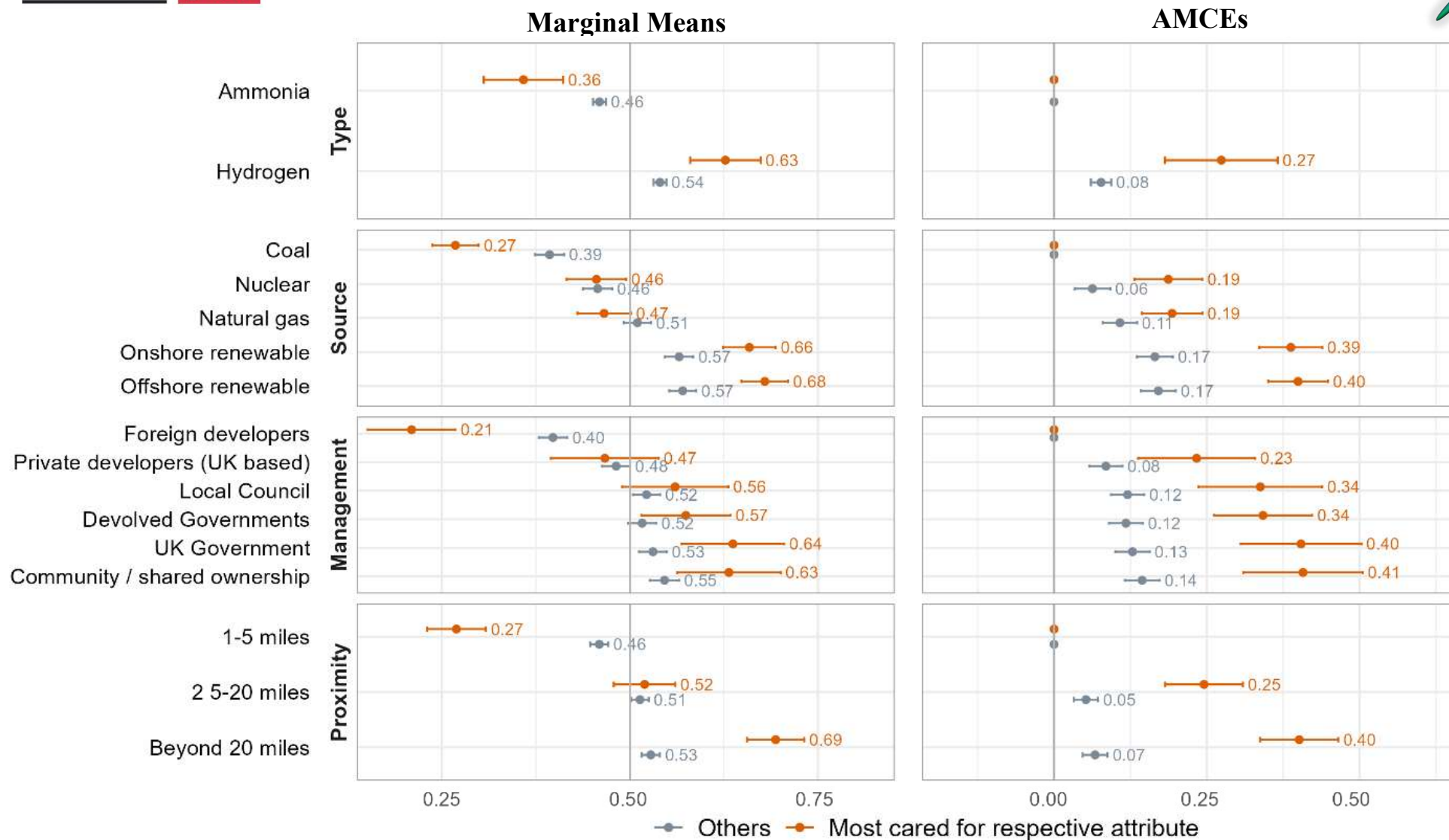
Community Engagement

No consultation
Consultation with council/leaders
Public consulted, input considered
Strong community say in decisions

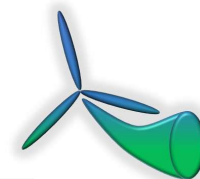


Siddiqi, M.U.A., Poortinga, W., Demski, C. Attribute priorities shape public support for hydrogen and ammonia energy projects. *Nature Communications*. (Under review).

Preferences by Self-Reported Attribute Priority (MMs and AMCEs)

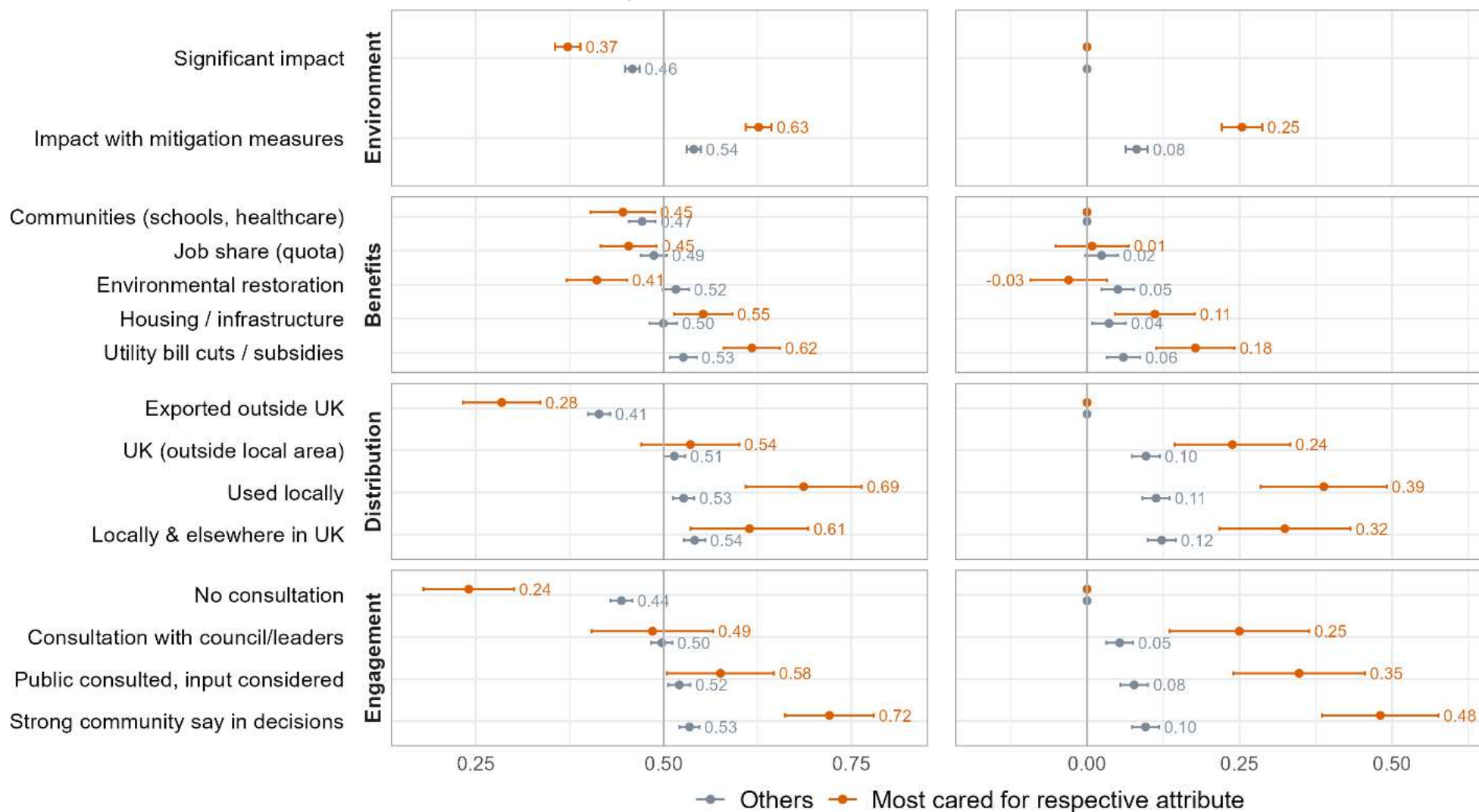


Preferences by Self-Reported Attribute Priority (MMs and AMCEs)



Marginal Means

AMCEs

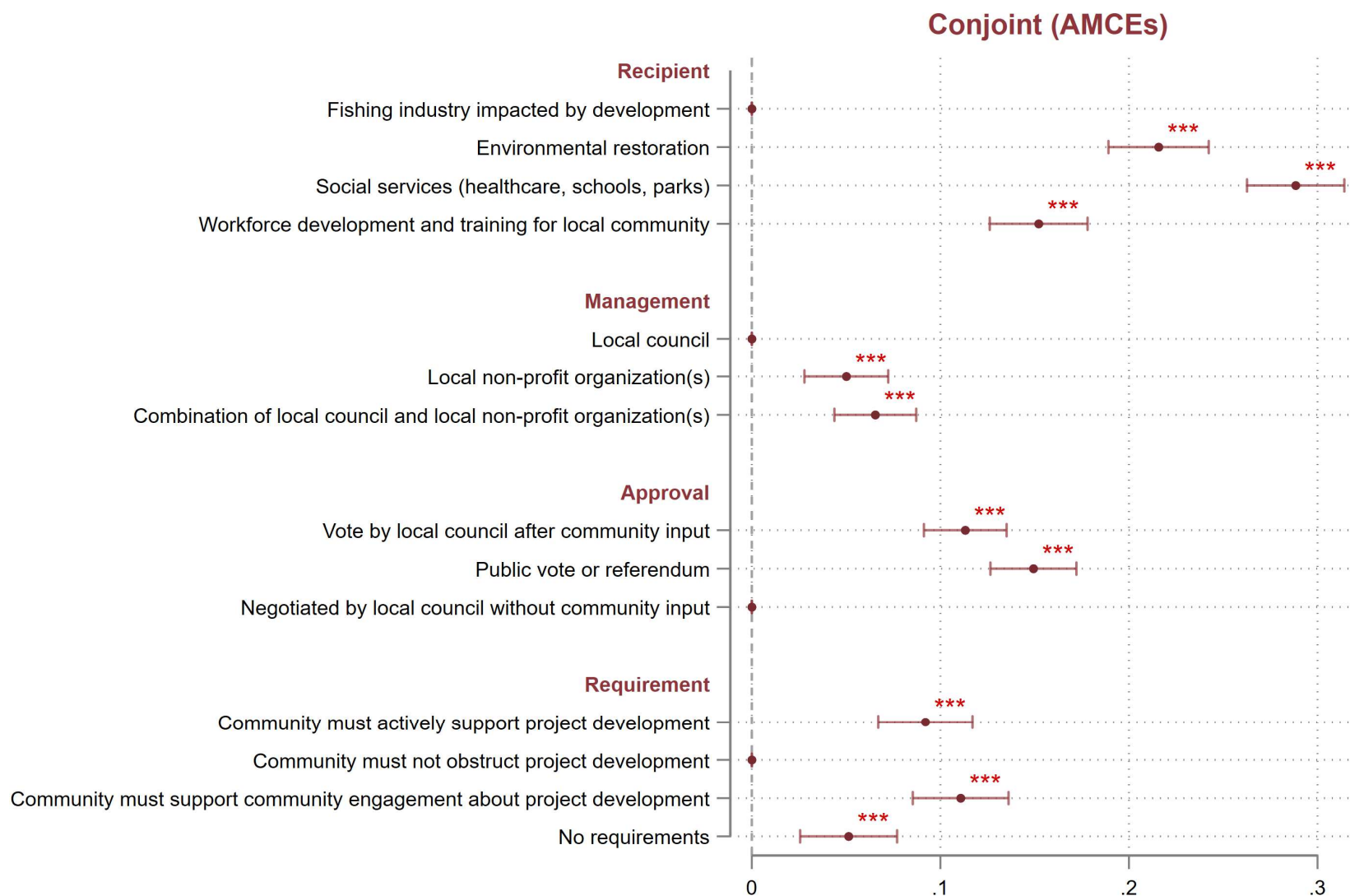


Conjoint Experiment: CBA Preferences



Features	Levels			
Majority of funding allocated to	Fishing industry impacted by development	Environmental restoration	Social services (healthcare, schools, parks)	Workforce development and training for local community
Approval of agreement by	Vote by local council after community input	Public vote or referendum	Negotiated by local council without community input	
Management of funds by	Local council	Local non-profit organization(s)	Combination of local council and local non-profit organization(s)	
Community requirements for receipt of funds	Community must actively support project development	Community must not obstruct project development	Community must support community engagement about project development	No requirements

CBA Preferences: AMCEs



Preferences for Project Characteristics – National Survey

- Hydrogen projects receive higher support than ammonia (public familiarity with both technologies remains low)
- Strong preference for renewable energy sources across political groups, but support varies
- Environmental mitigation increases acceptance, even for green projects
- Community and public ownership increases support
- Fair distribution of benefits is critical (Bill reductions, subsidies)
- UK-wide distribution with local use strongly increase support
- Proximity still affects acceptance
- Engagement strongly improves support
- Public support depends on multiple project features (design choices matter)
- Priority attributes matter more for some groups
 - People who care most about a feature react strongly to changes in that feature
 - Average support scores can hide strong opposition or support in subgroups

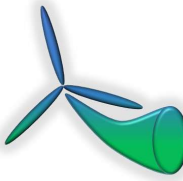




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Broad Takeaways (Shetland Workshops)



- Participation marked by motivation, curiosity, caution, and occasional confusion
- Preference for ‘green’ hydrogen, with important caveats
- Stronger acceptance of applications in heavy transport and industry
- Scepticism over local benefits vs. fears of becoming an ‘energy dumping ground’
- Key concerns: environmental impacts, scale of development, community benefits
- Very peculiar socio-economic context – industry shouldn’t worry about precedents
- Mistrust linked to information gaps and limited transparency – educational materials
- Strong connections with Renewable Energy Technologies
 - Perceptions of lost control shaped by experiences with past projects
 - Development of and transition to new energy technologies does not occur in vacuum
 - Inherit socio-technical landscape shaped by legacy infrastructure, institutions, actors, and practices
 - Carries forward long-standing public perceptions, collective experiences, and dominant narratives

Implication for project developers and policymakers



- Design projects around public priorities
 - Project design should consider different publics, not only overall averages
- Ensure credible mitigation and strong engagement
- Careful management of scale
- Sensitivity to location and visibility
- Expand shared ownership and community benefit mechanisms
- Procedural fairness is as important as technical design
 - Early, meaningful community engagement (strong place attachment)
 - Once public attitudes solidify they are rarely reversed by factual corrections alone
 - Crucial to adopt a proactive approach
 - Target communication to different groups
 - Grounded in an informed understanding of the audience's psychological predispositions.
 - Honest, accessible information from trusted local sources
 - Accessible and relatable public facing educational materials
 - Local impacts must be addressed directly (proximity)
 - Provide clear local benefits



Thank you!
Suggestions / Questions