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Acceptance before deployment: a systematic review and measurement audit of public acceptance research on four emerging net-zero energy technologies

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Systematic Review

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Abstract

Deep decarbonisation increasingly depends on technologies that most citizens have never encountered: small modular reactors (SMRs), hydrogen energy systems, carbon capture, utilisation and storage (CCUS), and offshore wind. Public acceptance is widely treated as a make-or-break condition for deployment, yet the evidence has grown in technology-specific silos and has never been audited for how acceptance itself is measured. This PRISMA 2020 systematic review spans all four families. A frozen, benchmark-validated search of Scopus and OpenAlex (16,806 unique records) was screened with a calibrated human–machine workflow (kappa = 0.821; 100% benchmark recall), yielding 689 full-text candidates and 534 included primary studies. Three findings stand out. First, the field is expanding rapidly and asymmetrically: 57% of the evidence post-dates the most recent comprehensive review, with CCUS (217 studies) and hydrogen (186) dominating, offshore wind (136) consolidating, and SMRs (17) markedly under-studied relative to policy salience. Second, study-level associations are directionally consistent for perceived benefit (70% positive), trust (58% positive) and perceived risk (54% negative), but inconsistent for proximity and socio-demographics, challenging distance-based siting heuristics. Third — the central result — the measurement base is thin: only 1.5% of studies reused a pre-validated acceptance instrument, 71.3% relied on ad hoc measures, 82.8% were one-shot cross-sections, 35.2% did not measure familiarity, and 72.7% examined pre-deployment technologies. Much of the literature thus appears to record unstable constructions of unfamiliar objects rather than settled public judgements. A measurement-first agenda — shared instrument cores, mandatory familiarity assessment, deployment-stage-explicit reporting, and longitudinal designs — is proposed.

1. Introduction

Virtually every mid-century decarbonisation pathway now relies on a portfolio of energy technologies that remain unfamiliar to the publics who will host, fund and use them: small modular reactors (SMRs) and other advanced nuclear designs, hydrogen production and end-use infrastructure, carbon capture, utilisation and storage (CCUS, including its bioenergy and direct-air removal variants), and offshore wind, increasingly in floating configurations. Since Wüstenhagen et al. distinguished socio-political, community and market acceptance (2007), a substantial empirical literature has treated public acceptance as a decisive, sometimes binding, constraint on deployment — a proposition repeatedly borne out by cancelled carbon storage demonstrations, stalled wind projects and contested hydrogen sitings (Batel et al., 2013; Firestone and Kempton, 2007; Wolsink, 2007).

That literature, however, has three structural problems. The first is currency. The most recent comprehensive synthesis of low-carbon technology acceptance, by Görsch et al. (2025a), closed its search in May 2021 and did not cover hydrogen among its eleven technologies; earlier landmark reviews — Huijts et al. (2012) on the psychology of energy technology acceptance and Perlaviciute and Steg (2014) on contextual and psychological determinants, and L'Orange Seigo et al. (L'Orange Seigo et al., 2014) on CCS — are a decade or more old. As Section 3.1 shows, more than half of the empirical record

on these four technology families post-dates May 2021. Policy-relevant conclusions are therefore being drawn from syntheses that predate most of the evidence.

The second problem is fragmentation. Hydrogen, CCUS, offshore wind and advanced nuclear research communities publish in largely separate venues, cite separate canons, and rarely test whether their explanatory models travel across technologies (Rand and Hoen, 2017; Scovell, 2022; Upham et al., 2015). Yet the deployment context that matters for policy is portfolio-wide: the same regions, often the same communities, are being asked to host several of these technologies at once, and national net-zero plans treat them as complements rather than alternatives. Whether the determinants of acceptance generalise across technology families is an empirical question that single-family reviews cannot answer.

The third problem, and the one this review is designed to expose, is measurement. Narrative and meta-analytic syntheses alike must take the primary literature's measurement practices on trust: if "acceptance" is operationalised with unvalidated single items, measured once, on respondents whose familiarity with the technology is unknown, then synthesised conclusions inherit those weaknesses invisibly. Survey methodology has long shown that attitude reports on unfamiliar objects are constructed in situ and highly sensitive to question wording, information provision and context (Schwarz, 1999; Sturgis and Allum, 2004); the informed-opinion tradition in CCS research demonstrated early that expressed opinions on unfamiliar technologies can be unstable pseudo-opinions unless respondents are given — and retain — relevant knowledge (de Best-Waldhober et al., 2009). No prior review has systematically audited the acceptance literature's instruments, temporal designs, familiarity checks or deployment-stage coverage. This matters now because the four families examined here are precisely the technologies for which publics are least likely to hold crystallised attitudes.

Four families anchor the review because they anchor the deployment portfolio. SMRs, hydrogen systems, CCUS and offshore wind occupy complementary niches in net-zero planning — firm low-carbon power, molecule-based storage and industrial decarbonisation, residual-emissions management, and bulk renewable supply — and their build-out timelines now overlap in the 2026–2040 window, so the same coastal and industrial regions will often be asked to host several simultaneously. They also share the property that makes acceptance measurement hardest: unlike rooftop solar or onshore wind, none is yet an everyday object of experience for more than a small minority of publics, so measured "acceptance" necessarily concerns anticipated rather than experienced technology. That combination — high policy weight, overlapping siting demands, low public familiarity — makes the state of this evidence base a first-order question.

This review therefore pursues four questions. RQ1 (landscape): what is the volume, distribution and design profile of empirical public-acceptance research on SMRs, hydrogen, CCUS and offshore wind? RQ2 (determinants): which determinants of acceptance are consistently supported across technology families, and which are family- or context-contingent? RQ3 (measurement audit): with what instruments, temporal designs, familiarity checks and deployment-stage coverage has acceptance been measured?

RQ4 (reporting quality): how transparently does the literature report funding, conflicts of interest and sampling?

These questions are addressed through a PRISMA 2020 (Page et al., 2021) systematic review of 534 primary empirical studies — to the author's knowledge the largest synthesis of public acceptance evidence for emerging net-zero technologies to date, and the first to audit the field's measurement practices. Beyond updating and unifying the fragmented evidence, the headline contribution is diagnostic: the review shows that the evidential foundation under a policy-critical literature is methodologically far thinner than its volume suggests, and derives a concrete measurement-first agenda from that diagnosis.

2. Materials and methods

The review followed PRISMA 2020 (Page et al., 2021). A protocol specifying research questions, eligibility criteria, the search strategy, screening procedures and the extraction schema was fixed before full-text screening began, and all subsequent amendments were logged with dates and rationales in the protocol's development log. The protocol and all analysis files (search strings, screening ledger, calibration set, extraction data and audit tables) are provided in Supplementary Materials A and B. The review was not prospectively registered; registration platforms for non-health-science reviews remain optional, and full in-protocol documentation of every deviation was prioritised instead. Large language model (LLM) assistance in screening and data extraction is reported transparently in Sections 2.4–2.6, including the human calibration and verification safeguards applied.

2.1. Eligibility criteria

Studies were included if they satisfied all of five criteria. (I1) Population: members of the general public — residents, consumers, citizens or community samples; studies sampling only experts, industry professionals or organised stakeholders were excluded. (I2) Technology: SMRs or other advanced/next-generation nuclear concepts measured specifically (generic nuclear-power attitude studies were excluded); hydrogen production, infrastructure or end-use applications; CCUS including CCS, CCU, BECCS and DACCS (nature-based or ocean-based carbon dioxide removal was out of family); or offshore wind including floating concepts (onshore-only wind studies were excluded, having been synthesised recently elsewhere (Rand and Hoen, 2017)). (I3) Outcome: an empirical measure of acceptance, acceptability, support, attitude, perception, willingness-to-pay/use, risk–benefit judgement, or discourse stance towards the technology. (I4) Design: primary empirical research — surveys, experiments, stated-preference studies, qualitative fieldwork, or text-as-data analyses with an explicit method; reviews, conceptual papers and techno-economic assessments without primary public data were excluded. (I5) Publication: peer-reviewed journal articles with full text available in English.

2.2. Information sources and search

Scopus and OpenAlex were searched, pairing four technology blocks (SMR/advanced nuclear; hydrogen; CCUS/BECCS/DACCS; offshore and floating wind) with an acceptance-outcome block (acceptance, support, opposition, attitude, perception, willingness and related variants). Before being frozen, the strategy was validated against a 19-study known-relevant benchmark spanning all four families and achieved complete (19/19) recall. The final search (11 July 2026) returned 12,947 Scopus and 7,274 OpenAlex records after within-source deduplication; cross-source deduplication by DOI and normalised title left 16,806 unique records for screening. Full search strings and the version-by-version search development log are provided in Supplementary Material A.

2.3. Selection process: calibration

Title–abstract screening combined principal-investigator (PI) judgement with LLM assistance under a pre-specified calibration-first design. The PI first hand-screened a stratified random calibration sample of 200 records. The same 200 records were then screened by the LLM using a frozen screening prompt (v1.0) encoding the eligibility criteria, with the model blind to the human verdicts. Human–model agreement reached Cohen's kappa = 0.821 (1960) (prevalence-adjusted bias-adjusted kappa, PABAK, 0.940 (Landis and Koch, 1977)), exceeding the pre-specified proceed threshold of 0.75, with model sensitivity of 12/12 on the calibration records the PI had marked as includes and zero critical (include→exclude) disagreements. Bulk screening began only after this calibration gate had been passed.

2.4. Selection process: bulk screening and full-text review

The remaining 16,606 records were screened by isolated LLM instances running the frozen v1.0 prompt, each record assessed independently and blind to any human verdicts, with a conservative unsure-escalation rule: records the model could not confidently exclude were retained for the next stage, and a designated unsure stratum was adjudicated by the PI, whose decisions are recorded in the screening ledger as attested PI verdicts. Screening of all 16,806 records completed with zero processing failures. In total, 689 reports proceeded to full-text review.

Full-text review excluded 155 reports (full text not available, 63; population not general public, 43; technology out of family, 23; no acceptance outcome, 5; not primary empirical, 4; not a peer-reviewed journal article, 4; full text not in English, 13), leaving 534 included studies. Every exclusion was individually confirmed by the PI, and all exclusions are listed with reasons in Supplementary Material B; full bibliographic references for all 534 included studies are provided in Supplementary Material C.

2.5. Data extraction

A 29-field extraction schema, piloted before deployment, was applied to every full text by isolated LLM extraction agents (one instance per document) under a strict instruction to record only information present in the document and to mark anything else as not reported. Fields covered bibliographics; country; technology family and subtype; deployment stage of the studied object on a four-level scale (S0 concept/no named project; S1 announced/planned; S2 siting/under construction; S3 operating);

acceptance dimension(s); object specificity (technology-in-general versus named local project); population and sampling; design family; theoretical framework; measurement properties (construct label, item count, response scale, validated-instrument use, familiarity measurement, information provision, temporal design); determinants with direction of association (positive, negative, non-significant, mixed); headline acceptance findings; quality flags; and funding/conflict-of-interest reporting. Every extraction record was checked against its source document, through full review by the research team complemented by independent adversarial re-verification of sampled records and of every exclusion decision; no errors in verdicts, determinant directions or headline figures were found. The complete set of structured extraction records (including all full-text exclusions with reasons) is preserved as machine-readable files in Supplementary Material B.

2.6. Synthesis methods and the measurement audit

Given the heterogeneity of outcomes, instruments and designs, no meta-analytic pooling of effect sizes was attempted. RQ1 and RQ4 are answered by structured tabulation. RQ2 is addressed by study-level direction counting: each study contributes at most one report per determinant category, classified as positive, negative, non-significant or mixed; this vote-counting approach establishes the direction and consistency of associations but not their magnitude, and is interpreted with that limitation explicit throughout Section 3.3. For RQ3, the measurement audit, three coders' rules were fixed before analysis: an instrument counts as validated-reused only when a study affirmatively used a pre-existing acceptance instrument with prior validation evidence essentially as published; adapted-items covers instruments assembled by borrowing or translating items from prior studies; everything else — including instruments with only internal reliability statistics — is study-specific/ad hoc. Familiarity measurement, information provision, temporal design and deployment stage were coded from the extraction fields under equally strict definitions. All audit classifications are reproducible from the released extraction files (Supplementary Material B), and all aggregate tables are generated by a single versioned analysis script archived with the data; the per-family cross-tabulations reported in Sections 3.3–3.4 are generated from the released extraction master by a companion versioned script archived alongside it.

3. Results

3.1. Study identification and landscape (RQ1)

Figure 1 presents the PRISMA flow. From 16,806 unique records, 689 reports proceeded to full-text review and 534 primary empirical studies were included. The included studies span 2003–2026 and report data from more than 60 countries. Among the 511 studies of human participants, 435 reported sample sizes, with a median of 575 respondents and a cumulative total of approximately 585,000 survey and interview participants; the 23 text-as-data studies add corpora exceeding 1.5 million public texts (tweets, comments and news items), including single studies analysing 569,103 posts on carbon dioxide removal (Repke et al., 2024) and 625,794 posts on green hydrogen (Jaca Madariaga et al., 2024).

The field is growing steeply and unevenly (Fig. 2, Table 1). By technology family — with 21 studies covering more than one family counted in each — CCUS accounts for 217 studies, hydrogen for 186, offshore wind for 136 and SMRs for only 17. Growth is concentrated in the most recent period: 305 studies (57.1%) were published in 2021–2026, after the May 2021 search cut-off of the most recent comprehensive review (Görsch et al., 2025a). Hydrogen shows the sharpest acceleration (126 of its 186 studies post-2020), reflecting national hydrogen strategies announced from 2019 onward; CCUS growth is driven by CCU product-acceptance and DACCS/BECCS studies joining the older storage-siting literature. The SMR evidence base is an order of magnitude smaller than the technology's prominence in national net-zero plans would suggest; notably, several of the 17 SMR studies are concentrated in Canada and report industry-linked funding, a concentration revisited in Section 3.5.

Table 1
Included studies by technology family and publication period (multi-family studies counted in each family; 534 unique studies).

Technology family	≤ 2010	2011–2015	2016–2020	2021–2026	Total
CCUS	15	41	53	108	217
Hydrogen	16	14	30	126	186
Offshore wind	12	17	36	71	136
SMR	1	0	3	13	17

Geographically — crediting every country in which a study collected public data, with multi-country studies counted in each — the United States (80 studies), Germany (70), the United Kingdom (60) and South Korea (44) dominate, followed by the Netherlands (34), China (26), Japan (25) and Denmark (22). The Global South remains sparsely covered — a substantive gap given that hydrogen export corridors and CCUS hubs are planned across it, and given the first cross-national evidence that publics in the Global South evaluate engineered carbon removal more favourably than publics in the Global North (Baum et al., 2024). Methodologically, single-wave questionnaire surveys dominate (213 studies), followed by stated-preference designs (discrete choice experiments and contingent valuation, 103), mixed methods (88), qualitative fieldwork (58), experiments (49) and text-as-data studies (23) — the last a visibly growing design family after 2020, applying sentiment and topic models to social media and news corpora (Novak, 2025; Ye et al., 2024). Object specificity splits roughly three-to-one: 391 studies (73%) measured attitudes towards the technology in general, while 137 (26%) examined a named local project and six examined both.

3.2. Four technology families: what the literatures study and find (RQ1)

Behind the aggregate landscape sit four literatures with distinct histories, objects and preoccupations. Each is characterised briefly before turning to the cross-cutting determinants (Section 3.3) and the measurement audit (Section 3.4).

3.2.1. CCUS

CCUS (217 studies) is the oldest and most experimental family. Its earliest included study dates from 2006, when Japanese researchers found that a short neutral explanation of geological storage raised mean acceptance from 4.7 to 5.8 on a seven-point scale (Tokushige et al., 2007) — an information-sensitivity result that foreshadowed two decades of informed-opinion designs (de Best-Waldhober et al., 2009). The family originated in the onshore storage controversies of the late 2000s — most prominently in the Netherlands and Germany — and still carries that imprint: risk perception (177 determinant reports), environmental values (164) and perceived benefit (144) dominate its determinant structure, and Germany alone contributes 43 studies. Because lay familiarity with capture and storage is persistently low, researchers almost always explain the technology before eliciting judgements (210 of 217 studies provided information), and the family supplies most of the corpus's information-provision and framing experiments (39 experimental studies): Dutch laboratory work showed that identical CCS positions shift acceptance in opposite directions depending on whether the communicating organisation is trusted for competence or for integrity (Terwel et al., 2009), and Swiss survey work traced how lay misconceptions about CO2 propagate into risk and benefit judgements (Wallquist et al., 2010).

The family's centre of gravity has shifted twice: first from storage siting towards CCU products, where evaluations are routed through consumer benefit (Arning et al., 2019); then, after 2020, towards engineered carbon dioxide removal, where BECCS and DACCS attract moderate, research-first support — Swiss respondents supported deployment at around 3.8 on a six-point scale but preferred further research to immediate roll-out (Jobin and Siegrist, 2020) — and where strongly climate-concerned respondents repeatedly read carbon capture as moral hazard rather than climate solution (Wolske et al., 2019). A 30-country survey extended this picture globally, finding mildly positive support for DACCS and BECCS everywhere but systematically higher support in the Global South (Baum et al., 2024), with low familiarity universal (means near 2 on five-point scales) (Sovacool et al., 2024); on social media, attention to carbon removal has grown and sentiment has become more positive over time (Repke et al., 2024). Media studies complete the family's discourse layer: Finnish print coverage of CCS from 1996–2015 was 60% positive but turned more negative after 2011 (Kojo and Innola, 2017), Utah newspapers framed CCUS as a lifeline for the coal economy (Xiao et al., 2026), and the European press covered direct air capture more sceptically than the North American press (Upham and Ibrahimović, 2024).

Two structural features of the CCUS evidence deserve emphasis. First, acceptance appears fragile and conditional rather than settled: repeated Québec surveys recorded provincial support for storage falling from 62% to 54% within fifteen months — and to roughly 31–40% after respondents heard opposing NGO arguments (Moutenet et al., 2012); Australian deliberative participants endorsed CCS only as an interim strategy and suspected industry would use it to prolong fossil dependence (Pisarski and Ashworth, 2013); and a recent Dutch two-wave study found CCS the least temporally stable of four energy technologies examined (Görsch et al., 2025b). Qualitative work across Spanish, French and Portuguese storage-candidate communities likewise found conditional acceptance — support contingent on safety verification, benefit-sharing, trusted oversight and exit options — to be the dominant public stance (Oltra

et al., 2026). Second, the family measures anticipatory judgement almost exclusively: only three of 217 studies observed an operating or under-construction facility (stages S2–S3), so essentially everything the literature knows about CCUS acceptance concerns imagined rather than experienced installations — including the robust finding that acceptance drops when storage moves near one's own county, as German survey data matched to 408 potential storage sites demonstrated (Braun, 2017).

A distinct engagement sub-literature runs alongside the survey mainstream. Deliberative and dialogue-based designs — round tables, citizen workshops, informed-choice questionnaires — recur across the family precisely because spontaneous opinion is so thin: Indiana's state-wide baseline found 74% agreement that underground CO2 storage is a good environmental approach, but only after respondents had reviewed a neutral factsheet and diagram (Carley et al., 2012), and the informed-opinion tradition has repeatedly shown that such supplied understanding, not prior attitude, does the evaluative work (de Best-Waldhober et al., 2009). The engagement studies also surface the conditionality that surveys flatten: publics grant CCS provisional, revocable licence — interim use, verified safety, shared benefit, credible exit — rather than the binary approval that percentage-support figures imply (Oltra et al., 2026; Pisarski and Ashworth, 2013).

3.2.2. Hydrogen

Hydrogen (186 studies) is the fastest-growing and most application-specific family. Its core is mobility — fuel-cell vehicles and refuelling stations dominate the studied objects — extended more recently by residential heating, industrial use and national production programmes; South Korea (31 studies), the United Kingdom (25), Germany (23) and Japan (17) lead, mirroring national hydrogen strategies. The family's roots are older than its recent boom: London studies from 2003–2004 found that fewer than half of respondents had even heard of hydrogen as a transport fuel, and that taxi drivers' willingness to join a fuel-cell pilot was driven by expected personal gain (Mourato et al., 2004; O'Garra et al., 2005a; O'Garra et al., 2005b); passengers on Stockholm's first fuel-cell buses rated the technology overwhelmingly safe once they had used it (74% safe versus 3% unsafe) (Haraldsson et al., 2006); and residents near Norway's first hydrogen filling station were more supportive the closer they lived to it (Thesen and Langhelle, 2008) — an early hint that direct experience, not distance, structures hydrogen acceptance (Ricci et al., 2008).

Methodologically, the family leans on surveys (90) and stated-preference designs (46), whose attributes increasingly distinguish production pathways (renewable versus fossil-based hydrogen). Korean discrete-choice studies illustrate the frontier: national respondents accepted a hydrogen portfolio standard but demanded roughly US$48 per month in avoided charges before rejecting it, while preferring green over grey production and greater separation distances (Kim et al., 2023a); community acceptance of a new refuelling station within 100 m of home was only 8% without compensation (Kwak et al., 2024); and 40% of a national sample accepted nuclear-produced hydrogen, roughly twice the share opposed (Kim et al., 2022). Knowledge and familiarity top the family's determinant structure (107 reports) — public awareness is consistently found to be low — followed by environmental values (105) and safety-centred risk perception (82) (Ricci et al., 2008; Scovell, 2022); perceptions of hydrogen risk and

familiarity also carry into vehicle-purchase choices, where fuel-cell vehicles trail hybrids and battery-electrics (Kim et al., 2023b). The family also contributes a comparatively large share of substantive siting-stage evidence (33 studies at S2), chiefly around refuelling-station siting, and its discourse layer is expanding fast: 76% of 625,794 English-language tweets on green hydrogen were positive (Jaca Madariaga et al., 2024), while Chinese platform comments on fuel-cell vehicles were predominantly neutral, mixing enthusiasm for the technology with cost and safety concerns (Ye et al., 2024). Emerging end-use studies extend the object space again — US farmers, for instance, supported waste-nitrogen green ammonia as fertiliser far more readily than electrolytic hydrogen itself (Wang et al., 2025).

Two internal differentiations increasingly organise the family. The first is by production pathway: acceptance is consistently higher for renewable-based than fossil-based hydrogen when instruments distinguish them — Korean respondents preferred green over blue and grey production mixes in the national portfolio standard (Kim et al., 2023a), and US farmers embraced a hydrogen-derived carrier (waste-nitrogen ammonia) while remaining cool towards electrolytic hydrogen itself (Wang et al., 2025) — which suggests that undifferentiated "hydrogen acceptance" figures conflate objects the public evaluates differently. The second is by object class: vehicles, stations, production plants and networks attract different determinant structures, with safety perception dominating infrastructure siting while cost and practicality dominate vehicle adoption (Kim et al., 2023b; Kwak et al., 2024; Scovell, 2022). Direct experience appears to soften both: Stockholm bus passengers (Haraldsson et al., 2006) and the drivers in a seven-month US fuel-cell fleet trial — whose safety comfort rose significantly over the study (Shaheen et al., 2008) — ended far less concerned than pre-deployment surveys predict.

3.2.3. Offshore wind

Offshore wind (136 studies) is the most mature family and the only one with a substantial body of evidence around consented and operating projects (61 studies at siting, operating or mixed stages, including post-construction studies of named wind farms). Its geography is coastal-industrial — the United States (42 studies), Denmark (15), South Korea (9), France, Germany and Norway — and its intellectual history runs through the Cape Wind controversy: early Cape Cod fieldwork found local opinion almost equally divided, with opposition rooted less in aesthetics than in perceived threats to place and livelihood (Firestone and Kempton, 2007; Kempton et al., 2005), and the first large comparative surveys recorded 78% support for a hypothetical Delaware project against 25–44% on Cape Cod, where a real project was on the table (Firestone et al., 2009). That contrast — general support, local contestation — made offshore wind the family whose scholarship most explicitly reframed opposition as an equity and fairness problem rather than a proximity reflex (Haggett, 2011; Wolsink, 2007).

The family's determinant structure is distinctive: place-related variables dominate (84 reports), reflecting two decades of work on seascape, visual impact and place attachment (Devine-Wright, 2009; Devine-Wright and Howes, 2010), with stated-preference studies (35) repeatedly monetising near-shore visibility and the premium respondents attach to moving turbines farther offshore. The United States' first operating project, Block Island, has become the family's natural laboratory and its strongest counter-NIMBY case: support among island and coastal residents remained at 82–87% across construction and

into operation (Firestone et al., 2020), attitudes became more positive as the project aged (Bingaman et al., 2023), place-meaning consistency — not distance — predicted evaluations (Russell et al., 2020), and tourists were willing to pay a premium of US$12–27 per trip for recreation sites with a view of the turbines (Trandafir et al., 2020). Conflict has not disappeared, however: tourism-dependent communities construct offshore wind as incompatible with coastal identity through recurring storylines (Rudolph, 2014), Estonian islanders sustained a decade-long campaign — an 8,000-signature petition and successful court challenge — against a marine-spatial-planning-backed project (Tafon et al., 2019), and US federal public comments frame opposition as defence of environmental amenity (Schneider and O'Neill, 2025). The newest evidence extends the family beyond its North-Atlantic heartland — majority support for government investment in Morocco (Korchy and Mishima, 2026), coexistence-based acceptance among Taiwanese respondents when siting is coupled to marine spatial planning (Liao, 2025), and small-sample but uniformly positive readings in Malaysia (Salleh et al., 2016) — and floating concepts are entering through narrative and expectation studies rather than siting surveys (Campos et al., 2024; Shamon et al., 2019).

A planning-and-process thread distinguishes the family's newest work. Where siting is embedded in marine spatial planning with visible coexistence provisions, acceptance tends to follow: roughly two-thirds of Taiwanese respondents endorsed wind development conditional on planned multi-use siting and environmental assessment (Liao, 2025). Where planning is experienced as imposed, the same instruments record durable resistance: Estonia's Hiiumaa case shows a procedurally marginalised community defeating a nationally backed project through a decade of petition and litigation (Tafon et al., 2019), and discourse studies find opposition organising itself globally, borrowing frames across jurisdictions in real time (Novak, 2025; Schneider and O'Neill, 2025). The lesson the family keeps generating — that process quality, benefit credibility and place meaning, not distance, tend to decide outcomes (Haggett, 2011; Russell et al., 2020; Wolsink, 2007) — is the most exportable finding in the corpus for the other three families, whose siting waves are only beginning.

3.2.4. Small modular reactors

SMRs (17 studies) are the outlier: an evidence base an order of magnitude smaller than any other family's, concentrated in Canada (6 studies), the United States (4) and South Korea (3), with all but three studies examining concept- or announced-stage objects and none an operating or under-construction reactor. The available studies converge on one point — publics know little about what distinguishes SMRs from conventional reactors — which means SMR acceptance cannot simply be read off the older nuclear-attitudes literature (Sovacool and Ramana, 2015). What the small corpus does show is patterned. Support is moderate and grows with engagement: 78% of Korean respondents were willing to pay for national SMR development, averaging about US$4.3 per household per year (Cho and Lee, 2025), repeated Finnish surveys recorded metropolitan support for siting an SMR rising from 54% to 65% between 2021 and 2022 (Kiviluoma et al., 2025), and UK residents living within a mile of two proposed sites were roughly 70% supportive at baseline (Osiolo and Mukundan, 2026). Acceptance appears sharply distance- and trust-dependent, however: a majority of Czech respondents rejected small reactors

within 10 km of home even while accepting them nationally (Hlavacek et al., 2023), Canadian host-region residents split evenly on a reactor within 50 km (Ghimire et al., 2026), affect and radiation risk perception — not technical knowledge — predicted Canadian support (Hurlbert et al., 2023), and Korean survey work identifies pre-decisional trust-building and authentic risk communication as the binding constraint (Cai and Hwang, 2026). Emerging Global South evidence follows the same psychology: Thai acceptance operated through planned-behaviour and innovation-attribute pathways rather than raw knowledge (Srinitiworawong and Kiattisin, 2026). Given the technology's weight in national net-zero plans and the funding concentration noted in Section 3.5, this is the corpus's most consequential gap: deployment decisions are currently informed by seventeen studies.

3.3. Determinants of acceptance (RQ2)

Table 2 and Fig. 3 summarise study-level reports of association between determinant categories and acceptance. Three determinants behave consistently across all four technology families. Perceived benefit is positively associated with acceptance in 70% of the studies reporting it (142/203). Trust — in developers, operators and regulators — is positive in 58% (101/174). Perceived risk is negative in 54% (117/216), with most non-negative reports reflecting fully mediated or interaction-conditioned specifications rather than truly positive risk effects. This benefit–trust–risk triad replicates the psychological core identified by earlier frameworks (Huijts et al., 2012; Perlaviciute and Steg, 2014; Siegrist, 2000; Slovic, 1987) and appears robust to technology family. The experimental and longitudinal evidence adds mechanism to the correlations: trust operates partly through affect (Midden and Huijts, 2009), is differentiated — competence-based and integrity-based trust condition persuasion in opposite directions (Terwel et al., 2009) — and functions pre-decisionally, shaping which communications are believed at all (Cai and Hwang, 2026); the Dutch decline in hydrogen support between 2008 and 2013 was traced specifically to declining trust in science and technology (Achterberg, 2014).

Table 2
Study-level reports of association between determinant categories and acceptance (each study contributes at most one report per category; totals include reports not classifiable into the four direction columns).

Determinant category	Positive (+)	Negative (−)	Non-significant	Mixed	Total reports
Trust	101	28	9	20	174
Perceived benefit	142	17	13	15	203
Perceived risk	28	117	34	13	216
Knowledge/familiarity	101	23	44	39	238
Environmental concern/values	113	52	36	37	255
Fairness/justice	19	12	1	2	35
Place/proximity	45	45	21	34	161
Affect/emotion	21	15	2	9	52
Socio-demographics	132	86	126	79	460
Policy/governance trust	26	13	4	2	52

Knowledge and familiarity are positively associated with acceptance in 42% of reporting studies (101/238) but non-significant in 18% and mixed in 16% — a heterogeneity consistent with information-based attitude construction: knowledge effects depend on what is learned, from whom, and what the respondent already believes (de Best-Waldhober et al., 2009; Sturgis and Allum, 2004). Swiss evidence shows why raw knowledge counts can mislead: specific misconceptions, not ignorance per se, drive risk and benefit perceptions of CCS (Wallquist et al., 2010), and a Japanese randomised experiment found that information delivered through family discussion shifted offshore-wind attitudes where identical information delivered directly did not (Komatsu et al., 2024). Environmental concern and climate-related values lean positive (113/255) but flip negative in a fifth of reports — most visibly for CCUS and BECCS, where strong environmental identities can read carbon capture as moral hazard rather than climate solution (Jobin and Siegrist, 2020; Wolske et al., 2019).

Place-related variables — proximity, place attachment, local siting context — are the least consistent category: 45 positive, 45 negative, 21 non-significant and 34 mixed reports. Simple distance-decay ("NIMBY") expectations receive no aggregate support, echoing two decades of critique of the NIMBY label (Devine-Wright, 2009; Devine-Wright and Howes, 2010; Wolsink, 2007): proximity lowers acceptance for German CCS sites (Braun, 2017) and Czech small reactors (Hlavacek et al., 2023), but raises it around Norwegian hydrogen infrastructure (Thesen and Langhelle, 2008) and leaves it unchanged — or improves it — around the operating Block Island project, where place-meaning consistency rather than distance carries the effect (Russell et al., 2020). Fairness and justice constructs (procedural and distributive) are

positive where measured (19/35) but appear in only 35 studies — 7% of the evidence base — despite their centrality in contemporary energy-justice scholarship (Sovacool et al., 2016) and despite qualitative evidence that procedural exclusion powers the most durable opposition campaigns (Tafon et al., 2019). Socio-demographics, the most frequently reported category (460 reports), are also the least informative: 27% of reports are non-significant and the signed reports conflict, supporting their treatment as sample descriptors or moderators rather than substantive determinants.

Read across rather than within families, the direction results sort into three tiers of generality. The benefit–trust–risk triad is family-general: it organises acceptance in every family in which it has been tested, from trust-differentiated persuasion around CCS (Terwel et al., 2009) to trust as the binding constraint on SMR deployment (Cai and Hwang, 2026) and safety-centred risk perception around hydrogen infrastructure (Ricci et al., 2008; Scovell, 2022). Value-laden determinants form a second tier — directionally stable within families but family-contingent: environmental concern leans positive across the corpus (Table 2), yet reverses for engineered carbon removal, where the strongest climate identities read capture as moral hazard rather than climate solution (Jobin and Siegrist, 2020; Wolske et al., 2019). The third tier — place and knowledge — is context-carried: its sign depends on what proximity and information locally mean. Distance predicts opposition where the object is an imagined storage site or reactor (Braun, 2017; Ghimire et al., 2026; Hlavacek et al., 2023), but predicts support where it indexes lived experience of operating infrastructure (Haraldsson et al., 2006; Russell et al., 2020; Thesen and Langhelle, 2008). The apparent incoherence of proximity in Table 2 is thus partly a deployment-stage artefact — the same variable measures imposed risk at unbuilt objects and familiarity at built ones — which is one more reason the stage profile documented in Section 3.4 matters for synthesis.

Policy and governance trust, tabulated separately in Table 2, deserves its own line: half of its 52 reports are positive (26) and a quarter negative (13), and the qualitative and longitudinal records suggest it operates upstream of the psychological triad, organising which projects get a hearing at all — from the procedurally marginalised opposition that defeated Estonia's marine-planning-backed project (Tafon et al., 2019), to the pre-decisional trust-building Korean SMR work identifies as the binding constraint (Cai and Hwang, 2026), to the national-level erosion that carried Dutch hydrogen support down with it (Achterberg, 2014).

These cross-family readings rest, moreover, on unevenly distributed research attention. Each family interrogates acceptance through a different methodological lens: experimental manipulations concentrate in CCUS (39 studies), stated-preference designs in hydrogen (46) and offshore wind (35), fairness and justice constructs largely in offshore wind's siting scholarship (Haggett, 2011; Tafon et al., 2019; Wolsink, 2007), while the seventeen SMR studies include a single experiment and nothing at siting or operating stages. Only 21 studies (3.9%) measure two or more families with the same instrument in the same sample, so between-family comparisons — including those drawn here — rest almost entirely on between-study inference across non-comparable instruments. Family differences in determinant importance therefore partly reflect what each literature has chosen to ask, a caveat that applies to every

cross-technology synthesis built on this corpus and that motivates the comparative designs proposed in Section 4.3.

3.4. The measurement audit (RQ3)

Figure 4 and Table 3 report the audit of how acceptance itself was measured — the review's central contribution. The results are stark. Of 534 studies, only 8 (1.5%) reused a previously validated acceptance instrument essentially as published — as when Norwegian researchers readministered the London hydrogen survey to enable direct cross-context comparison (O'Garra et al., 2005b; Thesen and Langhelle, 2008); 145 (27.2%) adapted items from prior studies; and 381 (71.3%) measured acceptance with study-specific, ad hoc instruments, typically bespoke Likert items or single-item support ratings, at most reporting internal reliability. Even methodologically sophisticated entries — pre-tested batteries refined through cognitive interviews (Carley et al., 2012), or theory-driven scales assembled from named sources (Deng and Dai, 2026) — stop short of instrument reuse, so results cannot be compared across studies at the item level. There is, in effect, no shared measurement standard in a literature of over five hundred studies: nearly every research team measures "acceptance" with its own ruler.

Table 3
Measurement audit of the included studies (N = 534).

Audit dimension	Category	n	% of 534
Acceptance instrument	Pre-validated instrument reused	8	1.5%
	Items adapted from prior studies	145	27.2%
	Study-specific / ad hoc / not reported	381	71.3%
Temporal design	One-shot cross-section	442	82.8%
	Repeated (within protocol)	58	10.9%
	Longitudinal (multi-wave)	9	1.7%
	Continuous (text streams)	25	4.7%
Familiarity	Measured	308	57.7%
	Not measured	188	35.2%
	Unclear	38	7.1%
Information provision	Provided before elicitation	353	66.1%
	Not provided / not reported	181	33.9%
Deployment stage	S0 concept (no named project)	168	31.5%
	S1 announced / planned	220	41.2%
	S2 siting / construction	48	9.0%
	S3 operating	21	3.9%
	Mixed stages	77	14.4%

Temporal design compounds the problem. 442 studies (82.8%) are one-shot cross-sections; 58 (10.9%) repeat measurement within a single protocol (typically before and after information provision), only 9 (1.7%) are strictly longitudinal across time points, and 25 (4.7%) observe continuously through text streams. The scarce longitudinal evidence is disproportionately informative — it supplied the Québec decline (Moutenet et al., 2012), the Dutch trust story (Achterberg, 2014), the Block Island consolidation (Bingaman et al., 2023; Russell et al., 2020), the Finnish SMR rise (Kiviluoma et al., 2025) and the direct demonstration that CCS acceptability is the least stable of compared technologies (Görsch et al., 2025b) — which underscores how much the field forgoes by measuring once. The one-shot share varies little by family (81–86% for CCUS, hydrogen and offshore wind) except among SMR studies (59%), whose small corpus happens to include several repeated designs.

Familiarity — by Section 3.3 one of the most frequently significant determinants — is itself unmeasured in 188 studies (35.2%; a further 7.1% are unclear). Two-thirds of studies (353; 66.1%) provided

respondents with information about the technology before eliciting attitudes, a defensible response to low public awareness that nonetheless means most recorded “acceptance” is an informed-opinion construct whose level depends on the specific information supplied (de Best-Waldhober et al., 2009; Tokushige et al., 2007); combined with the 35% that did not check familiarity at all, a substantial share of the literature cannot say whose opinion — informed, pseudo-, or experienced — it has measured (Schwarz, 1999).

Finally, the deployment-stage profile shows that 388 studies (72.7%) examined technologies at the concept or announced-plan stage (S0–S1); only 48 (9.0%) studied active siting or construction contexts and 21 (3.9%) operating facilities. The acceptance literature is thus overwhelmingly a literature of hypothetical acceptance — attitudes towards imagined objects — which prior work shows can diverge sharply from responses to concrete local projects (Batel et al., 2013; Devine-Wright and Howes, 2010; Perlaviciute and Steg, 2014), and which the corpus itself demonstrates: the support gap between hypothetical Delaware and contested Cape Cod projects (Firestone et al., 2009), and the contrast between pre-deployment anxiety and post-experience safety ratings on Stockholm’s fuel-cell buses (Haraldsson et al., 2006), are both stage effects. Together these four audit dimensions define what is termed here the measurement gap: a large, fast-growing, policy-consequential literature standing on unvalidated instruments, single observations, unverified familiarity and hypothetical objects.

Nor is the gap evenly distributed. The stage profile — the audit dimension that varies most sharply by family — runs opposite to deployment momentum: concept- and announcement-stage studies (S0–S1) account for 83% of CCUS evidence and 82% of the small SMR corpus, against 70% for hydrogen and 55% for offshore wind. Offshore wind holds most of the corpus’s experienced-object evidence (21% of its studies at S2–S3, including the post-construction record reviewed in Section 3.2.3), and hydrogen a sizeable siting-stage block around refuelling infrastructure; CCUS, the largest family, has three such studies, and SMRs none. The families whose deployment timetables most urgently need credible pre-siting evidence are thus precisely those whose evidence is almost wholly hypothetical, while the transferable lessons about how acceptance behaves around real projects come from the one family already past its first deployment wave (Bingaman et al., 2023; Firestone et al., 2020; Russell et al., 2020). Per-family cross-tabulations of deployment stage, temporal design and design family are provided in Supplementary Material B.

3.5. Reporting quality (RQ4)

Reporting transparency is moderate. Funding and conflict-of-interest information is present in 436 studies (82%), reflecting journal mandates diffusing through the 2010s; the remainder — concentrated in earlier years — report neither. Sampling is described adequately in most survey studies, though probability samples are a minority and many online-panel studies do not report response or completion rates. Two family-specific observations warrant note. First, within the small SMR corpus, several studies are situated in Canadian host-region contexts with disclosed industry or government-development funding — including nuclear-sector funding with a declared no-role statement (Hurlbert et al., 2023) — a concentration that argues for independent replication before their acceptance estimates inform siting

policy. Second, stated-preference studies — a fifth of the evidence — follow elicitation good practice unevenly, and willingness-to-pay estimates are rarely accompanied by the validity diagnostics recommended for contingent valuation (Arrow et al., 1993).

4. Discussion

4.1. What the unified map shows

Read against the syntheses that preceded it (Görsch et al., 2025a; Huijts et al., 2012; L'Orange Seigo et al., 2014; Perlaviciute and Steg, 2014), this review makes three additions. It brings the evidence current: 57% of included studies post-date the most recent comprehensive review's search, and the post-2021 literature is not merely larger but differently composed — more hydrogen, more carbon-removal variants (DACCS, BECCS, CCU products), more text-as-data designs, the first cross-national Global South comparisons (Baum et al., 2024), and the first substantive SMR studies. It unifies four family-specific literatures under one taxonomy, showing that the benefit–trust–risk core generalises across families while place effects, value effects and information effects are family- and context-contingent. And it quantifies, for the first time, the measurement practices underneath the entire enterprise.

The determinant results carry direct policy content. The consistency of trust and perceived benefit — and the inconsistency of proximity — suggest that deployment strategies premised on compensation-at-distance, or on siting away from people, may misread the evidence; what the literature actually supports is early procedural engagement that builds trust and makes benefits tangible and fairly distributed (Devine-Wright, 2009; Sovacool et al., 2016; Wolsink, 2007). The longitudinal fragments reinforce this: where process was experienced as fair and benefits materialised, as at Block Island, support consolidated after construction (Bingaman et al., 2023; Firestone et al., 2020); where trust eroded, as in the Netherlands' hydrogen programme, support declined without any local project failing (Achterberg, 2014); and where opposing arguments entered an information-poor environment, as in Québec, majorities thinned within months (Moutenet et al., 2012). Acceptance, in short, behaves less like a fixed public property to be measured once and more like a relationship that deployment processes continuously produce — which is precisely why the field's measurement habits matter.

The map also clarifies what is new relative to the prior syntheses, rather than merely larger. Huijts et al.'s psychological framework (2012) — benefit, risk, trust, affect, norms — is confirmed as family-general, but the audit shows the framework has been operationalised with almost no instrument continuity, so its constructs travel while its measurements do not. Görsch et al.'s eleven-technology comparison (2025a) established how acceptability orders across supply options to May 2021; the present review adds the families that ordering could not cover — hydrogen end-to-end, SMR-specific rather than generic nuclear, floating wind — and shows that the post-2021 literature (57% of the corpus) has shifted composition towards exactly those objects. And where the CCS-specific synthesis of a decade ago (L'Orange Seigo et al., 2014) could treat storage siting as the family's defining problem, the corpus now routes through

carbon removal and utilisation products, whose value-laden objections (moral hazard, naturalness) behave differently from siting risk (Arning et al., 2019; Jobin and Siegrist, 2020; Wolske et al., 2019).

The comparison with Perlaviciute and Steg's integrated agenda (2014) is equally instructive, because theirs was already a measurement argument: evaluations, they argued, are shaped jointly by psychological and contextual factors, and the field should study the two together rather than catalogue either alone. Twelve years on, the psychological half of that programme has generalised well — benefit, trust and risk behave lawfully in every family — but the contextual half was operationalised overwhelmingly as distance, and distance fails as a summary of context (Section 3.3). What does appear to behave lawfully is stage and process: hypothetical objects elicit systematically different judgements than experienced ones (Bingaman et al., 2023; Firestone et al., 2009; Haraldsson et al., 2006), and procedural quality outperforms compensation-at-distance as a predictor of durable outcomes (Devine-Wright, 2009; Tafon et al., 2019; Wolsink, 2007). At the same time, the acceptance object itself has multiplied — storage, utilisation products and engineered removal within CCUS (Arning et al., 2019; Jobin and Siegrist, 2020; Wolske et al., 2019); production pathways within hydrogen (Kim et al., 2023a; Wang et al., 2025); fixed and floating structures within offshore wind (Campos et al., 2024; Shamon et al., 2019) — so that single-figure "technology acceptance" increasingly averages over objects that publics demonstrably evaluate apart. Object-differentiated, stage-explicit measurement is the practical form the integration agenda now needs to take.

4.2. The measurement gap as a validity problem

The audit findings are not a methodological footnote; they condition the interpretation of every synthesis of this literature, including the present one. If 71.3% of studies measure acceptance with instruments that have never been validated against anything, then between-study differences in reported acceptance levels confound true attitudinal variation with instrument variation — a problem long recognised in attitude measurement (Dunlap et al., 2000; Schwarz, 1999) but never before quantified for this field. If 82.8% of studies measure once, the literature cannot distinguish stable judgements from momentary constructions, even though the few studies that measure twice keep finding instability (Achterberg, 2014; Görsch et al., 2025b; Moutenet et al., 2012). If a third of studies do not measure familiarity while two-thirds supply information before eliciting attitudes, then much of the recorded evidence is best read as informed-opinion elicitation (de Best-Waldhober et al., 2009) — a legitimate research object, but not the same construct as the spontaneous public opinion that ministries and developers typically invoke when citing acceptance statistics. And if 72.7% of studies examine technologies their respondents have never encountered in operation, the literature's headline percentages describe anticipatory reactions to imagined objects — reactions that the corpus's own stage-contrast evidence shows can shift substantially once projects become concrete (Bingaman et al., 2023; Firestone et al., 2009; Haraldsson et al., 2006).

These four weaknesses compound. A typical published figure — say, "62% support CCS" — will usually rest on an unvalidated instrument, administered once, to respondents of unmeasured familiarity, about a technology they have never seen, immediately after a researcher-authored description. Each qualifier is

invisible in the number's afterlife as it travels into strategy documents and impact assessments. The measurement gap is thus not only a research-quality problem but a policy-risk problem: deployment portfolios are being stress-tested against acceptance estimates whose construct validity is largely unknown. And because the stage gap concentrates in CCUS and SMRs (Section 3.4), the compounding is most severe exactly where deployment plans lean hardest on acceptance evidence.

4.3. A measurement-first research agenda

Six commitments would materially upgrade the field within a research generation. (1) Shared instrument cores: family-agnostic core batteries for acceptance, trust, perceived risk and benefit — validated, translated and openly documented, with published psychometrics — so that every study adds comparable data points even while retaining bespoke extensions; the near-total absence of instrument reuse documented in Section 3.4 is the single most tractable deficit. (2) Mandatory familiarity assessment: a two-item self-report plus one objective knowledge check costs under a minute of questionnaire time and would let analysts separate informed opinion, pseudo-opinion and experienced judgement (de Best-Waldhober et al., 2009; Sturgis and Allum, 2004). (3) Deployment-stage-explicit reporting: every study should state the studied object's stage (S0–S3) at fieldwork, enabling the stage-stratified synthesis this review could only approximate. (4) Longitudinal and panel designs: the nine longitudinal studies in this corpus punch far above their weight; funders commissioning acceptance research around named projects should default to pre/post-construction panels of the Block Island type (Firestone et al., 2020; Russell et al., 2020) rather than one-off polls. (5) Registered reporting of question wording and information materials: since elicited acceptance depends demonstrably on the information supplied (de Best-Waldhober et al., 2009; Tokushige et al., 2007), the stimulus is part of the finding and belongs in supplementary materials as standard. (6) Family-bridging comparative designs: only 21 of 534 studies measured more than one family with the same instrument in the same sample, so the field's cross-technology generalisations rest almost entirely on between-study inference; a modest number of deliberately multi-family studies — extending the comparative logic of Görsch et al. (2025a) to the emerging families — would anchor those generalisations more firmly than further single-family volume.

4.4. Implications for policy and practice

For decision-makers, four implications follow directly from the map. First, any single acceptance percentage — especially for SMRs, DACCS and floating wind, where the evidence is thinnest and almost wholly pre-deployment — is best treated as a provisional, elicitation-dependent estimate rather than a stable fact about the public; the corpus shows such figures moving by ten points or more within months under ordinary information dynamics (Kiviluoma et al., 2025; Moutenet et al., 2012). Second, measurement effort should follow where deployment is actually headed: the family profiles in Section 3.2 show hydrogen acceptance evidence concentrated on vehicles while strategies pivot to industrial use and heating, CCUS evidence concentrated on storage siting while portfolios pivot to removal, and SMR evidence concentrated in three countries — commissioning stage-matched, instrument-standardised studies along the actual project pipeline would repair the mismatch at modest cost. Third, the fairness deficit is actionable: procedural and distributive justice measures appear in only 7% of studies yet are

positive where measured and dominate qualitative accounts of durable opposition (Rudolph, 2014; Sovacool et al., 2016; Tafon et al., 2019); incorporating validated justice items into monitoring surveys would give planners early warning of the process failures that proximity variables do not capture. Fourth, the SMR deficit warrants repair before siting begins, not after: seventeen studies — none at siting or operating stage, concentrated in three countries, and carrying the funding pattern noted in Section 3.5 — currently stand behind acceptance claims for a technology that several national net-zero strategies treat as firm low-carbon supply. Independent, instrument-standardised baseline surveys and panels around candidate host regions, fielded before announcement effects contaminate baselines, would cost little against project budgets and would let deployment start from measured rather than assumed publics (Hlavacek et al., 2023; Kiviluoma et al., 2025; Sovacool and Ramana, 2015).

4.5. Limitations

Four limitations bound these conclusions. First, only peer-reviewed English-language journal articles were included; grey literature and non-English evidence — likely substantial for host-community studies in East Asia and Europe — are absent. Thirteen otherwise potentially eligible non-English reports (eight Korean, two Japanese, two German — the latter a mutually duplicated pair — and one Spanish) were excluded at this criterion and are listed in Supplementary Material B; a sensitivity tabulation that adds the twelve extracted non-English studies back shifts no headline audit estimate by more than half a percentage point. Second, screening and extraction were LLM-assisted. The attendant risks were mitigated by a pre-specified calibration gate (kappa = 0.821, include-sensitivity 12/12), a frozen prompt, isolated per-record model instances, conservative unsure-escalation to the PI, file-level audit of the corpus, and human review complemented by adversarial re-verification of extraction records; residual error nonetheless remains possible, which is why all structured extraction records are released for inspection. Third, direction counting weights each study equally regardless of sample size or rigour; it identifies consistency, not effect magnitude, and cannot correct for publication or reporting biases in the underlying literature. Fourth, the measurement audit applies strict, pre-specified definitions — a study using a carefully constructed but never-revalidated instrument is coded study-specific — so the headline percentages describe instrument reuse, not instrument quality; this is judged the appropriate severity for the question the audit asks.

5. Conclusion

Across 534 studies, more than half a million survey and interview participants and over 1.5 million analysed public texts, public acceptance research on SMRs, hydrogen, CCUS and offshore wind is voluminous, fast-growing and directionally informative: benefits, trust and risk perceptions behave consistently; proximity does not; fairness is under-measured; and the SMR evidence base is dangerously thin relative to its policy weight. But the field’s foundations do not match its ambitions. Almost no studies share instruments, most observe once, a third do not know what their respondents knew, and nearly three-quarters measure reactions to technologies that do not yet exist in respondents’ lifeworlds. Acceptance research has demonstrated that public responses can make or break net-zero deployment; it

has not yet built the measurement infrastructure to track those responses credibly. Building it — before the deployment decade forces the issue — is the field's most urgent task.

Abbreviations

BECCS, bioenergy with carbon capture and storage; CCS, carbon capture and storage; CCU, carbon capture and utilisation; CCUS, carbon capture, utilisation and storage; CV, contingent valuation; DACCS, direct air carbon capture and storage; DCE, discrete choice experiment; FCEV, fuel-cell electric vehicle; LLM, large language model; NIMBY, not in my backyard; PABAK, prevalence-adjusted bias-adjusted kappa; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SMR, small modular reactor; WTA, willingness to accept; WTP, willingness to pay.

Declarations

Author Contribution

J.L. conceived and designed the study, developed and froze the search strategy, screening protocol and 29-field extraction schema, conducted the title–abstract screening, full-text data extraction and analysis, produced all figures and tables, and wrote and revised the manuscript.

Data Availability

All data supporting this review are provided with the article. Supplementary Material A contains the search strings, screening statistics and sensitivity tabulations; Supplementary Material B contains the complete 534-study structured extraction dataset, the full-text exclusion listings, the aggregate data tables and the analysis scripts; and Supplementary Material C contains the full bibliographic list of all 534 included studies. The complete reproducibility package — including the frozen protocol, search strings, screening prompt, screening ledger, calibration data and structured extraction records for all assessed reports — is additionally deposited in a public repository; to preserve double-anonymized peer review, the repository link is withheld here and will be provided on acceptance.

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Figures

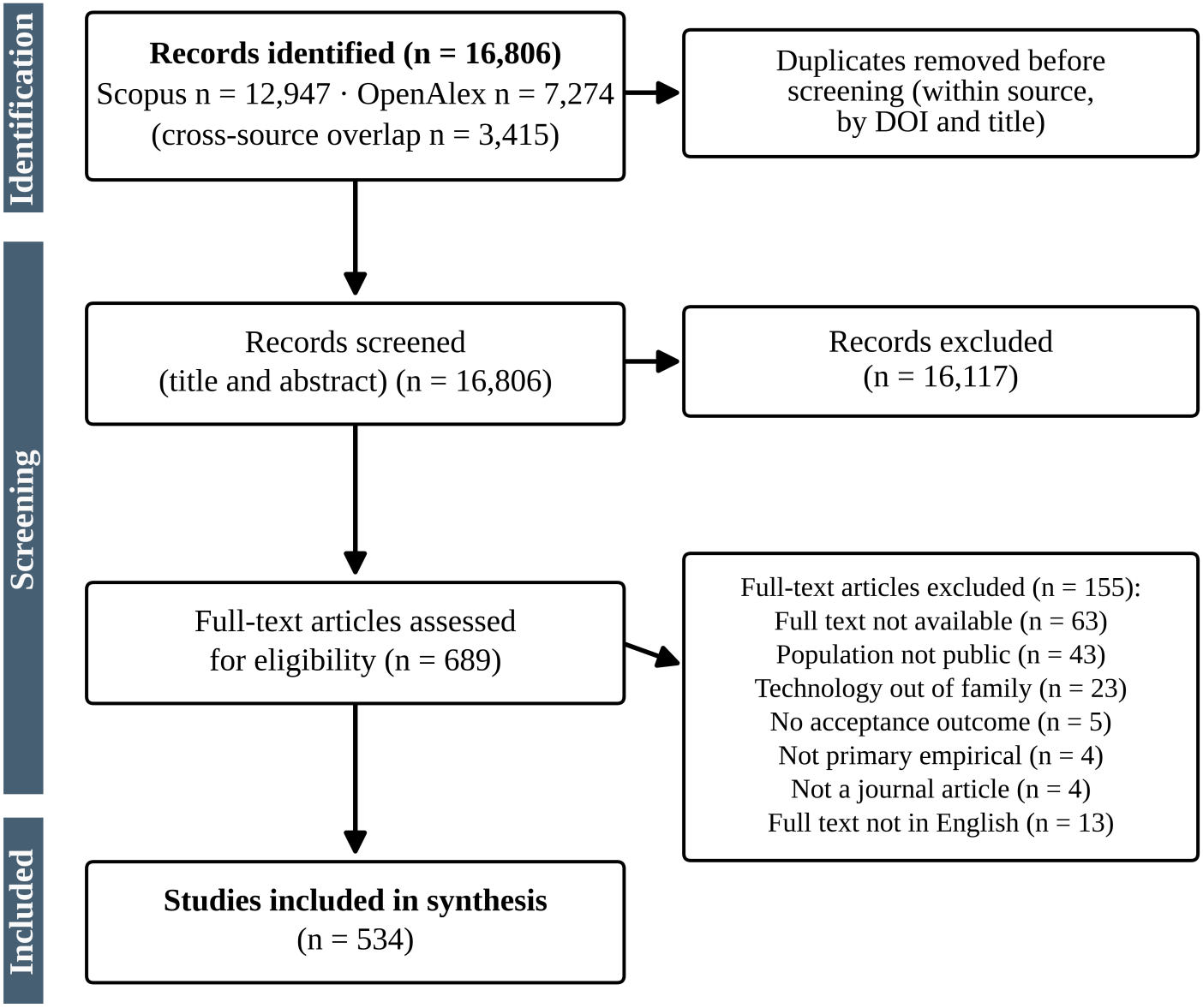


Figure 1

PRISMA 2020 flow diagram for the review. Per-source record counts are post within-source deduplication; the union removes cross-source duplicates by DOI and normalised title.

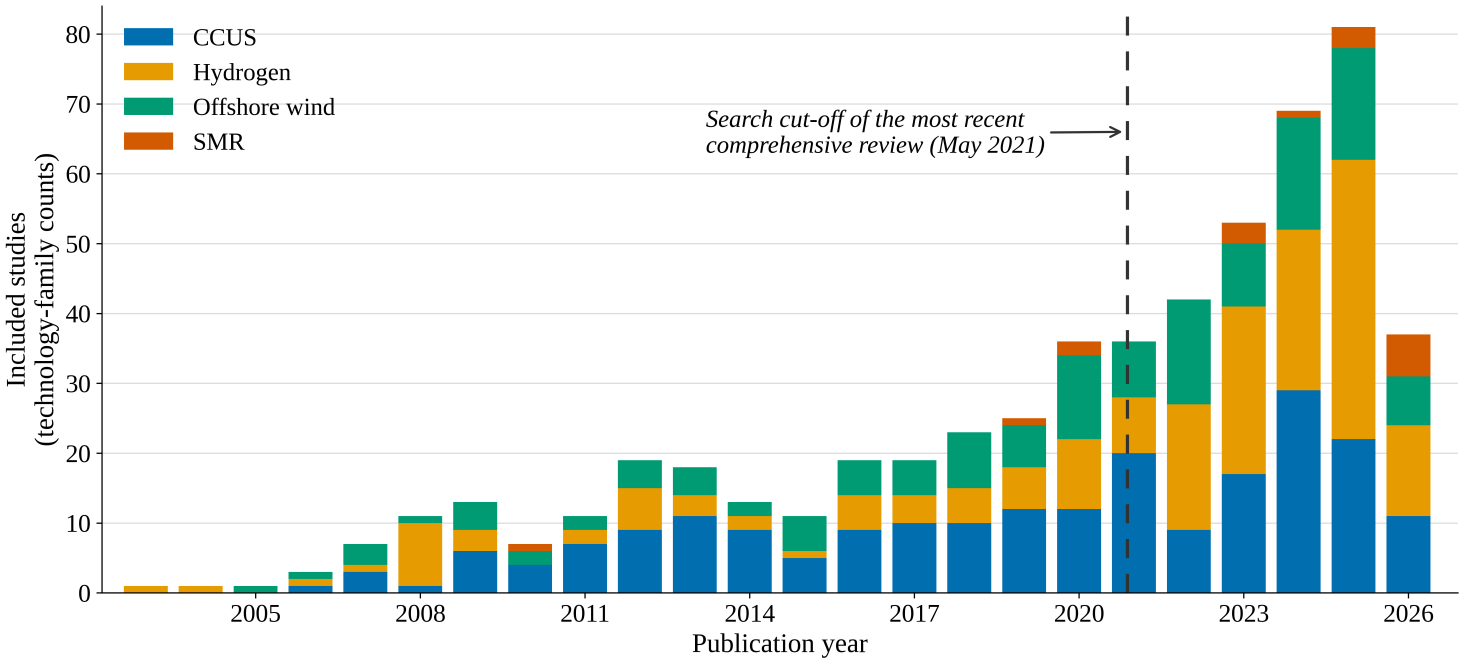


Figure 2

Included studies per publication year, stacked by technology family (studies covering multiple families counted once per family). Dashed line: search cut-off of the most recent comprehensive review (May 2021, Görsch et al. (2025a)).

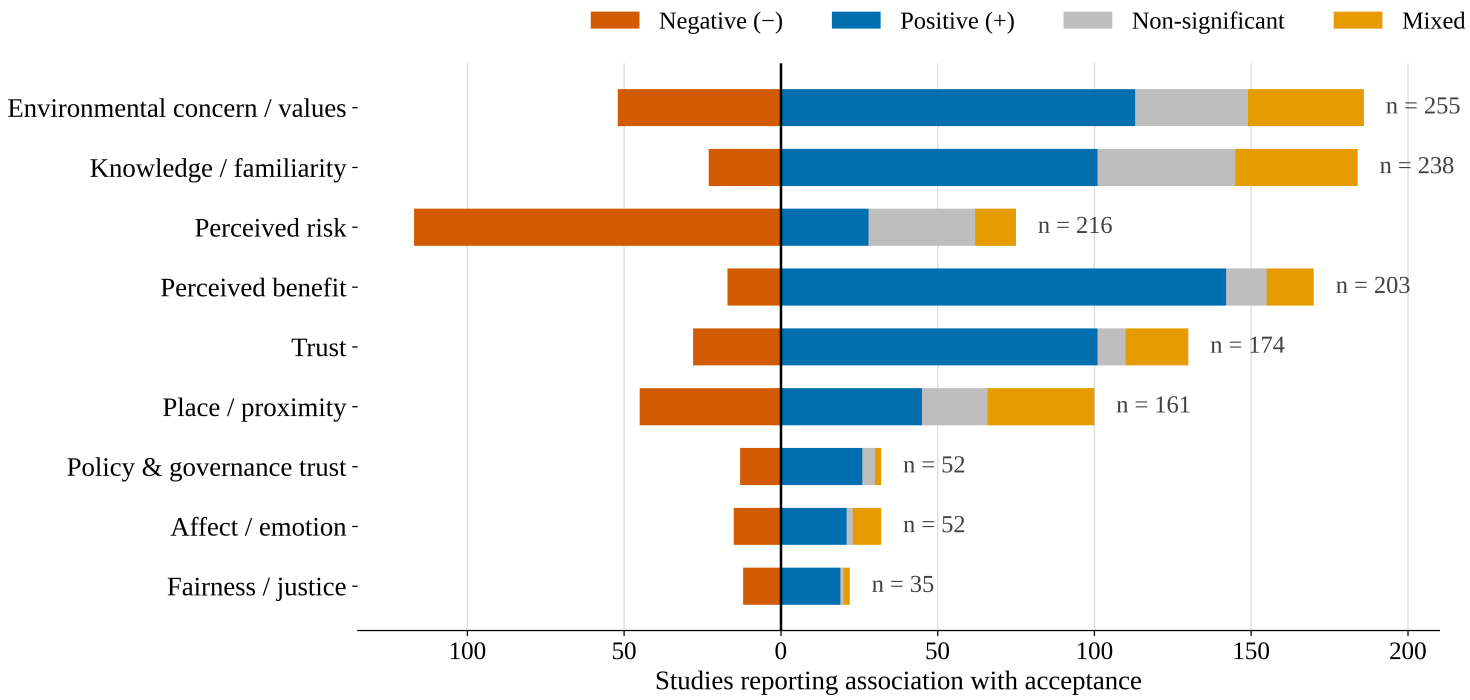


Figure 3

Direction of reported associations between determinant categories and acceptance across included studies (socio-demographics omitted for scale; see Table 2). Bars left of zero: negative reports; bars right of zero: positive, non-significant and mixed reports.

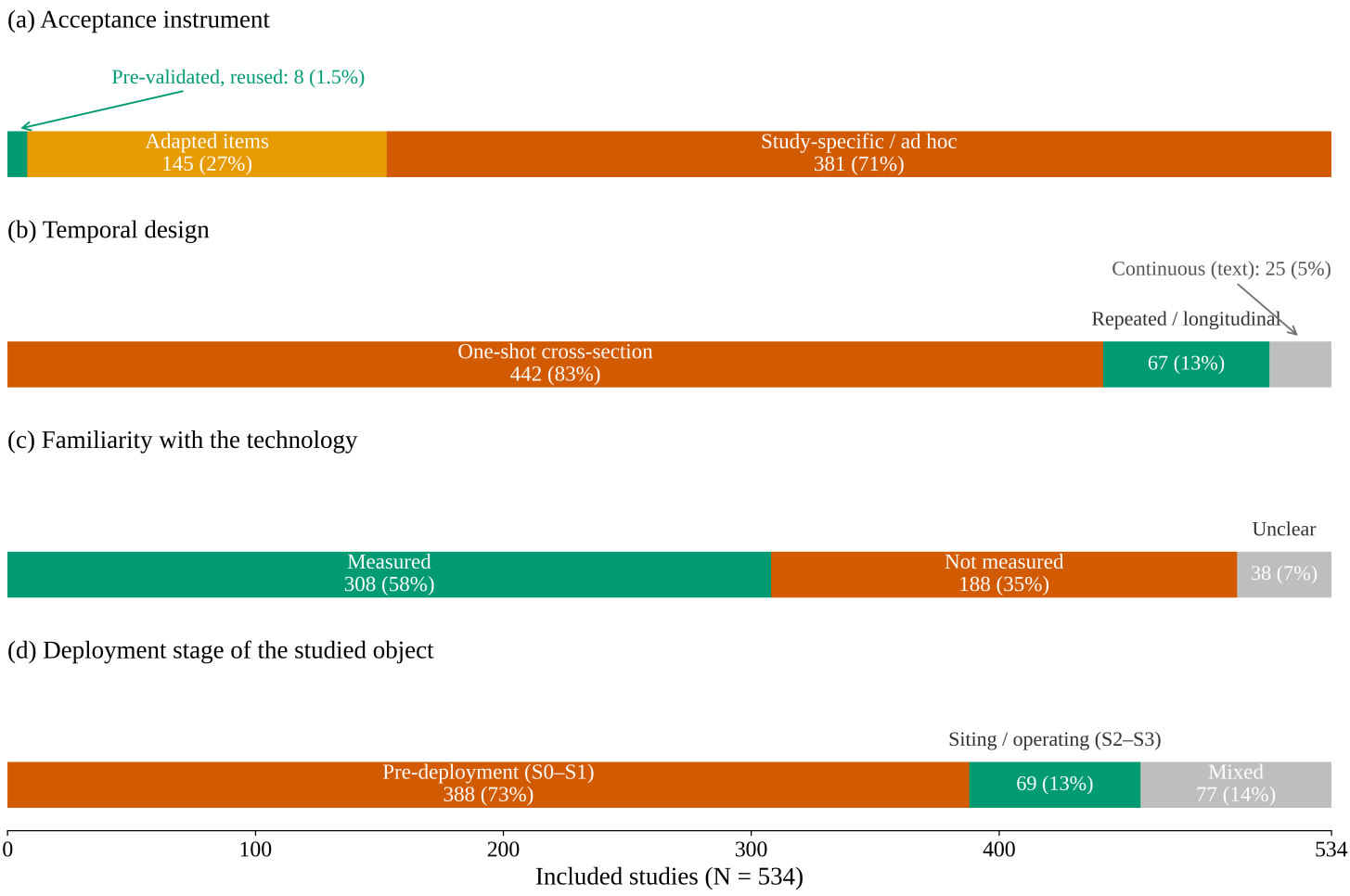


Figure 4

The measurement audit: how the 534 included studies operationalised public acceptance, across four audit dimensions (a–d).

Supplementary Files

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