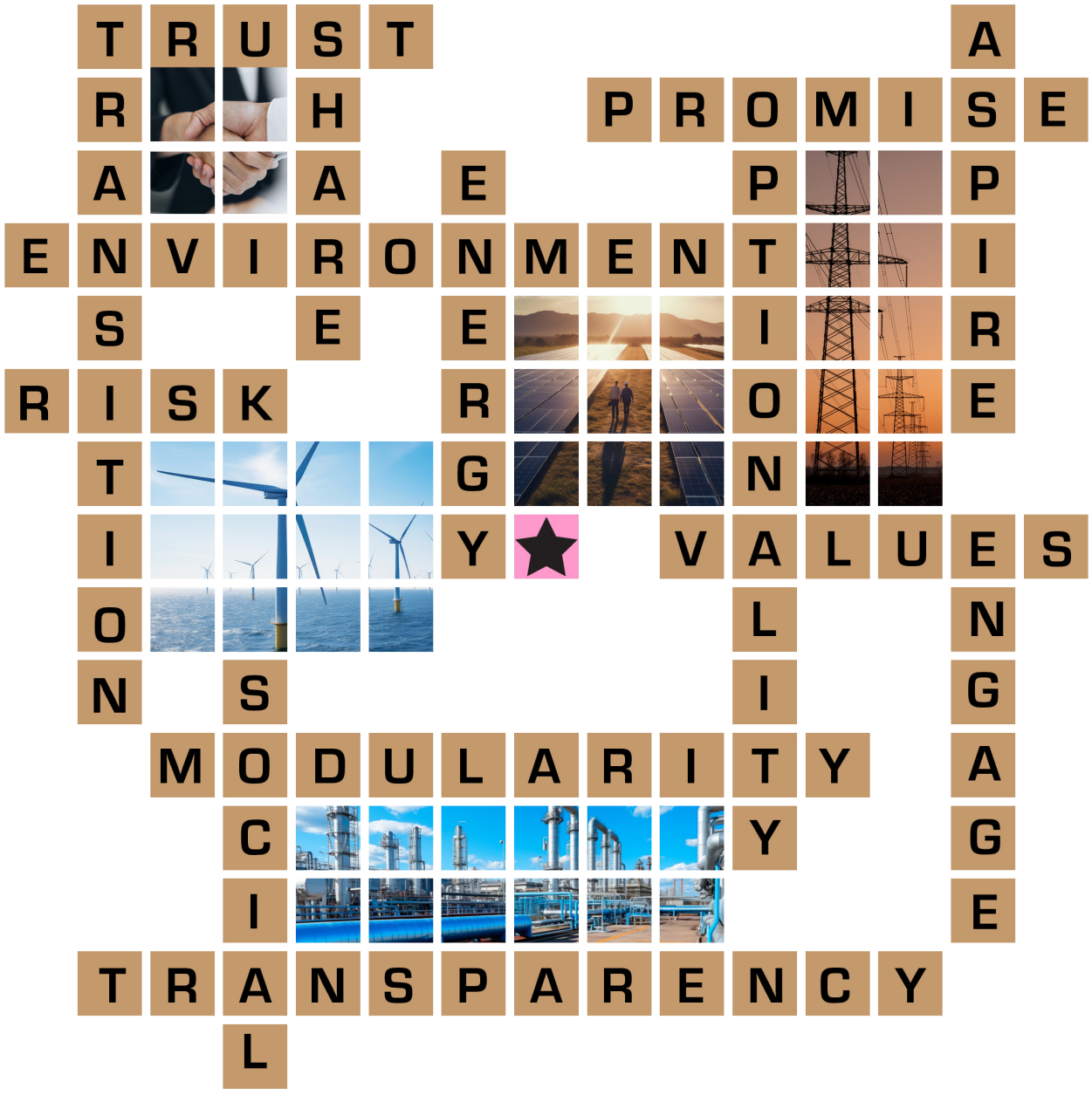

Princeton Net-Zero Stakeholder Survey

YEAR 1 (2023): RESULTS AND TAKEAWAYS

PRINCETON UNIVERSITY

Introduction

Delivering ambitious midcentury net-zero emissions goals set by nations around the world presents an infrastructure expansion challenge that is unprecedented in speed, scale, and complexity. The IPCC and IEA both recognize that serious progress must be achieved in the current decade to meet climate goals. In their first **From Ambition to Reality** report, Worley (a global provider of professional services in the energy sector) and Princeton University's Andlinger Center for Energy and the Environment identified the need to rethink infrastructure delivery practices and proposed five fundamental shifts in the way clean energy assets and infrastructure are conceived, developed, and delivered to bring this net-zero transition from ambition to reality.

The five *From Ambition to Reality* shifts as shown in Figure 1 entail (1) *Broadening Value*, (2) *Enabling Options*, (3) *Standardization*, (4) *Creating Partnerships*, and (5) *the Digital Accelerant*. Redefining the value of energy projects (Shift 1) involves moving beyond near-term financial valuations to include environmental, social, and longer-term economic benefits. Broader and faster community acceptance may also be gained by greater sharing of benefits among all stakeholders impacted by the transition. Shifts 2 and 3 propose engineering-centric changes such as expanding the technology option set to hedge against headwinds that might limit the speed of deployment of individual solutions, and standardization of designs to learn faster and reduce design and procurement delays. Shift 4 is about deeper collaboration and innovative partnerships that will provide for greater risk sharing, increased visibility of plans and progress, and more sharing of learnings between stakeholders engaged in the transition. And finally harnessing Shift 5, digital technology, can help speed up processes and improve visibility among different stakeholders.

Each shift can be measured on individual sets of three indicators. These shifts are designed to disrupt traditional ways of doing business and impact virtually every stakeholder associated with the transition. Companies, communities, investors, regulators, and other stakeholders in the energy transition will need to change their business models, mental models, and operations in fundamental ways. In a world that typically fears and avoids change, the goal of avoiding the existential and catastrophic risks of inaction in the face of climate change needs to motivate willingness to engage in a new paradigm built on these five fundamental shifts in processes, practices and norms.

Paradigm shifts and resulting change can be made to feel safer and more possible by tracking and publicizing progress towards the identified goals and, in the process, demonstrating buy-in and cooperation from a broad set of stakeholders. To do so, Princeton University's Andlinger Center for Energy and the Environment in 2023 launched an annual panel survey that recruited a global set of stakeholders engaged with and/or impacted by the energy transition, the Princeton Net-Zero Stakeholder Survey.

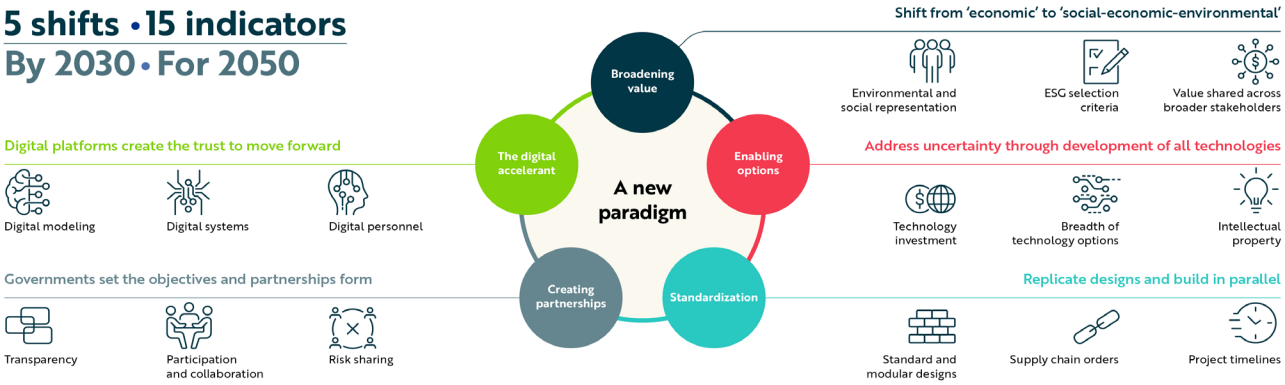

Figure 1. Five From Ambition to Reality shifts.

Findings

The initial 2023 **survey** provides a baseline for where stakeholders see progress on the five needed shifts and each of the indicators. Indicator values can range from 0 (no evidence) to 1 (great evidence), with values around .5 suggesting very modest progress in the desired direction. Table 1 shows the mean responses from the sample of 547 experts from three global regions (United States, Europe, and Asia Pacific) for the three indicators of each of the five shifts. Stakeholders also evaluated the current state of Shifts 2, 3, and 4 relative to five years ago. Mean responses to these questions are shown in Figure 2; responses are on a 0 (great deterioration from five years ago) to 1 (great improvement from five years ago) with a score of .5 suggesting no change from five years ago. There was a noteworthy and reassuring degree of consensus in the answers to most of the survey questions, both within and across geographic regions and across different types of stakeholders.

	All	USA	Europe	APAC
Shift 1: Broadening value. Shift from 'economic' to 'social-economicenvironmental'.	0.52	0.50	0.53	0.53
Environmental & social representation	0.53	0.51	0.53	0.52
ESG selection criteria	0.52	0.49	0.55	0.54
Value shared across broader stakeholders	0.48	0.47	0.48	0.50
Shift 2: Enabling options. Address uncertainty through development of all technologies.	0.60	0.60	0.61	0.61
Technology investment	0.78	0.79	0.77	0.79
Breadth of technology options	0.54	0.52	0.55	0.55
Intellectual property	0.46	0.43	0.48	0.47
Shift 3: Standardization. Replicate designs and build in parallel.	0.46	0.45	0.46	0.46
Standard and modular designs	0.47	0.47	0.47	0.48
Supply chian orders	0.40	0.42	0.34	0.43
Project timelines	0.40	0.40	0.41	0.40
Shift 4: Creating partnerships. Governments set the objectives and partnerships form.	0.54	0.54	0.54	0.54
Transparency	0.47	0.45	0.49	0.47
Participantion and collaboration	0.60	0.6	0.58	0.6
Risk sharing	0.54	0.54	0.57	0.5
Shift 5: The digital accelerant. Digital platforms create the trust to move forward.	0.55	0.55	0.55	0.57
Digital modelling	0.60	0.57	0.63	0.61
Digital systems	0.55	0.55	0.53	0.57
Digital personnel	0.47	0.47	0.46	0.42

Table 1. Summary results for five shifts and indicators.

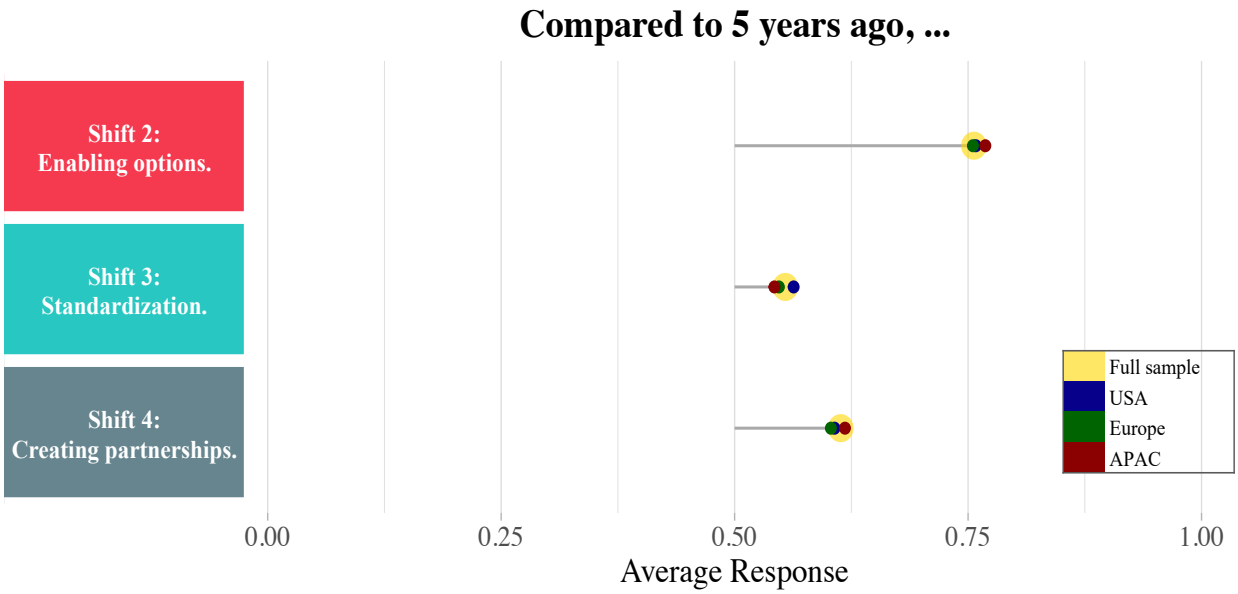

Figure 2. Average perception of how much shifts 2, 3, and 4 have changed compared to 5 years ago. 0 indicates great deterioration in the shift, .5 indicates no change in the shift, and 1 indicates great improvement in the shift.

As can be seen in Table 1 and Figure 2, the paradigm shift of *Enabling Options* (Shift 2) that addresses technological, economic, and political uncertainty through parallel development of multiple technologies scores most highly (M = 0.60, SE = 0.01) and has changed the most compared to five years ago (Figure 2). *Standardization* (Shift 3) focuses on replicable designs and building in parallel and has the lowest score (M = 0.46, SE = 0.01). In fact, the prevalence of bespoke or customized designs (the antithesis of standardization) has increased in the last five years (**Appendix, p. 6**). *Broadening Value* (Shift 1), which involves including a broader set of goals and values into project development, has the second lowest score (M = 0.52, SE = 0.01). In summary, stakeholders report that enabling all technological solutions is currently more common in net-zero projects, and the energy transition generally, than other shifts such as expanding value beyond economics, creating partnerships, standardizing projects, and using digital platforms to create transparency and build trust. We posit that this may be at least partly driven by recent technologically inclusive policy programs, such as the Inflation Reduction Act in the United States.

Closer inspection provides additional insights **within the five shifts**. In *Broadening Value* (Shift 1), the indicator that looks at broader "environmental and social science representation" in projects reveals that environmental scientists are reported to

be included on project teams and as having input on project decisions far more often than social scientists. We see a notable difference between the types of stakeholders when judging the degree of input that affected communities have and the extent that projects share value with those affected communities. Specifically, project developers, owners, and investors report high levels of input from and shared value with affected communities while other more remote stakeholders report lower levels of input and shared value. This suggests a disconnect between direct and remote project stakeholders and that communities do not feel involved enough in these projects.

"ESG selection criteria" are reported to be included in project decisions with moderate consistency, however these criteria are not weighted equally to financial objectives and are not measured consistently. A crucial component of broadening value is "extending value to a broader set of stakeholders". This indicator gets the lowest rating of what is happening in the field, where only ratings of workforce investment make it above the .50 mark, co-ownership with local communities, and sharing learnings with peers are far below.

The encouraging ratings for *Enabling Options* (Shift 2) mentioned earlier are driven by high ratings for its first indicator, "technology investments" (M = 0.78). Perceived progress is far lower for the second indicator "breadth of technology options" (M = 0.54) and lower still for the third indicator "intellectual property transfers" (M = 0.46). We see a similar pattern for the remaining three shifts. While there is significant reported willingness to move on *Standardization* (Shift 3), *Creating Partnerships* (Shift 4), and the *Digital Accelerant* (Shift 5) among organizations, there appears to be great reluctance to share data, information, plans, goals, or impacts with affected communities or other external stakeholders. As a result, affected communities report that they generally do not have access to project data or up-to-date information, leading to low perceived transparency and distrust on their part. When it comes to *Partnerships* (Shift 4), owners, developers, and investors are reported to have consistent and significant access to information and input into decisions while other groups, like workers/unions and community groups, fare far worse. Related to the apparent lack of trust among property owners and developers, the reported rate of sharing intellectual property is also low—most companies do not work with competitors or share learnings to achieve net-zero goals. While rates of "standardized and modular designs" are seen as increasing compared to five years ago, the use of bespoke designs is still very common. And while platforms for teams to collaborate on and share standardized designs are in greater existence compared to five years ago, there is no strong system in place that incentivizes standardization.

Our experts were asked to predict which paradigm shift would increase most over the next year. Answers were evenly split between *Broadening Value* (23%), *Enabling Options* (20%), *Standardization* (22%) and *Creating Partnerships* (22%), with the *Digital Accelerant* lagging at 13%. The experts were also asked which paradigm shift would show the least movement over the next year, with much greater consensus: 39% of experts selected *Broadening Value*, reflecting a perception that sharing economic value with other stakeholders and considering social and environmental value as equally important to economic value is challenging and unpopular.

Looking forward

The challenge of transitioning all global economies to net-zero emissions presents a daunting task which many believe will require profound shifts in practices, behaviors and relationships. Models which envision the pathways to net-zero implicitly assume a new paradigm in which such shifts are widely, or even universally, adopted and practiced. This assumes near perfect visibility and foresight, seamless coordination and flawless execution. But the real world is imperfect. The preliminary results from this year's survey suggest different levels of trust between different types of stakeholders. For example, access to digital platforms with up-to-date project information are broadly reported to increase trust in a project (M = 0.78). However, access to those platforms is not available to all stakeholders; asset owners, developers (M = 0.87), investors (M = 0.63), and contractors (M = 0.60) are reported to have broad and consistent access while there is little evidence that communities (M = 0.22) and regulators (M = 0.39) have access to these digital platforms. Taken together, the results from the first year of the Net-Zero Stakeholder Survey suggest that while promise exists, perceptions among different groups of stakeholders vary quite a lot, signaling concerns of a potential lack of trust among key actors, and/or concerns about the authenticity of commitments and intentions.

We intend to conduct this survey annually through 2030 and wish to expand the size and diversity of the expert sample. To do this, we need your help! We encourage readers of this white paper to **join us and sign up to contribute to the survey next year**. Please share this paper with colleagues and encourage them to join our survey panel in 2024 to contribute to this public good effort.

You can also copy and paste this link to join next year's survey:

https://princetonsurvey.az1.qualtrics.com/jfe/form/SV_bPAXWAGwUg3SceO

Or scan the QR code:

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Jordana Composto is a graduate student in Psychology and Social Policy at Princeton University. Her research focuses on the cognitive mechanisms of social norm perceptions and the role of organizational culture in addressing climate change. She is also a Beijer Young Scholar and served as a Contributing Author for Working Group III (Mitigation) for the 6th Assessment Reports of the UN IPCC. Jordana received a B.A. from Dartmouth College, double majoring in Quantitative Social Science and Environmental Studies.

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Her expertise in behavioral decision sciences has been sought by advisory committees and boards of the National Academy of Sciences, Engineering, and Medicine, a joint commission of the Nachhaltigkeitsrat (Sustainability Council) of the German government and the German National Academy of Sciences Leopoldina, and the US Environmental Protection Agency. She served as Lead Author for Working Group III (Mitigation) for the 5th and 6th Assessment Reports of the UN IPCC. She currently chairs the Science Advisory Boards of the Beijer Institute for Ecological Economics at the Royal Swedish Academy of Sciences, and is a member of the Science Advisory Boards of the Stockholm Resilience Center and the International Institute for Applied Systems Analysis.

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Chris’s 10-year academic career was preceded by almost 30 years in the private sector, initially as the founder of a successful process technology and engineering. He then spent more than a decade in senior executive roles in energy and resources, including as CEO of ZeroGen, an early pioneer in large-scale carbon capture and storage, and as deputy chairman of Gladstone Ports Corporation, one of Australia’s premier energy export hubs. In academia, Chris’s research is interdisciplinary, bringing engineering, energy systems, business and social sciences together to help overcome the challenges associated with the energy transition implementation. His work includes highly granular analysis and policy advice at national, sector and company scales. He has published articles on energy transitions, CCS, clean hydrogen, industry decarbonization and climate finance. He co-led Princeton’s influential Net-Zero America study and is leading Princeton’s participation in similar studies in Australia, and Asia.

Methods

We identified and surveyed an international set of experts with direct experience with net-zero energy transition projects (n = 547). Respondents came from three large regions selected for their leadership in the net zero transition: Asia-Pacific (n=131), Europe (185), and North America (n=247). Data were collected between April and August of 2023.

'Projects' were defined as low- and zero-carbon energy supply projects and infrastructure, including but not limited to: renewable electricity generation, transmission and/or pipeline infrastructure, firm generation and energy storage (e.g., batteries), low- and zero-carbon hydrogen and fuels production, carbon capture utilization and storage, and nuclear power. Experts were identified and recruited through systematic searches of professional databases and in a massive outreach through diverse professional networks around the world. This research was reviewed and approved by Princeton University's Institutional Review Board (IRB).

Recruited experts with exposure to net-zero projects fit the following categories: project owners, project developers, employees of financial institution, investors, EPC (Engineering, Procurement and Construction) service professionals, equipment providers, producers of materials (including mining, processing, refining, and primary manufacturing), contractors or builders, regulators, policymakers, member of community groups, landowners, employees of social and environmental NGOs, educators, university researchers, vocational educators, professional developer, and employees of labor organization, including unions and workers interest groups.