Exploring the Social Cost of Carbon for Internal Carbon Pricing: Insights from a Technology Probe

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***Abstract*—Internal carbon pricing (ICP) can be a powerful means of reducing greenhouse gas emissions for organizations. However, current carbon pricing is well below optimal levels as described by the Social Cost of Carbon (SCC). In this study, we construct a technology probe that casts SCC as a form of carbon pricing that allows sustainability professionals to set a price by adjusting a single ethical knob—the discount rate—which determines how much to "discount the future". This allows us to investigate their perceptions and attitudes towards ICP, SCC, and organizational responsibility towards society and the environment. We discover that framing the SCC purely as a function of the discount rate makes it a robust indicator of perceived climate responsibility at an organizational level. We find that organizations are at various stages of adopting internal carbon prices, highlighting the need for capacity building and consulting support. Introducing SCC as a significant metric in cross-cutting reporting frameworks may promote its widespread adoption as an unbiased measure of organizational commitment, and spur organizational climate action that go beyond token gestures or mere lip service.**

I. Introduction

Internal carbon pricing (ICP) has seen broad and accelerating uptake in recent years. Organizations ranging from corporations to municipal and regional governments, academic institutions and non-profits, have voluntarily adopted ICP as part of their efforts to rationalize their financial decisions, manage climate risks, and achieve climate and sustainability goals, such as science-based targets (SBTs) to reduce greenhouse gas emissions [1]. In 2020, over 2000 corporations across industries and geographic regions (including 226 of the world's 500 largest corporations) reported to Carbon Disclosure Project (CDP), the global environmental disclosure platform, that they were currently using or planning to use ICP [2].

The *Social Cost of Carbon* (SCC) is the marginal cost to society caused by the emission of one ton of carbon dioxide [3]. The SCC is the only pricing mechanism that attempts to internalize a set of harms caused by carbon emissions. This makes SCC an appealing metric for organizations seeking to internalize the societal impact of their emissions. Furthermore, equitable weighting criteria can be incorporated [4], [5] into the metric to make it a more equitable measure that accounts for the relative value of a dollar to different parts of society. The SCC can therefore serve as an important benchmark for ICP.

Recognizing that net damage to society can be broad in scope and spread over a long timescale, climate economists have built successive generations of integrated assessment models (IAMs) to quantify the SCC [6]–[9]. However, the adoption of SCC as an ICP has been very limited in the broader context. Among all corporations and regional governments that publicly disclosed current or planned ICP to CDP in 2022, not a single organization reported the use of SCC. Our analysis of the 2022 CDP Climate Change dataset (Section 11.3 of the CDP Report) shows that only 108 corporations out of 8,522 mention the terms "SCC", "damages", "social", or "society" in their filings. Within higher education institutions, a small number have recently adopted SCC as their ICP [10]. Additionally, there is a large gap between ICP levels adopted by corporations and the SCC, indicative of the under-pricing of carbon emissions.

This gap serves as the primary motivation for the present study, and the following research questions: (i) what are current levels of awareness and understanding of SCC within organizations; (ii) how can understanding of SCC be effectively facilitated within organizational contexts; and (iii) what are possible ways to catalyze organizational adoption of ICP that is more in line with the prevailing SCC.

We performed a technology probe study using a Social Cost of Carbon calculator to unpack these questions, seeking our participants' perspectives on the following: what makes the SCC a useful measure of social responsibility? Can we use the SCC to help connect the organizational ICP practices to their environmental and social harm reduction policies? Can a SCC-based ICP act as a useful metric to help drive higher ICP adoption?

The key findings of our study are as follows. First, we find that sustainability professionals can readily connect SCC to organizational responsibility and leadership. Second, while some organizations may be resistant to using SCC as ICP, others are enthusiastic early adopters, and still others see themselves as fast followers. Third, SCC has the potential to serve as a powerful guidepost for climate ambition, although this potential remains underexplored.

This work speaks to recent calls in the fields of Information and Communication Technologies for Sustainability (ICT4S) and Sustainable Human-Computer Interactions (SHCI) to shift

focus from nudging behaviors or optimizing workflows in organizational settings to supporting green policymaking by organizational leaders [11], [12]. Acknowledging that technology, design, and even sustainability voices and concerns have often been sidelined in organizational decision-making [13], [14], our work points to a new approach of leveraging information and information tools to help organizational leaders make policies for systemic change.

To the best of our knowledge, this paper is the first to utilize the technology probe method to evaluate attitudes towards the Social Cost of Carbon, the first to develop an online Integrated Assessment Model (IAM)-based tool designed for non-experts, and the first to draw a comparison between the challenges of setting an effective carbon price and determining the discount rate in SCC. The paper continues with a background on ICP, SCC, and the technology probe research method in Section 2. We describe our study design, including the design of the technology probe, in Section 3. We report the study findings in Section 4, and discuss the findings and offer some recommendations in Section 5 before concluding the paper.

II. Background

A. Internal Carbon Pricing

Different methods of internal carbon pricing have been adopted and implemented by different organizations. A *carbon fee* or *carbon levy* is a monetary amount charged to business units for each ton of emissions that they generate. An *implicit carbon price* captures the marginal abatement costs of reducing the organization's emissions. A *shadow carbon price* or *proxy carbon price* represents a theoretical internal cost of carbon that can be used in life-cycle analyses and capital investments decisions. Because they serve distinct purposes, an organization may choose to adopt multiple types of internal carbon prices.

In 2023, only 146 companies reported an ICP greater than US\$100/tCO_2 to CDP. While ICPs have ranged anywhere from US\$0.01 t/CO_2 to US\$3,556 t/CO_2, most reported ICPs are below the levels recommended by the High-Level Commission on Carbon Prices to be aligned with the Paris Agreement, which in 2017, concluded that "carbon prices needed to be at the level of [US\$40/tCO_2 to US\$80/tCO_2] in 2020 and reach [US\$50/tCO_2 to US\$100/tCO_2] by 2030 to be on track to keep temperature below 2^{o}C" [15].

While the adoption of ICP can help improve a corporation's environmental performance [16], successful implementation depends on a number of internal and external factors [17], [18].

Internal factors may include the size and maturity of an organization, the characteristics of an organization's sector (less carbon-intensive sectors may be less likely to adopt ICP), while external factors may include public policy on carbon pricing, especially uncertain carbon policy environments, as well as a general lack of knowledge about ICP. However, ICP adoption has increased steadily, with cities and regional-to-state scale adoption growing [19], leading to reduced carbon emissions in those economies [20].

B. The Social Cost of Carbon

The Social Cost of Carbon (SCC) is a metric that attempts to quantify the economic damages associated with the emission of one additional ton of carbon dioxide (CO2) into the atmosphere [3]. It represents the present value of the future stream of damages caused by that additional ton of CO2, taking into account factors like changes in agricultural productivity, human health impacts, property damage from sea-level rise, and the broader effects on the economy.

Since its introduction in 1982, the SCC has been estimated with successive generations of IAMs that capture the complex interactions between the climate, economy, and other systems. The most widely adopted IAMs at the time of writing are DICE [6], FUND [7], PAGE [8], and GIVE [9]. These models simulate the physical climate system, translate climate impacts into economic costs, and incorporate uncertainty through the use of probabilistic parameters. The specifics of model structure, damage functions, and parameter assumptions can have a significant influence on SCC estimates [21]. Meta analyses find recent SCC estimates that range from under US$0 per ton of CO2 to over US$2,000 per ton [22]. Moreover, the final values are heavily influenced by small changes in the discount rates used (with typical rates ranging from 1.5% to 3%) [23], issues around inequality [24] and attempts to assign monetary values to non-economic climate damages [21]. These factors make achieving consensus on the value of the SCC challenging, and a core recommendation from the National Academies of Sciences [25] was to create an open source computing platform to improve the transparency of and foster collaboration among the climate impacts modeling community. To this effect, a large number of IAMs have been open-sourced.

However, the complexities inherent in parameterizing IAMs and the knowledge required to understand their true impact render them inaccessible to most except climate change academics or policy makers in the global north, leading to limited uptake in SCC adoption globally. Finally, such estimates are only generated and accepted as and when policymakers deem the need.

There have been some recent attempts to ameliorate these issues, e.g., Resources for the Future's (RFF) SCC Explorer [26]. Before such a tool, users would need to download and build these models from source, as well as understand the jargon and science underpinning IAMs. It represents a large improvement in the public accessibility of such models, and our technology probe was inspired by this tool.

C. SCC as ICP

The use of SCC as an ICP is very limited in practice, and mostly in governments rather than corporations. Under different administrations, the U.S. Environmental Protection Agency (EPA) has regularly published SCC numbers for use by federal agencies in policy cost-benefit analyses. In 2023, it updated its SCC estimate to US$190/tCO2 [27], in line with scientists' estimates of US$185/tCO2 in 2022 [9]. However, its use was suspended in 2025 under the new administration, pending legal challenges in the courts. Despite the suspension

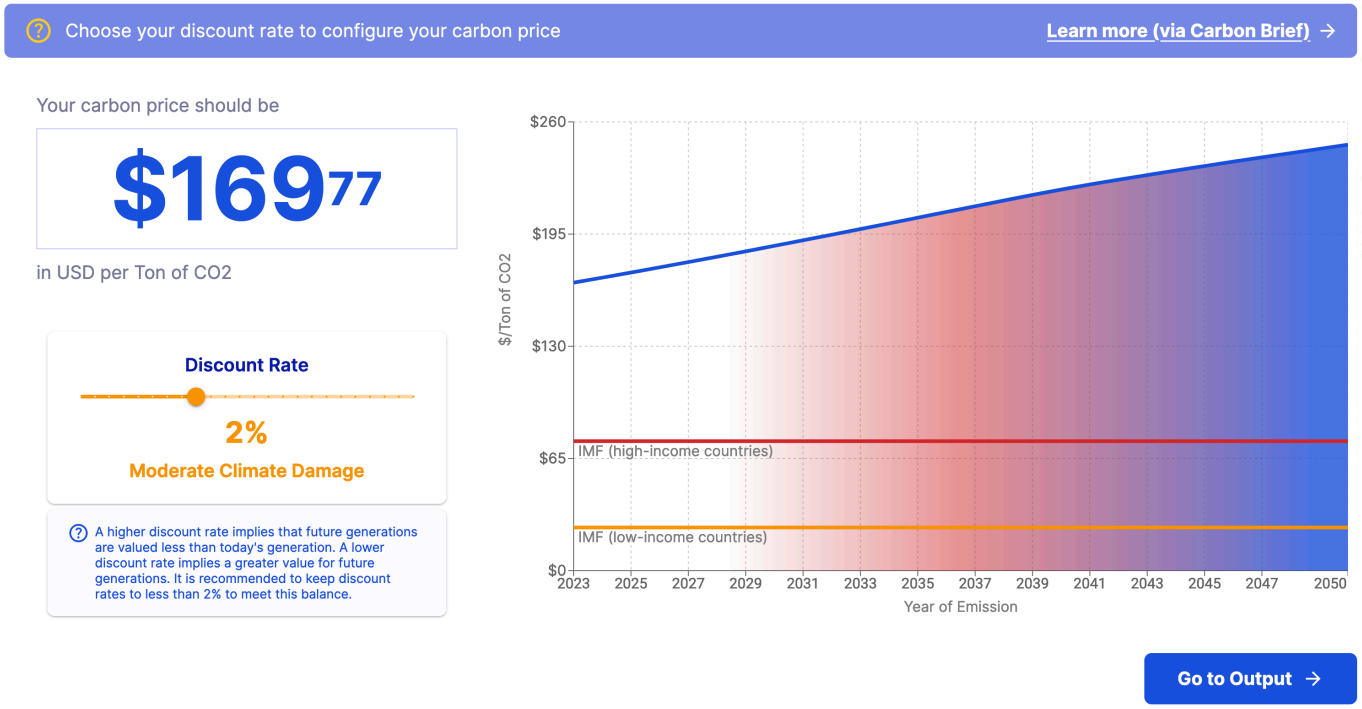


Fig. 1: The carbon pricing calculator page of the technology probe. The slider on the left is the only input available to users. The graph on the right shows carbon pricing at that discount rate for emissions in the future, assuming constant inflation.

at the federal level, several U.S. states continue to use the SCC at the state level.

In 2024, the German Environment Agency (UBA) published a report that uses the GIVE model to recommend an SCC of €300/tCO2 [28]. According to [29], several other countries including Canada, France, Mexico and Norway have implemented their own SCC estimates.

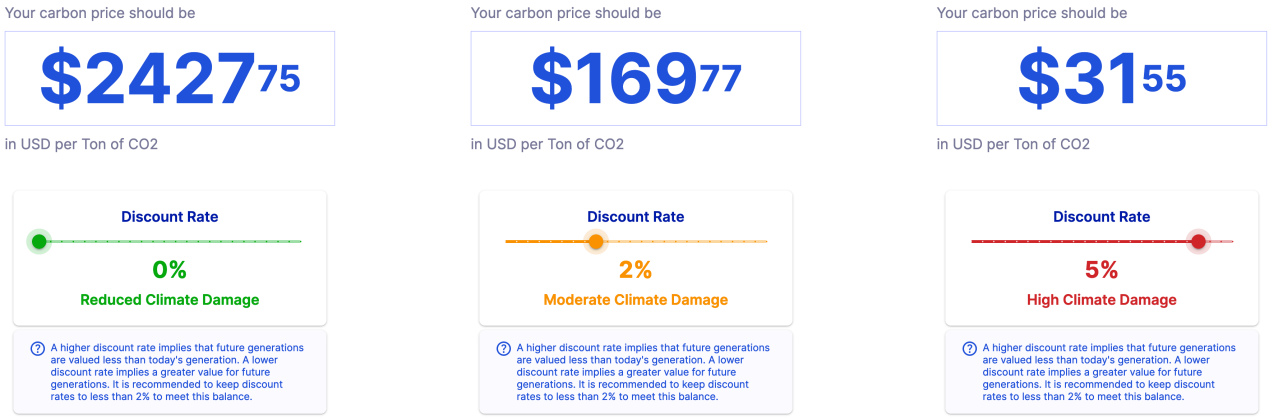
At the institutional level, the University of California system adopted an equity-weighted SCC of US$246/tCO2 with a 1.5% escalation rate as a shadow/proxy price in two high-level, capital project decision making tools [30]. These exceptions highlight how infrequently this metric has been adopted for real-world use cases.

D. Technology Probes

Technology probes are a research method used in human-computer interaction (HCI) and related fields to explore people's behaviors, needs, and interactions with technology in real-world settings [31]. A technology probe typically consists of a lightweight but functional technology that is deployed in the everyday environment of participants, such as the home and the workplace [32], [33]. They have been deployed in studies to investigate sustainability attitudes and practices in domestic or family settings [34]–[36], as well as in organizational settings to study office environment factors such as thermal comfort [37] and indoor air quality [38]. Our study is the first technology probe study to target sustainability professionals, such as Chief Sustainability Officers. This shifts the focus from nudging individual behavior or optimizing office workflows to supporting green policymaking by organizational leaders [11], [12], with the goal of influencing systemic change rather than individual action.

In the original paper introducing technology probes as a research method, Hutchinson et al. [31] identified three interdisciplinary goals: "the social science goal of understanding the needs and desires of users in a real-world setting, the engineering goal of field-testing the technology, and the design goal of inspiring users and researchers to think about new technologies." In our study, we use our probe as a research instrument to gather data and insights about the attitudes and practices of sustainability professionals with regards to ICP and SCC, as well as to inspire them to think about the organizational and technological innovations needed to realize the adoption of SCC as an ICP.

The technology probe allows us to examine current stances on ICP practices including their barriers to adoption, as well as the beliefs our subjects hold about the validity and efficacy of employing the SCC as an ICP. Our probe was designed iteratively with the help of feedback from small groups of relevant participants, and was released as a lightly tested product. Yet, we were not attempting to deploy the product, but try to cover the assumed information needs of our subjects before they were provided the tool. In that sense, this study is another step in further refining the final output, and indeed we conclude the study with pertinent recommendations.



(a) Low discount rate (b) Moderate discount rate (c) High discount rate

Fig. 2: The effect of choosing different discount rates using the slides on the calculator page of the probe. Note the changes in the text under the slider that alerts the user towards the ethical implications of their choice. This is a central design element of the probe which links a single manipulable input parameter to the outcome.

III. Methodology

A. The Technology Probe

As shown in Fig. 1, the technology probe was designed as an online carbon pricing calculator with the explicit goal of allowing participants to choose a carbon price that is amenable to their organization and industry. It was designed as a lightweight interface to an IAM that produces the SCC, with only a single input - the discount rate. This is predicated on the understanding that participants need to see the results of their actions; in this case – by setting a specific discount rate, they receive an explicit carbon price, as well as qualitative feedback on the effect of their choice on the overall socio-economic climate dynamics, as shown in Fig. 2. On setting a lower discount rate ($0\% \leq DR < 2\%$), the underlying text "Reduced Climate Damage" is shown in green. On setting a medium discount rate ($2\% \leq DR < 4\%$), the underlying text "Moderate Climate Damage" is shown in orange. And finally, on setting a higher discount rate ($4\% \leq DR$), the underlying text "High Climate Damage" is shown in red. The choice of traffic signal colors is a simple but nearly universal signaling of risk. This interactive choice-making is the heart of the technology probe and gives participants the agency to pursue courses of action appropriate to their needs while providing *some measure of feedback* on the consequences of those very actions.

We anticipated that participants will attempt to set a carbon price that their organization is willing to pay by moving the input slider to the appropriate location, and we wanted to not only enable this form of agency but also strike a balance in providing realistic feedback on that decision for the global commons. This interface could easily have been replaced by a table; however, a table would not have provided user agency while explicitly stating the link between the simple action of setting a carbon price and its larger consequences.

The rationale behind providing a single knob in the interface is our belief that the discount rate is the most important ethical parameter in the model – it determines how much to discount the impacts of greenhouse gas emissions in the future. It is the rate used to convert future costs and benefits into present-day equivalent values. This implies that if the participant sets a high value, they inherently give more importance to the well-being of humans and non-humans today as opposed to that of future generations. To ensure participants understand this implication, we provide a text guide in the user interface (refer to Fig. 2) - "A higher discount rate implies that future generations are valued less than today's generation. A lower discount rate implies a greater value for future generations". It is also well documented that discount rates have an outsized effect on the SCC [39]–[41]. We expected that this "ethical knob" will provide participants with a key insight into how their current ICP practices contribute to climate damages both in the near and long term.

We considered other IAM parameters such as damage functions and equity weighting, both of which carry ethical weight, but did not expose them as tunable parameters in the probe. Damage functions are crafted by climate economists and are not typically chosen by our target population. Equity weighting adds a monetary adjustment to different regions of the world – based on their contributions to and damages anticipated from climate change – but does not change the basic shape of the relationship between discount rate and

carbon price. Furthermore, it was not supported by most IAMs at the time of the study. Therefore, we prioritized simplicity in the design of the probe by providing a single knob that would have an outsized effect on the price.

Our technology probe maps the choice of ICP to the participants' willingness to mitigate the effects of climate change to future generations, human and non-human. In this way, casting their current or expected ICP within the framework of the SCC exposes the implicit ethical choice involved, and the ICP becomes a measure of equitable climate action, making this functional relationship between a chosen carbon price and their current actions palpable.

We developed the technology probe as an interface to the latest peer-reviewed IAM, to provide the most accurate carbon prices at different discount rates. We choose the Greenhouse Gas Impact Value Estimator (GIVE) model [9], considered the state-of-the-art in the field today [42]. After multiple design iterations, we settled on the following design architecture for the probe: we allow participants to set a single parameter, the discount rate, in the 0-6% range with a 0.5% granularity level. The rate is initialized at 2%, which is the most common baseline value for most IAMs. Based on the selected discount rate, the model generates an SCC value for each year up until 2050. We represent this price over time as a graph on the right side of Fig. 1. This value increases over time, exposing the nature of carbon pricing inflation as derived from IAMs.

The technology probe also includes a landing page, which displays three different sets of benchmarks relevant for internal carbon pricing (Fig. 3). The first panel lists prominent ICP levels chosen by large corporations. The second panel lists prevailing carbon tax levels for selected countries and jurisdictions. The third panel shows carbon prices recommended by different organizations. This display allows us to explore how participants think of their own ICP levels relative to those from their peers and to other external references.

B. Semi-Structured Interviews

We conducted semi-structured interviews with participants in order to see how they would interact with the technology probe and select a discount rate based on their context. In addition, we also wanted to better understand their knowledge of the SCC and experiences with utilizing and implementing ICP within their organizations. Our study protocol was approved by our Institutional Review Board. Informed consent was obtained from all participants, and all interviews were recorded, transcribed, and anonymized.

1) Participant Recruitment: We recruited participants through word-of-mouth and professional network websites, focusing on sustainability professionals within the private sector, sub-national governments, and universities. A total of eleven sustainability professionals participated in the interviews (Table I).

Within the private sector, we interviewed six participants across multiple industries, such as information technology, financial services, retail, and consulting. Three of them were from multinational companies that had a public stance on carbon pricing, with two from companies that additionally had a public stance on the SCC. These professionals were situated in sustainability departments with job titles such as "Assistant Vice President, Sustainability", "Climate Strategist", and "Environmental Sustainability Lead". The other three participants identified as sustainability consultants and were responsible for advising a portfolio of companies on sustainability issues and planning.

TABLE I: Study Participants

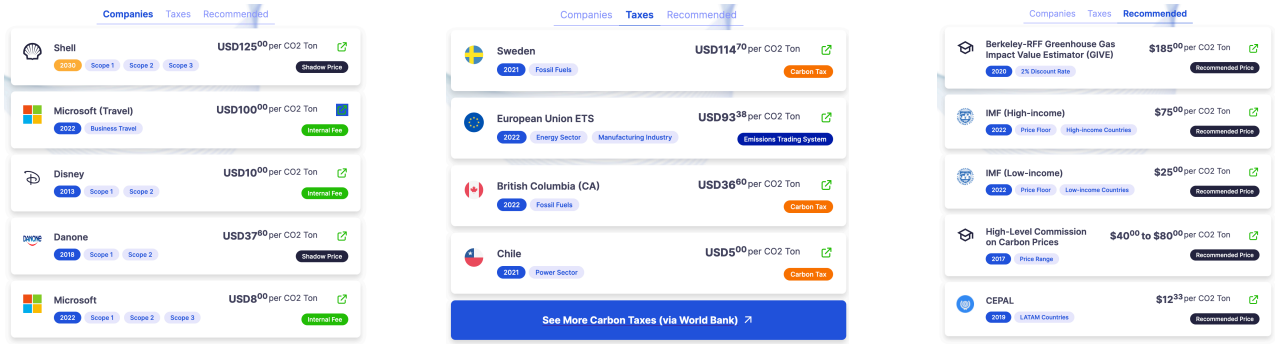
Code	Gender	Organization Sector	Region
P1	Woman	Information Technology	N. America
P2	Woman	Professional Services (Consulting)	Europe
P3	Woman	Retail	Europe
P4	Woman	Finance	N. America
P5	Woman	Professional Services (Consulting)	N. America
P6	Man	Professional Services (Consulting)	Europe
P7	Woman	Higher Education (University)	N. America
P8	Man	Municipal Government	N. America
P9	Man	Municipal Government	N. America
P10	Woman	Higher Education (University)	N. America
P11	Woman	Higher Education (University)	Europe

Two participants worked for a Canadian municipal government, and three participants were from universities in the United States and United Kingdom, with student body populations ranging from 20,000 to over 45,000 students. All of them worked in sustainability roles within their organization, and their job titles include "Chief Sustainability Officer" and "Assistant Director of Sustainability".

2) Interview Structure: Each session was held via videoconferencing and lasted approximately 45 minutes. The interviewer began by asking the participant a series of introductory questions about their role and organization, their current practices around ICP, and their familiarity with SCC.

Then, the interviewer shared a link to the technology probe and asked the participant to share their screen. The participant was first invited to read the introductory text to familiarize themselves with the probe. Next, the interviewer guided them to the calculator where they were asked to complete a series of tasks and answer follow-up questions. The tasks included moving the discount rate slider to 0%, 1%, and to the right, up until 5%. After each task, the interviewer asked for their interpretations of the various outputs, such as the graph, the calculated carbon price, and the discount rate slider and labels. Upon completion of the tasks, the interviewer asked the participant about their experience interacting with the probe and any challenges or areas of confusion, and to provide a rating on how difficult it was to use the probe.

Next, the interviewer asked a series of questions about the participant's understanding of SCC after interacting with the probe, if they could foresee opportunities and obstacles for adopting either the probe or the concept of SCC within their organization, and their observations on decision-making processes around ICP revisions. The interview concluded with the interviewer asking the participant if they believe their organization would increase their ICP and what a future ICP could look like in the year 2030.



(a) Companies with a carbon levy (b) Countries and jurisdictions with a carbon tax (c) SCC recommendations by different organizations

Fig. 3: Benchmarks displayed on the landing page of the technology probe.

IV. Results

Our technology probe exploring SCC as an ICP revealed both barriers and opportunities for organizational adoption. Sustainability managers generally lacked expertise in ICP and SCC concepts due in part to their inherent complexity. However, when interacting with our SCC-based carbon pricing calculator, participants quickly grasped SCC's relevance as an ICP method and recognized that prevailing carbon prices significantly underestimate climate damage costs. They showed considerable interest in exploring the model parameters and considering applications within their organizational contexts. While awareness of ICP was high among participants, implementation was limited. Only three participants (P6, P7, P10) reported their organizations had implemented ICPs, with just one using an SCC-based approach (P10). Two organizations had flight levies (P7, P11), though one did not consider this a form of ICP. Familiarity with ICP did not translate to understanding SCC. Before using our tool, participants rated their SCC familiarity at just 3.86 on a 10-point scale. While most were aware of the concept, they were neither familiar with the technical definitions nor the "considerations that go into setting a SCC" (P7).

A. Connecting SCC to Organizational Responsibility and Leadership

Despite initial unfamiliarity, participants quickly developed a sophisticated understanding of SCC through the brief interaction with our probe. First, they comprehended the inverse relationship between discount rate and calculated carbon price, recognizing that lower discount rates produced higher prices. They also understood that SCC-based prices escalate over time, even with fixed discount rates[1].

Second, participants connected discount rate choices to environmental responsibility and intergenerational impact. P2 noted that "the discount rate represents roughly the idea of responsibility; choosing a particular rate means choosing a level of responsibility." P3 observed that "[a] small change leads to very significant change in price of carbon." P6 correctly understood that a 0% discount rate values "future damages being just as valuable as today." Similarly, P1, upon decreasing the discount rate value to 0%, shared that "[the graph] is showing that we would consider the impact felt by future generations as significant, and therefore, we want to work to pay for that now", recognizing the causal relationship between valuing future impacts and implementing a high carbon price.

Participants from organizations with established carbon prices readily determined their implied discount rates using the tool, recognizing the corresponding damage values. Some developed their own insights on potential tool applications. P7 suggested that stakeholders might enter with "a-priori price targets" and discover that "their price level corresponds to a higher discount rate, and higher climate damages".

P9, working for a municipal government, explained how the SCC framework could quantify the climate ambition of an organization's leadership: "in contrasting the resulting price from this model with the existing price in place, that gives us context in terms of where the city might want to put leadership, with that leadership being converted to dollars and cents." They added that understanding the difference between current pricing and damage-reduction pricing "becomes a very useful piece of information for leadership." For those with existing ICP, the probe prompted critical reflection on current practices. P7 acknowledged: "Our organization thinks we are doing a lot with our carbon pricing, but according to this social cost of carbon model, maybe not so much." After using the probe, participants characterized it as a *robust visual indicator of climate change responsibility*. They appreciated seeing graphical representations of abstract concepts like responsibility and intergenerational impact, with several noting that visualizing the outputs increased their interest in learning more about SCC (P3, P4).

B. Operationalizing the SCC

Many participants began considering practical implementation of SCC within their organization's ICP efforts, articulating specific information needs to support adoption. They sought

[1]This is a function of monetary inflation over time, and the accumulation of climate damages with the accumulation of carbon in the atmosphere.

additional details about the SCC model to build confidence and understanding, both for themselves and other organizational stakeholders. P5 wanted to learn more about the GIVE model to enhance its credibility, specifically requesting clarification on qualitative terms like "moderate climate damage" and "high climate damage." P4, from a financial institution, emphasized the importance of clearly defining concepts such as value and damages, suggesting the inclusion of a methodology document and transparent access to SCC calculation inputs.

Participants also requested customization options to adapt tool outputs to their organizational contexts. P2, a consultant working with companies on sustainability initiatives, noted that their clients often struggle with carbon pricing implementation and suggested the tool should provide guidance on applying outputs to specific organizational settings. Others anticipated questions they would face when introducing the tool within their organizations, particularly regarding operational aspects. For example, P1 raised practical concerns such as "who is paying for [the social cost of carbon] out of what budget?" and whether the SCC would apply to the organization's scope 1, 2, and/or 3 emissions.

C. Resisting the SCC and ICP

Several participants expressed skepticism about using SCC as an ICP. P2 stated there was "no way [companies] are going to put real money on a fund based on these very high amounts," referring to the default value of USD 169.77 at a 2% discount rate. P6 described the SCC as "extortion," suggesting that "companies will not go near that figure [$400]". Both participants work as sustainability consultants with broad industry perspective and indicated that "at the moment there's no huge motivation to implement ICP". Some participants suggested that companies self-reporting ICP in CDP disclosure reports were merely paying "lip service," highlighting ineffective implementation. P2 reinforced this view, noting that ICP is not a corporate priority and typically only considered "when filling out Section 11 on the CDP questionnaire." This consultant summarized the price sensitivity versus action gap succinctly: "[companies will] either use a very low price, or apply the high price on a very small share of their emissions."

P2 also observed that organizations need to be advanced in their "carbon journey" and have sufficient resources to implement an ICP. They reported that their clients typically have "no background, no idea" about ICP and request training. Among dozens of organizations they work with, only one had established an actual carbon fund and pricing strategy, and that organization was already "in a very, very advanced position." This indicates a clear need for organizational capacity building.

D. Early Adopters and Fast Followers

At the opposite end of the spectrum, P10 successfully led their organization to adopt SCC as a proxy carbon price, incorporating it into a multi-organizational software platform for mapping fossil fuel reduction plans. Going beyond standard SCC, they championed an "equity-weighted" SCC, committing to an even higher price – $261/ton in 2024 with a 1.5% annual escalation rate. This participant represented a major outlier in our sample, highlighting the significant variance in ICP attitudes among participants.

Similarly, P7's organization maintained a comparable proxy carbon price and imposed a flight carbon levy of $10 for domestic flights and $25 for international flights. Both P7 and P10 were subject to regulatory carbon pricing in their respective jurisdictions. Their decarbonization efforts included a carbon levy fund supporting small pilot projects. Moreover, both P7 and P10 belong to large, research-focused university systems known for progressive views on carbon pricing, potentially contributing to their advanced position in their "carbon journey."

P11, also from a large university system, had implemented a flight levy but did not consider it an ICP. They believed carbon pricing wouldn't work within their organization, preferring a staged decarbonization approach aligned with financial goals (e.g., reducing heat consumption). When asked about their conservative ICP stance, they described themselves as "fast followers." Other organizations expressed similar sentiments, describing themselves as needing "industry buy-in first" (P4) or being "middle of the pack" (P1). P4 stated, "if you require us to do [it], then we do it," suggesting responsiveness to external pressure rather than initiative.

Our interviews revealed that early adopters differ from followers and laggards through a combination of high climate awareness among key stakeholders (likely influenced by their research-oriented environments), climate-aligned ambitions, and compliance with climate-focused regulations. One participant summarized adoption barriers by describing ICP as "a political game rather than a scientific game" (P10). The varied perspectives within our university sub-population highlight nuances in ICP expertise, capacity, and external pressures. P11's organization faced fewer governmental carbon regulations than P7 and P10, suggesting regulatory compliance as an important incentive. P7 reinforced this: "People are leaning on the regulatory price now as the benchmark because we are looking at that as a real cost – real cost out of pocket."

E. Benchmarking and Anchoring Bias

Beyond the interactive SCC calculator, our technology probe included a landing page displaying carbon pricing references from prominent organizations like Microsoft, the World Bank, and the European ETS (Fig. 3). Nearly all participants expressed interest in this section, viewing it as a collection of benchmarks. P3 remarked: "I am so surprised, but like a good surprise, in the sense that, I am mentally stuck to a price for carbon from reports of many years ago, so seeing that value per ton was very, very interesting." Participants with existing ICPs quickly compared their prices against these benchmarks. P7, whose organization has a flight levy, noted: "Microsoft has $100 a ton for travel? Maybe we'll work our way up to that."

Participants' views on ICP benchmarking revealed strong sensitivity to industry peers' actions (as reported in CDP disclosure reports) and regulatory pressures. This suggests

vulnerability to external signals within a rapidly changing information landscape. P10 shared: "People had a fear of being so far out an outlier in benchmarking. I had a list of [our peers] and their numbers, and everybody was at $60. If you are doing something that's five times more than your peers on average, you better be able to articulate it very well and clearly."

The prominence of benchmarks raises the question: can SCC effectively serve as a new ICP benchmark? P6, though strongly opposed to using SCC as an ICP, suggested that SCC might provide an "anchoring bias." This psychological phenomenon, first theorized by Tversky and Kahneman, describes how decision-makers rely heavily on initial information [43]. In pricing contexts, exposure to a high "anchor price" makes subsequent prices seem more affordable by comparison. This points to the possibility that by exposing sustainability decision-makers to SCC, it may induce them to accept higher ICPs than what is currently prevailing.

Since most organizations are likely followers rather than leaders in ICP adoption, providing the "true" cost of carbon via SCC may serve as a reality check. As P10 stated: "I like the social cost of carbon because it is as factual as it can get. You can leave it alone. You do it. You find your discount rate, and every 5 years you revisit." While our study did not find strong evidence that SCC acts as an anchoring bias, it clearly can function as a high-watermark – a universal framework providing an aspirational, "true" carbon price regardless of industry or location. The participants, by adjusting the discount rate slider, effectively discerned the impacts of their pricing decisions while maintaining agency. This combination of benchmarking and agency, around which we constructed our technology probe, may provide the foundation for future research examining SCC's potential as an anchoring price for ICP.

V. Discussion

As Riedel et al. [17] show, current ICP practices lag the true price of carbon by a large margin. The latest calculations for the Social Cost of Carbon, our best measure yet of the "true cost" of carbon, is USD 185/tonne in 2020 US dollars at a discount rate of 2% [9]. This is very far from the carbon pricing initiatives of the vast majority of corporations worldwide. Here we address a few possible solutions towards narrowing this gap.

A. Capacity Building

For organizations, adopting an SCC-based ICP resembles other climate actions – requiring present investment for future returns benefiting both the organization and society. Given the substantial financial implications, all key stakeholders must approve this decision. Therefore, capacity building becomes critical: stakeholders need to be (i) educated on SCC fundamentals and adoption rationale, (ii) equipped with information tools to select appropriate price levels, and (iii) supported during implementation within their organization.

Capacity building must also anticipate and address potential operational and budgetary hurdles, such as who pays from which budget, which emissions scopes apply, or the paying of lip service by applying carbon pricing to only a very small share of emissions, all raised as concerns by participants in Sec. IV-B and Sec. IV-C. A possible capacity building step would be to set up an internal sustainability fund into which business units pay a carbon fee, and from which the units can apply for grants to finance their own carbon-reduction projects. This transforms the internal carbon price from a "tax" into an "investment vehicle," making it budget-neutral for proactive units. Another capacity building step can be the convening of cross-functional "carbon governance" committees that include the CFO, COO, the Head of Procurement, etc., to translate the technical SCC concepts (e.g., implications of the discount rate) into the specific language of each unit. For example, the Procurement team might use the SCC to develop a vendor carbon scorecard in making supply chain decisions, while the Finance team can update their internal rate of return formulae to account for carbon risk.

Organizations naturally occupy different positions on their carbon journeys. A small minority are early adopters setting the pace for peers, while most are just beginning and often engage industry consultants for guidance. Consequently, capacity building should also target these consultants, empowering them to effectively guide clients on SCC-based ICP adoption, thereby scaling these efforts. External mandates and initiatives effectively drive organizational action. As P2 observed (Sec. IV-C), many clients only consider ICP when completing the carbon pricing section on CDP questionnaires. CDP introduced internal carbon pricing questions in 2015 and expanded to a full section in 2018. If CDP were to incorporate SCC and SCC-based ICP questions in future questionnaires, this would likely stimulate capacity building within participating organizations. Taking this further, capacity building efforts directed at CDP and similar industry-coordinating entities could provide even greater leverage.

B. SCC as a Guidepost for Ambition

Most participants demonstrated sophisticated understanding of how organizational ICP practices impact society at large. Even those resistant to SCC's high dollar value recognized that pricing actions affect future generations. This recognition – that collective organizational actions impact the global commons and all of society, present and future – supports the notion that SCC can provide a comprehensive, unifying framework across different regions, jurisdictions, and industries. The SCC may serve as an *aspirational* metric for internalizing emissions' societal impact, offering a guidepost for target-setting and benchmarking within ICP applications by revealing the substantial gap between current pricing and actual needs. Integrating SCC into ICP strategies and broader climate initiatives could potentially mainstream adoption across diverse industries.

The technology probe revealed a notable anchoring effect when participants were exposed to the SCC through the probe's interface (Sec. IV-E). This points to an opportunity for sustainability leaders to strategically utilize the SCC as

a cognitive anchor during ICP deliberations. Even if an organization does not immediately adopt the full SCC price, positioning it as the primary reference point can shift the organizational discourse – or "Overton window" [44] – making higher, more impactful carbon prices appear more reasonable and achievable.

Currently, no formal ICP targets exist beyond broader carbon pricing regulations like carbon taxes and emission trading schemes. This may reflect carbon pricing's inherent flexibility in accounting for diverse organizational contexts and implementation complexity. However, SCC can establish ambition levels for ICP strategies through target-setting approaches – our interviews demonstrate general willingness to consider SCC as an upper bound for organizational carbon pricing. The Science Based Targets initiative (SBTi) exemplifies ambitious climate target-setting, providing a framework for companies to commit to science-based emissions reduction. It consists of multiple steps that include developing a target for their company in line with the SBTi's criteria, submitting the target for validation, communicate the target to their stakeholders, disclosing their emissions and tracking target progress annually [45]. A similar approach could facilitate realistic ICP adoption, including stakeholder collaboration on ICP targets, systematic procedures for increasing ICP levels over time, comparison with current SCC figures, and annual progress reporting.

Beyond target-setting, SCC can serve as a benchmarking metric. Many participants expressed interest in carbon pricing levels recommended or implemented by other institutions, with some noting how peers' actions influenced their own climate initiatives. This suggests openness to comparing ICP strategies against external benchmarks, with SCC potentially serving as one such benchmark.

However, mere SCC exposure may not sufficiently influence ICP levels. To enhance adoption, integrating SCC into existing initiatives, frameworks, and resources could help mainstream ICP ambition. While SBTi primarily focuses on emissions reduction targets, recognizing SCC as a benchmark and emissions reduction tool could assist with mainstreaming. This can be particularly welcome for organizations that consider themselves to be fast followers rather than early adopters (Sec. IV-D). Additionally, initiatives like the We Mean Business coalition [46], C40 [47], and UC3 (Second Nature) [48], representing numerous companies, sub-national governments, and academic institutions, could acknowledge SCC as an important metric connecting economic and societal carbon impacts for organizational adoption.

C. Same Same, But Different Interfaces for IAMs

For our technology probe, we leaned heavily into the idea of taking a complex economic model and simplifying it into a single ethical decision. In addition to confronting our participants with a single decision parameter, the discount rate, we also showed them a single SCC price, rather than a distribution over price that is typically produced by the IAMs.

We believe that this design choice served our study goals well, as participants who started with partial or no understanding of the SCC reported substantial increases in comprehension after interacting with the probe. Even so, the probe is not intended to be a prototype or blueprint for an ICP tool in a real-world organizational setting. To be a useful and effective decision support tool, it also must be seen as trustworthy. As the participants engaged with the probe, many sought additional details about the SCC model (Sec. IV-B), essentially asking "can we trust the model?". The probe's veil of simplicity might have inadvertently undermined trust in an otherwise scientifically rigorous model by appearing overly simplistic or opaque.

Designing a trustworthy system involving environmental data is known to require a nuanced approach towards transparency, data provenance, and other trust affordances [49]. Instead of a single IAM interface, a spectrum of interfaces may be necessary to cater to different audiences and objectives, e.g., convincing organizational leadership on adopting SCC for ICP, versus supporting an organization in choosing their ICP with an SCC-based benchmark. Within each interface design, a progressive disclosure strategy may be productively employed. Starting with a simple base case, users can choose to "open the black box" or "peek under the hood" by selectively and progressively drilling down on layers of model details, enable choices for additional model parameters, and verify outputs based on different model assumptions. We believe that a productive line of research inquiry can be pursued to connect the dots from trustworthy IAM interface design to organizational ICP capacity-building, SCC adoption, and beyond.

D. Future Work

This study has examined capacity building needs, target-setting applications, benchmarking opportunities, and interface design complexity regarding SCC adoption. Future research should explore several key directions. First, to leverage target-setting for SCC adoption, we need to understand how organizations can progress toward higher ICP levels and identify necessary tools, resources, and approaches. Second, research should investigate how organizational sector and size influence SCC incorporation into operations. Third, since SCC can help organizations internalize emissions' societal impacts and potentially become a benchmark for ambitious ICP strategies, studies on benchmarking efficacy in climate action and resulting environmental impacts are essential. Finally, more research is needed on the effectiveness of exposing stakeholders to SCC throughout the ICP decision-making process.

VI. Conclusion and Policy Implications

In this study, we developed a technology probe to engage with sustainability professionals, aiming to gain a deeper understanding of the factors influencing organizations to adopt internal carbon prices based on the Social Cost of Carbon. Our findings revealed that organizations are at various stages of their carbon reduction journeys. Some are enthusiastic early

adopters, others are eager fast followers, and some remain skeptical of internal carbon pricing altogether. Despite our small sample of sustainability practitioners, it is evident that there is a strong need for capacity building within organizations and for consultants, to support organizational decarbonization efforts.

Prevailing policy discourse considers the Social Cost of Carbon to be a useful tool for long-term policy discussions and guiding climate action frameworks, but limited in utility for setting corporate climate strategies. However, our study points to an opportunity to bring SCC into boardroom discussions on internal carbon pricing. Many of the sustainability professionals in our study could readily connect SCC with organizational responsibility and leadership, and demonstrated openness to its adoption.

We see a promising parallel in the momentum around the adoption of science-based targets by corporations over the past decade. Just as corporations have been willing and eager to set emission reduction targets that are aligned with the 2°C or 1.5°C goals of the Paris Agreement, there can be similar support for setting internal carbon prices that are aligned with the science-based SCC. In other words, the SCC can serve as an ICP benchmark and a guidepost for ambition that can be embraced by corporations.

Indeed, the SBTi and other complementary initiatives can serve as catalysts for SCC uptake by setting reporting targets for ICP where organizations can use the SCC as a reference and ratchet up their ambitions over time. These same initiatives can also serve as vehicles for scaling up capacity-building efforts, by educating their members on the fundamentals of SCC, developing information tools to help them choose the appropriate price levels over time, and support them with deployment and implementation within their organizations.

Through our technology probe, we discovered that framing the SCC purely as a function of the discount rate makes it a simple yet robust indicator of perceived climate responsibility at an organizational level. Further work is needed to determine how this can be effectively implemented as a useful method for setting an internal carbon price. Our tool represents an initial exploration of various ways to interface with the models that produce the SCC, and we will likely need a range of such tools to assess their usefulness to different users in different decision contexts.

Methodologically, we hope that the technology probe method, as a qualitative research approach that introduces existing or speculative technologies into real-world settings with relevant stakeholders, can be more widely adopted in corporate and other organizational policy settings. In addition to gathering insights about users' needs, behaviors, and attitudes, the probes can also serve as boundary objects in policy design, facilitating communication between diverse stakeholders, and help identify the social and technical aspects that need to be addressed in policy frameworks.

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REFERENCES

[1] J. Rockström, O. Gaffney, J. Rogelj, M. Meinshausen, N. Nakicenovic, and H. J. Schellnhuber, "A roadmap for rapid decarbonization," *Science*, vol. 355, no. 6331, pp. 1269–1271, 2017.

[2] N. Bartlett, T. Coleman, and S. Schmidt, "Putting a price on carbon: The state of internal carbon pricing by corporates globally," *Carbon Disclosure Project (CDP) North America: New York, NY, USA*, 2021.

[3] W. Nordhaus, "How fast should we graze the global commons?" *The American Economic Review*, vol. 72, no. 2, pp. 242–246, 1982.

[4] D. Anthoff, "Social cost of carbon: Equity weighting," Ph.D. dissertation, Masters thesis, Oxford University. 86, 90, 2004.

[5] C. Hope, "Discount rates, equity weights and the social cost of carbon," *Energy Economics*, vol. 30, no. 3, pp. 1011–1019, 2008.

[6] W. D. Nordhaus, "An optimal transition path for controlling greenhouse gases," *Science*, vol. 258, no. 5086, pp. 1315–1319, 1992.

[7] R. Tol and D. Anthoff, "The climate framework for uncertainty, negotiation and distribution (fund), version 1.5," *Institute for Environmental Studies, Vrije Universiteit, Amsterdam*, 1996.

[8] C. Hope, J. Anderson, and P. Wenman, "Policy analysis of the greenhouse effect: an application of the page model," *Energy Policy*, vol. 21, no. 3, pp. 327–338, 1993.

[9] K. Rennert, F. Errickson, B. C. Prest, L. Rennels, R. G. Newell, W. Pizer, C. Kingdon, J. Wingenroth, R. Cooke, B. Parthum *et al.*, "Comprehensive evidence implies a higher social cost of co2," *Nature*, vol. 610, no. 7933, pp. 687–692, 2022.

[10] A. R. Barron and B. J. Parker, "Selecting an internal carbon price for academic institutions," *Smith College: Northampton, MA, USA*, 2018.

[11] V. Thomas, C. Remy, M. Hazas, and O. Bates, "Hci and environmental public policy: Opportunities for engagement," in *Proceedings of the 2017 CHI conference on human factors in computing systems*, 2017, pp. 6986–6992.

[12] C. Bremer, B. Knowles, and A. Friday, "Have we taken on too much?: A critical review of the sustainable hci landscape," in *Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems*, 2022, pp. 1–11.

[13] A. Sampatsing, S. Vos, E. Beauxis-Aussalet, and J. Bogner, " How Do Companies Manage the Environmental Sustainability of AI? An Interview Study About Green AI Efforts and Regulations ," in *2025 11th International Conference on ICT for Sustainability (ICT4S)*. Los Alamitos, CA, USA: IEEE Computer Society, Jun. 2025, pp. 121–132. [Online]. Available: https://doi.ieeecomputersociety.org/10.1109/ICT4S68164.2025.00021

[14] Y. W. Park and Y. J. Park, "Csr advocacy and organizational change: Perspectives from within the firm," in *Corporate Social Responsibility and Entrepreneurship for Sustainability: Leading in the Era of Digital Transformation*. Springer, 2021, pp. 51–69.

[15] "Open knowledge repository," https://openknowledge.worldbank.org/entities/publication/58f2a409-9bb7-4ee6-899d-be47835c838f, (Accessed on 05/20/2024).

[16] B. Zhu, C. Xu, P. Wang, and L. Zhang, "How does internal carbon pricing affect corporate environmental performance?" *Journal of Business Research*, vol. 145, pp. 65–77, 2022.

[17] F. Riedel, G. Gorbach, and C. Kost, "Barriers to internal carbon pricing in german companies," *Energy Policy*, vol. 159, p. 112654, 2021.

[18] N. Bento and G. Gianfrate, "Determinants of internal carbon pricing," *Energy Policy*, vol. 143, p. 111499, 2020.

[19] L. J. Ferreira, L. P. Dias, and J. Liu, "Adopting carbon pricing tools at the local level: A city case study in portugal," *Sustainability*, vol. 14, no. 3, p. 1812, 2022.

[20] A. Finley, W. He, H. Huang, and C. Hon, "Analyzing the effectiveness of carbon pricing instruments in reducing carbon emissions in major asian economies," *Sustainability*, vol. 16, no. 23, p. 10542, 2024.

[21] R. S. Pindyck, "Climate change policy: what do the models tell us?" *Journal of Economic Literature*, vol. 51, no. 3, pp. 860–872, 2013.

[22] P. Wang, X. Deng, H. Zhou, and S. Yu, "Estimates of the social cost of carbon: A review based on meta-analysis," *Journal of cleaner production*, vol. 209, pp. 1494–1507, 2019.

[23] S. Evans, R. Pidcock, and S. Yeo, "Social cost of carbon - q and a," https://www.carbonbrief.org/qa-social-cost-carbon/, Feb 2017, accessed on April 2024.

[24] F. Dennig, M. B. Budolfson, M. Fleurbaey, A. Siebert, and R. H. Socolow, "Inequality, climate impacts on the future poor, and carbon prices," *Proceedings of the National Academy of Sciences*, vol. 112, no. 52, pp. 15 827–15 832, 2015.

[25] N. A. of Sciences, Medicine, D. of Behavioral, B. on Environmental Change, and C. on Assessing Approaches to Updating the Social Cost of Carbon, *Valuing climate damages: updating estimation of the social cost of carbon dioxide*. National Academies Press, 2017.

[26] B. C. Prest, K. Rennert, R. G. Newell, and J. Wingenroth, "Social cost of carbon explorer," 2022, accessed: 2025-01-24. [Online]. Available: https://www.rff.org/publications/data-tools/scc-explorer/

[27] U.S. Environmental Protection Agency, "Report on the social cost of greenhouse gases: Estimates incorporating recent scientific advances," 2023.

[28] Umweltbundesamt, "Gesellschaftliche kosten von umweltbelastungen," 2024, accessed: 2025-01-24. [Online]. Available: https://www.umweltbundesamt.de/daten/umwelt-wirtschaft/gesellschaftliche-kosten-von-umweltbelastungen#methodik-zur-schtzung-von-klimakosten-

[29] T. Carleton and M. Greenstone, "Updating the united states government's social cost of carbon," *University of Chicago, Becker Friedman Institute for Economics Working Paper*, no. 2021-04, 2021.

[30] E. Vaughan, "University of california implementation of a social cost of carbon," University of California, Santa Cruz, Tech. Rep., 2022.

[31] H. Hutchinson, W. Mackay, B. Westerlund, B. B. Bederson, A. Druin, C. Plaisant, M. Beaudouin-Lafon, S. Conversy, H. Evans, H. Hansen *et al.*, "Technology probes: inspiring design for and with families," in *Proceedings of the SIGCHI conference on Human factors in computing systems*, 2003, pp. 17–24.

[32] H. Tobiasson, A. Hedman, and S. Yngve, "Still at the office: designing for physical movement-inclusion during office work," in *ICH'14 XIII Brazilian Symposium on Human Factors in Computer Systems, 27th to 31th October 2014, Brazil*, 2014.

[33] N. Merrill and J. Chuang, "From scanning brains to reading minds: Talking to engineers about brain-computer interface," in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*, 2018, pp. 1–11.

[34] E. Jones-Garcia, S. Bakalis, and M. Flintham, "Consumer behaviour and food waste: understanding and mitigating waste with a technology probe," *Foods*, vol. 11, no. 14, p. 2048, 2022.

[35] M. V. A. Lindrup, M. B. Skov, and D. Raptis, "Between egoism and altruism: A mixed-methods study of reflections about energy use in the life cycle of high preference grocery products," in *Nordic Human-Computer Interaction Conference*, 2022, pp. 1–10.

[36] S. Rodgers, B. Ploderer, K. Vella, and M. Brereton, "Phenology probes: Exploring human-nature relations for designing sustainable futures," in *Proceedings of the 34th Australian conference on human-computer interaction*, 2022, pp. 216–228.

[37] A. K. Clear, S. Mitchell Finnigan, P. Olivier, and R. Comber, "Thermokiosk: Investigating roles for digital surveys of thermal experience in workplace comfort management," in *Proceedings of the 2018 CHI conference on human factors in computing systems*, 2018, pp. 1–12.

[38] S. Snow, M. Oakley, and M. Schraefel, "Performance by design: supporting decisions around indoor air quality in offices," in *Proceedings of the 2019 on Designing Interactive Systems Conference*, 2019, pp. 99–111.

[39] K. Arrow, M. Cropper, C. Gollier, B. Groom, G. Heal, R. Newell, W. Nordhaus, R. Pindyck, W. Pizer, P. Portney *et al.*, "Determining benefits and costs for future generations," *Science*, vol. 341, no. 6144, pp. 349–350, 2013.

[40] W. D. Nordhaus, "A review of the stern review on the economics of climate change," *Journal of economic literature*, vol. 45, no. 3, pp. 686–702, 2007.

[41] J. Guo, C. J. Hepburn, R. S. Tol, and D. Anthoff, "Discounting and the social cost of carbon: a closer look at uncertainty," *environmental science & policy*, vol. 9, no. 3, pp. 205–216, 2006.

[42] R. S. Tol, "Social cost of carbon estimates have increased over time," *Nature Climate Change*, vol. 13, no. 6, pp. 532–536, 2023.

[43] A. Tversky and D. Kahneman, "Judgment under uncertainty: Heuristics and biases: Biases in judgments reveal some heuristics of thinking under uncertainty." *science*, vol. 185, no. 4157, pp. 1124–1131, 1974.

[44] J. G. Lehman, *'The Overton Window': Made in Michigan*. Mackinac Center for Public Policy, 2010.

[45] "How it works - science based targets initiative," https://sciencebasedtargets.org/how-it-works, (Accessed on 05/20/2024).

[46] "Home - we mean business coalition," https://www.wemeanbusinesscoalition.org/, (Accessed on 05/20/2024).

[47] "C40 cities - a global network of mayors taking urgent climate action," https://www.c40.org/, (Accessed on 05/20/2024).

[48] "University climate change coalition (uc3) - second nature," https://secondnature.org/initiative/uc3-coalition/, (Accessed on 05/20/2024).

[49] L. Thornton, B. Knowles, and G. Blair, "Fifty shades of grey: in praise of a nuanced approach towards trustworthy design," in *Proceedings of the 2021 ACM Conference on Fairness, Accountability, and Transparency*, 2021, pp. 64–76.