SMARTargets™

A Methodology for Grounded and Actionable Climate Targets Aligned with Global Goals

SMARTARGETS METHODOLOGY INDEPENDENT SCIENTIFIC PEER REVIEW COMMENTS AND SMARTARGETS' SCIENCE TEAM RESPONSES

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SMARTargets Methodology Independent Scientific Peer Review Comments and Responses

Introduction

This document communicates the scientific peer review feedback EPRI received on the draft SMARTargets Methodology. Independent, scientific peer review of the SMARTargets Methodology is an essential and critical component of the methodology's development process and scientific credibility. To reliably inform decisions, it is imperative that the methodology be well-grounded in the relevant science and applying that science appropriately. For the peer review, EPRI assembled a panel of independent experts at the frontier of the science relevant to this topic. The panelists needed to have the required and appropriate expertise, credibility, objectivity, and absence of conflicts of interest. The resulting scientific panel included the following experts:

- **Professor Max Brown,** Colorado School of Mines: Electric sector and energy system modeler and formerly with the U.S. National Renewable Energy Laboratory (NREL).
- **Dr. Vaibhav Chaturvedi,** Council of Energy, Environment, and Water of India: Long-term modeling and carbon markets expertise.
- **Professor Celine Guivarch,** Ecole des Ponts ParisTech and CIRED: Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report Working Group III Lead Author on global pathways and societal impacts, as well as global transitions and climate management modeler and expert.
- **Dr. Stephane Hallegate**, World Bank: Chief climate economist and lead on country transition analyses.
- **Professor Thomas Heller,** Stanford University: Finance climate risk assessment expert.
- **Professor Robert Lempert,** RAND: Decision-making under uncertainty expert.
- **Professor Granger Morgan,** Carnegie Mellon University: Decarbonization, power sector, scenario, and uncertainty analysis expert.
- **Professor Roberto Schaeffer,** Federal University of Rio de Janeiro: IPCC Sixth Assessment Report Working Group III Coordinating Lead Author on global pathways, as well as global and Brazil transitions and decarbonization modeler and expert.
- **Professor David Victor**, University of California San Diego: Climate policy and legal expert.

The independent scientific peer review process is a key milestone, and unique characteristic, of the SMARTargets Methodology's development process. Overall, the methodology has been developed with broad and constructive input from stakeholders, industry technical experts, the scientific community, and the general public. In addition to the scientific peer review, methodology development engagement activities have included a stakeholder advisory group of key stakeholders from the investment, environmental, regulatory, consulting, and non-financial corporate communities; industry subject matter experts; a public comment process (ongoing); and, public and stakeholder outreach events. We are grateful to all for the substantive input they have provided that has improved the methodology's grounding and usefulness to companies and stakeholders.

Background

SMARTargets (https://msites.epri.com/smartargets) is an EPRI research initiative that is developing a new methodology to help companies worldwide set scientifically grounded and actionable greenhouse gas (GHG) emissions targets aligned with science and the Paris Agreement temperature goal. Over the last

year, EPRI has developed a draft methodology, which includes identifying scientific and operational requirements from assessment of the relevant science, to engagement with companies and stakeholders and operationalization of the identified requirements into a draft methodology.

EPRI is a non-advocacy, nonprofit, scientific research organization with a public benefit mandate to inform dialogue. EPRI has extensive, recognized expertise in, among other things, climate scenarios, climate risk assessment, societal transitions, reporting, disclosure, and stakeholder engagement, as well as recognized research community and scientific leadership and participation in activities such as the IPCC, U.S. National Climate Assessment, U.S. National Academies of Science, Engineering, and Medicine, and the Task Force on Climate-related Financial Disclosures (TCFD) Advisory Group for Scenario Guidance.

The SMARTargets Initiative is motivated by recognition that important decision-making issues and on-the-ground realities, such as uncertainty, differences in decarbonization opportunities, and multiple social objectives, need to be explicitly incorporated into corporate GHG target decision-making and low-carbon transition planning.

The initial focus of SMARTargets is development of a methodology for electric power, gas, and transmission and distribution utilities worldwide; however, the methodology will be helpful to other sectors and types of companies as a template.

Peer review process

Scientific integrity was paramount in the peer review process—from development of the panel, to execution of the review, to communications of the feedback received and our responses. The key pieces of the process are described below.

Reviewer selection

The peer review panelists needed to have the required and appropriate expertise, credibility, objectivity, and absence of conflicts of interest. Specifically, a panel with expertise in the following relevant scientific disciplines was sought, and assembled:

- Potential global transitions,
- Potential sub-global transitions,
- Risk assessment and management,
- Decision-making under uncertainty,
- Country decarbonization and risk assessment,
- Company planning and risk management,
- Power and energy system modeling, and
- GHG accounting.

In addition to the expertise listed above, the panel selection sought international perspectives. The final panel includes perspectives from Latin America, Europe, Asia, and North America and a prominent international multi-lateral organization. Each reviewer signed an agreement for confidentiality and confirmation of their independence and absence of conflicts of interest.

Peer review charge

Reviewers were provided with a review charge set of instructions and questions, as well as the draft methodology, scientific foundations, appendices, and reporting template. In the charge, reviewers were asked to provide comments as individuals and respond to the questions as possible and practical. Reviewers were not required to respond to each charge question, nor were they limited to the charge questions. The questions were provided simply to help reviewers focus on areas where their feedback would be particularly valuable. The charge questions sought input on the scientific foundations, the methodology, implementation and outputs, and other general aspects. The specific charge questions are presented in Box 1. Note that the draft methodology at that time was described in terms of three components. Thus, there are charge questions referring to each of these components.

Peer review implementation

An initial meeting initiated the review—introducing the panel to each other, introducing the draft methodology, and discussing the review process. Reviewers were then provided with the following set of draft SMARTargets materials: Methodology, Scientific Foundations, Company Reporting Template, and Appendix with illustrative implementation examples. Throughout the review process, reviewers were given the opportunity to ask questions of the methodology developers.

Reviewer responses to the charge varied. Some responded to each charge question, others responded more generally with their own structure, and some did not provide feedback on aspects of the methodology. Follow-on calls were arranged with individual reviewers when needed to clarify specific comments, address questions, and encourage additional feedback on the methodology.

Summary of major issues and revisions

This section summarizes the major issues and revisions identified from the scientific peer review feedback, as well as the draft review feedback from the Stakeholder Advisory Group, utility technical experts, and EPRI subject matter experts.

Of course, additional important more detailed comments were received, many of which are represented in the scientific peer reviewer feedback found below. These comments were also given serious consideration during the revision process; however, they are too numerous to list. The major issues and revisions noted here are provided to help the reader understand the larger changes to the methodology, scientific foundations, and other supporting materials.

Major issues

The following are the major issues identified from the comments received:

- Improve accessibility and volume management of the methodology and other information provided,
- Clarify science foundations insights, including implications,
- Enhance illustrative examples to help communicate and understand implementation,
- Improve implementability of the methodology,
- Clarify and further justify emissions reductions companies evaluate and their alignment assessment, and
- Clarify validation and verification discussion (e.g., internal controls, validation level, proprietary information).

BOX 1 Peer Review Charge Questions

On the Scientific Foundations: The draft SMARTargets Methodology is based on assessment of the science relevant to company-level GHG target setting and potential transitions. The Science Foundations document identifies key observations from assessing that science and then derives scientific and operational requirements for the SMARTargets Methodology.

- Question 1: Are we fully considering the science relevant to company GHG target setting, and if not, what specific additions should be incorporated?
- Question 2: Do you agree with the key scientific observations and are they adequately supported? Do you have suggestions for additional key scientific observations or scientific support that you think are important to company GHG target setting conversations and methodologies?
- Question 3: Do you agree with the methodology scientific and operational requirements derived from the assessment and are they adequately supported?

On the SMARTargets Methodology: The draft SMARTargets Methodology consists of 3 components that are designed to help companies evaluate and set ambitious and actionable GHG targets and strategies that are aligned with the Paris Agreement and science, as well as help companies assess and manage low-carbon transition risk.

- Question 4: Are the components of the methodology and the outputs adequately described and understandable for company implementation and external stakeholder comprehension?
- Question 5: Are the components and steps appropriately grounded and well-defined for company implementation and for creating meaningful information for informing company strategy and communicating with external stakeholders?
- Question 6: In Component 1, the methodology is designed to provide three types of alignment with the Paris Agreement. Are the required aspirational GHG targets aligned with the Paris Agreement and sufficiently justified? Also, do they make sense as a starting point for company assessment, strategy development, and stakeholder engagement? Are the other types of Paris Agreement alignment relevant and sufficiently justified? Is the required evaluation of the Aspirational Targets, enabling conditions, and Qualified Targets without enabling conditions a useful and scientifically justified approach for companies?
- Question 7: In Component 2, practical issues relevant to company GHG target setting and achievement are raised. Is the scientific justification provided sufficient to support consideration of these issues and to potentially not set targets for some emissions categories?
- Question 8: In Component 3, is the proposed company-specific transition risk analysis scientifically appropriate for helping companies identify transition possibilities, uncertainty, risks, enabling conditions, and risk management strategies?

On SMARTargets' Implementation and Outputs: The SMARTargets Methodology is designed to be a standardized process that provides transparency and comparability in steps, analyses, decisions, and outputs, producing a substantial amount of information regarding analyses, targets, strategy, and risk management. The methodology is to be implemented by companies to inform company strategic planning and stakeholders on potential low-carbon transitions, targets and strategies, and risks and risk management; and Appendix B provides implementation examples to help elucidate the steps, inputs, outputs, and the teams involved. Furthermore, the draft SMARTargets Reporting Template illustrates the specific outputs that are possible and proposed from implementing the methodology.

- Question 6: Will the methodology produce meaningful information for utilities and stakeholders on potential company transitions, targets, strategies, and enabling conditions, as well as risks and risk management strategies?
- Question 7: Will the standardized process provide sufficient transparency and comparability that helps stakeholders understand and evaluate targets and strategies for individual companies as well as across companies?

On other general aspects: The draft SMARTargets Methodology should be implementable by company practitioners and expert consultants, learn from other relevant experiences (e.g., resource planning), and be understandable to stakeholders and the public.

- Question 8: How effective is the current document structure? Are there any sections that you feel could be revised for better clarity and/or flow?
- Question 9: How does this methodology compare with other frameworks for company-level GHG target setting and assessment you may have encountered?
- Question 10: In addition to the feedback you have provided thus far, are there other elements of the SMARTargets Methodology that you think could be enhanced to further strengthen the methodology?
- Question 11: Beyond what you may have already provided, do you have additional suggestions regarding references or resources that could be considered and suggestions for how they could be considered?

Major revisions

The following are the major revisions in response to the major issues and other comments received:

- **Document structure** – To make the methodology more readily understandable and accessible, the structure was completely revised to, among other things, convey the methodology and its unique value earlier and provide a more logical structure regarding details – steps, communications, justification, and supporting materials.

- **Methodology structure** – To better communicate the scope of the methodology and its steps, the structure was completely revised, shifting to a linear, and more intuitive, flow with eight clear steps that included some reordering of implementation activities from the previous draft.

- **Science foundations:**
  - To facilitate communications and use, the scientific requirements for a science-based methodology were broken into two types of requirements: requirements for science-based alignment with a global average temperature, and requirements for science-based decision-making.
  - To clarify the role of science and facilitate more productive discussions on alignment with science and the Paris Agreement, the discussion was revised to explicitly differentiate alignment with science from alignment with the Paris Agreement.
  - To address comments regarding vague and overlapping insights and opportunities for strengthening points, the Key Scientific Observations were consolidated and their company target setting relevance was strengthened. Additional citations were also added and the global pathway limitations discussion was revised for consistency with the methodology's use of global pathways.

- **Illustrative examples –** To improve their value and usability, the illustrative examples were enhanced in a number of ways, including being more explicit about company decision use of the results, adding additional types of illustrative results, and clarifying the pathways for achieving aspirational and qualified targets.

- **Implementability –** The methodology was revised in the following ways to improve its implementability:
  - Being more explicit about the implementation requirements to help companies prepare,
  - Improving guidance on what needs to be done regarding emissions categories,
  - Clarifying scenario design concept and discussion,
  - Revising modeling requirements to facilitate near-term use of current capabilities (with economy-wide changes considered via exogenous sensitivities) while encouraging long-term use of regional economy-wide modeling,
  - Providing starter information for some input decisions to facilitate conversation, as well as to be considered as options, and
  - Asking companies to characterize which outcomes are risky/challenging and communicate the metrics used.

Peer reviewer comments and responses

Peer review feedback overview

Overall, the feedback from the scientific peer reviewers was positive, with individual suggestions for strengthening elements of the methodology and improving communications, accessibility, and implementation. Below are quotes indicating the supportive nature of the comments across reviewers. Each reviewer's specific feedback is provided in the next section along with the SMARTargets scientific team's responses.

- ***Professor Maxwell Brown**: "Overall, this work makes an excellent contribution to the ongoing discussion and application of scientific principles to company-level greenhouse gas reporting. The guidelines and recommendations provide a well-structured, actionable starting point for companies seeking to align their pollution reduction objectives with the overarching goals of the Paris Agreement."*

- ***Professor David Victor**: "The effort is far ranging, complex and thoughtful…we really need to hammer home the key point—the "science" doesn't say a single pathway and realistic pathways require attention to a wide range of contingencies."*

- ***Professor Robert Lempert:** "The SMARTargets methodology is a valuable and much-needed contribution. The draft report describes the methodology as science-based and seeking to align with the Paris Agreement. The methodology does meet these expectations."*

- ***Professor Roberto Schaeffer**: "All components and steps are absolutely grounded and well-defined for company implementation and for creating meaningful information for informing and supporting company strategy and communicating with all external stakeholders. The documentation provided is extremely robust in all aspects."*

- ***Dr. Stephane Hallegate**: "The report does a great job at summarizing knowledge and provides an excellent review of what we can learn from global modeling exercises. Supporting firms and utilities in using these insights in their own planning and target-setting process will be extremely useful, and the report is a great step in that direction."*

- ***Professor Thomas Heller**: "I have lots of questions and comments, as well as plaudits for your focus, on the risk analytics."*

- ***Dr. Vaibhav Chaturvedi**: "…it is clear to me that once it is socialized it will be a useful contribution to advancing not just target setting (that many companies are already doing) but in terms of advancing real understanding of what companies need to actually deal with while moving towards the targets or even while setting targets."*

While most of the reviewers reviewed the Methodology and the Scientific Foundations document and provided positive comments, one reviewer expressed more concern. However, this reviewer only reviewed the Scientific Foundations document. Furthermore, as discussed in our responses below, many of the reviewer's concerns were addressed by the methodology. This reviewer's feedback expressed concern about potential bias towards less ambitious targets. This feedback was helpful in highlighting the need to revisit communications of the scientific assessment. The reviewer eventually provided a few

suggestions for the methodology, recommending that we clarify how uncertainty is not necessarily a reason for less ambition, and when discussing targets and considering difficulties and barriers, ensuring balanced discussion about the possibility of more and less ambitious targets.

Professor Max Brown, Colorado School of Mines

Note: Professor Brown provided high-level feedback ("Main feedback") as well as responses to the charge questions ("Responses to specific prompts"). Professor Brown's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

Main feedback

Overall, this work makes an excellent contribution to the ongoing discussion and application of scientific principles to company-level greenhouse gas (GHG) reporting. In short, the authors should be proud of what they've accomplished as it is no small feat. The guidelines and recommendations provide a well structured, actionable starting point for companies seeking to align their pollution reduction objectives with the overarching goals of the Paris Agreement (PA). The SMARTargets framework offers the broader corporate and policymaking community a comprehensive set of considerations and structured plans for developing meaningful and effective decarbonization strategies.

Response: Thank you for the overall comment and encouraging remarks.

Given that my primary focus rests in computational modeling, the following suggestions will focus primarily on the recommendations related to economic and energy systems modeling, beginning page 17 of the February 2025 draft. My comments and recommendations on the modeling aspects are as follows:

• The endorsement of economy-wide modeling is highly commendable, as it aligns with prevailing, state-of-the-art approaches. Current research underscores the limitations of static boundary conditions in energy systems modeling as they fail to account for the broader, sector-wide transformations occurring across the economy. The electricity sector, in particular, exerts far-reaching influences by supplying energy both directly to households and indirectly to all commercial enterprises, making an integrated approach essential.

Response: Thank you for sharing these technical points on the value of economy-wide modeling. We have refined the modeling requirements discussion to strengthen our recommendation for regional economy-wide modeling.

• The emphasis on intertemporal optimization (i.e., perfect foresight) is warranted and standard practice across many different industries but the pros and cons should be presented. The representation incorporates future, 'expected' market conditions; however, in doing so, it grants perfect information to the modeled decision-maker(s). While having a long-term, foresighted perspective is undoubtedly valuable for planning, it is equally important to recognize the limitations of assuming that market participants possess perfect knowledge of future conditions. A more balanced approach would be to consider multiple foresight specifications, including myopic, rolling-horizon (windowed foresight), and fully intertemporal models, in order to present a range of outcomes under different assumed market representations.

Response: Good suggested addition. We have added discussion on intertemporal optimization, including helping readers understand that the approach is designed to acknowledge that expectations about future markets are relevant to current investment decisions and that modeling different conditions is a way to capture expectations about different potential future markets.

• The current modeling recommendations do not address how distributional impacts should be considered within the framework. Specifically, there is no mention of how potential economic impacts across different income groups should be incorporated—an aspect that is particularly relevant to stakeholders categorized under 'Other Utility Teams' in Figure 12. A valuable enhancement would be to introduce language around disaggregating model outputs to assess household-level net economic welfare with a key focus on energy affordability.

Response: Good suggestion. We have added discussion of secondary analyses opportunities, including evaluating distributional implications relevant to equity and just transition priorities.

• Building on the previous point, the modeling framework also does not explicitly discuss how to evaluate potential changes to key business indicators such as company-specific profit and rates of return on assets/investments. These factors are crucial for businesses seeking to understand the financial implications of their decarbonization efforts. While no model can fully predict market dynamics with certainty, incorporating mechanisms to estimate these impacts—even in a stylized manner—would be an essential improvement.

Response: Good point. Given the state-of-the-art of current economy-wide and system modeling, we see this as another type of secondary analysis that could be implemented using the primary transition analysis as inputs for evaluating changes to business indicators. The methodology also stresses that companies are welcome to develop additional metrics as suits their needs. In general, meaningful climate risk metrics is an important area of discussion and development on which EPRI is facilitating dialogue.

• The modeling recommendations would be strengthened by including a discussion on how companies might parameterize and customize the costs and performance attributes of both existing and future energy technologies.

Response: Good idea. The discussion of technology cost and performance assumptions for defining Fuller/More Limited encourages companies to use published sources while also ensuring that the specifications are meaningful plausible extremes for them. The scenario analysis revision process is also an opportunity for tuning these parameters after reviewing preliminary results.

• Finally, and I say this as a modeler myself, it is important to recognize that detailed computational modeling is not always necessary or practical. Consider the case of a small electricity utility serving a single municipality—while their decarbonization efforts are undoubtedly valuable, the market-based repercussions of their actions may not extend beyond secondary or tertiary effects. Consequently, the authors should provide guidance on when full-scale modeling is warranted versus when simpler, "backof-the-envelope"calculations would be sufficient for decision-making.

Response: Helpful point. We have a discussion acknowledging that some sources will not require full-scale modeling analysis and the methodology allows for simpler approaches. We will continue to explore ways to consider differences in companies, including size, that could imply different analytical effort. The concept and methodology steps, however, would be identical regardless of the company size.

The current framework is complete for energy supply and conversion companies. To enhance the applicability of the framework, the authors could consider expanding the methods and discussion to more comprehensively incorporate strategies for major energy-consuming industries, such as industrial manufacturing. This approach involves integrating decarbonization considerations for various emitting

sectors—whether they operate upstream, midstream, or downstream relative to energy production—and would significantly enhance the framework's breadth. For example, how might a manufacturing company develop and implement a strategy to reduce its embedded emissions in alignment with achieving PA goals? Notably, this would require a considerable expansion of the current work, and it may be more practical to introduce such refinements in a future iteration, i.e. a 'SMARTargets 2.0' release.

Response: Thank you for recognizing the broader applicability of SMARTargets and encouraging us to consider applications beyond utilities. For now, we are trying to keep the scope manageable. As such, we have highlighted the applicability of the SMARTargets approach as a template for other sectors and types of companies, noting the opportunity to expand its application, as well as the need for customization given differences in uncertainties, markets, and abatement opportunities.

Responses to specific prompts

Following are brief responses to the questions posed in the Review Guidance Document.

Question 1: Are we fully considering the science relevant to company GHG target setting, and if not, what specific additions should be incorporated?

For energy utilities: Yes, I believe you have covered all the bases necessary for GHG target setting in a cohesive and succinct presentation.

Response: Great!

Question 2: Do you agree with the key scientific observations and are they adequately supported? Do you have suggestions for additional key scientific observations or scientific support that you think are important to company GHG target setting conversations and methodologies?

Generally, yes. However, the discussion on Pg 12 could be expanded to include the ability for companies to trade both with other sectors and across time/space. For example, the implementation of banking and borrowing of emissions credits reduces costs substantially. Further, being able to implicitly incentivize intra- and crosssectoral decarbonization through company trading substantially reduces costs. Thus, a discussion on flexibility 'levers' is warranted.

Response: Thank you for the support! Good idea to enhance the discussion of cooperative mechanisms as enabling conditions, as well as sources of flexibility.

Question 3: Do you agree with the methodology scientific and operational requirements derived from the assessment and are they adequately supported?

Yes - to the best of my knowledge, the authors have covered all necessary requirements.

Response: Terrific!

Question 4: Are the components of the methodology and the outputs adequately described and understandable for company implementation and external stakeholder comprehension?

Yes - however, one potential future product would be a more approachable presentation of the work such as a video, infographic, and/or set of succinct instructions.

Response: Great! Thank you also for the suggestions for improving access and approachability. We have revised the draft methodology document significantly to improve accessibility and understanding, including developing graphics that more readily communicate. Your suggestions

for using other medium are very useful. We will consider those as options for expanding our outreach and education efforts with the final methodology.

Question 5: Are the components and steps appropriately grounded and well defined for company implementation and for creating meaningful information for informing company strategy and communicating with external stakeholders?

Overall, the authors have done an incredible job creating a product that is actionable while still retaining a general perspective for energy supply and conversion companies. One major point of value that hasn't been emphasized is the presentation and capturing of risk across a wide range of potential outcomes.

Response: Thank you for the positive feedback! We have enhanced the discussion regarding the methodology's risk assessment and management value.

Question 6: In Component 1, the methodology is designed to provide three types of alignment with the Paris Agreement. Are the required aspirational GHG targets aligned with the Paris Agreement and sufficiently justified? Also, do they make sense as a starting point for company assessment, strategy development, and stakeholder engagement? Are the other types of Paris Agreement alignment relevant and sufficiently justified? Is the required evaluation of the Aspirational Targets, enabling conditions, and Qualified Targets without enabling conditions a useful and scientifically justified approach for companies?

I am (admittedly) not familiar enough with the Paris Agreement to adequately address this question.

Response: Thank you for your candor.

Question 7: In Component 2, practical issues relevant to company GHG target setting and achievement are raised. Is the scientific justification provided sufficient to support consideration of these issues and to potentially not set targets for some emissions categories?

Yes - ideally, the company itself would define the emissions categories that seem realistic to cover and to define achievable goals.

Response: We agree. The newest draft further emphasizes the importance of companies assessing their circumstances to identify emissions categories for which they can pursue actionable targets and strategies.

Question 8: In Component 3, is the proposed company-specific transition risk analysis scientifically appropriate for helping companies identify transition possibilities, uncertainty, risks, enabling conditions, and risk management strategies?

Yes - considerations here generally align with the modeling comments mentioned prior.

Response: Great!

Question 9: Will the methodology produce meaningful information for utilities and stakeholders on potential company transitions, targets, strategies, and enabling conditions, as well as risks and risk management strategies?

Absolutely.

Response: Fantastic! Thank you for the feedback.

Question 10: Will the standardized process provide sufficient transparency and comparability that helps stakeholders understand and evaluate targets and strategies for individual companies as well as across companies?

As long as the reporting is presented transparently to the public, yes.

Response: We have stressed the transparency value of the approach. The standardized reporting template, in particular, will result in significant transparency, enhanced understanding and communications, and improved dialogue.

Question 11: How effective is the current document structure? Are there any sections that you feel could be revised for better clarity and/or flow?

A short note - I would relocate the modeling requirement discussion after the risk analysis. We do not need the specifics of modeling in order to understand the general idea and it disrupts the flow in discussing the components.

Response: The modeling requirements discussion has been revised and relocated.

Question 12: How does this methodology compare with other frameworks for company-level GHG target setting and assessment you may have encountered?

This is the first methodology I have seen targeted at specific company actions as opposed to accounting protocols. From this perspective, SMARTargets is unique in that it helps inform corporate strategy beyond broader policy design considerations.

Response: Great! Thank you for letting us know.

Question 13: In addition to the feedback you have provided thus far, are there other elements of the SMARTargets Methodology that you think could be enhanced to further strengthen the methodology?

This has been incorporated in previous comments and minor comments below

Question 14: Beyond what you may have already provided, do you have additional suggestions regarding references or resources that could be considered and suggestions for how they could be considered?

As it stands, the document covers existing literature well. Should the authors expand to inter-company trading and/or industrial and embodied emissions, a good starting point is in Dr. Carolyn Fischer's work, here:
https://www.brookings.edu/wp-content/uploads/2019/10/PP_Fischer_FINAL-1.pdf

Response: Thank you for the overall feedback here that we are covering the literature well. Thank you also for the reference. We do not currently cover flexibility mechanisms in detail or embodied emissions. Instead, we have chosen to focus on higher level observations and insights regarding cooperation cost-effectiveness, strategy implications, and target setting for upstream, direct, and downstream sources.

Further, minor suggestions

A small list of further suggestions:

• Convert the decision-making process for target setting (page 15) to a flow diagram, Figure 11 not descriptive enough to be particularly useful. Response: Great idea! A new methodology flow diagram was created.

• The discussion surrounding base year specification (page 31) is not immediately clear. For example, ”our base year recommendations for a company setting a target are to use the latest global emissions pathways to inform the aspirational targets that they evaluate” - this does not provide actionable advice. Response: The text has been revised for clarity and to make it more actionable.

• (very minor) Page 14 - line 5, list starts at ’4’. Response. thank you!

Dr. Vaibhav Chaturvedi, Council of Energy, Environment, and Water of India

Note: Dr. Chaturvedi provided high-level feedback across two correspondences that indirectly respond to the charge questions. The second correspondence was in response to clarification questions from the SMARTargets Team. Dr. Chaturvedi's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

First Correspondence

I have read the two documents (methodology and scientific foundations) carefully. I wasn't able to add comments in the review document provided, hence the delay. Apologies for that. I am giving my key comments here. Let me know if I also need to respond to each question in the review document.

1. The scientific foundations are clearly described and are solid.

Response: Terrific! Thank you!

2. The document is clearly written. It is easy to follow. The gaps in existing methodologies are mentioned and the additional components in this guidance (e.g. uncertainty and trade off assessment, multiple objectives, flexibility, aspirational versus qualified targets, etc) are clearly argued and communicated, the logic and evidence behind it is clear.

Response: Great! Thank you for letting us know.

3. The guidance is clearly an advancement over existing guidances like SBTi which focus on all companies to achieve net-zero in the same year.

Response: Thank you for the feedback! Note that the Aspirational Targets (ATs) in this draft are asking all companies to evaluate and pursue the same aspirational percent reductions by GHG, including a net-zero CO_2 target by 2050 or earlier. This may look similar to SBTi, but the SMARTargets Methodology as a whole is very different. The methodology recognizes the limitations of global pathways, especially that they do not represent individual company transition opportunities. Thus, the methodology helps a company identify their unique transition opportunities and challenges for achieving the ATs and then helps them identify their unique Qualified Targets (QTs) for the highest level of reductions under different conditions. Thus, the identification of the opportunities, challenges, QTs, and QT conditions is radically different than SBTi, going well beyond it in informing and supporting science-based company-specific decision-making, actionable targets and strategies, and risk management.

4. The framing and communication behind the three components is clear.

Response: Great! Thank you!

5. While the framing and logic of the three components is clear, the scenario design concept presented in Table 10 was not clear to me. The difference between decarbonisation incentives and options versus uncertain other conditions was not intuitive and clear to me. This part is critical for the company level stakeholders to actually think about scenario design and use it to inform decisions, but this whole section up to table 11 was not so clear to me. While the other following text along and especially Table 12 does

give some examples, the difference between the two axes was not really clear to me even after these descriptions. Please relook at this part. If any of your company level contact

Response: Thank you for letting us know. We have clarified, and in general improved, the scenario design concept, discussion, and tables.

6. Apart from what is mentioned in point 5, the whole document is very well written and it is clear to me that once it is socialised it will be a useful contribution to advancing not just target setting (that many companies are already doing) but in terms of advancing real understanding of what companies need to actually deal with while moving towards the targets or even while setting targets.

Response: Thank you for sharing this with us! Valuable feedback!

7. The final point I want to make is a potential future challenge. I think the strength of this guidance is also its potential limitation. The good part about many other such guidances is their simplicity. Simplicity is extremely valuable, especially for non-technical communities like corporate decision makers. In that sense, everyone understands that 'my company needs to achieve net-zero by 2050' even though they don't really understand it. They just need to hire a consultant who can develop a net-zero pathway for them that they can follow. The SmartTargets guidance is a lot more complicated than that. Beyond the corporate decision makers, I sense that a community of 'consultants/advisers' needs to be developed who understand how to undertake and communicate more complex things like uncertainty and trade off assessment, scenario design etc. Corporate decision makers would in all probability never learn these things themselves but end up relying on consultants. The impact of SmartTargets would end up being as solid as the set of consultants, analysts and advisors. Just wanted to highlight this point.

Response: Very helpful observation! Thank you! It is something we have been thinking about. We are proposing something that is not necessarily complex, but does require effort and likely needs some outside support, but that should not be a barrier to uptake. The methodology builds on and leverages existing company planning processes and analysis. For instance, utilities already do scenario analysis for resource planning. As such, we have stressed that existing utility planning capabilities can be used and we have provided guidance for how those capabilities can be creatively applied to evaluate regional economy-wide transition opportunities and risks. We have also recommended, but not required, regional economy-wide modeling, encouraging consideration in the long-run as a complement to existing planning modeling. In addition to the methodology, we are also working on providing supporting resources, such as training and technical resources, for companies and their potential advisers and experts helping them with SMARTargets implementation, validation, and progress verification activities.

Second correspondence

I had already read the charge questions based on which I submitted my comments.
Yes, the difference between ATs and QTs is adequately clear from the document, and it is also clear that ATs are by and large like SBTi targets.

Response: As noted in the response above, the SMARTargets approach is very different from SBTi, and a significant advance in terms of recognizing unique opportunities and risks and helping companies developing actionable strategies and identify opportunities for increasing ambition. We have added discussion clarifying the differences, and similarities.

I relooked at the charge questions. The only thing that came to my mind (though it might be too much I think), is that should the methodology actually suggest creating pathways for achieving both ATs (essentially 2050 net-zero targets) and the QTs? If this is already there then this was not explicitly clear to me. The way the document read to me was that it would ultimately create pathways for the QT scenario after assessing uncertainties and trade-offs. If creating pathways for ATs and QTs is possible, it could help in the following two ways:

1. It would help the companies compare what they will need to do if they want to achieve the ATs in addition to what they need to do to achieve the QTs.
2. It would allow companies that already have SBTi aligned targets to also go for SmartTargets.

This could be a strategic thing to do.
If this is already there in the document, then apologies for missing it.

Response: Great feedback and ideas! Yes, the approach will help companies develop pathways for ATs and QTs. We have clarified this in the revised document, as well as noted the planning and risk management value of SMARTargets to companies who already have SBTi targets.

Professor Celine Guivarch, Ecole des Ponts ParisTech and CIRED

Note: Professor Guivarch provided initial comments only on the scientific foundations document and did not review the methodology main document. Many of the issues raised in Professor Guivarch's initial comments are addressed in the methodology, so we followed-up with her and asked if she could please review and comment on the methodology. In the end, she was unable to review and comment on the methodology in detail. She was, however, able to provide additional high-level guidance related to the methodology. The charge questions and Professor Guivarch's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response." Responses that address multiple comments are presented upfront.

Response: Professor Guivarch's initial comments raise a variety of important issues. Overall, many of the concerns raised are addressed by the methodology. For instance, the methodology requires companies to set ambitious aspirational targets as well as clearly and transparently communicate their challenges, risks, and opportunities for addressing them and increasing emissions reductions. In addition, there is not unbounded flexibility. Companies are required to define and justify what they consider challenges and risks based on their circumstances and actual opportunities.

In general, the methodology is doing exactly what Professor Guivarch is suggesting in her overall Question 2 statement about what the methodology should do: "…consider a long-term target/vision of what it means for the company to operate in a Net Zero world, what business model it would have then, what products it would sell, how its value chain and production processes could look like, what gross and net emissions it would have. Then, it could derive what it means to get there, including short-term targets, on emissions but also beyond emissions on the underlying transformations of production processes, business models, productive capital, and investments associated."

Below we respond to specific issues raised by Professor Guivarch:

- **Overemphasis of uncertainty** – Thank you for calling this out. This was not the intent. We did not mean to imply that anything and everything is aligned with the Paris Agreement. As shown in various figures and tables, that is clearly not the case. Most importantly, that is not what is implemented in the methodology. The observation that there is uncertainty, and transitions and implications are sensitive to alternative conditions, is why the scientific requirements for the methodology identify consideration of uncertainty and multiple priorities as requirements. It is also what motivates the methodology's required transition risk scenario design and analysis that helps companies understand their transition opportunities and risks and identify enabling conditions for Aspirational Targets and Qualified Targets and their associated conditions. Furthermore, the SMARTargets assessment of alignment with the Paris Agreement is bounded. Finally, we have revised the text discussing uncertainty to clarify its implications for the methodology, including that it is not unbounded.

- **Consideration of other social priorities** – While not a primary comment, Professor Guivarch made reference to the need to consider the Paris Agreement's consideration of other priorities. We agree that this is essential for informed dialogue and decision-making, which is why this is one of the scientific requirements for a science-based methodology. The draft methodology itself facilitates consideration of multiple priorities by helping companies create information regarding potential

transition implications and risks related to multiple priorities, including sustainability, affordability, reliability, and local economic development, as well as supporting secondary analysis that companies can undertake (e.g., equity, air quality). No specific suggestion was provided, however, we have increased the emphasis of this feature and benefit of the methodology.

- **Global emissions pathways –** Professor Guivarch asked us to add clarification regarding our use of the IPCC Sixth Assessment Report (AR6) global pathways. We have added the requested clarification. Specifically, we have clarified that we are using the AR6 vetted scenarios only. Professor Guivarch also suggested that the global budget and pathway ranges should be narrower than what is presented. However, we are not seeing why the budget or pathway ranges should be narrower than what AR6 provided, which considers the factors Professor Guivarch noted (climate feedback risk, non-CO_2 uncertainty) in the IPCC's approach that uses a standardized simple climate model (SCM) and different emissions pathway sets. The ranges, of course, are certainly smaller for a 1.5°C (with 50% likelihood) temperature future than for higher temperature outcomes but it is not narrow given what we find in the vetted AR6 data (from both Working Group I and III). Our approach is to report and assess what is currently publicly available and in use by stakeholders. This includes the current literature assessed by the IPCC and what is currently used by stakeholders in methodologies and communications.

  Regarding the global pathways, Professor Guivarch also commented on whether the full ranges are the uncertainty. Given what the data represents, using the full ranges as uncertainty is justified. The different pathways represent different assumed conditions, including system dynamics via different models, and therefore uncertainty about those conditions. In general, we do not find justification for narrowing the ranges, for instance with percentiles, given the nature of the data which does not support statistical inference. Regarding the precautionary principle, it is being represented to some extent by using the pathways in the 1.5°C (w/ 50% likelihood) category, which is consistent with what was agreed to by the international community in the Paris Agreement, as well as the well-below 2°C scenario category definitions of the IPCC. However, a company needs to consider the set of potential global transitions aligned with well-below 2°C given their relevance to planning and strategy.

  Professor Guivarch also commented on removing obsolete AR6 scenarios but no specific suggestion was provided. We agree that many global pathways are inconsistent with emissions observations and policy realities and these issues are discussed in the document. However, the scientific assessment must consider, evaluate, and use the current information available—IPCC, IEA, TPI, etc.—that is informing stakeholders, methodologies, and international policy. There is certainly a need for updated global scenarios that not only align with history but reflect actual transition opportunities. Some of the newer global transition analysis discussed in the Scientific Foundations document begin to fill this gap, such as that producing probabilistic sub-global transition distributions. Note that, we anticipate updating the methodology over time for new developments related to the international goals and science. The methodology is readily updatable given that the key concepts of the approach are not dependent on a particular temperature goal or set of pathways.

Professor Guivarch suggested that the global pathways within a range should not be viewed as equivalent. From a climate outcome point of view, they are equivalent by construction. The global pathways in an IPCC AR6 temperature-likelihood group (e.g., 1.5C with 50% likelihood) are not different in terms of their climate implications. The pathways in each climate category were determined by the IPCC authors to all be in the same temperature (with likelihood) category.
It is true that a higher global CO_2 pathway is typically associated with a lower non-CO_2 pathway and we have added discussion on this. However, it is challenging in a methodology providing guidance at the company level to address this concern, since this kind of coordination is beyond a company. As such, the methodology requires the evaluation of CO_2 and non-CO_2 ATs aligned with the PA goals. It also requires identification of QTs that are the highest possible ambition, not the lowest level of ambition. The transition opportunity results also facilitate discussion of likelihoods regarding the future conditions and specific transition outcomes and abatement.

- **Companies doing something less than the aspirational targets (ATs) resulting in global emissions that are not aligned** – Professor Guivarch commented that if all companies do less than the global average reduction pathway, global emissions will be above that AT pathway associated with a 1.5°C outcome. However, no specific suggestion was provided on this point. As suggested by Professor Guivarch, the percentage reduction in the sum would be less than that in the AT global pathway if all companies do less than that level of percentage reductions. However, if all companies set targets within the 1.5°C range, the collective outcome will also fall within that range—thereby aligning with the temperature goal. It is essential to keep in mind that global pathways are not representative of the transition opportunities for individual companies; and, as such, the public should expect that companies will identify different transitions and challenges in evaluating AT opportunities. In fact, modeling results show that some regions may experience increasing emissions while others are declining in the pursuit of the international temperature goals. Given the limitations of global pathways, the SMARTargets Methodology approach is to use the ATs as generic aspirational levels of effort that facilitate ambition and coordination and help identify opportunities for greater ambition by asking companies to evaluate what it would take to reach AT reduction levels. By evaluating what it would require for AT outcomes, the companies will provide valuable information that identifies opportunities for greater ambition and coordination while at the same time identifying what can actually be done by a company and providing justification for it and thus facilitating progress.

- **Companies choosing targets** – Professor Guivarch expressed concern that companies might be able to choose targets they prefer. The methodology addresses this and by no means allows companies to get off easy on ambition. The aspirational targets (ATs) are required by all and must be evaluated. This ensures the aligned global outcome, with companies evaluating uncertainty about the conditions and their differences in opportunities and challenges. Companies are required to transparently communicate what they consider a challenge or risk and its implications. The methodology also allows companies to identify qualified targets; but, the bar is high, with companies required to be transparent on how they are defining and managing the challenges.

- **Some companies needing to do more when others do less** – Professor Guivarch commented that if some companies do less in reducing emissions, others would need to do more to keep global emissions on track. This sort of emissions reduction allocation is what one sees in cost-effective global regional emissions reductions results and we see clearly how alternative conditions can result in some countries doing more and others doing less than they would under other conditions. Unfortunately, existing scenario results do not provide guidance for this sort of dynamic with companies since the scenario information provides no guidance to individual companies. This is why the methodology requires companies to do their own specific transition risk analysis and provide the information on their potential transitions. By doing so, stakeholders will be able to understand those opportunities and evaluate if a company is doing its higest possible effort given the conditions and tradeoffs and risks. Also, it is important to recognize that global results are contingent on conditions that are uncertainties that need evaluation and that they are driving the country-sector allocation of emisisons reduction effort we see in global pathways. For instance, economy-wide policies provide a market for low-carbon electricity that supports more rapid emissions reductions in the power sector. Furthermore, global cooperation results in even greater reductions in country power sectors with the lowest cost reductions. SMARTargets views cross-sector and cross-company coordination as an important role for policy to enable more cost-effective transitions. We believe it is impractical to impose coordination on company targets. In general, the absence of cost-effective coordination is a key weakness of company targets as a strategy and this issue is something we discuss in the document.

- **Qualified targets (QTs) more ambitious than aspirational targets (ATs)** – Professor Guivarch called out the need to recognize that deviations from ATs can be both directions. She is correct and our examples in the documents actually illustrate both directions. For instance, we have examples of how economy-wide policies can result in electric sector decarbonization that is faster than the ATs. These policies are an example of an enabling condition. In this case decarbonization pressure on end-use sectors creates demand for low-carbon electricity that provides revenues to the power sector that facilitate faster power sector investment in low-carbon energy and faster decarbonization. As such, we have revised the description of ATs and QTs to clarify and discuss how different conditions can facilitate deviations in either direction.

Initial comments (based only on review of the Scientific Foundations document)

- **Question 1:** Are we fully considering the science relevant to company GHG target setting, and if not, what specific additions should be incorporated?

  Paris Agreement has other goals beyond the "well below 2°C", in particular in article 4 the goal "*to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty*". The science concerning this other goal should also be considered and accounted for company GHG target setting.

  Response: Good point. The methodology accounts for this. The global pathways being considered account for the goal noted, with a net zero CO_2 outcome range that reflects and meets the

objective. In addition, consideration of other social priorities is a requirement and key part of the methodology.

- **Question 2:** Do you agree with the key scientific observations and are they adequately supported? Do you have suggestions for additional key scientific observations or scientific support that you think are important to company GHG target setting conversations and methodologies?

  The document uses the terms “aligned”, “compatible” and “consistent” (with a temperature goal) without defining them. It would be necessary to define and explain if they are used as synonyms or carry some nuances.

  Response: Thank you for calling this out. We have clarified the terms and their use to reduce confusion.

  Key scientific observations are formulated in ways that emphasize the uncertainty over the actual scientific findings. The language over-emphasizes the uncertainty to the point it could be interpreted as “any pathway/any target can be aligned with Paris Agreement goal”, which is not a fair depiction of the state of knowledge. It is well-known that over-emphasis on uncertainty language is precisely a discourse from actors trying to minimize meaningful action.

  The overall phrasing of the key scientific observations is extremely vague and broad, which is not giving precise direction for meaningful and ambitious target setting.

  For instance, “wide ranges of global emissions budgets and pathways are consistent with limiting global average temperature to a particular level” is not reflecting the scientific knowledge. On the contrary, for low temperature targets, remaining emissions budgets are small and narrow. The quantification of remaining CO2 budget depends mainly on (i) the probability to meet the temperature target, (ii) the changes in non-CO2 emissions and other radiative forcing. So this is not uncertainty, it is about the precautionary principle about reaching a temperature target for (i), and the actions to reduce non-CO2 emissions and other radiative forcing for (ii). In addition, the risks of positive feedback loops being triggered do reduce remaining carbon budgets (see eg Gasser, T., M. Kechiar, P. Ciais, E. J. Burke, T. Kleinen, D. Zhu, Y. Huang, A. Ekici, and M. Obersteiner. 2018. “Path-Dependent Reductions in CO 2 Emission Budgets Caused by Permafrost Carbon Release.” *Nature Geoscience* 11 (11): 830–35. https://doi.org/10.1038/s41561-018-0227-0.), which should be considered.

  Response: Thank you for calling this out. We have revised the scientific observations to be more precise. See overall response above for discussion regarding the comments on ranges and the precautionary principle.

  In addition, the emphasis on cost-optimal pathways/targets is misrepresenting the knowledge about decision making under uncertainty, which precisely shows that strategies should aim for robustness instead of optimality.

  Response: Professor Guivarch is correct that the pathways in the literature are primarily cost-effective solutions for different conditions (and models). We have added clarification on this point and also better clarified how this information is being used in the methodology. Specifically, the methodology is supporting robust decision-making. The methodology uses the different

transitions as alternative future states under different conditions from which insights, such as no regrets and risk management strategies, are drawn for robust decision-making. The approach is not attempting to identify one optimal pathway but instead helping companies understand the transition possibilities and define their decision space for risk management and the development of robust strategies.

Overall, in the scientific document, it is explained that many pathways or targets at non global levels can be aligned with a global temperature goal. This is obvious, but what it does not say, and is in fact absolutely critical, is that stating that a given non-global target is aligned with a global goal implies making an assumption about what other entities (territories/sectors/companies) are doing to make the overall pathway consistent at the global level. All entities (territories/sectors/companies) cannot take the target "they" prefer and then have consistent global pathways. So the scientific document completely eludes the question of "fair ambition" and equity, which is a central question. By setting a target for itself, an entity implies a vision of what others should be doing so that the global pathway is consistent with Paris Agreement. Making this vision, these assumptions, transparent should be part of what setting a target is, otherwise it cannot be claimed to be aligned with Paris Agreement.

Response: The aspirational targets (ATs) directly address this comment. The ATs ensure the aligned global outcome while recognizing uncertainty about and differences in conditions, which impact the role each company plays. See the overall response above on companies choosing targets that addresses the concern that companies might choose what they prefer. In general, the methodology is consistent with the Paris Agreement approach to country pledges, in this case requiring companies to identify their highest possible ambition considering their circumstances, as well as the level of effort required at the global scale to reach the temperature goals.

The position to consider the full range of existing scenarios, rather than some statistics (eg 5th and 95th percentiles), is well justified. However, I wonder whether the analysis was made with the full range of scenarios in the AR6 global scenarios database, or restricted to the scenarios that passed the vetting procedure put in place by IPCC authors to exclude scenarios that have features that are far from data ranges for past dates or that have implausible levels of CDR for 2030. It would be important to restrict the analysis to the latter.

Response: Clarification that the IPCC vetted scenarios were used was added (see overall response above). Thank you for the support for our justification for using full ranges.

About vetting scenarios and excluding them from the analysis, the method should consider removing scenarios from the AR6 database that have become obsolete. Indeed, the scenarios correspond to articles published before 2022, which means some are obsolete, in particular those with global emissions peak in the past now.

Response: See overall response above. Note that all of IPCC AR6 global net CO_2 pathways peak in the past. This was also true in IPCC Special Report on 1.5°C and the Fifth Assessment Report, as well as IEA and many other pathways.

The method that considers GHG gases separately is most welcomed, because aggregating to CO2-equivalent always raises issues. However, it is important to stress that ranges of pathways for the different gases are not independent: values for all at the upper-end of the ranges would not end

up being compatible with the temperature target; on the contrary value at the higher end of the range for CO2 requires that non-CO2 are relatively low in the corresponding range.

Response: Thank you for the support for considering the GHGs separately. See overall response above for discussion of the relationship between CO_2 and non-CO_2 pathways.

The conclusion that a global pathway is more appropriate than a sectoral/territorial pathway is double-edged. On the one hand, indeed, what matters for the climate are the global emissions. But, on the other hand, unless everyone follows the global emission reduction – which is precisely what is not efficient/feasible/etc as stated in the document – some territories, sectors and companies will have to do more reductions than the global average (because some will do less). Therefore, using a method that identifies the global average as an "aspirational target", and then discusses barriers to meet the aspirational target therefore leading to set a possibly less ambitious target would result, if all entities would follow this method, in a situation where the aggregation of all targets set would imply more emissions than the global average.

Response: See overall response above. In addition, it is helpful to reinforce a key insight that helps explain why SMARTargets' Paris Agreement alignment approach to total global emissions, instead of sectoral, makes sense and is scientifically justified. Many stakeholders do not realize that there are strong enabling assumptions for the outcomes being cited and used in global pathways. For instance, all the 1.5°C global emissions pathways produce a U.S. electric sector with faster emissions reductions because there is an immediate global economy-wide policy. That assumed policy is creating demand for low-carbon electricity and providing revenues that support faster decarbonization in the power sector. That is a key enabling condition, and we see this dynamic in global pathways, as well as national outcomes and our SMARTargets illustrative analysis. Furthermore, there is an implied global emissions permit market in the modeling and the U.S. power sector is in essence getting paid by other sectors and countries to reduce emissions faster, especially in the near-term. The key point here is that how global emissions reduction effort gets allocated across countries and sectors depends on uncertain policy design and other conditions, and that allocation is highly sensitive. The SMARTargets proposed Paris Agreement alignment is with global total emissions because the allocation of effort is uncertain and highly sensitive and, therefore, companies need to evaluate alternative conditions and transition opportunities and identify enablers that can facilitate greater ambition.

In Figure 9, it is unclear what "optimistic" and "pessimistic" refer to, and what probabilities to meet the temperature targets are considered.

Response: Thank you for calling this out. Additional descriptive details have been added to the figure's note.

The discussion about the feasible and infeasible scenarios is relying on a specific study under given assumptions about energy demand, economic growth, population. So the conclusion about infeasibility is conditional to those assumptions, and could simply mean that other levers (eg sufficiency) would have to be mobilized to make the temperature reachable.

Response: Yes, model infeasibility is dependent on the model and the assumptions. We have revised the discussion to be clear that model infeasibility does not mean absolute infeasibility. It is not true, however, that you can always have feasibility and it is just a matter of the right

combination of assumptions. The characteristics of pathways and assumptions should be subjected to feasibility assessment (e.g., peaking in emissions inconsistent with observations, global idealized policy coverage and cooperation). The main point here is that model infeasibility rates increase with fewer options, which is a robust insight. In addition to the study noted, we cite another model comparison study with this finding for a different set of conditions. Most model comparison studies do not collect this information across models. There are, however, individual model studies with this finding for similar and other levers that highlight that, in general, constraining options and response flexibility, result in a greater likelihood of model infeasibility.

Key scientific observation 7, that states it is not effective, or feasible, that all sectors/companies have the same GHG outcome is absolutely valid. However, the discussion completely leaves aside the fact that some will have to do more than the average (if some do less because they are in conditions "difficult to decarbonize"). If the scientific observation doesn't give elements to justify when a company/sector is in a context to do more or less than the average – or at least elements to make transparent by the company – it opens the door to all companies explaining they chose a target lower than the average (which ends up in a global emissions pathway higher than what is aligned with the temperature goal). Again the same type of language is used in key scientific observation 9 "not all companies will be able to achieve the target"… this neglects the fact that if some do less than the target, some will have to do more… For instance, it is a robust finding that emissions reductions in the power generation sector are faster than for the economy-wide emissions. This finding indicates that taking the global economy-wide average reduction is not an appropriate target for a company operating in the power generation sector.

Response: See overall response above. Additional discussion added to the document on how the allocation of effort is dependent on the assumed conditions and is highly uncertain. Also, Professor Guivarch's comment regarding the faster pace of decarbonization in the power sector is not recognizing that economy-wide policies are providing a market for low-carbon electricity that supports its more rapid emissions reduction. See response above for more on this. This point is critical and reiterated in the revised draft with examples. Without the demand for low-carbon electricity, the rate of low-carbon technology adoption in the power sector will be slower. Furthermore, the price of electricity will be increasing and potentially lead to emissions leakage as end-use sectors substitute fossil fuels for electricity (e.g., EPRI, 2022). As noted earlier, it is also important to note that the global pathway results are assuming global cooperation with an implied global emissions permit market, which is resulting in the power sectors of the world getting paid to reduce emissions even faster by other sectors and countries.

- EPRI, 2022. *Opportunities for Decarbonizing Minnesota's Economy: Energy System Supply and Demand Assessment*. EPRI, Palo Alto, CA: 2022. #3002019333.

In key scientific observation 10, the phrasing "global pathways also find decreasing but continued reliance on fossil fuels" is very weak compared to the scientific knowledge. First, it should distinguish between fossil fuels, since the decrease in coal use is extremely strong for instance. And the decrease should be quantified, and the conditions necessary to assume continued reliance should be stated.

Response: Good suggestion to clarify this point. The original text is not incorrect, but it could be more specific. The key observation has been revised and the examples discussing transitions differentiate between fuels.

In key scientific observation 11, the phrasing “there is no scientific justification for prioritizing an individual pathway from the set” is, again, a language that allows the interpretation that all pathways would be equivalent. This is not true. Not all pathways involve the same risks (for climate target, or other development goals), imply the same reliance on given technologies, etc. For instance, pathways at the higher end of the carbon budget range imply higher risks of crossing tipping points in the climate system, with the associated risks. Pathways at the higher end of the emissions corridor in the short-term imply higher risks of overshoot, and higher development of negative emissions technologies afterwards, with the associated risks that are well documented in the scientific literature.

Response: The key observation has been revised. See the overall response above for discussion regarding what is aligned and not and global pathways and their use.

In key scientific observation 12, the discussion and questions are suggesting companies could/should exclude from their targets scope 2 or 3 because they have less control over these emissions. Instead, to give elements for meaningful target setting, the discussion should give elements on how to set targets and actions to reduce also those emissions. Also, the discussion suggest that are regulated “with regulations aligned with the Paris Agreement” should be excluded from a company’s target; but the document fails to give criteria to judge what make a regulation “aligned with the Paris Agreement”. Also in the discussion of scientific observation 12, there is a short paragraph stating that pricing emissions is more effective than other types of regulations, citing only one reference dating from 2014. This is not always the case when there are several market failures for instance (eg when there is also an innovation market failure). This paragraph on this point is simplifying the findings from the economic literature to the point of making a strawman.

Response: The control issue raised is addressed by the methodology. The methodology discusses control not as a justification for not setting a target a priori but, instead, as justification for considering categories of uncertainty related to control (e.g., the size of the regional gas market is not in the control of most gas utilities). As for Paris Agreement alignment of regulations, we have added guidance for assessing this alignment. It was missing. Thank you also for the comment on the efficiency of pricing emissions. We were not trying to oversimplify the discussion. So far, we have focused on the carbon externality, but we could expand the analysis by incorporating additional literature on other relevant market failures. However, the main point that pricing emissions directly (vs. indirectly) is more economically efficient still holds, as does cooperation that facilitates least-cost reductions.

The method that ends-up suggesting to consider as an “aspirational” target for a company the aggregate global average reduction in percentage terms eludes the question of burden-sharing and equity, but in fact carries a specific view on the topic, that of “grandfathering”. This means that high emitting companies or sectors are given an advantage with this reduction in percentage terms target, because they can keep a higher emission-intensity than others. This type of “grandfathering” target setting is a barrier for new comers, and disadvantages companies that have already reduced their emissions and are better than average in intensity terms. It can even create a moral hazard to not reduce emissions too much to keep this advantage of grandfathering.

Response: The comment appears to refer to emissions intensity targets, whereas the methodology being proposed is focused on mass-based percent reduction emissions targets. SMARTargets does not permit higher-emitting companies to maintain higher emissions intensity; rather, all companies are required to evaluate and pursue absolute emissions reductions consistent with the international goals. High-emitting companies will need to reduce a greater volume of emissions to meet these goals. While emissions intensity indicators are useful for assessing energy efficiency and fuel use, they can be influenced by a variety of factors. For example, low-emitting companies may still exhibit high intensity if they operate inefficiently due to outdated technology or other constraints.

We encourage companies to monitor and report intensity indicators as they provide valuable insights into changes in operational efficiency and fuel mix. However, the methodology requires the evaluation of mass-based targets, since the ultimate objective is to achieve total emissions reductions, not just improvements in intensity. Note that we are continuing to consider how to accommodate different types of companies, including new companies. Public feedback is welcome on this issue.

The method doesn't give elements about which sectors or companies should do more than the average, but it does give many levers to set a target less than the average (by considering the aspirational target is not reachable thus setting a less ambitious one, by justifying some emissions could be excluded from the scope of the target…). By considering only one direction to deviate from the global aggregate average, the method is biased towards not being aligned.

Response: Thank you for the comment. We've clarified that the QTs can be either more or less ambitious depending on conditions. If a company's circumstances allow it to reduce more emissions than the ATs, it can pursue a transition with greater reductions.

Overall, the scientific observations are formulated in vague and weak terms, emphasizing uncertainty and biased towards setting targets less ambitious than the global average, which could give all elements to "justify" minimal action, instead of ensuring meaningful aligned targets are set. Instead, a methodology to set a target could consider a long-term target/vision of what it means for the company to operate in a Net Zero world, what business model it would have then, what products it would sell, how its value chain and production processes could look like, what gross and net emissions it would have. Then, it could derive what it means to get there, including short-term targets, on emissions but also beyond emissions on the underlying transformations of production processes, business models, productive capital, and investments associated. Some elements from https://www.un.org/en/climatechange/high-level-expert-group may be important to consider.

Response: The methodology is doing exactly what Professor Guivarch suggests with her statement: "Instead, a methodology to set a target could consider a long-term target/vision of what it means for the company to operate in a Net Zero world, what business model it would have then, what products it would sell, how its value chain and production processes could look like, what gross and net emissions it would have. Then, it could derive what it means to get there, including short-term targets, on emissions but also beyond emissions on the underlying transformations of production processes, business models, productive capital, and investments associated."

- **Question 3:** Do you agree with the methodology scientific and operational requirements derived from the assessment and are they adequately supported?
  No, see comments above.

  Response: We are surprised Professor Guivarch did not agree with these since they are intuitive and pragmatic—consider uncertainty, recognize differences in opportunities, inform and consider multiple priorities, provide flexibility, support resilience and robustness. As shown in their comments, the other peer reviewers were supportive of these scientific and operational requirements. It appears that Professor Guivarch's response is based on the draft Key Scientific Observations (KSOs), instead of the scientific requirements themselves that were derived from the KSOs. As noted in the overall response, Professor Guivarch did not review the methodology, which addresses many of her concerns.

Additional comments related to the SMARTargets Methodology

Overall, I would suggest you pay specific attention to two main elements:

- clarify for the reader that uncertainty does not give a reason for less ambition. Because the scientific background document is very much emphasizing the uncertainty in the ranges of emissions compatible with a given temperature goal, it may give the impression that the KSO "consider uncertainty" is mainly about that aspect.
- when discussing target setting, including the consideration of "aspirational target" and then consideration of difficulties and barriers, make sure the discussion is balanced and not only hinting in the direction of less ambitious targets

  Response: See overall responses above. Both of the suggestions are addressed.

Dr. Stephane Hallegate, World Bank

Note: Dr. Hallegate provided high-level feedback that indirectly responds to the charge questions. Dr. Hallegate's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

Reviewer comments

The methodology is addressing a very important and timely issue, but also one of the most difficult dimensions of the agenda, namely the translation of global goals into decentralized strategies. The report does a great job at summarizing knowledge and provides an excellent review of what we can learn from global modeling exercises. Supporting firms and utilities in using these insights in their own planning and target-setting process will be extremely useful, and the report is a great step in that direction.

Response: Thank you for the summary comment and supportive words.

Scientific observations

My main comment on the scientific observations is that there are many of them, and they tend to be vague. For instance, the observation #10: "global emission pathways provide robust qualitative transition insights for companies" makes sense but do not add much information. I'm not sure anyone would doubt observation #12, "there are practical issues to consider before setting a target." I think the observations should be statements about the information/insight themselves, not the fact that the information/insights exist, and common-sense observations could be removed. If you could focus on a few observations, and make them about the relevant information people should know, it would really help.

Response: Very helpful feedback. Other peer reviewers had similar suggestions. In response, we have revised and reduced the key scientific observations and company implications, making them more specific and focused on the most relevant insights.

The key topic of the methodology is alignment with Paris Agreement, but this is not clearly defined. While the text stresses the flexibility between a global goal, a national objective, and a company target, it does not mean that "everything works". My recommendation here would be to focus on identifying what is **not** aligned, and what scenarios are telling us about it. The idea would be to assume that every country will want to do its part in the future (even if they don't at the moment) and assess what activities would then be consistent. In many ways, the work done on stranded assets and financial sector stability may be a good entry point, enabling you to identify misalignment as a business risks, and proposing to set targets that protect the utility against this risk (e.g. asking the question, "if my government decides in 2030/2035 to go to net zero in 2050, how much in trouble am I?"). This is the spirit of the RDM approach, so I'm sure Rob will also propose ideas here (see also my comments below). Doing so would help you manage the fact that at the moment, you stress the uncertainty so much that many readers may just think that any target is consistent with the Paris Agreement. And it would help navigate the global vs national context.

Response: We have added discussion regarding what is aligned and not aligned with a global temperature outcome to clarify that not everything is aligned. We have also refined the communications on uncertainty to avoid misunderstandings and highlight the importance of evaluating uncertainty to support robust decision-making (RDM) under uncertainty that, among other things, will help identify the risks of a shift to a low-carbon policy.

You also have a few key issues with the scenarios:

- **One is the role of the 1.5 degree target** that is now hard to align with. I don't think you can avoid making a clear statement on what you use to define alignment. In contrast with what observation 3 suggests, there is almost no flexibility left to achieve 1.5 degree…

  Response: The scientific observation has been revised in the reformulation of the set of observations. In addition, there is discussion about the challenges of limiting warming to 1.5C (e.g., the warming to date, historical emissions trends, pathway assumptions) that imply that it is an aspirational goal. We have also added text noting that ranges are narrower for lower temperature goals.

- Another one is that **many scenarios are now out of date**, so you probably need to "clean up" the set of scenarios used in the methodology.

  Response: Dr. Hallegate did not provide a specific suggestion for how to "clean up" the scenarios, though in follow-up clarification, he noted the need for revising economic projections, which is an ongoing activity in the research community. Technically, all the 1.5°C scenarios (and most 2°C scenarios) are "out of date" since they are all inconsistent with historical emissions (e.g., global CO_2 emissions peaking before 2020). As noted in other responses to reviewers, we agree that current global pathways are inconsistent with emissions observations and policy realities and that there is a need for updated global scenarios that not only align with history but reflect actual transition opportunities. However, we are reluctant to throw out all these projections since they are informing much of the current discussion, as well as current methodologies. Therefore, we think that the scientific assessment must evaluate and use the current information—IPCC, IEA, TPI, etc.—that is informing stakeholders and methodologies. Our approach is to acknowledge their deficiencies and the need for plausible futures, while at the same time recognizing that they still provide guidance regarding the level of global emissions consistent with the Paris Agreeement temperature goals.

  By the way, some of the newer global transition analysis discussed in the Scientific Foundations document begin to fill this gap, such as that producing probabilistic sub-global transition distributions. We also note that SMARTargets can be readily updated over time as climate change and international goals evolve and new scenarios information emerges. The basic scientific requirements, such as the need to consider uncertainty, unique opportunities, and multiple priorities, will be unaffected, however, but alignment with international goals may need to be revisited depending on the nature of the new developments. Overall, the methodology is not dependent on a specific international climate goal and can be easily adjusted to a change in goals.

- A second one is the **reliance on "least cost scenarios" in models**, while it's obvious that this is not the path being followed, largely due to other considerations around technology dominance, energy security considerations, and social dimensions (e.g., adjusting the pace of coal exit to political considerations).

  Response: This issue was also raised by others, but from a different point of view. The pathways in the literature are primarily cost-effective solutions for different conditions (and models). Other social priorities besides emissions and costs are relevant to actionable transitions. This is why

SMARTargets requires consideration of multiple priorities and facilitates the creation of information that informs discussion and decision-making on sets of priorities and balancing trade-offs. Furthermore, the methodology supports robust decision making by exploring potential transitions and implications under different conditions from which insights, such as no regrets and risk management strategies, can be drawn. Discussion regarding the use of the least-cost (cost-effective) pathways has been added, as has additional discussion related to the consideration of multiple priorities. Secondary analysis using SMARTargets outputs, such as evaluation of transition distributional implications, is also now communicated as an opportunity for additional analysis and insights.

I think the methodology would be better if those issues were explicitly addressed.

Flexibility? Key observation #7 suggests that firms will have different GHG outcome, but it's unclear what it means, and the timeline being considered. Maybe here, it's useful to consider the literature on firms in declining sectors, which suggest three key options: (1) exit the market (organized retreat) before values collapse; (2) transform and mobilize different technologies or produce another product (e.g. green instead of carbon intensive electricity); (3) focus on capturing the residual market, if you have a comparative advantage. And good to clarify that around 2050, there is frankly very little uncertainty or flexibility in the system, especially in the power sector.

Response: The key observation has been integrated with others to more clearly communicate the main point that transition opportunities vary by company. The main point is that transition opportunities for decarbonization vary between companies due to differences in assets, systems, markets, resources, local policy, customers, etc. One implication of this fact is that uniform targets across companies will not be cost-effective for decarbonizing society. We allow companies to develop their own risk management strategies without prescribing specific options from the literature. This recognizes that opportunities vary substantially and that the electricity and gas sectors are likely to face distinct strategic choices in managing transition risks.

Fuels. Also, it may be useful to go into various fuels to present a discussion of their "consistency" with Paris. The current text often refers to fossil fuels in general. And the document could have much more on fugitive emissions (I think it's mentioned only once, and in a sentence suggesting that firms have no control over it, which is puzzling). It's a key uncertainty on the footprint of using gas, and a really important dimension for setting any target linked to power generation.

Response: Good point! We referred to fossil fuels in general because the mix of fuels in the transition varies depending on future conditions. The illustrative analysis now highlights this point. We have added discussion and examples that illustrate the potential transitions of different fossil fuels and their sensitivity to alternative conditions.

Resilience/adaptation. Is it tenable at this point to have such a methodology without a strong focus on resilience and adaptation? And could it help maintain the momentum? One can't assess the feasibility of a power mix without considering the future changes in climate (e.g., water for hydro, risks from wildfires) as well as changes in demand (load from AC).

Response: Good observation. The SMARTargets analysis can be used to inform physical climate risk assessment and vice versa. We are adding discussion on this to help readers see this opportunity. It's

worth noting that earlier this year, EPRI launched the Climate READi physcial cliamte risk assessment framework for electric utilities. We plan to continue advancing our research on corporate climate-related risks, with a focus on frameworks for integrating assessment and management of both transition and physical risks.

Methodology

Many frameworks?

- I was a little unclear about the methodology, in part because there are multiple frameworks: there is figure 1 with the 6 steps, and then figure 2 with the 3 components, and figure 4 with another series of steps (but it's only for component #3?). In the end, I'm not sure what is the key methodological approach. One key question is whether the components are supposed to be considered as a series of steps, or as the end result of the steps. Simplifying the methodology would be useful.

  Response: Our apologies for the confusion. Figure 1 was not methodology steps. It was summarizing scientific requirements. In response to this and similar comments from other reviewers suggesting clearer communications on the methodology implementation process, we have created a new eight step flow diagram to clarify the methodology structure and implementation. We have also revised the scientific requirements graphic to avoid the confusion the previous version created.

- There are also key aspects of the methodology that are unclear, for instance when the report asks "Specifically, companies are required to evaluate a 2030 or 2035 interim emission reduction aspirational target." It's unclear what "evaluate" means in this context. Is it that they have to make the assessment and report on it, without necessarily agreeing on the aspirational guidance?

  Response: We have substantially revised the methodology structure and implementation communications to clarify the steps and details and simplify and streamline the presentation. This should address the kind of issue noted. For the example in Dr. Hallegate's comment, we have clarified that companies need to evaluate and pursue interim targets for either 2030 or 2035, and that they are welcome to consider additional interim (pre-2050) targets.

- On figure 1, it's unclear to me what the real difference between step 2, 5 and 6: considering uncertainty (step 2) is mostly about creating the flexibility to respond to different possible futures (step 5) and supporting robust strategies (step 6). Similarly, the "uniqueness" and the "multiple objectives" seem very redundant to me. It's also difficult in practice to look into robustness as a final step: it could instead be considered early on in the definition of the strategies. One suggestion here could be to organize the steps differently: (1) first, you want to collect all relevant objectives, climate and non-climate related, as well as the key operational constraints; (2) then, you can explore various strategies to achieve those goals, and those strategies will necessarily create tensions and trade-offs across your objectives; (3) you can then select a flexible strategy that can achieve the objectives and adapt over time as uncertainty gets resolved; (4) finally, you can translate your strategy into a set of medium- to short-term milestones and targets. One challenge of course, and I think it's particularly true for utilities, is that this is not a "climate target"

process (and I doubt it can be): it is rather a strategy process, in which climate is one of multiple goals and dimensions.

Response: As noted above, Figure 1 was not methodology steps but, instead, scientific requirements. We have revised the figure to avoid this confusion, and we have also created a new methodology flow diagram that clearly communicates the methodology steps. As for the second part of the comment that suggests how we might organize the steps, the transition risk analysis of the methodology (component 3 in the peer review draft) was designed to help companies do what the reviewer is suggesting. Tailored transition risk analysis is still a key feature of the draft methodology but is now labeled Step 4 in the new methodology step structure (and has seven phases).

- I think the only way to convey the methodology is through an example – at the moment, the document may feel very abstract.

  Response: Thank you for sharing this comment. This is why we developed the illustrative examples that are presented in Appendix B. The reviewer may not have had a chance to review the appendix. Other reviewers did and we have made improvements based on their feedback.

Absolute vs. relative metrics. Figure 3 plays a key role here, but I'm not sure how this can be applied to different actors. A utility with a large share of coal would need to do more, and one with a lot of RE would need to do less. How are different actors expected to use these numbers? Wouldn't it be better to focus on intensity metrics (e.g., gCO2/kWh) that are expected to decline to zero?

Response: We thought quite a bit about intensity vs. mass percent reduction targets. The methodology requires all companies to evaluate and pursue the aspirational targets, which are mass percent reduction targets. The differences in companies comes through in the transition risk analysis where their differences in opportunities emerge as differences in transition challenges and risks. The benefit of having mass targets is that it produces the emissions level outcomes consistent with the international goals; and, evaluating these reductions creates the information needed for informed discussion about challenges to and enabling conditions for greater ambition. We will continue to explore ways to consider differences in companies. Public feedback welcome on this issue. Currently, through the methodology, a company with very low emissions would identify Qualified Targets (QTs) that are appropriate for its specific circumstances and explain how these targets reflect its risks and opportunities—while also evaluating the implications, challenges, and enabling conditions for Aspirational Targets (ATs).

The additional issue here is that we do not have reliable intensity benchmarks for alignment with the international goals. They require sectoral results, such as emissions per unit of electricity generated, but the sectoral results derived from global pathways are contingent on unrealistic assumptions regarding global policy coverage and cooperation and global technology availability and deployment. The sectoral allocation of emissions reduction effort is highly sensitive to these assumptions, which is why they are key uncertainties companies need to evaluate. It is also why the sectoral results, including intensity results, are poor corporate benchmarks.

Enabling conditions. It's unclear what it means "without enabling conditions". Should people assume that there will be no technological improvements? No policy changes? It sounds like this may lead to unrealistic scenarios. If they account for likely changes in policies and technologies, then how much should they assume? Should you give them some guidance?

Response: Thank you for calling this out. We have moved away from this language of with and without enabling conditions when referring to the different types of targets. It was confusing readers. They are now referred to as Aspirational and Qualified Targets with clearer definitions and cleaner separation. We have also better defined enabling conditions with examples.

Overlapping targets? I do not think it makes sense not to create a target when "the category's emissions are regulated to a level that is Paris Agreement aligned." It's not because a category's emissions are covered by an ETS that it should not be covered by a firm's target. (Otherwise, no EU utility should have any target?)

Response: Dr. Hallegate did not provide a technical argument for dropping consideration of whether an emissions category is regulated by Paris Agreement aligned policy. Corporate targets emerged in large part as a response to the absence of policy. Thus, it is appropriate to consider whether they are needed once policy emerges. From an economic efficiency point of view, it is not economically efficient to internalize the social externality of emissions more than once since it creates extra cost without additional environmental benefits. From a stakeholder and public point of view, the emissions are managed to a Paris Agreement aligned level either way. Both are not needed. To avoid the extra social cost, companies should consider not setting a target if they are already internalizing the externality and managing the emissions due to Paris Agreement aligned regulation. Note that an EU (or any other) utility may still choose to set targets under the methodology, even if they are regulated at a Paris Agreement level. However, if they choose to, the methodology encourages them to attempt to set targets consistent with the policy to help manage the ineffiency costs from layering targets on top of regulated emissions.

On the selection of the models, and because you're after transparency, could you identify models that are open source, or at least have a clear and transparent description? It is definitely not the case for all models. Would you want the analytical work to be follow some replicability standard so that people can see the underlying assumptions? How would you manage commercial secrecy and ensure transparency?

Response: We have revised the minimum modeling requirements. We do not require open source but we do require a clear modeling description. We have also provided current examples of models, and their model descriptions, that comply with the minium modeling requirements. The validation step also includes criteria related to documenting the modeling approach and assumptions. Note that, this is an area we expect to evolve and refine over time as utilities, stakeholders, and experts supporting implementation develop experience with the methodology.

Table 3. Is table 3 suggesting that electricity costs are going to increase by 100 to 400% by 2030? This sounds very surprising (and maybe unrealistic?).

Response: Yes, that is what the illustrative results are suggesting. The near-term costs can be significant due to the investment and retirement requirements for achieving the interim Aspirational Targets (as seen in the corresponding capacity addition and investment cost results). We have added additional discussion to help better explain the near-term cost implications.

Professor Thomas Heller, Stanford University

Note: Professor Heller provided high-level feedback that indirectly responds to the charge questions. His initial comments were focused on GHG accounting alternatives and emissions liability management. Subsequent oral comments, in response to SMARTargets Team questions and clarifications, considered the methodology's approach to low-carbon transition strategy development and risk management, including their relationship to Professor Heller's initial comments. Professor Heller had intended to write-up these additional comments; however, he was unable to do so due to unexpected circumstances. As a result, we have noted the oral feedback received below. Professor Heller's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

Reviewer comments (including summary points regarding oral feedback)

I have lots of questions and comments, as well as plaudits for your focus, on the risk analytics.

Response: Thank you for the plaudits for our focus on risk assessment and management! A call was arranged with Professor Heller to discuss his questions and comments, some of which are documented below.

However, my immediate concern is with the less central issue of carbon accounting, which is likely to have little correlation with risk at the scope one, and even scope two, level. Depending on how you define scope 3, up and downstream, the correlations become meaningless. Against these rather bizarre, if still predominant, GHG accounting methods, which differ from normal financial accounting conventions for idiosyncratic and historical reasons, I have been tightly associated with the development of alternative carbon accounting rules, developed at Harvard and Oxford Business Schools along with my Stanford Sustainable Finance Initiative colleagues (Emissions Liability and Emissions Liability Management). ELM mirrors the conventions and principles of familiar corporate, financial and national accounting, and can eliminate the divergent application standards and incomparability of GHG accounting.

My committed position is that without reform of current predominant carbon accounting practices, results and incentives to manage carbon properly will not be possible.

I had feared in my initial conversation with you that a central position that might be given in EPRI's work to GHG multi-scope accounting would trouble my engagement. I can see how one might separate emissions counting (once, twice or three times) from risk analysis in characterizing climate diagnostics and performance evaluation by limiting the GHG exercise in practice to direct and indirect electricity emissions, and then really focusing on granular risk and risk dynamics. But this is not clear in the components or the methodology as now written. The use of GHG categories without more discussion of accounting reforms in play is inconsistent with my strongly held views. I attach a short compendium of core ELM papers, but we would need to discuss how these alternative views are reflected in the SmarTargets work to associate myself with the project.

Response: Very helpful GHG accounting and liability perspectives. We have expanded the GHG accounting discussion to include this GHG accounting approach and the e-liability concept. We have also highglighted that the methodology is not dependent on a particular GHG accounting approach. The alternative approaches simply provided alternative ways for defining the emissions categories for the transition risk analysis. The approach for evaluating potential transitions and abatement opportunities and risks is unaffected. Furthermore, the same is true for e-liabilities. It is an alternative to regulation—changing the

voluntary management of emissions to mandatory, just as regulation would do. Both define liability and create emissions reduction incentives to reduce the liability. The bottom line is that the SMARTargets Methodology can be applied to either GHG accounting approach and can be applied in different policy environments—e-liability or regulation—to assess transition opportunities and risks for compliance and inform strategy development. We have discussed the compatibility of SMARTargets with Professor's Heller's ideas on GHG accounting and liability and he aggrees that it is compatible and the transition risk analysis is necessary and valuable.

As noted, Professor Heller provided subsequent oral comments in response to SMARTargets Team questions and clarifications. Those comments focused on the methodology's approach to low-carbon transition strategy development and risk management, including their relationship to Professor Heller's initial comments. In addition to what was already noted, these included the following:

- The need to be more circumspect about GHG accounting and alternatives
    - The GHG Protocol was never intended as an accounting system. It is inconsistent with standard accounting systems that do not count units over and over and gets in the way of understanding accountability.
    - Accounting reform is necessary going forward and needs to be recognized in forward looking activities like SMARTargets. Among other things, it could be offered as an alternative GHG accounting option.
- The need to be explicit about budget allocation
    - Include discussion of why the methodology is not considering emissions budgets and allocation. Also, need to highlight role and necessity of removals, in general in global paths and for aspirational targets.
- The need to focus on risk
    - Consideration of risk is a virtue in what is being proposed. It will help push more people into doing needed risk analysis.
    - It is difficult to do both economy-wide transition and financial analysis. SMARTargets need to be open to methodological issues like this. For now, the methodology needs to define where it stops and how it informs utility planning activities. SMARTargets can inform utility planning and later utility planning decisions will inform SMARTargets modeling. They need to inform each other over time via a loose "integration" that goes back and forth.

Response: As mentioned in the previous response, we have added discussion of alternative GHG accounting approaches, as well as the need for potential reform, and noted the approach discussed by Professor Heller (with the citations listed below). We have also noted that the SMARTargets Methodology is agnostic regarding the GHG accounting approach and can readily accommodate alternative approaches. In addition, we have recommended that companies track advances in GHG accounting research and methodologies given it's relevance to company climate targets, strategies, and risk management.

Regarding emissions budgets, SMARTargets is focused on pathways and helping companies identify actionable transition opportunities. Furthermore, we have stressed that the science does not support identifying a robust budget or pathway for a company. The relationship between global and company emissions pathways (or budgets) is not 1-to-1. There are wide ranges of national and sectoral budgets and pathways consistent with a temperature goal and the allocation of emissions reduction effort to countries and sectors is highly uncertain and sensitive to alternative policy and non-policy conditions. Furthermore,

the current information is too aggregate and abstract to inform companies on their markets and transition opportunities. This is why companies need to evaluate their transition possibilities.

Lastly, thank you for the support for SMARTargets' focus on transition risk assessment and management. As for bridging the gap between economy-wide and financial analysis, we have added discussion reinforcing the importance of regional economy-wide evaluation of opportunties and risks that discusses how this informs and integrates with utility planning and how it can inform secondary analyses, like financial analysis, as well as other analyses (e.g., air quality, equity). We would welcome additional feedback from Professor Heller, other academics, and stakeholders on complementary financial analyses based on SMARTargets' outputs. SMARTargets can be a valuable source of information for financial analyses and meaningful climate disclosures.

References provided by Professor Heller

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Professor Robert Lempert, RAND

Note: Professor Lempert provided high-level feedback that indirectly responds to the charge questions. Professor Lempert had intended to provide additional detailed feedback but was unable to due to unexpected circumstances related to the Los Angelos wildfire. Professor Lempert's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

Reviewer comments

The SMARTargets methodology is a valuable and much-needed contribution. The draft report describes the methodology as science-based and seeking to align with the Paris Agreement. The methodology does meet these expectations. But the report also seems to have implicit assumptions about the purpose of goal-setting activities and, in particular, the exercise of GHG-target setting. It would be helpful to make those assumptions more explicit in the report.

SMARTargets describes itself as a risk management strategy. As you well know, risk management involves value-based decisions regarding what risks are most important to address and what tradeoffs are acceptable. Target-setting activities are often seen in the literature as coordination and communication devices. Coordination devices in the sense of enabling multiple actors, such as those that exist within a particular firm, to align their activities with the goals. Communication devices in the sense of a firm making its intentions clear to its suppliers, customers, regulators, and the public. The SMARTargets methodology seems consistent with these views of GHG-targets, and such views seem to inform design choices such as difference between aspirational and qualified targets and the guidance for the latter which involves balancing trade-offs and risks.

SMARTargets seems to well fulfill its role as a risk management strategy. But this reader would find the document and the methodology easier to understand if the report laid out its view of GHG targets and their role in a theory of corporate and societal change. It would help the reader to better understand questions such as the difference between aspirational and qualified targets, what tradeoffs are being considered, and what it communicated to stakeholders. Making explicit the report's view on the role of targets would complement the document's laudatory science-based focus in laying out the methodology.

Response: Thank you for the very supportive overall comment! We also appreciate your recognition of the risk management value of the methodology and its scientific basis. Both, very helpful feedback. Regarding the purpose of the methodology and targets, we have revised the discussion to clarify its purpose related to both, including clarifying the overall problem being addressed, the need for considering trade-offs and the types of trade-offs to inform society's diverse goals, and the differences between Aspirational and Qualified Targets. We have also further highlighted that one of the key virtues of a SMARTargets implementation is the transparent and standardized communication of targets, strategies, and their justification that inform internal and external stakeholders and facilitate productive dialogue and coordination.

Professor Granger Morgan, Carnegie Mellon University

Note: Professor Morgan provided high-level feedback that indirectly responds to the charge questions. His comments below also reflect responses to clarifications and questions from the SMARTargets Team based on initial comments from Professor Morgan. Professor Morgan's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

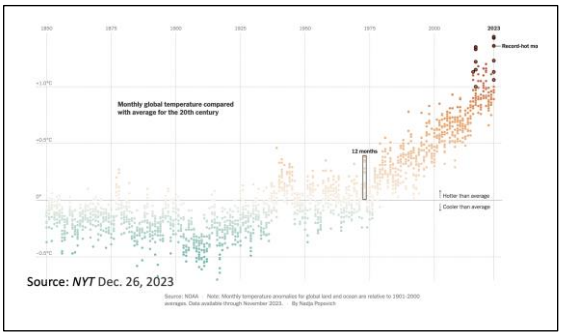
Reviewer comments

Comments by Granger Morgan on the SMARTargets Documents

I provide these comments in two parts. Part 1 considers the question "if I were a utility CEO with at least an MBA-level background in economics and decision making, and a desire to adopt a socially responsible position vis-à-vis decarbonizing my operations, how might I proceed?" Then in Part 2 I offer a number of specific comments on the SMARTargets documents. To avoid confusion, readers who are only interested in the SMARTargets documents may wish to skip directly to Part 2.

Part 1: How might I proceed as a utility CEO independent of the SMARTargets materials?

Average global temperatures recently exceeded 1.5°C. This may be a short-term excursion caused by a combination of ENSO and other factors, but the long-term trend is unmistakable. The world is heading toward a dangerous level or warming and the many largely negative impacts that will come with the resulting climate change.



While some countries are taking serious steps to reduce emissions others, including the new US Government, are either in denial or unwilling to take serious steps to reduce emissions.

If I were the CEO of a power company who wanted to take a socially responsible approach to reducing emissions from my company's operations, the first thing on which I would want to get some guidance is how I should think about my responsibility as just one of hundreds of thousands of contributors to the emission problem across the developed and developing world. Should I:

1. Give no consideration to what any other emitting entities are doing?
2. Operate on the assumption that all the emitters in both developed and developing countries have an equal responsibility to align their reductions with what would collectively be needed to stabilize the climate.

Or,

3. As a company operating in the developed country that has contributed more (both in absolute tonnes and in tonnes per capita) than any other nation to creating the climate problem, assume that I have a greater responsibility than a firm located somewhere else to work on achieving emission reductions.

While it does not address the question explicitly, my reading of the SMARTargets documents is that the approach makes the *normative* assumption that all emitters around the world should assume an equal

responsibility to reduce emissions.[1] Accordingly I will proceed on the assumption that as a hypothetical CEO I will opt for 2. I could do sensitivity analysis later if I am not sure about that choice.

Having made that assumption how should I proceed? I would want to develop a best estimate of the global marginal cost ($/tonne abated) of the emissions reduction needed to achieve stabilization so that I could use this to inform my corporate decision-making. There is of course, considerable uncertainty about the cost of achieving climate stabilization.[2] Hence, one thing I would find very useful to my decision making would be a summary of the state of the literature that would allow me to make an informed judgment.

Given the highly politicized nature of the climate discourse in this country, and the fact that the US has once again begun the process of withdrawing from the Paris Agreement, I would probably *not* frame the question in terms of Paris but rather in some other more general way such as limit average warming ≤2°C in 2050 and/or ≤1°C in 2080.

Let's call the global marginal cost of emissions reduction M=C±U$/tonne CO_{2e}. Just for illustrative purposes in what follows, suppose that after reviewing the literature on the cost of achieving stabilization, I choose M=70$±30$/tonne.

Then, in looking across my operations I should work to estimate the marginal cost of making reductions in each of the various Scope 1-3 (Table 2) activities over which I have some control. Wherever across that set I can achieve a reduction at a marginal cost of less than C-U $/tonne CO_{2e} (e.g. in the case of my illustration for ≤$40/tonne) I should figure out how to promptly get started doing that.

For activities with marginal costs that lie within the interval C±U$/tonne (i.e. for my illustration between $40 and $100/tonne) I should first identify activities where the total tonnage is more than some modest fraction of my total emissions (i.e. I should devote most of my attention to the larger emissions) and then focus on finding new approaches, technologies or operating strategies that could move the cost of reducing those larger emissions down below this range. When I see opportunities that could achieve that but will require significant RD&D I should press on EPRI, DOE and my supplier companies to do that. In the shorter term, I might also consider purchasing some offsets, but many of those that are now on offer are rather dubious,[3] and in any event in the long run, the planet will need actual reductions across the board.

The same arguments are true for marginal costs above C+U$/tonne.

In deciding how to proceed I would want to think in terms of the relative cost to reduce significant emissions across all the activities in my corporate portfolio, and then, if in some cases, for reasons of admirative efficiency, framing some things in terms of targets made sense, I would do that.

[1] That the authors of SMARTarget intended this interpretation was confirmed by a response to an earlier version of my comments that read: "SMARTargets is not about burden sharing based on past emissions. We are focused on what role a company might play in the future given uncertain conditions and opportunities."

[2] See for example Kotchen, M. J., Rising, J. A., & Wagner, G. (2023). The costs of "costless" climate mitigation. *Science*, *382*(6674), 1001-1003.

[3] See for example Buma, B., Gordon, D. R., Kleisner, K. M., Bartuska, A., Bidlack, A., DeFries, R., ... & Hamburg, S. P. (2024). Expert review of the science underlying nature-based climate solutions. *Nature Climate Change*, *14*(4), 402-406.

This of course brings me to the need to build a database of the emissions and associated uncertainties of all my firm's direct and indirect activities, and what reducing emissions from each would cost – topics which the SAMRTarget material does address.

Response: Thank you for the helpful set of thoughts regarding how a CEO could approach target setting. The SMARTargets transition risk analysis is doing what Professor Morgan is describing, but with a quantity emissions reduction aspiration that fixes the environmental outcome and evaluates the cost uncertainty. Professor Morgan's general points here regarding identifying the least cost options and portfolios for a range of reduction levels is also what SMARTargets is designed to do: help companies evaluate the incremental implications of increasing levels of emissions reductions in order to identify the greatest reductions possible under different conditions. Among other things, this will help a company derive abatement supply information that will allow them to entertain potential allowances and offsets (and their prices) as alternative strategies.

Overall, SMARTargets is designed specifically to help a CEO decide how to proceed: evaluating their options and identifying potential transition portfolios and their implications. Furthermore, SMARTargets is designed to help companies develop needed emissions and uncertainty inputs. Note that we have revised the methodology structure to explicitly include steps for GHG inventory development and verification. In addition, the methodology includes steps for identifying uncertainties and translating uncertainties into the transition risk scenario design. The SMARTargets Methodology is helping a CEO pursue ambitious reduction levels aligned with international goals by helping them assess their potential role and risks for low-emissions transitions that take into account their unique opportunities and set of social priorities, including costs. The company will need to be transparent on what they consider challgenges and risks and how they are planning to address them.

We also want to acknowledge and respond to other specific points raised by Professor Morgan:

- *Global marginal costs:* Just a note that signficant variation is found in current estimates (e.g., IPCC, 2014; EPRI, 2018; IPCC, 2022). In addition, modeling capabilities differ with some models not able to meaningfully resolve carbon prices. As a result, it is difficult to identify a robust range. Also, current global marginal cost estimates are likely biased downward since most global stabilization pathways are based on an idealized policy assumption of immediate global coverage and cooperation.

- *Aggregate targets:* Professor Morgan seems to be suggesting aggregate targets instead of individual emissions category targets. This makes scientific sense from an economic efficiency point of view and is an option to companies in the SMARTargets Methodology. Companies can develop aggregate targets and evaluate options for pursuing cost-effective reductions across a set of emissions categories.

- *Offsets:* The footnote provided by Professor Morgan cited a discussion of natural climate solutions (NCS). There is a great deal more information available on offsets and many types of offsets—e.g., NCS, direct air capture (DAC), bioenergy with CCS (BECCS), and non-CO_2 abatement. Offsets, as a whole, should not be dismissed based on one type or one paper. Furthermore, trade-offs need to be considered. Trade-offs are an inevitable part of climate management and characterizing and balancing them is important for practical solutions (e.g., IPCC, 2022b; Rose et al, 2020).

- *Generalize methodology:* Great idea to frame SMARTargets in general terms. We have added discussion about how the methodology is flexible and can be adapted to changes in international goals, as well as scientific developments. The methodology can be easily adapted to alternative global average temperature goals. However, many stakeholders still aim to design targets aligned with the Paris Agreement, or are asked to do so. We provide clear guidance to support them in this process. Currently, 194 countries remain part of the Paris Agreement, and the SMARTargets methodology is designed to be applicable worldwide.

References related to responses

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PART 2: Some Specific Commentary on the SMARTarget Documents

The executive summary of the SMARTarget Documents *does* tell the reader what the approach is designed to accomplish (e.g. the list on page ix and discussion on pp ix and x), and it *does* explain what emissions should be considered (pp xii -xiii) but then I found much of the following discussion pretty abstract. As I outline below, I think many readers would find examples in the main text, that clarify the abstract concepts, to be helpful.

Response: Thank you for calling out the need to be less abstract. We have revised the discussion to be more explicit and concrete on concepts, steps, and insights. This includes using the graphics more effectively to make points.

The aspirational targets (Figure 3) need some additional elaboration and justification. I understand these are based on the several cited sources, but what is it about these that make them preferable to possible alternatives? Why is there is no discussion about the dramatically different atmospheric residence times associated with these GHGs? Why for example, given the more rapid benefits that can be achieved by reducing emissions of more radiatively potent and short-lived CH_4, so much more modest than those for CO_2? Given its extraordinarily high GWP (~24000), and it's ~3,000yr atmospheric lifetime, why does the target for SF_6 remain unchanged through 2050? Shouldn't there be a serious effort to control releases and eliminated use? While most utility decision makers will presumably care most about the next few decades, some will be concerned about the long run implications of their choices.

In reviewing an earlier version of these comments, the authors of SMARTargets responded that

> "…differences in forcing and abatement cost-effectiveness between GHGs are accounted for in the modeling that generates the global pathways. Thus, the results we are using reflect those considerations."

That was unclear to me from my reading of the document, nor do I understand what assumptions are being made, for example, that lead to the conclusion that no significant effort is made to reduce emissions of a potent very long live GHG like SF_6. Given my confusion about this, and the fact that the modeling presumably contains multiple important assumptions, some further elaboration would be helpful.

Response: Good suggestion. In general, we have added more justification and detail explaining what the pathways represent and why they are appropriate. In addition, we have clarified that differences in forcing and abatement cost-effectiveness between GHGs are accounted for in the global pathway modeling. This was not noted previously. In general, the global pathway modeling estimates a portfolio of least-cost reduction strategies across GHGs and sources for achieving a climate outcome with an assumed set of conditions. The results consider differences in how the climate responds as well as abatement option availability and costs between GHGs and sources. In addition, from a company GHG reduction strategy point of view, the GHGs also differ in their uncertainties, risk management opportunities, and transition risk assessment methodological needs.

Understanding that authors of SMARTargets want to remain technology agnostic, could you at least offer some alternative examples to make the ideas underlying Figure 4 a little more concrete? If you do not want to do it in the executive summary, perhaps you could include a forward reference there to a table or something later in the text that offers several alternative concrete illustrations across the several stages of this diagram. For a couple of different kinds of firms, that have very different mixes of technology (e.g. much or little wind or solar, much of little combined cycle gas; much or little coal) what might a scenario design look like? How might it be implemented? What might be potential transitions and target implications? And, what might result from the review?

Response: We have added additional discussion about differences in company circumstances that would relate to technology options and uncertainties. These differences are an additional argument for the need to be technology agnostic. Without company-specific evaluation of opportunities, we do not know how valuable a technology might be and what the trade-offs are of not having it. SMARTargets transition risk analysis will help companies understand the value and trade-offs and customizing the assumptions regarding technology sets will ensure that the insights are plausible relevant alternatives that generate meaningful insights for each company.

Similarly, it was unclear what the reader was supposed to infer from Figure 5, which just seems to appear without much explanation.

Response: The executive summary was revised and this figure no longer appears. However, additional explanation was added where the updated version of this figure now appears. Thank you for calling this out.

On the top of page xx, we read that the approach is "scientifically grounded," and then later at the top of page xxi the phrase "scientific alignment" is used. One could read these as implying that science tells one the answer. It seems to me that "scientifically informed" would be more accurate. I realize there is a strong desire to be able to say, "what we are doing is determined by the science," but my reading is that the approach involves quite a bit of normative content.

Response: Thank you for bringing this up. We are certainly not trying to make judgements here. We have added text noting that "informed" is more appropriate for the reason noted by Professor Morgan. However, given the current stakeholder dialogue on this topic that uses "science-based," we feel the need to speak to it to connect better with stakeholders. As such, we explain this, and use terms like grounded, aligned, and science-based.

It was unclear whether Professor Morgan was commenting in general on the approach being normative. The methodologies concept is objective and neutral and directly derived from the science. However, it is important to note that companies will need to make decisions when implementing the methodology. For instance, they need to define their technology assumptions and their set of other uncertainties. They also need to identify risks and strategies. In all cases, companies will need to document and justify their decisions. This means there is a normative element but companies will need to be transparent and provide rational for their choices.

Throughout the document there are references to "PA" and "PA temperature goals."
As I suggested above, give some thought to whether you want to tie this so closely to the Paris agreement that is now politically sensitive in the US at the Federal level and in at least some parts of the county. Could you find some other phrase like "temperature stabilization goals" (TSG) that would not be quite so much a political lightning rod.

Response: This is a good point. However, it is hard to ignore the Paris Agreement since it is of interest to many stakeholders and most countries in the world are participating. As noted earlier, the methodology is flexible and can be easily adapted to changes in international goals. Text noting this feature has been added.

While rather abstract, the list on pp 4-5 describing why SMARTargets is novel is good.

Response: Thank you for the feedback on the list.

On the title to Chapter 2, "targets based on science," see my comment above. Consider "targets informed by science" or "science informed targets." I understand that many stakeholders may be looking to effectively "hide behind the science" rather than make explicit normative judgments, but in the long run it is not clear that EPRI does them a serve be helping them to do that.

Response: See response above.

The list of key scientific observations (pp8-9) is good. However, just as Figure 5 seems to appear suddenly, without much context or explanation, to some degree Figure 8 appears in the same way. In both cases, a longer caption that explains to the reader what they should infer from the diagrams would be most helpful.

Response: Thank you for the feedback on the Key Scientific Observations. Improved explanation and caption have been added with respect to the figure noted.

The same is true for Figure 9. the caption should tell the reader what insight they should take from the diagram beyond "EPRI has done interesting analysis of alternatives".

Response: Improved explanation and caption have been added with respect to the figure noted.

Moving on to Ch 3, at the top of page 17, adding just a few sentences explaining *why* a company needs to assemble these things, and how the results will be used in the process of their choosing their strategy, would be helpful.

Response: Thank you for calling this out. This has been addressed in the revised draft.

Again, the discussion is abstract. I realize you want to remain technology and strategy agnostic, but many readers would probably find it helpful if the discussion on pp 17-18 included some illustrative examples so that readers could see concrete examples of the sorts of things that mighty emerge from the process for utilities with a variety of different mixes of emission sources.

Page 20 Figure 12. Again, very abstract. Some illustrative examples either in the figure caption or in the text could help.

Response: Thank you for the feedback. We have improved the discussion and use of the figures to try to address the problems noted.

Page 21 line 20. Rather than immediately telling the reader what SMARTargets *requires*, I would suggest beginning with a sentence or two that motivates that need.

Response: Helpful suggestion. We have added explanation regarding the interim targets. Thank you.

Pages 21-22, same issues as the previous discussion of Figure 3.

Response: Addressed above.

Table 6, I suppose most people will not share my negative reaction to stating these targets to two significant figures, but this whole exercise is inherently an approximate process so too much precision is misleading.

Response: Fair point. We kept the two significant digits (e.g., -56%) simply to help differentiate the Aspirational Targets over time and to be consistent with what is shown in the corresponding figure with the global pathways associated with the targets.

Pg 23 line 17. By "removal," do you mean removal from the atmosphere (DAC, nature-based solutions, etc.) or CCS? Either way, shouldn't both be listed?

Response: Yes, thank you. We have added clarification.

After a few references to "qualified targets" the item on lines 42-44 on pg. 23 is the first significant mention in the main body of the document. The second paragraph on page 24 with a reference to "the most they can do" really doesn't clarify things very much. What are "enabling conditions"? Emission standards that tell a company they are not allowed to emit more than X tonnes/kWh, or something else? Ditto bottom of pg. 27.

Response: We have revised and clarified this text to address the comment.

While a discussion of global pathways at the bottom of page 24 is sensible, once again the discussion on the bottom of that page and on pg. 25 is abstract.

Response: We have revised the text to be less abstract.

Similarly, while the first paragraph at the top of page 27 is sensible it's very abstract and a few examples would help the reader to better understand

Response: We have revised to be less abstract.

The text does say that Figure 14 is just one example, but the caption does not.

Response: Figure has been removed.

The discussion on pp30-32 is sensible. However, what is the reader supposed to do with it? Rather than disrupting the narrative on Component 1, it might be better to simply to briefly mention these issues and included the longer discussion in an Appendix.

Response: These discussions have been relocated and revised to better intergrate with the overall flow. Thank you for mentioning this.

Finally, after 30 pages of general and often quite abstract discussion, on page 32 the reader comes to a section about the company setting specific targets. However, this discussion is very brief (~2 pages) and very abstract. As a CEO or VP for environment, what should I actually do and how should I do it?

Response: This discussion has been revised and made more operational as part of the overall effort to make the methodology more accessible and implementable.

In my earlier draft I had written that if I read Figures 4 and 15 correctly, they basically say adopt an iterative approach, which is of course very sensible. The authors of SMARTargets told me:

> "…these figures are focused on…scenario results development process to develop a strategy, not an iterative decision-making process where one is revisiting their initial strategy. We can add discussion on revisiting one's strategy using milestones and considering contingency plans…"

Clarifying that fact, and then also adding some discussion of the value of an iterative approach to the development of a firm's strategy would be good additions

Response: Thank you for working through this with us. The methodology has been revised to explicitly include a monitoring and strategy adjustment step.

Pages 44-52 layout seven steps to implement SMARTargets. Again, with the exception of Table 14, and a few of the later plots, there is not much in the way of examples that would help the reader to better visualize what might be involved at each step. I gather that Appendix B is intended to help the reader with that, but I think a forward reference here, and then some greater clarity and specificity in that appendix would be appropriate.

Response: Good idea. As noted, we have revised the methodology steps and discussion to make implementation more concrete and clear. This includes examples to more clearer communicate the steps and outputs. It also includes a revised SMARTargets Reporting Template that makes the output from each step very explicit.

Having called for illustrative examples in the discussion above, I figured that when I looked at Appendix B, I might finally get some specifics. I remained disappointed. For example, table AE1 tell the reader where they might sensibly set targets, but then the paragraph at the bottom of that page really doesn't tells the reader anything about *how* to go about actually setting those targets. I have much the same reaction to most of the rest of Appendix B. I do note that figure AG3 provides a marginal abatement cost curve of the sort I suggested in my opening comments that a utility might use for all its various sources of emission, but then the discussion never quite gets around to suggesting what to do with such a curve.

Response: Thank you for the feedback. We have revised the main text and Appendix B examples to be more concrete on how to use the illustrative information provided.

Finally, I had to get a magnifying glass to read Table 2, Figure 9, and a few others. Consider flipping them on the page like this:

Response: Helpful feedback. We have revised the table to be easier to read. We have also revisited graphics.

Table 3. Illustration of cross-scenario outcome ranges for multiple variables for a Midwest U.S. region with the SMARTargets core electric sector net-zero CO_2 by 2050 scenarios

Source: EPRI SMARTargets illustrative analysis

Figure note: Ranges associated with the four scenarios described in the Figure 4 notes.

	Affordability			Stability				Optionality	Sustainability			
	Change in Wholesale Electricity Price	Electric Sector Costs		Total New Generation Builds	Total Generation Retirements	Net Power Imports	Variable Renewable Generation	Electric Load Growth	Dispatchable Resources	CO_2 Emissions Reductions	CO_2 Emissions Intensity	In-State Clean Electricity
	% Change vs 2020	$ Billions NPV		GW from 2020	GW from 2020	% of Load	% of Total MWh	% Change vs 2020	% of Total Capacity	% reduction from 2020	% reduction in tCO2/MWh from 2020	% of MWh
		Total	Capital							Electric / Economy		
Ranges for 2035	+109% to +388%	212 to 278	29 to 59	99 to 137	30 to 41	-23% to -3%	52% to 64%	5% to 46%	53% to 61%	77% to 99% / 46% to 92%	79% to 100%	77% to 90%
Ranges for 2050	+19% to +43%	263 to 343	64 to 103	250 to 308	61 to 79	-6% to -2%	74% to 85%	30% to 73%	42% to 50%	100% to 100% / 72% to 126%	100% to 104%	94% to 99%

Professor Roberto Schaeffer, Federal University of Rio de Janeiro

Note: Professor Schaeffer provided feedback that directly responds to the charge questions. Professor Schaeffer's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

Reviewer comments

On the Scientific Foundations:

- **Question 1:** Are we fully considering the science relevant to company GHG target setting, and if not, what specific additions should be incorporated?
  Yes. The relevant science to company GHG emissions target setting is being fully considered. The text makes it clear that, given the climate system dynamics, global warming is a function of both the cumulative emissions and the profile of those emissions over time, and how company GHG target setting is molded by that. Nothing to add here.

- **Question 2:** Do you agree with the key scientific observations and are they adequately supported?
  Yes. The key scientific observations that are listed in the document are correct and adequately supported. Nothing to add here.

- Do you have suggestions for additional key scientific observations or scientific support that you think are important to company GHG target setting conversations and methodologies?
  Nope. Nothing to add here.

- **Question 3:** Do you agree with the methodology scientific and operational requirements derived from the assessment and are they adequately supported?
  The assessment is extremely robust and adequately supported. Nothing to add here.

  Response: Thank you for the constructive feedback on these important questions related to the relevant science, its assessment and insights, and the derived scientific and operational requirements for the methodology. We are glad you support the assessment and conclusions.

On the SMARTargets Methodology: The draft SMARTargets Methodology consists of 3 components that are designed to help companies evaluate and set ambitious and actionable GHG targets and strategies that are aligned with the Paris Agreement and science, as well as help companies assess and manage low-carbon transition risk.

- **Question 4:** Are the components of the methodology and the outputs adequately described and understandable for company implementation and external stakeholder comprehension?
  Yes. All components of the methodology and the outputs are extremely well described and easily understandable for company implementation and external stakeholder comprehension. The documentation provided is extremely clear in all aspects. Nothing to comment on or add here.

Response: Thank you for providing feedback on the methodology documentation. Your positive reaction is very helpful as we consider the drafts strengths and potential improvement opportunities. We have used a similar approach for the next draft. However, we have revised the characterization of the methodology structure and flow based on the feedback from you and others.

- **Question 5:** Are the components and steps appropriately grounded and well-defined for company implementation and for creating meaningful information for informing company strategy and communicating with external stakeholders?
  Yes. All components and steps are absolutely grounded and well-defined for company implementation and for creating meaningful information for informing and supporting company strategy and communicating with all external stakeholders. The documentation provided is extremely robust in all aspects. Nothing to comment on or add here.

  Response: Thank you for providing feedback on the methodology justifications. Your very encouraging response helps us as we consider revision opportunities. We have retained key aspects of the scientific justification. However, based on the feedback from you and others, the justification discussion has been refined to simplify the presentation, avoid misunderstandings, and strengthen key points.

- **Question 6:** In Component 1, the methodology is designed to provide three types of alignment with the Paris Agreement. Are the required aspirational GHG targets aligned with the Paris Agreement and sufficiently justified? Also, do they make sense as a starting point for company assessment, strategy development, and stakeholder engagement? Are the other types of Paris Agreement alignment relevant and sufficiently justified? Is the required evaluation of the Aspirational Targets, enabling conditions, and Qualified Targets without enabling conditions a useful and scientifically justified approach for companies?

  Yes. The SMARTargets Component 1, with its three types of alignment with the Paris Agreement (PA), covers pretty well both quantitative and qualitative alignment with the PA. The required aspirational GHG targets are well aligned with the PA and very well justified. The same can be said about the other types of PA alignment. All the documentation provided is very relevant, well justified and scientifically sound. Nothing to comment on or add here.

  Response: Thank you for providing feedback on the draft Paris Agreement alignment approach. Your supportive reaction has informed our revisions. Based on the feedback from you and others, we have clarified and strengthened the communications and justification on the Paris Agreement alignment approach, as well as differentiated it from alignment with science.

- **Question 7:** In Component 2, practical issues relevant to company GHG target setting and achievement are raised. Is the scientific justification provided sufficient to support consideration of these issues and to potentially not set targets for some emissions categories?
  Yes. In Component 2 all practical issues relevant to company GHG target setting and achievement are raised based on sound scientific justification that is properly provided in the documentation in sufficient detail. Nothing to comment on or add here.

  Response: Thank you for providing feedback on the draft practical issues consideration within the

methodology. These are frequently ignored issues. Your supportive comments reinforce that these are important and relevant.

- **Question 8:** In Component 3, is the proposed company-specific transition risk analysis scientifically appropriate for helping companies identify transition possibilities, uncertainty, risks, enabling conditions, and risk management strategies?
  Yes. The documentation provided is extremely detailed in all aspects. Nothing to comment on or add here.

  Response: Thank you for providing feedback on the transition risk assessment component. Your encouraging response helps us as we consider improvement opportunities. Based on all the feedback received, we have refined and streamlined the discussion to improve comprehension and accessibility.

On SMARTargets Implementation and Outputs: The SMARTargets Methodology is designed to be a standardized process that provides transparency and comparability in steps, analyses, decisions, and outputs, producing a substantial amount of information regarding analyses, targets, strategy, and risk management. The methodology is to be implemented by companies to inform company strategic planning and stakeholders on potential low-carbon transitions, targets and strategies, and risks and risk management; and Appendix B provides implementation examples to help elucidate the steps, inputs, outputs, and the teams involved. Furthermore, the draft SMARTargets Reporting Template illustrates the specific outputs that are possible and proposed from implementing the methodology.

- **Question 6:** Will the methodology produce meaningful information for utilities and stakeholders on potential company transitions, targets, strategies, and enabling conditions, as well as risks and risk management strategies?
  Yes, in all aspects. Nothing to comment on or add here.

  Response: Thank you for the feedback on the outputs produced by the methodology. Your remarks are important confirmation of the value of the types of information proposed to be produced.

- **Question 7:** Will the standardized process provide sufficient transparency and comparability that helps stakeholders understand and evaluate targets and strategies for individual companies as well as across companies?
  Yes, in all aspects. Nothing to comment on or add here.

  Response: Thank you for providing feedback on the standardized process. Your positive remarks confirm that what is proposed can be valuable to stakeholders and companies adopting SMARTargets, facilitating transparency, comparability, communications, and informed dialogue.

On other general aspects: The draft SMARTargets Methodology should be implementable by company practitioners and expert consultants, learn from other relevant experiences (e.g., resource planning), and be understandable to stakeholders and the public.

- **Question 8:** How effective is the current document structure? Are there any sections that you feel could be revised for better clarity and/or flow?
  The current document structure is extremely effective and well thought of. In my view, no additional revisions are needed in the current document, as it is already sufficiently clear, and it also flows very smoothly.

  Response: Thank you for providing feedback on the document structure. Despite your support, given all the feedback received, we have revised the structure significantly to improve accessibility, understanding, and implementation.

- **Question 9:** How does this methodology compare with other frameworks for company-level GHG target setting and assessment you may have encountered?
  On only one occasion I had the chance to review another framework for a specific company-level GHG target setting, and I must confess that this one here is much more robust.

  Response: Thank you for this constructive and supportive statement that SMARTargets is a more robust approach.

- **Question 10:** In addition to the feedback you have provided thus far, are there other elements of the SMARTargets Methodology that you think could be enhanced to further strengthen the methodology?
  I must confess that I am really feeling bad here for not being able to provide any useful comment/feedback. Either I am not smart enough to provide intelligent suggestions, or the document provided is already too good. I sincerely believe (or hope at least) that the latter is the case here.
  Response: Your comments have been very helpful, especially given your particularly salient and essential expertise for this review as a Coordinating Lead Author for the IPCC's Sixth Assessment Report chapter specifically assessing global transition pathways for climate management (IPCC, 2022). Supportive comments are as important as improvement suggestions. Thank you for sharing your extensive IPCC, national modeling, and scientific community research experience and expertise and helping us develop a well-grounded methodology with meaningful outputs.

    - IPCC, 2022a. Riahi, K., R. Schaeffer, J. Arango, K. Calvin, C. Guivarch, T. Hasegawa, K. Jiang, E. Kriegler, R. Matthews, G.P. Peters, A. Rao, S. Robertson, A.M. Sebbit, J. Steinberger, M. Tavoni, D.P. van Vuuren, 2022: Mitigation pathways compatible with long-term goals. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA.

- **Question 11:** Beyond what you may have already provided, do you have additional suggestions regarding references or resources that could be considered and suggestions for how they could be considered? **Nope. In my view the document is comprehensive enough and robust enough, so that no additional suggestions come to my mind. Congratulations.**

  Response: Thank you!

Professor David Victor, University of California San Diego

Note: Professor Victor provided both high-level indirect feedback and direct feedback that responds to the charge questions, including responding to clarification questions from the SMARTargets Team. Professor Victor's comments are below in black and the SMARTargets Team's responses are in blue and denoted with the label "Response."

Reviewer comments

Thanks for the draft SMARTargets materials—the main report plus three additional docs (Science Foundations; Appendix B; and reporting template). I have read them all, focusing on the science foundations and the main report.

The effort is far ranging, complex and thoughtful.

Main comments:

First, I found the materials hard to get organized in my head quickly. Partly that is the volume; partly it is the writing, which is highly repetitive in places; partly it is just the cover pages and the tables of contents that are hard to line up. (A master table of contents and clear logical ordering of the documents would help.) My overall impression is of a document that has a lot to say but at a 30,000 foot level. A lot of the discussion is quite abstract, making it hard to see who would do what with the material on hand—even Appendix B, which I was very keen to read because it thought it would be a worked example with illustrations from real companies. But Appendix B is also pretty abstract—it would benefit from some illustrations (even partial illustrations) of how EPRI has applied these methods to real companies or State IRPs or such. I had no sense what, if I were a utility, the output from this effort would look like,, how it would improve on existing procedures (e.g., IRPs), what it would cost to implement, etc. There's a lot of material here, but readers will need to be able to see the organization and main logical flow quickly.

Response: Very helpful feedback. In response to yours and similar comments, we have revised the draft methodology and supporting materials significantly to make them more accessible, implementable, and to manage the overall volume. This includes creating a new methodology overview that quickly gives the reader an overall feel for the methodology scope and value before diving into step details, scientific justification, and communications/validation. This also includes being less abstract with insights, concepts, and their application, improving the use of figures and tables, and reducing repetition. Note that, the illustrative examples are still somewhat abstract since the full methodology has not yet been applied. We fully expect early adoption of the methodology to be learning opportunities, illustrating the methodology's value and identifying potential refinements.

Second, I think you need to clarify EPRI's role right at the outset—why are you writing this report, the problem you are trying to solve, etc. My understanding is that utilities (electric and gas) today face a lot of reporting and target-setting requirements (e.g., CDP, SBTi, etc etc). But in practice those are too prescriptive and cumbersome and not well enough connected to business strategy—many of those other schemes are pretending to be "science based" when, in fact, the science doesn't prescribe a single pathway. On top of that, climate science doesn't tell companies that face practical challenges—fiduciary duty, lack of adequate technology, adequate policy support, etc—what to do. As I see it, your report is offering some different perspectives on how to address these problems, and I agree 100% that is important to do. But if SMARTargets is supposed to solve that then there needs to be a hard nosed

statement about what you are doing that is new and important. I would also favor some kind of table that offers a comparison—here is what SMARTargets will do for companies that they can't do already, here's what SBTI does (and not), etc etc.

Response: Very helpful suggestion. We have revised the executive summary and introductory material to be more clear about why we are doing this and its value. Many of the points made by Professor Victor are a part of the goal and motivation, as well as inform the methodology design.

Third, related to the above comment, I think the executive summary needs a big reworking. It is highly repetitive and it seems almost to avoid stating your most important findings about how companies need to do X, Y, And Z. The core of the analysis is organized around three big steps—use those same steps in the ES. Also, consider making a box with the core science-based findings (more on this below).

Response: Thank you for the suggestion. We have completely rewritten the executive summary, including repurposing it and substantially shortening it. The executive summary is now focused on introducing the reader to the topic and content. In addition, as mentioned above, a methodology overview has been created that quickly gives the reader an overall feel for the methodology scope and value before diving into details, scientific justification, and communications/validation. We have also revised the key scientific observations and their communications, including graphics, to simplify, make them more accessible, and improve communications on their relevance to corporate target setting.

Fourth, the Science Foundations document seems right to me—I have no disagreements with what you write. I don't think it is a good idea to make it a separate document. instead, I would cut it by a factor of three and embed it into the core paper—or put a short version of it in the main report and then the rest in an appendix. In addition, I don't see why you need to have 12 science observations since many of them overlap on each other and all of them, in varied ways, overlap with the SMARTargets process. As I see it, there's just a few key things to emphasize that come from the SCIENCE:

1. There's no singular relationship between emissions and temperatures. To the extent that "Paris" means a temperature goal (as you know, Paris also has a net zero goal) then there are lots of pathways to get there, and there is no 100% guarantee that any single pathway will absolutely deliver a particular temperature outcome. This is because of uncertainty in climate sensitivity and because of the stock nature of most climate pollutants.

2. There's no singular way to translate global emissions pathways to pathways that apply to regional and national political units, even those most legal obligations and a lot of reporting systems are at the national level. This is because any cost-effective and politically viable strategy will involve allocation of effort that varies by country and sector and because strategies to create collective action by countries (e.g., .CBAM) are still evolving and will have detailed impacts that are hard to predict.

3. There's no single way to translate national emissions pathways into pathways that apply at subnational and sectoral levels. Logic here is same as in item #2 above, but with greater granularity.

4. Climate policy is not an island. It depends on lots of other things in the economy (economic growth, cost of capital, innovation policies, trade, investment, political support) that, in turn, can have big impacts on the best and on practical ways to control emissions.

Reponse: Thank you for letting us know that you agree with the Key Scientific Observations. Thank you also for the suggestions for refining them. We have done exactly that: reducing the number to remove overlap and refining the statements. This process took account of Professor Victor's suggestions above and other feedback. We have also refined the corporate target setting implications to better help readers appreciate the relevance of each Key Scientific Observation and to help them more easily see the connection to the derived scientific and operational requirements for the a science-based methodology.

Maybe I am missing something, but in terms of the SCIENCE it's really those four Plus/minus. From there some implications follow—for example, the need to look at multiple pathways and also at contingent pathways, the need to look at what can be measured and implemented (as opposed to what is imagined as ideal), the need to integrate climate action into business and policy strategy. (By the way, because of all those contingencies and uncertainties—which agree with 100%--I was surprised just to see single trajectories offered as examples in figure 3 of pxiii of the main document—seems to me that the whole point of this exercise is NOT to offer single trajectories.) But those implications are less "science" and more logical extensions of the scientific setup and, in any case, belong centrally in the SMARTargets main document.

Response: Thank you for the additional feedback on the scientific insights. As part of the revision process mentioned in our previous response, we have integrated the suggestions above into the revision of the Key Scientific Observations and the corporate target setting implications. We have also revised the Aspirational Targets graphic referenced so that it now includes the 1.5°C and 2°C global pathway ranges. As noted by Professor Victor, this helps communicate that there are many consistent pathways and wide ranges. It also helps the reader better understand the approach regarding ATs as well as how the overall SMARTargets approach is taking into account the ranges and the uncertainty in future conditions.

Fifth, throughout, there's a lot language issues (eg, targets, pathways, goals, etc) and a lot of complexity in the framing (three components, with subcomponents whose terminology is both complex and doesn't map directly on to the main text) that left my head spinning in places. It could be that my head just spins. But I have the sense that there is a much tighter and more linear organization that could help—as I have suggested for the science section above.

Reponse: Helpful feedback. As noted, we have completely revised the presentation of the methodology to make it more accessible and implementable. As suggested by Professor Victor, the revised presentation of the methodology structure is a linear standardized sequence of steps that is easier to understand, communicate, and document for transparency, validation, and comparability. We have also revised our language for consistency and to reduce unnecessary additional complexity.

Sixth, in many places the charts and text seem to undercut your core message. This is most striking with figure 3 of the main report, which shows aspirational targets as single targets by gas. But the whole idea behind multiple pathways for a stock pollutant (notably CO2) is that there isn't a single route. I worry that we don't have some iconic images. For example, I could imagine a full page chart that showed multiple pathways for the globe on the left, trickling to multiple pathways for multiple countries in the middle, trickling to still more multiple pathways for multiple firms on the right. Or something like that. we really need to hammer home the key point—the "science" doesn't say a single pathway and realistic pathways require attention to a wide range of contingencies. (Related, I would be careful not to equate "paris alignment" with 1.5—instead, point out that no matter what the ultimate temperature goals there are multiple pathways. My work on "blinking" points to the need, soon, for many companies and governments to revise their targets).

Response: Thank you for calling this out. We have revised the graphics (figures and tables) to better support core messages, such as there being multiple and wide ranges of global and sub-global pathways consistent with any global temperature goal. We have ensured that the key point Professor Victor noted is also captured: the science does not identify a single pathway for companies and realistic pathways require attention to a wide range of contingencies. Lastly, we have revised the text to clearly differentiate requirements for being science-based from those for being Paris Agreement aligned. Related to this, we have also noted that the methodology is not dependent on the Paris Agreement or a 1.5°C goal. The methodology is readily updatable to shifts in international goals and scientific understanding. The core concepts for alignment with science and the Paris Agreement, and the need for company-level assessment of transition opportunities and risk are robust.