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planet positive 2030

Strong Sustainability by Design

GUIDING PRINCIPLES

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IEEE

Strong Sustainability by Design - Version 1 (Draft)

Request for Input

Public comments are invited on the first version of ***Strong Sustainability by Design: Prioritizing ecosystem and human flourishing with technology-based solutions*** that identifies specific issues and pragmatic recommendations regarding sustainability and climate change to achieve "Planet Positivity" by 2030.

This draft compendium has been created by committees of the Planet Positive 2030 Initiative[1] that is supported by IEEE Standards Association (IEEE SA). The Planet Positive 2030 Initiative community is composed of several hundred participants from six continents, who are thought leaders from academia, industry, civil society, policy and government in the related technical and humanistic disciplines. At least one hundred fifty members of this community have contributed directly and have worked to identify and find consensus on timely issues.

The document's purpose is to identify specific issues and candidate recommendations regarding sustainability and climate change challenges to achieve "Planet Positivity" by 2030, defined as the process of transforming society and infrastructure by 2030 to:

- Reduce GreenHouse Gas (GHG) emissions to 50% of 2005 emissions by 2030[2]
- Significantly increase regeneration and resilience of earth's ecosystems[3]
- Be well on the path to achieving net zero GHG emissions by 2050 and negative GHG emissions beyond 2050
- Continue to widely deploy technology as well as design and implement new technological solutions in support of achieving technological solutions designed and deployed to achieve "Planet Positivity"

In identifying specific issues and pragmatic recommendations, the document:

- Provides a scenario-based challenge (how to achieve "Planet Positivity by 2030") as a tool to inspire readers to provide contextual technical and general feedback as part of this RFI.
- Advances a public discussion about how to build from a "Net Zero" mentality to a "Net or Planet Positive" ("do more good") societal mandate for all technology and policy.
- Continues to build a diverse and inclusive community for the Planet Positive 2030 Initiative, prioritizing the voices of indigenous and marginalized members whose insights are acutely needed to help ensure technology and other solutions are valuable for all. Of keen interest is how we can encourage more in-depth participatory design in our processes.
- Inspires the creation of technical solutions that can be developed into technical standards (IEEE Standards Association, for example ICT and power & energy related standards, IEEE P7800™ series) and associated certification programs.
- Facilitates the emergence of policies and regulations; regulations that would potentially be interoperative between different jurisdictions (countries).

[1] Planet Positive 2030is part of The Sustainable Infrastructures and Community Development Industry Connections program

[2] As described in the United Nations Climate Change Conference (COP 21) Paris Agreement of 2015.

[3] According to the High Ambition Coalition for Nature and People, "In order to address both the biodiversity crisis and the climate crisis, there is growing scientific research that half of the planet must be kept in a natural state….experts agree that a scientifically credible and necessary interim goal is to achieve a minimum of 30% protection by 2030." Protection for land and water of "30 x 30 by 2030" was recommended during COP15 United Nations Convention on Biological Diversity.

By inviting comments for *Strong Sustainability by Design*, the Planet Positive 2030 community provides the opportunity to bring together multiple voices from the related scientific and engineering communities with the general public to identify and find broad consensus on technology to address pressing environmental and social issues and proposed recommendations regarding development, implementations and deployment of these technologies.

Details on how to submit public comments are available in the **Submission Guidelines**.

Comments in response to this request for input will be considered by the Planet Positive 2030 Initiative committees for potential inclusion in the first public edition of *Strong Sustainability by Design* ("*Strong Sustainability by Design*, First Edition") anticipated to be made available to the general public during the fourth quarter of 2023.

- For further information, learn more at the Planet Positive 2030 Initiative website.
- For our Frequently Asked Questions (beyond RFI submission), please click here.
- Get in touch at: PlanetPositive2030@ieee.orgto get connected to a committee or any other reason.
- Please, subscribe to our newsletter here.

If you're a journalist and would like to know more about the Planet Positive 2030 Initiative, please contact: Standards-pr@ieee.org

Disclaimers

Strong Sustainability by Design is not a code of conduct or a professional code of ethics. Engineers and technologists have well-established codes, and we wish to respectfully recognize the formative precedents surrounding issues of sustainability and the professional values these codes represent. These codes provide the broad framework for the more focused domain addressed in this document, and it is our hope that the inclusive, consensus-building process around its design will contribute unique value to technologists and society as a whole.

This document is also not a position, or policy statement, or formal report of IEEE or any other organization with which is affiliated. It is intended to be a working reference tool created in an inclusive process by those in the relevant scientific and engineering communities prioritizing sustainability considerations in their work.

A Note on Affiliations Regarding Members of Planet Positive

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A Note Regarding Recommendations in This Document

Strong Sustainability by Design is being created via multiple versions that are being iterated over the course of two to three years. Planet Positive2030 is following a specific concurrence-building process where members contributing content are proposing “candidate” recommendations so as not to imply these are final recommendations at this time. This is also why the word, “Draft” is so prominently displayed.

Our Membership

Planet Positive2030, an initiative supported by the IEEE Standards Association as part of the Industry Connections Program, Sustainable Infrastructures and Community Development program (SICDP) currently has more than 400 experts involved in our work, and we are eager for new voices and perspectives to join our work.

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Guiding Principles - Table of Contents

Please click Principle names to go directly to each Principle.

Guiding Principles

Future Vision

It is 2030.
Greenhouse gas (GHG) emissions are significantly reduced, and the earth's lands and ecosystems are on the way to recovery as imagined by the 2022 Convention on Biodiversity[4]—a recovery that will enable planetary-scale environmental regeneration and resilience.

The catalyst for this transformation was a profound sense of urgency stemming from the looming *climate emergency* as the earth moved closer to the climate tipping point (*the point of no return)*. The transformation has been driven by a reformed sense of leadership and planetary-scale collaboration informed by the notion of *deep care*—for the environment, for the earth's biospheres and for human dignity (ascribed to all people, including historically marginalized populations, equally).

Decision-makers have adopted caregiving and long-term sustainability as guiding principles for action to address both the need for reduction of greenhouse gas emissions and adaptation to the unavoidable impacts of climate change. The majority of global political, business, and community leaders, many of whom represent groups marginalized in the past, have more fully embraced the values of justice, diversity, equity, and inclusion in shaping new policies, new economic and business models, new tools for measuring growth, and new standards of practice.[5]Sustainable behavior that balances today's needs with the needs of future generations is now integral to cultures around the globe—for individuals as well as for organizations.

Humans are sharing the planet's resources with a vast variety of other organisms. Emerging technologies, including responsibly developed artificial intelligence systems (AIS), are being applied to implement climate change mitigation and adaptation strategies. We have developed sustainable and regenerative practices and have recognized that we are caretakers of the planet. Change is driven by an increased awareness of the interconnectedness and interdependence among different types of stakeholders.[6]

[4] UNConvention on Biological Diversity, Conference of the Parties, CBD/COP/15/L.25, (18 Dec. 2022), https://www.cbd.int/doc/c/e6d3/cd1d/daf663719a03902a9b116c34/cop-15-l-25-en.pdf

[5]The UN "Guiding Principles on Business and Human Rights" contain three chapters, or pillars: protect, respect, and remedy. These pillars define specific, actionable steps for governments and companies to take to meet their respective duties and responsibilities aimed at preventing human rights abuses in company operations, and provide remedies if such abuses occur. These guiding principles are valid for all kinds (and sizes) of businesses.
Seehttps://www.ohchr.org/documents/publications/guidingprinciplesbusinesshr_en.pdf.

[6]Stakeholders are human-centric and other lifeforms and the environment, including: the earth's biospheres, peoples, individuals, institutions, businesses, industries, governments, organizations, academia, and society at large.

Introduction

The goal of a long-term, flourishing planet Earth can be attained if the current warming trend of the earth's atmosphere is first halted and then reversed. Reduction of GHG emissions is a paramount goal. While shifting from fossil fuel-based economies to largely greenhouse gas emissions-free economies is the foremost agenda to address the looming climate crisis, it is also important to observe a balance for all stakeholders between the urgency of today's energy and societal needs, the urgency of tomorrow's looming climate catastrophe and achieving a long-term, flourishing planet Earth.

Embracing complexity throughout the pursuit of this goal is vital. The increasing recognition of interdependencies between society and the environment means that the transition to a sustainable future is a complex or "wicked problem."[7] This means the process of transitioning to a planet-positive society will not be easy or straightforward. Competing goals and problem sets, different cultural or governance approaches, and moving or unmeasurable targets mean that the journey will not be linear and will not be without political—or other forms of—disagreements or conflict. Indeed, addressing and responding to the realities of climate change may be the most important and complex problem humanity has ever faced. Failure to do so will have lasting harmful impacts and consequences for all stakeholders, including present and future humanity and the planetary biospheres. Honoring, recognizing, and including the large diversity in stakeholder cultures and in local, regional and global conditions and needs requires flexibility and a diversity of approaches to creating a planet positive society.

The very succinct **definition of planetary sustainability** by an unknown participant from Africa at the United Nations (UN) meeting in Johannesburg (Rio + 10), **"Enough for All—Forever"** can serve as a key guidepost. Individual, institutional, business, industry, government, organizational, academic and societal stakeholders share the responsibility to "take care" of the planet Earth and its biospheres, our home.

The **guiding principles** of *Strong Sustainability by Design* are intended to provide a framework for the document's strategies and recommendations capturing both the desire for planetary sustainability and the complexity that is inherent in fulfilling this desire. They embody the overall "impossible" goals of Planet Positive 2030.[8]

[7] Horst W. J. Rittel and Melvin M. Webber, "Dilemmas in a General Theory of Planning," *Policy Sci* 4 (1973):,155–169.

[8] The Two "Impossible" Goals of the Planet Positive 2030 Initiative:
Transform society and infrastructure to achieve Planet Positivity.
Identify the technological solutions we need to design, innovate and deploy to reach Planet Positive 2030.

The foundation: The need for a flourishing planet, human rights, and values

The foundation for the guiding principles is the need for a flourishing planet to sustain all life. The guiding principles are built upon the United Nations (UN)Universal Declaration of Human Rights,[9] Declaration on the Rights of Indigenous Peoples,[10] Declaration on the Rights of Disabled Persons,[11] Declaration on the Right to Development,[12] Rio Declaration on Environment and Development,[13] Resolution on the human right to a clean, healthy and sustainable environment,[14]and Convention on the Rights of the Child; regional human rights declarations; and the IEEE Code of Ethics.[15]

Human dignity and the human values of peace, freedom, social progress and equal rights form the values basis underlying *Strong Sustainability by Design*. Enshrined within the UN's Charter and its Universal Declaration of Human Rights for nearly three-quarters of a century, these broad values have guided the UN's efforts to fairly represent the world's diverse nations and cultures.

Alignment with UN values embraces a powerful declaration for universal human values that guide human societies. Having those values form the basis for *Strong Sustainability by Design*'s guiding principles provides a powerful, cultures-wide foundation for guiding the efforts of humans as caretakers and caretaker advocates of a flourishing planet.

Essential to the success of the guiding principles are accountability, transparency, freedom of expression, and protection of whistleblowers. The goal is a flourishing planet—all nations, all peoples, all that supports life.

[9] UN General Assembly, Resolution 217 (III), Universal Declaration of Human Rights, A/RES/217 (III) (10 Dec. 1948), https://www.un.org/en/about-us/universal-declaration-of-human-rights.

[10] UN General Assembly, Resolution 61/295, *Declaration on the Rights of Indigenous Peoples*, A/RES/61/295 (13 Sept. 2007), https://www.un.org/development/desa/indigenouspeoples/wp-content/uploads/sites/19/2018/11/UNDRIP.

[11] UN General Assembly, Resolution 3447, *Declaration on the Rights of Disabled Persons,* A/RES/3447 (9 Dec. 1975) https://www.un.org/disabilities/documents/convention/convoptprot-e.pdf.

[12] UN General Assembly, *Declaration on the Right to Development,* A/RES/41/128 (4 Dec. 1986). https://www.ohchr.org/sites/default/files/Documents/Issues/Development/RTD_booklet_en.pdf.

[13] UN General Assembly, *Report of the United Nations Conference on Environment and Development (3-14 June 1992), Annex I: Rio Declaration on Environment and Development*, A/CONF.151/26 (vol. I) (12 Aug. 1992), A/CONF.151/26/Vol.I: Rio Declaration on Environment and Development (un.org).

[14] "UN General Assembly Declares Access to Clean and Healthy Environment a Universal Human Right," UN News, United Nations, 28 July 2022, accessed 5 Sept. 2022, https://news.un.org/en/story/2022/07/1123482.

[15] "IEEE Code of Ethics," adopted by the IEEE Board of Directors, 2020, accessed Feb. 2023, https://www.ieee.org/content/dam/ieee-org/ieee/web/org/about/corporate/ieee-code-of-ethics.pdf.

Ten guiding principles

1. ***Responsible and ethical leadership from individuals, organizations, and communities.*** The responsibilities of individuals, of organizations, and of communities should be broadened to include an increased role in addressing the challenges of climate change, sustainability, and socioeconomic and environmental stewardship. New knowledge brings responsibility and demands action. Leadership requires collaboration and cooperation with ***all*** stakeholders impacted by decisions. Implementation of technology and policy development must always consider environmental flourishing and human wellbeing in accordance with specifics established by guidelines such as the United Nations Sustainable Development Goals.[16]

2. ***Justice, diversity, equity, and inclusion.*** Championing justice, diversity, equity, and inclusion should be a part of climate change strategies recognizing that climate change impacts are often felt most by those with the least resources. It is the responsibility of those with the most resources to support those who lack resources in an equitable manner. Addressing climate change should reduce conflict, violence, and inequity.

3. ***Energy systems transformation.*** The transition from a fossil fuel-based energy system to a system that is based on clean and sustainable sources of energy must ensure that energy accessibility, affordability, sustainability, and reliability are maintained through all phases of the transition. This transition should also *ensure access for all to affordable, reliable, sustainable, and modern energy.*[17] A successful energy transition will enable GHG emission reductions not only in the energy/power sectors but in all sectors using energy, thereby supporting the decarbonization and electrification of these sectors.

4. ***Mitigation and adaptation.*** In responding to the challenge of climate change, and to prevent a climate catastrophe, society needs to both mitigate (i.e., reduce) GHG emissions and adapt to the impacts of a changing climate. Both goals require urgent action. The goals of mitigation and adaptation may come into conflict, and society will have to balance these conflicts.

5. ***The regenerative imperative and a circular economy.*** Thinking and action must broaden beyond current economic, business, societal, and resource utilization models to achieve sustainability and for people and the planet to flourish for many generations to come. Future economic, societal, and business models should take resource constraints into account and emphasize new public imperatives such as circularity, ecological regeneration, zero waste, and human flourishing and well-being.

6. ***Balance between today's needs and the needs of the future.*** In the course of transitioning societies and the global economy toward a sustainable future, today's short-term needs must balance with the long-term, global aspirations for a flourishing planet. This balanced approach should address all needs, including access to food and clean water, health care, and other essential goods necessary for a healthy standard of living.

[16] "The 17 Goals," Department of Economic and Social Affairs, Sustainable Development, United Nations, accessed Feb. 2023, https://sdgs.un.org/goals.

[17] "Goal 7: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All," Department of Economic and Social Affairs, Sustainable Development, United Nations, accessed 9 Nov. 2022, https://sdgs.un.org/goals/goal7.

7. ***Alignment of global goals with local goals and actions***. The transition to a more sustainable future will be driven by local actions that should also produce positive global benefits. Local actions and global goals should support each other.

8. ***Culture of sustainability***. Strategies and actions should move society toward building a culture of sustainability and 'doing good' that is based on respect for all living beings and for the Earth. Sustainability efforts must move beyond minimizing harm to restoring and regenerating human and environmental systems.

9. ***Responsible use of technology and technology labeling.*** The design, development, use, and disposal of technology should be a dynamic ongoing process for evolving an appropriate, timely response to both *negative impacts*—the unforeseen consequences of technology on people and planet—and *positive impacts*—the opportunities to relieve suffering, increase flourishing and equity, and better steward the planet.

10. ***Knowledge-based decisions, transparency, and accountability*.** Informed decisions are based on metrics, sound data, relevant information, context, experience, and perspective; these factors all contribute to knowledge and accountability. Knowledge-based decisions are thus made on the basis of good evidence and sound reasoning; this, in turn, can make hard decisions more defensible and accountable. Application of appropriate metrics and reevaluation of decisions at appropriate time intervals enable accountability and corrective actions.

The following sections of this chapter discuss each of the guiding principles in more detail, including providing recommendations.

Guiding Principle 1—Responsible and ethical leadership from individuals and organizations

The responsibilities of individuals, of organizations, and of communities should be broadened to include an increased role in addressing the challenges of climate change, sustainability, and socioeconomic and environmental stewardship. New knowledge brings responsibility and demands action. Leadership requires collaboration and cooperation with ***all*** stakeholders impacted by decisions. Implementation of technology and policy development must always consider environmental flourishing and human wellbeing in accordance with specifics established by guidelines such as the United Nations Sustainable Development Goals.

Background

Professional communities include technical and nontechnical professionals[18] who are committed to a sustainable future and who are experienced and knowledgeable regarding the paths toward this future. There is an imperative for leadership from this community to inspire global cooperation and collaboration at all levels of society.

This leadership imperative applies to both individuals and organizations. Individual responsibility includes the choices and actions of our lives and our roles in leading change within organizations. Organizations play a significant role in achieving long-term sustainability of the earth's biospheres since their decisions and activities impact the planet on both community and global scales. Organizations should see themselves as both agents for increasing "collective good" and understanding imperatives to implement necessary structural and operational changes. In doing so, professional communities make key contributions towards achieving a flourishing planet.

Increased engagement in public policy that is focused on creating a more sustainable world will be necessary. Professional communities will need to utilize technical knowledge and understanding of stakeholder concerns and leadership skills to help guide public investment decisions and promote necessary regulatory shifts.

Recommendations

1. Work with professional organizations to broaden their definitions of professional responsibility to place greater emphasis on sustainability, climate change, environmental stewardship, and responsible technology.

2. Engage in activities focused on educating, communicating, and engaging with the public regarding the science behind climate change, the value that the natural world provides to society, and the future impacts of climate change.

3. Support efforts to incorporate leadership in sustainability and programs of technical skills related to sustainability, climate change action, and environmental stewardship in the curriculum for professional education and other fields of study.

4. Support efforts and highlight best practices related to the inclusion of sustainability and environmental, social, and governance (ESG) metrics for all types of organizations.

[18] Includes professionals from various technical, scientific, and nontechnical disciplines.

5. Support the sustainability leadership initiatives of other organizations and collaborate with these organizations for increased impact.

6. Engage in public policy advocacy at all levels of government that supports the goals of Planet Positive 2030.[19]

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

Case studies

1. According to Engineering Change Lab—USA, there are two key elements to the leadership imperative.[15]
    - Stepping up to leadership roles:
        - Communicating, connecting, convening, and caregiving
        - Challenging the status quo and catalyzing change
        - When necessary, taking the heat and holding steady
    - Building bridges:
        - Collaborating across disciplines and with all other stakeholders
        - Proactively reaching out across divides and between factions
        - Managing polarities and resolving conflicts
        - Committing to an open-source ideology that also recognizes sources
        - Maintaining cultural awareness and empathy

Further resources

1. Annas, George J., Chase L. Beisel, Kendell Clement, Andrea Crisanti, Stacy Francis, Marco Galardini, et al. "A Code of Ethics for Gene Drive Research." *The CRISPR Journal* 4, no. 1 (19 Feb. 2021).

2. Engineering Change Lab USA (website).

3. Engineering for One Planet (website).

4. McMeekin, Mike. "Climate Change Noble Purpose for Engineering Statement," 12 Aug. 2021.

5. Sustainable Development Technology Canada (website).

[19] The Two "Impossible" Goals of the Planet Positive 2030 Initiative:
Transform society and infrastructure to achieve Planet Positivity.
Identify the technological solutions we need to design, innovate and deploy to reach Planet Positive 2030.

Guiding Principle 2—Justice, diversity, equity, and inclusion

Championing justice, diversity, equity, and inclusion should be a part of climate change strategies recognizing that climate change impacts are often felt most by those with the least resources. It is the responsibility of those stakeholders with the most resources to support those who lack resources in an equitable manner. Addressing climate change should reduce conflict, violence, and inequity.

Background

Climate change, sustainability, and environmental challenges affect people differently based on factors such as location and resources. Some of these impacts can be direct, such as how extreme weather events and rising temperatures can disproportionately affect historically marginalized communities who may not have the resources to adapt to these changes. Those with fewer resources are often the most affected and have the least ability to respond to the impacts of climate change and other sustainability-related challenges.

The involvement of historically and currently marginalized populations allows for unique experiences and perspectives to be contributed to the decision-making processes of government, especially concerning sustainability. For example, communities of color may face different environmental health risks and challenges compared to other groups, and their input on how to address these issues can be valuable and essential for successful change.

Therefore, it is beneficial for governments and organizations to actively engage with historically marginalized communities, listen to their voices, and take their experiences into account when creating policies and making decisions about sustainability. This will allow for the solutions developed to be more comprehensive, so everyone in society can benefit from a sustainable future.

More specifically, climate change can have a range of impacts on historically marginalized communities. These impacts include the health impacts of air pollution, lack of access to clean water and sanitation, rising sea levels, extreme weather events, and other climate-related events. These impacts have—and will—lead to a lowered quality of life.[20]

In addition, intersectionality includes multiple forms of social inequalities and vulnerability that interconnect and overlap with each other. Intersectionality addresses more than the categories of identities; it also includes the intricacies necessary to understand persistent social, political, and structural inequalities that, in turn, translate into various types of vulnerabilities and the unequal caring of needs and responsibilities.

Technology plays a critical role in managing climate risks and impacts, but historically marginalized communities are often left out from benefiting from these technologies. The Technology for Climate Justice Reporting Framework in Figure 22.4, *Reporting framework for technology to address Loss and Damage and contribute to climate justice* aims to analyze technology needs to reduce losses and damages for

[20] IPCC, "Climate Change: A Threat to Human Wellbeing and Health of the Planet. Taking Action Now Can Secure Our Future," press release no. 2022/08/PR, 28 Feb. 2022, https://www.ipcc.ch/site/assets/uploads/2022/02/PR_WGII_AR6_english.pdf.

decisionmakers. The framework includes two repositories of technologies: one for technologies currently used to address impacts and risks and another for planned technologies.[21]

As of early 2023, millions of people living in the northern region of Africa are on the brink of famine, struggling to have one meal a day. Drought has devastated their living conditions. Climate change causes droughts to be more frequent and severe, which will continue to negatively impact the lives of the African people.

Indigenous peoples, who are especially reliant on their land for day-to-day survival, are leading the way with initiatives aimed at quelling the environmental disasters they suffer as a result of global warming and extreme weather conditions.

And yet, despite the discrepancy in how different groups and countries are affected by climate change, many previous negotiations and policy decisions have excluded nongovernmental organizations, activists, civil society, and those most vulnerable to the effects of climate change. These groups, while present, are not allowed an equal opportunity to contribute to policy decisions. Human rights must always be respected in the implementation of decarbonization strategies. Technically advanced, wealthier countries have a responsibility to respect the human rights of all people.

The common rhetoric surrounding climate change implies that the effects of climate change exclusively impact developing nations, while, in reality, developed nations are far from exempt. It is often the marginalized communities in developed nations who also suffer from its uneven impacts.[22,23,24] Notably, in 2005, Hurricane Katrina completely devastated and changed the lives of many Americans, but the people who were hurt the most were people of color, women, children, the poor, and people with disabilities.

Recommendations

1. *Utilize resources and disseminate climate information in formats that are accessible to communities.*[25] For example, in Banke and Bardia district in Nepal, they used community information boards to explain appropriate flood mitigation measures and the community-based early warning system. Please, see Figure 22.1, https://link.springer.com/chapter/10.1007/978-3-319-72026-5_22/figures/1 in "Technology for Climate Justice".[26]

[21] Marc van den Homberg and Colin McQuistan, "Technology for Climate Justice: A Reporting Framework for Loss and Damage as Part of Key Global Agreements," chap. 22 in *Loss and Damage from Climate Change: Concepts, Methods and Policy Options*, ed. Reinhard Mechler, Laurens M. Bouwer, Thomas Schinko, Swenja Surminski, and JoAnne Linnerooth-Bayer (Springer, Cham, Climate Risk Management, Policy and Governance book series, 29 Nov. 2018), https://doi.org/10.1007/978-3-319-72026-5_22.

[22] The Data Team, "Climate Change Will Affect Developing Countries More Than Rich Ones,"*The Economist*, 9 May 2018, https://www.economist.com/graphic-detail/2018/05/09/climate-change-will-affect-developing-countries-more-than-rich-ones?ppccampaignID=17210591673&ppcadID=&gclsrc=ds&gclsrc=ds.

[23] "Climate Change and the Developing World: A Disproportionate Impact," *U.S. Global Leadership Coalition* (blog), Mar. 2021, https://www.usglc.org/blog/climate-change-and-the-developing-world-a-disproportionate-impact/.

[24] Kermal Davis, "Devastating for the World's Poor: Climate Change Threatens the Development Gains Already Achieved,"UN Chronicle, from vol. XLIV, no. 2 "Green Our World!" (2007), https://www.un.org/en/chronicle/article/devastating-worlds-poor-climate-change-threatens-development-gains-already-achieved.

[25] Farzaneh Shaikh Khatibi et al., "Can Public Awareness, Knowledge and Engagement Improve Climate Change Adaptation Policies," *Discover Sustainability* 2, no. 1 (23 Mar. 2021): 1–24, https://doi.org/10.1007/s43621-021-00024-z.

[26] van den Homberg and McQuistan, "Technology for Climate Justice."

2. *Develop climate change ambassadors from different communities* as messengers, prepared with leadership support, tools, training, and resources to communicate with and engage the public and community partners on their climate change issues.[27]

3. *Integrate intersectional thinking into climate solutions,* collaboration between communities, policymakers, and other key stakeholders through bridging traditional knowledge and climate science[28] and active participation at each stage—from engagement in creating policy and developing technology to implementing solutions and strategies for climate change—and working in collaborative ways with all levels of community and government.[29]

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

Case studies

1. Biskupska, Natalia, and Albert Salamanca. Co-Designing Climate Services to Integrate Traditional Ecological Knowledge: A Case Study for Bali, Indonesia. Stockholm: Stockholm Environment Institute, Oct. 2020.

2. Second Nature. "Climate Justice Case Studies." Accessed 15 Jan. 2023.

Further resources

1. Amorim-Maia, Ana T., Isabelle Anguelovski, Eric Chu, and James Connolly. "Intersectional Climate Justice: A Conceptual Pathway for Bridging Adaptation Planning, Transformative Action, and Social Equity." *Urban Climate* 41, art. 101053 (Jan. 2022).

2. Bruine de Bruin, Wändi, and M. Granger Morgan. "Reflections on an Interdisciplinary Collaboration to Inform Public Understanding of Climate Change, Mitigation, and Impacts." *Proceedings of the National Academy of Sciences* 116, no. 16 (Jan. 2019): 7676–7683.

3. Fadahunsi, Olayemi. "Climate Change on the Front Line: Why Marginalized Voices Matter in Climate Change Negotiations." Global Witness (blog). 9 Aug. 2017.

4. UN General Assembly, Resolution 61/295. Declaration on the Rights of Indigenous Peoples. A/RES/61/295. 13 Sept. 2007.

[27] U.S. Fish and Wildlife Service National Wildlife Refuge System, *Climate Change Communications and Engagement Strategy for the National Wildlife Refuge System*, Feb. 2014, https://climatechange.lta.org/wp-content/uploads/cct/2015/03/ClimateChangeEngagementStrategyFinal.pdf.

[28] Gleb Raygorodetsky, "Why Traditional Knowledge Holds the Key to Climate Change," United Nations University (online resource), 13 Dec. 2011, https://unu.edu/publications/articles/why-traditional-knowledge-holds-the-key-to-climate-change.html.

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Guiding Principle 3—Energy systems transformation

The transition from a fossil fuel-based energy system to a system that is based on clean and sustainable sources of energy must strive to maintain energy accessibility, affordability, sustainability, and reliability through all phases of the transition. This transition should also strive to provide access for all to affordable, reliable, sustainable and modern energy.[30] A successful energy transition will enable GHG emissions reductions not only in the energy/power sectors but in all sectors using energy, thereby supporting the decarbonization and electrification of these sectors.

Background

In 2021, the International Energy Agency published a roadmap to building a global energy sector with net zero emissions. The target date was 2050. In it, the agency called for a "complete transformation of how we produce, transport and consume energy," and that this process hinged, "on an unprecedented clean technology push to 2030."[31] Covering a broad and interconnected range of human activities—power generation, transportation, heating and cooling, industry, agriculture and more, all producing greenhouse gas emissions[32]—such a complete transformation of the world's energy infrastructure is a complex and difficult undertaking.

This energy system transformation is critically necessary considering that almost three quarters of the global greenhouse gas emissions are associated with the energy sector (electricity, heat and transportation); see diagram showing global greenhouse gas emissions by sector for 2016 at https://ourworldindata.org/emissions-by-sector.

This energy system transformation is feasible as reported by researchers at LUT University and the Energy Watch Group in their report: *Global Energy System based on 100% Renewable Energy*[33] and by Christian Breyer et al.[34] Other authors comment that wind and solar may not be enough, as "the only way in which wind/solar could meet all (or nearly all) global energy needs is if energy use is drastically curtailed."[35] Many degrowth and limits-to-growth experts agree.[36] Nuclear power generation is suggested as a fossil fuel

[30] "Goal 7: Ensure Access to Affordable, Reliable, Sustainable and Modern Energy for All," Department of Economic and Social Affairs, Sustainable Development, United Nations, accessed 9 Nov. 2022. https://sdgs.un.org/goals/goal7.

[31] Bouckaert, Stéphanie, Araceli Fernandez Pales, Christophe McGlade, Uwe Remme, and Brent Wanner. *Net Zero by 2050: A Roadmap for the Global Energy Sector*, (Paris: IEA, May 2021), https://www.iea.org/reports/net-zero-by-2050.

[32] Hannah Ritchie, "Sector by Sector: Where Do Global Greenhouse Gas Emissions Come From?" *Our World in Data* (online resource), 18 Sept. 2020, accessed 5 Sept. 2022, https://ourworldindata.org/ghg-emissions-by-sector.

[33] Manish Ram et al., *Global Energy System Based on 100% Renewable Energy—Power, Heat, Transport and Desalination Sectors*, Study by Lappeenranta University of Technology and Energy Watch Group (Berlin: Lappeenranta University of Technology, March 2019), http://energywatchgroup.org/wp-content/uploads/EWG_LUT_100RE_All_Sectors_Global_Report_2019.pdf.

[34] Christian Breyer et al., "On the History and Future of 100% Renewable Energy Systems Research." *IEEE Access* 10 (2022): 78176—78218, https://ieeexplore.ieee.org/document/9837910.

[35] Patrick Moriarty, and Damon Honnery, "Feasibility of a 100% Global Renewable Energy System," *Energies* 13, no. 21 (22 Oct. 2020), https://doi.org/10.3390/en13215543.

[36] J. P. Hansen, P. A. Narbel, and D. L. Aksnes, "Limits to Growth in the Renewable Energy Sector," *Renewable and Sustainable Energy Reviews* 70 (2017), https://doi.org/10.1016/j.rser.2016.11.257.

alternative that can make up renewable energy deficits,[37,38] but it faces concerns including accidents and nuclear waste management. Other emerging energy technologies, such as geothermal and negative emission biofuels will additionally factor into production deficits. Most scenarios and projections predict it will take a combination of technologies to transition to a fossil fuel-free global energy system.

The energy system transformation is not limited to switching from fossil fuel-based energy sources, it also requires energy efficiency measures and energy conservation. Energy conservation (e.g., turning a device off when not in use) and energy efficiency measures (e.g., replacing high-intensity discharge light bulbs with LED lighting for street lighting) are the low-hanging fruit.

This transition must address the disposition of the elements of our old energy system(s) through integration into the new system, reuse, and waste minimization. Depending on local and regional contexts, this may or may not be extraordinarily difficult for both technical and human or social reasons. It will be technically complex due to the interconnectedness of competing needs, often expressed as the *food/l*and-*w*ater-*e*nergy *nexus*, for example for biofuels.[39] Agriculture and solar panels may compete for land use. Energy production may have significant water requirements.[40]

Perhaps more difficult will be the human and social challenges;[41] political constraints;[42] and economic challenges.[43] Steering this transition through so many conflicting challenges will not be an easy task. But the cost of maintaining the existing energy infrastructure is far higher—the future of our planet's ecosystems. Manish et al.[44] claim that renewables-based energy generation will be more cost-effective than current systems.

This difficult transition must balance human and planetary needs—an *equitable* balance. A "just transition" as described by the Stockholm Environment Institute is "a transition that minimizes disruption for workers and communities reliant on unsustainable industries and energy sources."[45] This transition provides for

[37] Duc Hong Vo et al., "The Role of Renewable Energy, Alternative and Nuclear Energy in Mitigating Carbon Emissions in the CPTPP Countries," *Renewable Energy* 161 (2020), https://doi.org/10.1016/j.renene.2020.07.093.

[38] The Oxford Institute for Energy Studies, "The Role of Nuclear Energy in the Global Energy Transition" https://a9w7k6q9.stackpathcdn.com/wpcms/wp-content/uploads/2022/08/The-Role-of-Nuclear-Energy-in-the-Global-Energy-Transition-ET14.pdf, 2022

[39] SDSN/FEEM 2021, *Roadmap to 2050: The Land-Water-Energy Nexus of Biofuels*, Sustainable Development Solutions Network (SDSN) and Fondazione Eni Enrico Mattei (FEEM), 2021, https://roadmap2050.report/static/files/roadmap-to-2050-biofuels.pdf.

[40] "Special Report: Water vs. Energy," *IEEE Spectrum*, 28 May 2010, https://spectrum.ieee.org/special-reports/water-vs-energy/.

[41] Martin Pasqualetti, "Social Barriers to Renewable Energy Landscapes," *Geographical Review* 101, no. 2, (Apr. 2011), https://doi.org/10.1111/j.1931-0846.2011.00087.x.

[42] Oksan Bayulgen and Jeffrey W. Ladewig, "Vetoing the Future: Political Constraints and Renewable Energy," *Environmental Politics* 26, no. 1 (2017):49-70, https://doi.org/10.1080/09644016.2016.1223189.

[43] James P. Dorian, Herman T. Franssen, and Dale R. Simbeck MD, "Global Challenges in Energy," *Energy Policy* 34, no. 15 (2006): 1984-1999, https://doi.org/10.1016/j.enpol.2005.03.010.

[44] Manish Ram et al., *Global Energy System Based on 100% Renewable Energy.*

[45] Georgia Piggot et al., *Realizing a Just and Equitable Transition Away from Fossil Fuels*, (Seattle, WA: Stockholm Environment Institute, Jan. 2019) https://www.sei.org/wp-content/uploads/2019/01/realizing-a-just-and-equitable-transition-away-from-fossil-fuels.pdf.

accessibility, ubiquitous access, affordability, sustainability, and reliability for the differing cultural and economic needs of diverse multitudes, as it develops and implements clean and sustainable energy sources for all.

Ultimately, despite these challenges and complexities, this energy system transformation is a ***doable task.*** According to Julia Steinberger, an ecological economist at the University of Lausanne, the process "is entirely doable, and it is doable fast, but it will come with a price tag which will then be repaid forever after in a prosperous and healthy society."[46] There will be innumerable benefits. They will result in economic opportunities, particularly for less developed countries, as economies are built upon access to abundant energy resources. Societies will experience a tremendous positive health impact in response to clean air and water,[47] for example, preventing premature deaths and reducing healthcare costs. There will be many others.

Models exist, such as leveraging innovations from the space industry and other environments where sustainability principles are critical.[48] There are other roadmaps and resources to help guide the way.

Most importantly, energy systems transformation is achievable—it is a *doable* task.

Recommendations

Address the energy transition to a renewable, clean electricity-based system as an early priority and in a contextualized, sustainable way, as it is an energy enabler for other sector transitions. Associated water, food, and communications (i.e., connections to the internet and services) challenges will be easier to resolve as the new energy generation and distribution system spreads across geographies and cultures, making clean renewable electricity widely accessible.

1. *Collaborate among all nations on the energy transition process, while factoring inequity differences between countries.* Consider all nations as being part of the energy transition process, especially the poorest nations who themselves don't have the wealth or resources available to acquire renewable energy systems. All nations should feel confident that the international community will provide the necessary support, for example, knowledge, information, and best practices for transitioning their economies from fossil fuel dependence to renewable energy-based systems. No nation should be excluded or unable to participate in this transition, nor should the transition pose too great an economic burden. Such a barrier would hinder active participation with the rest of the global community. This transformation should be economically affordable, technologically sustainable, reliable, and available to all nations regardless of their economic status.

2. *Implement the United Nations recommendations for the renewable energy transition:*[49]

[46] Sam Meredith and Lucy Handley, "'It Is Entirely Doable, and It Is Doable Fast': Experts on How to Navigate the Energy Transition," *CNBC*, 22 Nov. 2021,https://www.cnbc.com/2021/11/22/climate-how-to-navigate-the-energy-transition-away-from-fossil-fuels.html.

[47] Yijun Gai et al., "Health and Climate Benefits of Electric Vehicle Deployment in the Greater Toronto and Hamilton Area," *Environmental Pollution* 265, pt. A (2020), https://doi.org/10.1016/j.envpol.2020.114983.

[48] Deep Space Food Challenge (website), https://www.deepspacefoodchallenge.org/.

[49] "Five Ways to Jump-Start the Renewable Energy Transition Now," UN Climate Action (website), May 2022,https://www.un.org/en/climatechange/raising-ambition/renewable-energy-transition?gclid=cj0kcqjwzqswbhdparisak38ly_wxnq8bmgjruizfo_efcix3o6vcu0nplcld6571whngsz5fi2jpleaakjiealw_wcb.

a. "Make renewable energy technology a global public good via radically increased actions in policy, education, media, and other venues."[50,51]
b. "Improve global access to components and raw materials via financial incentives, public-private partnerships, governmental and private sector support."[52]
c. "Level the playing field for renewable energy technologies versus fossil fuel-based energy."[53]
d. "Shift energy subsidies from fossil fuels to renewable energy."[54]
e. "Triple investments in renewables."

3. *Decentralize and diversify energy production* as much as practical and feasible. Distributed generation increases resilience, reliability, and reduces transport.[55]

4. *Encourage and incentivize energy conservation*—energy not used, need not be produced—energy not used, need not be paid for:
    a. Through widespread educational campaigns and possibly sharing metering devices for individuals to test power consumption of devices.
    b. Incentivize energy efficient devices of all kinds—for example, from light bulbs to vehicles.
    c. Give ownership "of energy consumption" to the user through data sharing and choices, for example, the London Hydro Green Button program.[56]

5. *Strongly enable participation by small- and medium-sized enterprises in the energy sector*. This will help decentralization and diversification of energy production as well as development of energy-efficient devices and services, and, at the same time, support economic development.

6. *Increase technical literacy in general and technical knowledge/know-how* through workforce retraining and development[57] to support appropriate procurement and use of technology as well as safe, knowledgeable operation and maintenance of deployed technologies.

7. *Educate for a future literacy mindset.*[58]

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[50] Paul Komor, and Morgan Bazilian, "Renewable Energy Policy Goals, Programs, and Technologies," *Energy Policy* 33, no. 14 (2005), https://doi.org/10.1016/j.enpol.2004.03.003.

[51] Elke D. Groh and Charlotte v. Möllendorff, "What Shapes the Support of Renewable Energy Expansion? Public Attitudes between Policy Goals and Risk, Time, and Social Preferences," *Energy Policy* 137 (2020), https://doi.org/10.1016/j.enpol.2019.111171.

[52] Benjamin K. Sovacool, "Expanding Renewable Energy Access with Pro-Poor Public Private Partnerships in the Developing World," *Energy Strategy Reviews* 1, no. 3 (2013): 181–192, https://doi.org/10.1016/j.esr.2012.11.003.

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https://www.taylorfrancis.com/chapters/edit/10.4324/9781849772341-16/removing-subsidies-levelling-playing-field-renewable-energy-technologies-jonathan-pershing-jim-mackenzie.

[54] Laura Merrill et al., *Making the Switch: From Fossil Fuel Subsidies to Sustainable Energy* (Nordic Council of Ministers, 10 May 2017), https://books.google.com/books?id=t1QkDwAAQBAJ&dq=Shift+energy+subsidies+from+fossil+fuels+to+renewable+energy&lr=&source=gbs_navlinks_s.

[55] David Grosspietsch, Marissa Saenger, and Bastien Girod, "Matching Decentralized Energy Production and Local Consumption: A Review of Renewable Energy Systems with Conversion and Storage Technologies," *WIREs Energy and Environment* 8, no. 4 (9 Jan. 2019), https://doi.org/10.1002/wene.336.

[56] "Green Button Platform," London Hydro (website), accessed 5 Sep. 2022, https://www.londonhydro.com/greenbutton.

[57] Judith Macdonald Fueyo, "Technical Literacy versus Critical Literacy in Adult Basic Education," *Journal of Education* 170, no. 1 (Jan. 1988), https://doi.org/10.1177/002205748817000109.

8. *Share best practices and know-how widely* for communities and business around the globe to implement.[59]

9. *Design and implement new energy systems*—including production, transport, storage, and use—from the outset such that the components enable a circular economy (as much as possible).[60]

10. *Provide for ubiquitous reliable access to resources.* Strive to provide ubiquitous reliable access to clean, affordable sustainable energy and access to water, clean air, food, and services around the globe as the transition completes.

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

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Guiding Principle 4—Mitigation and adaptation

In responding to the challenge of climate change, and to prevent a climate catastrophe, society needs to both mitigate (i.e., reduce) GHG emissions and adapt to the impacts of a changing climate. Both goals require urgent action. The goals of mitigation and adaptation may come into conflict, and society will have to balance these conflicts.

Background

Upon releasing a new IPCC report in February 2022, the IPCC noted in a press release:

> *The report clearly states Climate Resilient Development is already challenging at current warming levels. It will become more limited if global warming exceeds 1.5 °C (2.7 °F). In some regions it will be impossible if global warming exceeds 2 °C (3.6 °F). This key finding underlines the urgency for climate action, focusing on equity and justice. Adequate funding, technology transfer, political commitment and partnership lead to more effective climate change adaptation and emissions reductions.*[61]

As of 2022, the Nationally Determined Contributions (NDCs) by countries to mitigate GHG emissions to limit warming to less than 1.5 °C (as agreed by the Paris Accord to be the target to protect the planet) is currently viewed as insufficient.[62]

In early 2023, the IPCC AR6 Synthesis Report stated in 2.1. under the headline: Observed Changes, Impacts and Attribution:

> *Human activities, principally through emissions of greenhouse gases, have unequivocally caused global warming, with global surface temperature reaching 1.1°C above 1850-1900 in 2011-2020. Global greenhouse gas emissions have continued to increase over 2010-2019, with unequal historical and ongoing contributions arising from unsustainable energy use, land use and land-use change, lifestyles and patterns of consumption and production across regions, between and within countries, and between individuals (high confidence). Human-caused climate change is already affecting many weather and climate extremes in every region across the globe. This has led to widespread adverse impacts on food and water security, human health and on economies and society and related losses and damages6 to nature and people (high confidence). Vulnerable communities who have historically contributed the least to current climate change are disproportionately affected (high confidence).* [63]

[61] IPCC, "Climate Change."

[62] "The CAT Thermometer," Climate Action Tracker (online resource), Nov. 2022, Available at: https://climateactiontracker.org/global/cat-thermometer/.

[63] IPCC, "AR6 Synthesis Report", 2023, https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_LongerReport.pdf

Mitigation

As soon as feasible, mitigate human caused GHG emissions. GHGs include carbon dioxide, which form the bulk of the problem, as well as methane and nitrous oxide, which also hold heat in the atmosphere. It is not possible to instantly stop all processes that create GHGs because they are intertwined with the daily lives of citizens. It is necessary to find and implement sustainable solutions that generate energy, products, and services without generating GHG emissions, or, at the very least, significantly reduced GHG emissions. In some cases, this will require research, development, and innovation, very quickly.

Time is of the essence. According to a UN Intergovernmental Panel on Climate Change (IPCC) report finalized on April 4, 2022, to limit warming to 1.5 °C, global GHG emissions should peak before 2025 and be reduced by 43% by 2030. Methane must be reduced by 34% by 2030. Even if we are willing to tolerate warming of 2 °C, global GHG emissions must peak before 2025 and be reduced by 27% by 2030.[64]

All sectors of the economy will have to contribute. Key sources of GHG emissions are illustrated in Figure TS.6 of the IPCC mitigation report.[65] This figure illustrates direct plus indirect GHG emissions by end-user sector for 2019: industry 34%, agriculture/forestry/land use 22%, buildings 16%, transportation 15%, and other 12%.

It is not just about electricity production. Looking at electricity and heating production, it contributes 23% of total carbon dioxide (CO_2) emissions and is distributed across the sectors above. While ground transportation may be able to transition to electricity, innovations will be needed to transition food production, protect nature, and produce steel, cement, and other industrial processes.

GHGs linger in the atmosphere for hundreds of years. While reforestation, biomass, and other natural systems can sequester carbon (ocean, land, soil sequestration), innovative breakthroughs are needed to achieve decarbonization - even if the mitigation goals are met. Carbon capture and storage is one of the approaches. Because carbon capture and storage require energy (endergonic systems), it is necessary to power carbon sequestration and storage with non-GHG "green" energy sources such as solar energy.

Adaptation

Adapt to the climate changes that people are and will be facing. In this document, adaptation is a method—or methods—for being resilient; that is, it is the ability of society to maintain essential functions and structures as well as to generate the capacity for its transformation. This adaptation will also require dealing with extreme weather events that climate change is making more frequent and more intense. Unfortunately, there is a significant gap between the current state of adaptation and the needed adaptations.[66]

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[64] Priyadarshi R. Shukla et al., ed. Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, (Cambridge, UK and New York, NY: Cambridge University Press, 2022), https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/.

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[66] *Climate Change 2022: Mitigation of Climate Change. Working Group II Contribution to the IPCC Sixth Assessment Report*, Technical Summary, p. 71, TS.D.1, https://www.ipcc.ch/report/sixth-assessment-report-working-group-2

Preparing for extreme weather. Climate change is making extreme weather more intense and more frequent. Reducing the risks caused by extreme weather requires planning, building resilient infrastructure, and strengthening natural systems like dunes and lagoons.

Preparing for extreme climate. Adaptive actions are needed to reduce vulnerability of natural and human systems. For example, changes in farming and land management practices will be needed, including the identification and development of species of crops and livestock with increased resilience.

Adaptations are usually planned and implemented as a response to extreme events and are focused on the specific risks they bring. For example, coastal flooding may result in new adaptation projects such as ecosystem replanting or building hard infrastructure such as levees. These projects may buy time to consider longer-term projects such as relocating people and structures from harm's way. The adaptations recommended below are organized by the specific risk they pose.

The 2022 IPCC report warns that "Available evidence on projected climate risks indicate that opportunities for adaptation to many climate risks will likely become constrained and have reduced effectiveness should 1.5 degree C global warming be exceeded."[67]

Our generation's responsibility to future generations. We must expeditiously solve the climate crisis so that we leave future generations a world that is supportive and nurturing.

Recommendations for mitigation of GHG emissions

Note: The recommendations indicate responsibility for action—Corporate/Industry (I), Policy/Government (G), Academia (A), and Community/Individual (P). A lowercase letter indicates a secondary level of responsibility.

1. *Electrify all land-based transportation* (which constitutes 10% of GHG emissions). Passenger cars, trucks, and buses are the low-hanging fruit of the transportation sector for quick electrification. There are few technology problems to be solved. Government policy action could begin to mandate this as well as establish a recharging infrastructure.

2. *Reduce emissions from planes* (1.8% of GHG emissions) *and ships* (1.6% of GHG emissions) and invest in research and development (R&D) for biomass fuels - provided they are sustainable -, improved fuel efficiency, and electrification. Technology challenges around the latter include the weight and energy density of batteries. Other R&D ideas include using hydrogen either as a fuel or for fuel cells, assuming hydrogen can be produced with green electricity.

3. *Switch the electricity grid* (23% of GHG emissions) *to renewable, clean electricity generation*. There is little reason to delay this transition and continuation of building new fossil fuel power plants prolongs the carbon emissions. Further R&D is needed for energy storage and for building the necessary infrastructure to handle distributed generation (e.g., solar panels on houses and buildings).

4. *Electrify heating* (5%of GHG emissions) *and cooking* (1% of GHG emissions). There are no technological barriers to decarbonizing buildings and house heating and cooking.

[67] Portner et al., Technical Summary in Climate Change 2022. p. 43.

5. *Reduce emissions from agriculture, livestock, and food supply* (11% of GHG emissions). This could be accomplished through demand-side changes (reducing eating of beef for example), improved efficiencies (e.g., reducing food waste), and technological changes to reduce emissions on the production side (e.g., lower energy methods of making fertilizer and changing the diet of cows and rice growing methods to reduce methane emissions).

6. *Reverse deforestation and protect the ocean*. Trees and the ocean store a tremendous amount of carbon. Oceans store approximately 6 billion metric tons of carbon per year, with trees/soil storing another 0.3 billion metric tons/year.[68]

7. Reduce greenhouse gas emissions coming from industry, including from the production of cement, steel, plastic, and other manufacturing (24% of GHG emissions).

8. *Develop and/or deploy carbon dioxide removal methods to counter residual emissions*. While all the above recommendations will reduce the amount of new carbon in the atmosphere, it is still necessary to eliminate the carbon people have been generating since the industrial revolution. While some of this can be done by enacting policies to encourage tree planting, reforestation, and low-till farming, it is likely innovations will be needed to capture and sequester additional atmospheric carbon. Another highly viable option may be increased ocean-based carbon sequestration. While not all greenhouse gas emitting industrial processes may be replaced by decarbonized processes in the short term, the emissions produced by these installations should be captured to avoid adding further to the atmospheric greenhouse gas levels.[69]

9. *Clearly capture, analyze, and publicize actionable information on GHG contributions from products, services, and sectors* to allow company, organizational, and personal decision-making to reduce GHG emissions.

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

Recommendations for adaptation to climate change

Unlike mitigation responses, which have a global impact, adaptation tends to be done at the local level and focused on specific risks.

It is impossible to list all potential responses, but this list of recommendations provides examples of some of the common threats.

1. Coastal socioecological systems.

[68] Ken Buesseler et al. and The Ocean Twilight Zone Team at Woods Hole Oceanographic Institution, *The Ocean Twilight Zone's Role in Climate Change*, ed. Jesse Ausubel (Woods Hole Oceanographic Institution),

[69] Buesseler et al., *The Ocean Twilight Zone*, 90.

a. *Harden coastal defenses*. Dikes, seawalls, flood barriers and other hard infrastructure provide temporary protection but may worsen the problem in the long run by allowing unsustainable development (an example of "maladaptation").

b. *Implement integrated coastal zone management*. Ecosystem-based approaches (setting aside wetlands at the blue-green interface, replanting coastal grasses and salt marshes) provide additional space for coastal systems to migrate inland.

c. *Plan coastal retreat when other approaches become insufficient or unaffordable*.

2. Terrestrial systems.
   a. *Implement forest-based adaptation*. Implement sustainable forest management, forest conservation and restoration, reforestation, and afforestation, restoring natural vegetation and wildfire regimes.

   b. *Implement sustainable aquaculture and fisheries*. Eliminate overexploitation and reduce pollution and runoff.

   c. *Practice biodiversity management and ecosystem connectivity*.

3. Water security.
   a. *Improve water use efficiency* and reduce leaks in water systems.

   b. *Improve water resource management*. Set aside additional reservoirs, catchments, and wetlands to catch and maintain water during variable rainfall.

   c. Prepare for rationing in times of severe drought.

4. Food security.
   a. *Improve cropland management*. Implement earlier planting, changes in crop varieties, improvement in water management for crops, use of heat-and drought-adapted genotypes, soil improvements, soil moisture conservation, and agricultural diversification.

   b. *Implement efficient livestock systems*. Implement improvements in water management for livestock, genetic improvements for heat and drought varieties, and reduced intensification of livestock management to improve resilience.

   c. *Support R&D* related to cultivating agricultural and livestock species with increased resilience to temperature, water, and other climate stressors. Develop new practices and promote existing, for example indigenous knowledge-based, to conserve food and live with weather extremes.

5. Urban infrastructure.
   a. *Implement green/blue urban infrastructure*. Utilize urban agriculture, urban trees, green roofs, parks and open spaces, rain gardens, and watershed restoration.

   b. *Create sustainable land use and urban planning*. Consider reforestation in and around urban areas, allocating additional land to sea level rise and disincentivizing development in vulnerable areas.

   c. *Require new buildings to be resilient and able to withstand extreme weather conditions. Older buildings should be similarly renovated.* Modify building codes to consider climate change risks

locally to require energy backup systems, emergency water tanks, raising buildings above the flood protection elevation level, reinforcing roofs, and building in wildfire resistance, as appropriate.

d. *Implement sustainable urban water and sanitation management*. Harden infrastructure to work during floods and droughts.

e. *Improve knowledge at the local and regional levels* (hydraulic studies, flood zones, risk assessments), raise awareness in local communities of the risks, create threat monitoring capabilities (e.g., stream and river monitoring), and establish plans to reduce vulnerability to existing and new buildings. More specific data (hyperlocal) would help people and communities better understand the risks they face.

6. Energy systems.
   a. *Make community power systems more resilient to extreme weather events*–for infrastructure critical to society and our economy. With the transition to electric transportation vehicles, factories, heating, and so forth, the need for reliable energy systems becomes increasingly important.

   b. *Consider the potential impact to power systems of multiple risks simultaneously*: extreme heat increasing demand, drought reducing cooling water for power systems, widespread heat waves reducing the ability to source power from neighboring areas. In the southwestern United States and other drought-prone areas, hydroelectric systems are at risk of reducing power output, requiring other systems to shoulder increased loads. Electric Vehicles are creating a new and significant demand on domestic power networks. Energy demand used for air-conditioning could triple by 2050.[70]

   c. *Enhance the electricity grid infrastructure*. Integrate distributed energy sources such as solar panels as well as storage systems to buffer the loads and provide more resilience.

   d. *Improve the efficiency of cooling equipment*. As cooling is increasingly needed in many locations around the planet, it will be important to improve the cooling provided per kilowatt of power.

7. Human health.
   a. *Develop health information systems*. Implement integrated risk management, early warning systems, disease tracking and management (e.g., Lyme disease, malaria, new virus strains).

   b. *Create health system adaptations*. Implement vaccine development for existing and new disease coverage, mental health support, improved heat resistance of the built environment, and advanced water and sanitation systems.

   c. *Prepare for heat stress*. Implement heat action planning, cooling centers, air-conditioning subsidies, and cooling suits for outdoor workers.

   d. *Secure water quality/quantity*. Provide clean drinking water as local water resources dry up.

[70] Faith Birol, "Seven Steps to Make Electricity Systems More Resilient to Climate Risks," World Economic Forum, 15 July 2021, accessed 30 Jan. 2023, https://www.weforum.org/agenda/2021/07/climate-change-electricity-energy-security-extreme-weather/.

e. *Develop health emergency response plans*. Disasters and climate change–induced health issues require more emergency response capabilities.

8. Living standards and equity.
   a. *Provide education/reeducation to allow livelihood diversification* as climate change eliminates some jobs.

9. Peace and mobility.
   a. *Plan for relocation and resettlement*. Limits to adaptation are already being reached in some areas for both animals and humans. Some experts consider mobility to be a response rather than an adaptation but may be necessary as additional parts of the earth become inhabitable due to sea level rise, heat, or drought approaching 2050. Society must reduce the impacts of relocating vulnerable populations and infrastructure due to sea level rise, wildfires, heat, and drought.

   b. *Enable human migration.* Barriers to voluntary migration and resettlement should be addressed.

   c. *Support ecosystem migration.* Many species are moving to cooler climates where possible. Humans need to assist in this effort where necessary to help sustain the ecosystem on which we depend.

10. Cross-cutting solutions.
   a. *Integrate climate change into all planning* (e.g., federal, state, city, and company plans) *and implementation of conservation and environmental management*.

   b. *Organize disaster risk management*. Society must prepare for extreme events caused by climate change, such as floods, heat waves, drought, hurricanes, tornadoes, wildfires, insect and disease outbreaks. Companies, organizations, and communities must develop personnel disaster risk-management strategies to prepare for extreme weather and climate conditions.

   c. *Create early warning systems*. Speed the development of systems to forecast and warn of extreme events, provide situational awareness, and communicate important information.

   d. *Develop social safety nets*. Strengthen social services for extreme events and climate change–induced disruption such as food insecurity.

   e. *Create risk-spreading and cost-sharing systems*. Develop community seed banks, wells and water systems, and power systems.

   f. *Develop a systems-oriented approach to reduce the conflict and trade-offs between mitigation and adaptation and to support long-term resilience*.

   g. *Support research into solar radiation modification* (SRM), which seeks to reflect more sunlight back into space, reducing the heating of Earth. Further study is needed to understand its benefits and risks.

   h. *Support research and development in all areas of adaptation* to speed adaptation and reduce costs. The long-term goal is to flow investment into mitigation projects to reduce the GHG emissions and climate heating.

i. *Establish regional, national, and international cooperation capabilities to respond to extreme weather conditions*, for example, a regional transmission organization to share electric load and water system partnerships to improve water system reliability and system capability.

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

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Guiding Principle 5 - The regenerative imperative and a circular economy

Thinking and action must broaden beyond current economic, business, societal, and resource utilization models to achieve sustainability and for people and the planet to flourish for many generations to come. Future economic, societal, and business models should take resource constraints into account and emphasize new public imperatives such as circularity, ecological regeneration, zero waste, and human flourishing and well-being.

Background

Waste characterizes our linear economy. Single-use items from finite resources are discarded into landfills and float in vast ocean patches, wash onto beaches, spill across forests, and soil lakes and streams. Material waste produced by a throwaway economy is destroying entire ecosystems. Coupled with energy waste fueled by fossil fuels pumped from finite reserves, the damage is further compounded by duplicate waste in many areas—even as other areas struggle with not having even basic energy needs met. The GHGs from these efforts, in turn, are warming a finite atmosphere and fueling a climate crisis that threatens the future of the planet—and life itself.

Humanity faces an imperative: the need to transition from this wasteful linear economy to a system both sustainable and regenerative. A circular economic system is needed: a system in which finite resources are turned into items that not only have a history but a future.

This means taking a resources stewardship approach, which maintains resources indefinitely for future generations. As popularized in William McDonough's seminal book, *Cradle to Cradle: Remaking the Way We Make Things*, this necessitates moving from linear *cradle-to-grave* resource usage to *cradle-to-cradle* circular utilization in which nothing goes to waste.[71] Resources are extracted once from the planet, and after extraction, they enter a circular, ongoing usage cycle. The end-of-life cycle for one item sees its components rebirthed in others. The planet does this naturally, as in nature, there is no waste. The by-product of one process is the feedstock for another process.

Governments must create circular economies that manage waste to zero, maximize resources, and incorporate "de-manufacturability." Common steps and targets in such transitions are available and known. Steps to taking a "Circular Economy" approach and ranging from smarter product manufacture to recovery of materials are detailed here.[72]

Implementing these targets will not be an easy task. Technologies must be expedited to capture and reuse the many types of linear waste. Social structures will have to be developed to foster the transition from linear economics to a circular counterpart. This is a complex and challenging undertaking.

Waste management is just one goal of an emerging circular economy.

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[71] William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things*, (New York: North Point Press, 2002), http://www.mcdonough.com/writings/cradle-cradle-remaking-way-make-things/.

[72] Piero Morseletto, "Targets for a Circular Economy," *Resources, Conservation, and Recycling* 153 (2020), https://doi.org/10.1016/j.resconrec.2019.104553.

- "Circular Economy has the potential to understand and implement radically new patterns and help society reach increased sustainability and wellbeing at low or no material, energy and environmental costs."[73]

The challenges and successes are similar to implementing a space habitat such as the International Space Station or communities able to survive for generations in inhospitable (hot, cold, dry) environments. In the context of resources, experiences, knowledge, and so forth, space habitats are based on the premise of circular design closed-loop systems that minimize and utilize waste as much as possible.

Resource management is the second critical challenge. This requires the reuse of components of manufactured items either directly or as feedstock for new products. It also requires regeneration of the earth's ecosystems and biospheres that sustain life on Earth. This includes regenerative farming practices, restoring ecosystems like mangrove forests and coral reefs (to name a few), and reversing desertification in many places around the world.

Finally, the regenerative imperative and circular economy also require changes in the way products and services are designed. Design requirements for strong sustainability must include "design for de-manufacturability."

Recommendations

1. *Governments must develop policies that encourage and support development and implementation of new innovations.* Support must also be given to businesses and organizations who are applying these innovations and building circularity and regenerative practices into their business and organizational models, including their supply chains, products, and services.
    a. Given the challenges and risks associated with these new features, businesses should be rewarded for their ambition and leadership whenever they succeed in proving that new economic and business models are both viable and profitable.

    b. The philosophy behind a circular economy is one that sees multiple, collaborative social segments as forces for good. Business, government, academia, community, and society-at-large all become domains in which innovative solutions can be created for tackling global problems and achieving planetary sustainability.

2. *Set targets, R&D milestones, and develop policies and resources to implement:*
    a. Necessary *social infrastructure* around waste reclamation and reuse. Paradoxically, waste reclamation often "ironically increases the risk of creating a demand for these waste streams, which thereby may become commodified" and increase linear economy path dependencies.[74]

    b. Creation of future *economic and business models* expanding upon, and emphasizing, regeneration, human flourishing, and well-being.[75,76]

[73] Patrizia Ghisellini, Catia Cialani, and Sergio Ulgiati, "A Review on Circular Economy: The Expected Transition to a Balanced Interplay of Environmental and Economic Systems," *Journal of Cleaner Production* 114 (2016): 11–32, https://doi.org/10.1016/j.jclepro.2015.09.007.

[74] Rachel Greer, Timo von Wirth, and Derk Loorbach, "The Waste-Resource Paradox: Practical Dilemmas and Societal Implications in the Transition to a Circular Economy," *Journal of Cleaner Production* 303 (2021), https://doi.org/10.1016/j.jclepro.2021.126831.

[75] Patritzia Ghisellini et al., "A Review on Circular Economy."

c. *Natural ecosystem regeneration*, such as reversal of desertification, restoration of wetlands, and so forth.

3. *Set policy for and practice contextualized regenerative farming and food production*.

4. *Expedite research, development, deployment, and adoption of technologies promoting ten common circular economy strategies*.[77]
   a. *Refuse*. Eliminate unnecessary single-use products.

   b. *Rethink*. There are two aspects: 1) production of multipurpose "widgets" rather than a number of single-use "widgets" and 2) develop a sharing economy (equipment rental) and/or sharing community (neighborhood sharing).

   c. *Reduce*. There are two aspects: 1) using less resources in production of "widgets" and 2) reduction of consumption of goods.

   d. *Reuse*. Develop a sharing economy, passing items from one user to another.

   e. *Repair*. The right to repair should be inherent with every product.

   f. *Refurbish*. Rebuilding, refurbishing with repaired or improved parts.

   g. *Remanufacture*. De-manufacture "widgets" into reusable parts for other products or the same type of product.

   h. *Repurpose*. Innovative use of widgets for purposes other than originally intended—as a whole or in part or with additional parts.

   i. *Recycle*. Sorting end-of-life items for reuse of materials.

   j. *Recovery*. Recovery of materials through separation of materials into feedstock streams for the "next" semipermanent product.

5. *Design systems and products from the outset for circularity.*
   a. Design, implement, and operate installations and/or devices to include end-of-life plans for circularity.

   b. Design systems for zero waste (minimizing waste) and maximizing efficiencies.

   c. Design for modularity, repairability, high efficiency, and long service.

   6. *Make accounting more encompassing regarding values.* Move forward from gross domestic product (GDP) accounting toward accounting inclusive of other metrics (environmental, biosphere, well-

[76] Paul Shrivastava and Laszlo Zsolnai, "Wellbeing-Oriented Organizations: Connecting Human Flourishing with Ecological Regeneration," *Business Ethics, the Environment & Responsibility* 31, no. 2 (2022): 386–397, https://doi.org/10.1111/beer.12421.

[77] Morseletto, "Targets for a Circular Economy."

being, etc.). GDP does not capture unpaid work of caregivers and other aspects of the caring economy; volunteer efforts that contribute to the economy; leisure time; and other aspects that are important to human well-being.

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

Case studies

1. Singapore Turns Sewage into Clean, Drinkable Water, Meeting 40% of Demand
   "The tiny island nation has little in the way of natural water sources and has long had to rely principally on supplies from neighboring Malaysia. To boost self-sufficiency, the government has developed an advanced system for treating sewage involving a network of tunnels and high-tech plants."
   Agence France-Presse. "Singapore Turns Sewage into Clean, Drinkable Water, Meeting 40% of Demand." VOA News. 10 Aug. 2021.

2. Zero-Waste Communities across the Globe
   Eight cities in Asia, Europe, and North and South America, along with four online communities, showcase approaches to zero waste.
   "Zero Waste Communities Across the Globe." Zero Waste (blog). 3 Mar. 2021.

3. Nine Examples That the Transition to a Regenerative Economy is Underway
   "Southface Institute has created the following series of case studies to share success stories from regenerative economy pioneers. Each case study examines its subject through the interdependent lenses of the natural environment, the social environment and the built environment."
   Shea, Bailey, and Shane Totten. "Nine Examples That the Transition to a Regenerative Economy is Underway." Southface Institute (blog). 23 Mar. 2021.)https://www.shareable.net/9-ways-to-create-a-local-regenerative-economy/

4. 9 Ways to Create a Local Regenerative Economy
   Nine steps towards creating decentralized cooperative local economies that emphasize local production with local resources to meet local needs to build local wealth.
   Bjonnes, Roar. "Nine Ways to Create a Local Regenerative Economy." Shareable (website). 11 Aug. 2021.

5. Achieving one-planet living through transitions in social practice: a case study of Dancing Rabbit Ecovillage
   "This article examines DR's extraordinary energy and resource savings through the lens of social practice theory, which focuses on the meanings, competencies, and materials that individuals combine to form everyday practices."
   Boyer, Robert H. W. "Achieving One-Planet Living through Transitions in Social Practice: A Case Study of Dancing Rabbit Ecovillage". *Sustainability: Science, Practice and Policy* 12, no. 1 (2016): 47–59.

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Guiding Principle 6—Balance between today's needs and the needs of the future

In the course of transitioning societies and the global economy towards a sustainable future, today's short-term needs must balance with the long-term, global aspirations for a flourishing planet. This balanced approach should address all needs, including access to food and clean water, health care, and other essential goods necessary for a healthy standard of living.

Background

At the heart of sustainability is the understanding that our resource utilization cannot surpass the rate of resource availability and reuse. There is only one earth in our planetary system. If the earth's biosphere gets destroyed, there is no new home for life on earth. With this in mind, the aim is to reduce resource waste through an understanding of current needs and needs of the future to avoid Earth Overshoot Day (the point at which our consumption outstrips the planet's biocapacity in each annual cycle).[78] Therefore, a required understanding of our present socioeconomic capacity contextualized among individuals and communities—locally to globally—is needed while integrating the multifactorial conditions that determine resource utilization, availability, and rate and the effects of these on our environment.

Another way of expressing this imperative is that decisions should follow the *Seventh Generation Principle* in which "decisions made today should result in a sustainable world seven generations into the future."[79] This intergenerational mindset should see all people concerned for the health and well-being of future generations, that is, all people's children's children and the generations beyond, just as much as people are concerned for their own health and well-being today.

Healthy humanity depends upon a healthy planet, both directly through the ecological services that it offers and indirectly through the positive impacts of the living environment on stress and mental health. It also requires an understanding of how needs differ across demographics and how climate change may influence these needs, while accounting for future adaptations and changes. For example, if consumption outstrips production, people today impoverish their children. Overconsumption is not the only issue; for example, a lack of recycling of wastes that contaminate the environment will also have direct and indirect population effects. There is no return from extinction!

We need to develop adjustment mechanisms that allow us to constantly improve our social and economic systems such that we can provide for our short-term needs with one hand, while working on the long-term transformation process with the other hand.

Recommendations

1. Consider stakeholder needs and the impacts of projects in the short, medium, and long term.

2. Design for maintainability, sustainability, repair, reuse, and recycling.

[78] Earth Overshoot Day (website), https://www.overshootday.org.

[79] Indigenous Corporate Training (website), accessed 16 Aug. 2022, https://www.ictinc.ca/blog/seventh-generation-principle#:~:text=The%20Seventh%20Generation%20Principle%20is,seven%20generations%20into%20the%20future.

3. Maintain the right to repair and the right to tinker.

4. As much as possible, avoid creating single-use products.

5. Develop collaborations between programs, organizations, and institutions (e.g., government, academic, and nonprofits) that have an understanding of and data available for individual and community needs.

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

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Guiding Principle 7—Alignment of global goals with local goals and actions

The transition to a more sustainable future will be driven by local actions that should also produce positive global benefits. Local actions and global goals should support each other.

Background

The more that local societies align their own goals and actions with global goals and objectives, the greater likelihood we will achieve a fundamentally sustainable planet. Local communities across our globe have been, are, and will be impacted directly and indirectly by climate change. Moreover, there are local differences across communities: at the individual level, at the family level, at the housing level, at the neighbor and community level, at the village, town, and city level, and at the county, state, and national level. At *all* levels, we will benefit by integrating relevant data and information from diverse sources that contextualize, weights, and evaluates outputs that educate our decision-making to produce positive global benefits. From this approach, local actions will match and move towards our global goals.

This is significant and beneficial, as this approach accounts for the diverse and multifactorial effects of climate change. The people of communities most impacted by climate change are also poor, disadvantaged, and underserved and, therefore, are the least able to respond appropriately and effectively. These also include agricultural, manufacturing, and environmental goods communities, where climate events directly and indirectly lead to socioeconomic impacts that have global implications.

Thus, the impacts of climate change effects will lead to increased competition and conflict, lower general quality of life and health, and increased inequities. Through balancing our socioeconomic factors globally through technological means, and in a manner that is also beneficial for distributed local communities in need, not only will we successfully address climate change, we also will address socioeconomic issues—such as poverty, lack of education, and lack of socioeconomic mobility and support—faced by communities across the world, while also addressing potential conflicts and inequities. In turn, this will lead to improved human rights, well-being, competence, and accountability as well as improve outcomes in response to climate change. This strategy will make the best use of resources and collective capacity for the well-being of future generations, and it will promote a shared and heightened understanding of human cultures and experiences in a technology-supported world.

Recommendations

1. Organize and/or research local to global relationships accounting for differences in a multifactorial approach of human (e.g., demographic, health, occupation, and education) and environmental factors (e.g., temperature, humidity, flora, and fauna), independently and dependently, regionally, and across time (past, present, and future).

2. Connect low-income, high-risk, and high-need communities with programs and organizations that can provide immediate, short-term, and/or long-term support.

3. Organize, develop, guide (from preexisting initiatives, new initiatives, and also, ideally, integrated collaborations), and engage relevant technologies and communities—for example, government, organizations, academia, and industry—that address and support recommendations 1 and 2, with emphasis and priority given to technologies and programs that apply sustainable practices and

knowledge that are inexpensive, simple, approachable, relevant, and long-lasting and that minimize resource utilization and waste.

4. Organize details and share diversity, equity, inclusion, and accessibility information that is adapted for and empathetic toward individual, cultural, and socioeconomic differences and circumstances in support of sustainable programs.

5. Develop timelines and objectives that are adaptive in real time and in the short and long term and are based on priorities and factors related to local and global contexts from the above recommendations and that balance, align, and integrate local and global goals and initiatives.

6. Develop knowledge sharing and communication mechanisms that teach—both technical and nontechnical—actions and outcomes across backgrounds and professions, realizing that the current intellectual property protection system can pose barriers to sharing solutions.

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

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Guiding Principle 8—Culture of sustainability

Strategies and actions should move society toward building a culture of sustainability and doing good that is based on respect for all living beings and for the earth. Sustainability efforts must move beyond minimizing harm to restoring and regenerating human and environmental systems.

Background

Actions are most powerful and effective when we have a clear understanding of what we are doing, how we can do it, and perhaps most importantly, why our actions are necessary and important. The more we understand how our human civilization is impacting and changing the world around us, the more capable and confident we, as a global community, can be to make necessary changes. These changes must be made not only in our own personal lives but also within the technological systems that underpin our societies and the global economy. Indeed, the more we understand the significance of our individual choices and the immense power of our collective, international actions, the global problems and challenges that we face today should become less threatening and more manageable, if not resolvable. We must therefore understand that every action we take should lead us one step closer to achieving a sustainable future.

Many great sustainability initiatives and purpose-driven organizations have been launched in recent years, with the United Nations Sustainable Development Goals (SDGs) one of the most well-known. Recent research (see the *Nature* article in Further Resources) has shown, however, that while the SDGs have had positive effects in terms of generating global discussion, as well as shaping some isolated policy reforms, "there is little evidence that goal setting at the global level leads directly to political impacts in national or local politics." This suggests that goal setting is largely ineffective unless it is also accompanied by a *commitment and willingness to act* at the local level in accordance with the stated goals such as the SDGs.

Acting sustainably, therefore, starts with individuals, communities, organizations, and nations making an explicit commitment to live, work, grow, and prosper in accordance with the necessary courses of action that promote the long-term health and well-being of all living beings and ecological systems on our planet. This commitment needs to be made not just at the level of individuals but also within systems at local, national, and international levels. This commitment then needs to be written into actionable policies. Culture also plays a key role in embedding this commitment to act sustainably within the social psychology of organizations and other large collectives.

This is a global problem, and we are all interconnected; therefore, we cannot rely on each nation or region to cease unsustainable actions or implement sustainable ones in isolation. Although poorer countries are impacted more severely by the impacts of climate change, they did not contribute the most to the current crisis. Similarly, they are the least able in terms of resources, technology, and time to take significant actions.

Recommendations

1. We, that is, business, academia, government, society, organizations, and individuals, must recognize and acknowledge that talking about sustainability is futile unless we also seriously commit to taking the necessary actions to achieve long-term planetary health and well-being—actions speak louder than words.

2. To act sustainably, businesses, industries, governments, international and other organizations should inscribe and/or embed their commitment to long-term planetary health and well-being into their policies, codes of conduct, mission statements, and other governing doctrines.

3. Businesses and industries need to recognize that they play a central role in how natural resources are either used and/or impacted by their business activities. Businesses and industry need to establish an ecological consciousness. They need to take a proactive role in overseeing how their business is impacting the environment, combined with methods and procedures that aim to minimize environmental impact and achieve best practices and optimal use of resources while doing business. These actions must be consistently invested in and applied to every aspect of their businesses—not just in building design or supply chains but also in the artificial intelligence (AI) they build or implement, in their work from anywhere versus forced commute policies, and in their building, site plans and employee travel requirements and event-planning practices.

4. Businesses must hold the advocacy groups that lobby governments on their behalf to the same standards that they claim to apply to themselves publicly. Advocacy groups should not lobby for weaker policies or longer implementation periods or greater subsidies on behalf of any organization that is making sustainability claims.

5. Businesses should aim to qualify to become ethically certified, for example, B-Corp, Fair Trade International, Climate Neutral, and People for the Ethical Treatment of Animals (PETA).[80]

6. Governments need to make national commitments and develop action plans to deliver on their commitments to treaties such as the Paris Agreement and Kyoto Protocol and to global climate summits such as the Conference of the Parties (COP). Such commitments can be further accomplished by passing climate targets into law.

7. Governments at the local level should also pursue policies such as those included below.
   a. Subsidize renewable energy.

   b. Tax fossil fuels.

   c. Major economies need to donate sustainable materials for renewable energy and regenerative agriculture to economies that cannot afford them.

   d. Invest in carbon-sucking concrete.[81]

   e. Stop companies from using tax havens to avoid contributing to the tax base needed to fund these initiatives.

   f. Heavily invest in water recycling and reuse.[82]

[80] Kayti Christian, "Sustainability Certifications: What Do They Actually Mean?" The Good Trade (website), 15 Apr. 2022, https://www.thegoodtrade.com/features/sustainable-certifications-and-standards/.

[81] Heather Clancy, "Carbon-Sucking Concrete Is Capturing Attention and Funding," GreenBiz, 6 May 2021,https://www.greenbiz.com/article/carbon-sucking-concrete-capturing-attention-and-funding.

[82] Talib Visram, "Low-Income Neighborhoods Have Fewer Trees. Here's Why That's a Problem," *Fast Company*, 22 June 2021, https://www.fastcompany.com/90648768/low-income-neighborhoods-have-fewer-trees-heres-why-thats-a-problem.

g. Plant more trees, especially in low-income neighborhoods where pollution is higher and where residents are also less likely to have air-conditioning for the summer (temperatures rise significantly higher in areas with no trees); residents also are more likely to have underlying health conditions.

h. Restore the ocean and waterways.[83]

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

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2. Finland aims to be net zero by 2035 and net negative by 2040. https://www.climatechangenews.com/2022/05/31/finland-sets-worlds-most-ambitious-climate-target-in-law/

3. Former Unilever CEO Paul Polman Says Aiming for Sustainability Isn't Good Enough—The Goal Is Much Higher. Companies must "take responsibility for that total impact in the world. I call it the total handprint, all consequences intended or not. Where we see some companies going wrong nowadays is that they celebrate and herald the positive sides of their business model. But when it gets to undermining democracy or hate speech or child addiction, they don't want to take that responsibility."
4. https://hbr.org/2021/11/former-unilever-ceo-paul-polman-says-aiming-for-sustainability-isnt-good-enough-the-goal-is-much-higher

5. How Salesforce wants to make its supply chain more sustainable. "With these new contract terms, Salesforce is taking a swing at one of the more intractable sources of a company's carbon footprint, Scope 3 emissions, which include everything outside of direct operations, such as travel, waste, and supplies." https://fortune.com/2021/06/22/salesforce-supply-chain-sustainability/

6. Could Google's carbon emissions have effectively doubled overnight?https://www.newyorker.com/news/daily-comment/could-googles-carbon-emissions-have-effectively-doubled-overnight

7. Salesforce teams up with AT&T to cut IoT emissions.https://www.axios.com/2022/06/23/salesforce-att-carbon-emissions-iot-devices

[83] Whitney Johnston, "Salesforce Unveils New Policy Priorities to Protect the Ocean," Salesforce, 8 June 2022, https://www.salesforce.com/news/stories/salesforce-ocean-policy-actions-2022/.

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Further resources

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2. "The Business Guide to Carbon Accounting." Salesforce (website). 9 May 2022.

3. CK Staff. "Global 100 Resources." *Corporate Knights*, 3 Apr 2021.

Guiding Principle 9—Responsible use of technology and technology labeling

The design, development, use, and disposal of technology should be a dynamic ongoing process for evolving an appropriate, timely response to both negative impacts—the unforeseen consequences of technology on people and planet—and positive impacts—the opportunities to relieve suffering, increase flourishing and equity, and better steward the planet.

Background

Each wave of technology has resulted in unforeseen consequences: fire, language, writing, printing, electricity, computing, transistors, AI, and more. We can learn from earlier waves and recognize that the responsible design, development, use, and disposal of technology is a dynamic cyclical process, not a two-step binary dance of *backlash* followed by *bring in the laws and regulations*. We can learn from drug and nutrition labeling, which recognized the need to alert customers about how they would be affected by what they consume. Today, we consume technology 24/7, and it affects our health and lives.

Advanced technologies such as AI and machine learning present great opportunities for enhancing our own human capabilities for tackling climate change and other global problems. These same technologies also pose serious risks and dangers to the health, well-being, and dignity of human life and to the broader fabric of our societies and the environment. Advanced technologies will not lead to nor generate beneficial outcomes automatically—for technology is only as good as we are. It is therefore up to those of us who are technologists to decide how technology is designed and developed and whether we believe that our technologies are being built to work and serve in the best interests of humanity.

All technologists bear some degree of responsibility in the production process of the technologies that they are working to create. Should instances of irresponsible or unethical uses of technology occur, those involved in their creation and development must be able to raise concerns in a way that can help prevent any risks or dangers from occurring downstream, in the real world. The technology industry and the community of technical professionals must be receptive to these concerns and be brave enough to call out instances where technology is not being developed in a responsible way. Responsible use of technology also applies to the way in which organizations and businesses use technology for their own purposes; industrial use of technology should not perpetuate activities that are inherently unsustainable and that work against our ultimate objective of creating long-term sustainability. Responsibility requires, first, an awareness of what constitutes good and bad actions and behaviors and, second, the willingness to encourage and promote good actions and behaviors while also preventing or calling out bad actions and behaviors when they are noticed. Failing to develop and use technology ethically and responsibly will result in risks and dangers occurring in the world that could have otherwise been prevented.

Recommendations

1. Development of technology should be accompanied by a responsible technology checklist, attesting if the development and deployment of the technology is:
    a. centered on the person or people;
    b. respectful of the natural environment and stewardship of the planet;
    c. sustainable by design;
    d. preserves desired privacy and security by design;

e. protects personal information with timely, specific informed consent on the private or public use of data;
f. accountable to the people who use it and to the planet—in addition to the people who fund and manage it;
g. ethical by the IEEE Code of Ethics;[84]
h. deployed in solutions that are appropriate to the context of the problem (not all problems need technology);
i. deployed where a human is in the loop with respect to overseeing and managing technological systems; and
j. developed with due respect for justice, fairness, the law, and public interest.

2. Development of technology should take into account feedback**;** track and measure deployment of technology at the innovation and experimentation stage, filtering out technology that triggers undue backlash; and implement a standardized feedback process for technology innovation with checkpoints to catch dangerous or irreconcilable issues.

3. Future development of technology should develop 'responsible technology' labels for robustly tested technology and certification of responsible technology.

Technological Insights and Recommendations

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Case studies

In semi chronological order:

Drug labels came into widespread use in the 1800s. They came into common use because of the need to label pills. Early pharmacy labels included the same information they do today: how often to take the medication, how much to take, and essential information for those taking the medication.

*Food and Drug Act of 1906.*The United States was very slow to recognize the need for a national food and drug law. Frederick Accum's "Treatise on Adulterations of Food and Methods of Detecting Them" had been published in London and Philadelphia in 1820, and Great Britain's first national food law was passed in 1860. A variety of US state laws dated from colonial times. Conditions in the US food and drug industries a century ago included uncontrolled use of chemical preservatives and toxic colors. Changes from an agricultural to an industrial economy had made it necessary to provide the rapidly increasing city population with food from distant areas. But sanitation was primitive compared to modern standards. The great pioneers of bacteriology were just starting their victories over infectious diseases. The milk was unpasteurized. Cows were not tested for tuberculosis.

[84]"IEEE Code of Ethics."

The 1962 drug amendments tightened control over prescription drugs, new drugs, and investigational drugs. It was recognized that no drug is truly safe unless it is also effective, and effectiveness was required to be established prior to marketing—a milestone in modern medical history. Drug firms were required to send adverse reaction reports to the US Food and Drug Administration (FDA), and drug advertising in medical journals was required to provide complete information to the doctor—the risks as well as the benefits.

Vehicle information labels in the United States include the 17-digit vehicle identification number (VIN) and also some or all of these: the vehicle emissions label, the certification (safety) label, tire information label, service parts identification label, air-conditioning label, coolant label, and belt routing diagram.

The trend toward prevention. If there is one dominating theme in the FDA's history, it is the change from a law that was primarily a criminal statute—protecting consumers through the deterrent effect of court proceedings—to a law that is now primarily *preventive* due to informative regulations and controls before marketing can begin. The laws requiring approval before marketing formed important changes in the FDA's methods regulating food and drugs in the United States (www.fda.gov). They specifically required the agency to issue regulations explaining the requirements and procedures. The 1962 Drug Amendments called for current good manufacturing practice (GMP) regulations to set standards for plant facilities, maintenance, laboratory controls, and so forth to prevent errors or accidents that could harm consumers. The idea was too good to be restricted to drugs, and in 1969, the first GMPs for food establishments were issued. All such regulations are based on actual industry practices.

Nutrition labels. The Nutrition Labeling and Education Act of 1991 (NLEA) marked the culmination of a groundbreaking effort to provide information on food labels to help consumers make better choices and encourage food companies to produce healthier food. The NLEA required food packages to contain a detailed, standardized nutrition facts label with information such as: serving size; the number of calories; grams of fat and saturated fat; total carbohydrate, fiber, sugars, and protein; milligrams of cholesterol and sodium; and certain vitamins and minerals. The 2020 Nutrition Facts label required the largest food manufacturers (those with over $10 million in annual food sales) to use the revised label after the US FDA announced an extension to its May 27, 2016 final rule.

Further resources

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Guiding Principle 10—Knowledge-based decisions, transparency, and accountability

Informed decisions are based on metrics, sound data, relevant information, context, experience, and perspective; these factors all contribute to knowledge and accountability. Knowledge-based decisions are thus made on the basis of good evidence and sound reasoning; this, in turn, can make hard decisions more defensible and accountable. Application of appropriate metrics and reevaluation of decisions at appropriate time intervals enable accountability and corrective actions.

Background

Planet Positive 2030 sets goals that require new designs, models, and ongoing discovery of processes that support coherent strategies and build collective knowledge of our entire ecosystems—putting the emphasis on contextual parameters, "systems," and "systems of systems." Metrics and accountability are essential for charting progress towards goals.

Information-based systems require meaningful metrics that measure the impact of the entire system on people and the planet, while developing new models for organic growth. Such information-based systems rely on metrics and measurements and, thus, build confidence and trust in our reporting. Furthermore, such accountable systems enable meaningful communications, inform new models for transitioning to performance improvement, and leverage technology to provide scenarios for transformation to sustainable systems.

To achieve sustainable and equitable outcomes, decision-making processes require refinement and precision based on scientific, data-driven methodology, including contributions by nontechnical disciplines (e.g., culture, history, education, communication, and policy). All stakeholders are accountable and have a moral responsibility as caretaker advocates to speak up about and share findings that may be expected to be impactful to the environment and biospheres—whether they are positive or negative impacts.

Recommendations

1. Comprehensive data, reliable information, and knowledge-based decision-making should be the first steps for determining organizational actions, behaviors, and public policy. The increasing complexity, nonlinearity, and rapid pace of change in societies and environments render the transition to a sustainable future a "wicked problem." Planetary biospheres and human societies are approaching tipping points. Transparency—at least—should be vital to any decision-making process.

2. Multi- and interdisciplinary teams should be involved in developing climate change, regenerative, and sustainability policies at the business, academic, governmental, and political levels.

3. All organizations should be able to show and describe how data collection and the use of data (e.g., models, simulations, projections) have minimized inaccuracies and errors (e.g., bias, discrimination, race/gender skews) or at least account for variation, which can produce false or inaccurate outputs/reports. These may be from poor methodology, lack of contextualizing, poor leadership, unethical behavior, and inaccurate representation.

4. Careful oversight and consideration should be practiced and applied with regard to the technological systems used for generating data-driven knowledge and outputs.

5. Decision-making processes should be scrutinized by an appropriate independent party for verification and validation with respect to relevant guiding principles.

6. All organizations should have policies about transparency, accountability, reporting, and decision-making processes.

7. All organizations should provide education and training about transparency, accountability, reporting, and decision-making processes.

Technology gaps and solutions

- Sensors for data collection.
- Information handling.
- Information reliability.
- Analysis, data security, data governance, data AI.
- Tools: modeling tools, communications, blockchain, other collective intelligence
- processes as they are being developed[85]
- AI explainability

Technological Insights and Recommendations

This space is intentionally left blank to encourage technically oriented feedback for public Request for Input.

Case studies

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