

Addressing climate and sustainability through technology, policy, and business models: An impact paper from MIT Forefront

[MIT Forefront](#), a series of online discussions designed to bring together leaders from different sectors to address some of the most important issues of our time, focused in its latest panel on how innovations in technology, business models, and public policy can help drive progress on the world's climate and sustainability challenges. As articulated by moderator Ernest J. Moniz, the Cecil and Ida Green Professor of Physics and Engineering Systems Emeritus, founding director of the MIT Energy Initiative, and a former US Secretary of Energy, the world will need “supercharged innovation” if the goal of net-zero greenhouse gas emissions by mid-century is to be achieved.

No less important is the challenge of adapting to other climate-related challenges even if that mitigation goal is met. As just one indicator of the urgency of these challenges, [US data](#) show that whereas over the last 40 years the average number of extreme weather events leading to \$1 billion or more in damages was seven per year, that average increased to 16 per year during the most recent five-year period, and in 2020 alone there were 22 such events.

This impact paper summarizes and synthesizes the panel discussion and offers additional insights contributed by the participants in a private roundtable conversation that immediately followed the main session.*

The Central Role of Business

The transition to a low-carbon sustainable economy will touch the lives of almost everyone in a direct and tangible way and will be determined by countless individual decisions that directly or indirectly affect energy supply and use as well as other sources of greenhouse gas emissions. But the role of large businesses in helping to engineer the transition will be crucial.

The MIT Forefront panel identified five key factors that will determine the success of these business sector efforts:

- (1) the adoption of ambitious corporate mitigation and sustainability goals;
- (2) the development of innovative business models that can employ this potential and deliver sustainability and profitability simultaneously;
- (3) public policies to incentivize the adoption of such goals and create a framework within which businesses can pursue them profitably;
- (4) new tools to enable investors to evaluate corporate progress towards mitigation and sustainability goals that earn the trust of both investors and the environmentally conscious public; and
- (5) technological innovations necessary for the profitable achievement of these goals.

* The roundtable conversation was held under the [Chatham House Rule](#), so comments from the roundtable attendees are not attributed.

These five factors are explored in the following paragraphs.

Setting Ambitious Climate Goals

A growing number of companies are adopting ambitious carbon mitigation goals for themselves and are urging others to do likewise. More than 100 companies, across 25 industries in 16 countries, have signed the [Climate Pledge](#), which commits them to achieving net-zero annual carbon emissions by 2040. Some companies have set themselves even more ambitious goals. Arvind Krishna, chairman and CEO of IBM, noted that his company intends to achieve net-zero emissions by 2030 and will not rely on carbon offsets to do so. He estimated that 90% of these reductions can be achieved with existing tools and methods.

The path to decarbonization will be longer for petrochemical and other manufacturing businesses that are heavily dependent on fossil fuels. Jim Fitterling, chairman and CEO of Dow, reported that his company is one of 200 of the world's largest corporations that have set a target date of 2050 for net-zero emissions.

Jeff Wilke, who retired as CEO of Worldwide Consumer for Amazon in February 2021, the company that cofounded the Climate Pledge, told the group that Amazon's decarbonization strategy is focused on packaging and transportation, and that the toughest challenge is in the transportation sector, where full electrification will be necessary.

There was agreement among the participants that the meaning of "net zero" will need to be clarified, and that the standards for accounting for offsets, in particular, will need tightening.

Integrating Innovative Technology into Business Models

Several of the participants agreed with MIT Vice President for Research Maria T. Zuber's observation that bringing every aspect of the global economy to net-zero carbon will mean going as far as we can, as fast as we can with the tools that are now available while simultaneously investing in new technologies and capabilities that will be required to reach that goal. Even in the absence of new technologies, re-optimizing the use of existing assets—such as transportation fleets—will help companies make progress towards the new decarbonization goals alongside traditional business objectives. Zuber also noted that businesses that champion new technologies can play a pivotal role in making them more palatable to policy makers.

Participants also reported that pursuing decarbonization in combination with other sustainability strategies, such as reducing wastewater generation or packaging waste, often brings mutual benefits. In many cases, however, decarbonization will require more far-reaching changes in business models. Fitterling anticipated the need to site production facilities not only in locations where feedstock costs are lowest, but also in locations closer to the customers in order to reduce transportation-related emissions; however, this in turn will mean learning to produce cost-effectively at smaller scale. When Moniz asked how companies are prioritizing decarbonization strategies relative to investments in greater resilience and adaptation to climate-related disruptions and longer-term changes, Wilke reported that Amazon was investing in both but that reducing emissions was receiving higher priority.

Implementing Policy Innovations

While investments in new business models and new technologies will be essential for the transition to a low-carbon economy, these investments will not occur without the exertion of public authority on a large scale. Even under normal circumstances, it is challenging to introduce new technology into

commodity markets. In addition, one roundtable participant observed that large companies are skilled at defending their market positions, but they are not always as good at pursuing new opportunities. Clear rules on carbon pricing, clean electricity standards, and energy efficiency standards for buildings, transportation, and appliances will be essential to incentivize the necessary corporate strategies and investments.

Governors, state legislatures, mayors, and city councils will continue to play an important role in climate policy, but the federal role will be the deciding factor. There was broad agreement on the importance of [carbon pricing](#)—as one participant put it, “carbon emissions are the largest externality in the history of the world”—but the participants also noted that border adjustments will be an essential component of a successful domestic carbon-pricing policy and that this will not be easy to achieve. It is problematic that the United States is not leading on carbon pricing. In the absence of comprehensive climate legislation, other countries will question whether US leadership in climate diplomacy will outlast the tenure of this administration. One participant, noting that many people still do not recognize the risks of climate change, argued that the government should do more to support education in this area.

Another participant emphasized the importance of eliminating subsidies for high-emission activities such as dairy and meat production. This includes in developing countries, where there is the potential to leapfrog practices such as factory farming that have long been dominant in developed countries, much as many developing countries have skipped landline phone service and gone straight to cellular communications networks.

Earning Trust on All Fronts

Companies are aware of the need to build trust among often-skeptical members of the public when it comes to the actual impact of their climate strategies, but they must of course also satisfy their investors, who have little appetite for high-cost solutions that may erode competitiveness. Krishna insisted, however, that climate solutions aren’t inherently incompatible with rewarding investors, and that in the longer run investments in innovation can deliver both private returns and solve public problems.

Another participant called for simple metrics of the decarbonization status of companies useful for investors, analogous to the Sharpe ratio or the price-to-earnings ratio in corporate finance, and challenged university researchers to develop such tools. Moniz predicted that the Biden administration will elevate the issue of climate risk disclosure in financial regulations. Wilke emphasized the need for detailed accounting of climate impacts—in the case of Amazon, down to every single delivery and package—taking account of lifecycle emissions as well as product-substitution impacts. He argued that the key to public trust is transparency, science-based standards, and rigorous measures of improvement relative to a well-defined baseline.

Prioritizing Technological Innovation

The panelists strongly agreed on the importance of technological innovation for both advanced and emerging economies. As Krishna noted, the technologies now available are nowhere near sufficient to achieve the net-zero emission goal, and more low-carbon options are urgently needed. Moniz pointed out that while decarbonization of the power sector is essential, in the longer run this will need to be complemented by zero-carbon fuels. One participant emphasized the limits on the role of renewables in low-carbon power grids and saw no prospect for full decarbonization without some version of nuclear technology to provide scalable firm low-carbon power. Moniz suggested that [fusion energy](#) should not be ruled out in this regard and that the outlook for fusion should be much clearer in five years.

Another high priority is the electrification of manufacturing processes, including cement and steel production. Fitterling discussed the potential for electricity to substitute for natural gas in the manufacture of ethylene, the largest-volume product produced in the petrochemicals sector. Here again the importance of a firm low-carbon power source like nuclear, in combination with renewables, was emphasized. New catalytic processes for converting propane to propylene and ethane to ethylene could also significantly reduce the CO₂ footprint of the petrochemicals industry.

Several participants commented that the net-zero emissions goal will be out of reach in the absence of scalable, implementable, negative emissions technologies. One called for massive investments in an effort to drive down the cost of carbon removal technologies.

The Role of Universities in Climate Innovation

As Zuber noted, training the next generation of climate innovators and deploying them to these influential companies is of vital importance. In a similar vein, the business leaders on the panel all foresee a time when further progress towards their decarbonization goals would be blocked without new solutions to augment existing technologies. All anticipated that university research and innovation will play a critical role.

An example is the [MIT Climate Grand Challenges](#) initiative, which is engaging hundreds of researchers from across the Institute in projects to develop and implement high-impact, science-based mitigation and adaptation solutions on an accelerated basis. This initiative is focusing on hard, unsolved problems where progress depends on the advancement and application of frontier knowledge in engineering and the physical, life, and social sciences. [One such project](#) involves bringing together the vast amounts of data from weather satellites, ground stations, soil monitors, and drones with advanced artificial intelligence and high-performance computing technologies to make better predictions of extreme climate-related risks at the local scale, an essential capability for building cost-effective climate change resilience at the community level.

Many of the toughest climate-related problems require a synthesis of scientific, social scientific, and humanistic knowledge because both the problems and the solutions more often than not have to do with how people live and work, and increasingly universities like MIT are mobilizing researchers from across the disciplinary spectrum to focus on these problems.

Summary of Recommendations

- The public sector must be the primary instigator of climate action. Markets left to their own devices will not deliver the necessary response. The purpose of public action should be to unlock the immense skills and resources of America's research universities, private entrepreneurs, investors, producers, and energy users so that they can carry forward most of the innovation tasks.
- A carbon price must surely be a part of any climate strategy. But the stick of higher prices must be counterbalanced—in the public mind and in practice—by the incentives of good jobs and better, safer, and ultimately less expensive products and services made possible by new technologies, new business models, and new institutions.
- To sustain the “supercharged innovation” that will be needed to achieve the goal of net-zero emissions by mid-century, public funding for R&D should be expanded and research universities must continue to accelerate their quest for new, innovative technologies. The portfolio should include high-risk but potentially high-impact options for delivering affordable zero-carbon fuels and negative emissions technologies. To maintain public support, near-term evidence of progress towards climate goals will also be essential.