Advance sustainability

Accelerating a Carbon-Free Future

Microsoft policy brief on advanced nuclear and fusion energy

Microsoft

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Introduction

Our mission at Microsoft is to empower every person and every organization on the planet to achieve more. Creating a sustainable future is a part of that, which starts with the sustainability of our own business but doesn't stop there. In 2020, we announced a bold set of targets: to be a carbon negative, water positive, zero waste company that protects ecosystems—all by 2030. (You can learn more about Microsoft's goals and progress in our 2022 Environmental Sustainability report.) To mitigate the most severe impacts of climate change, it is critical to invest in a broad range of initiatives, technologies, and approaches that will enable progress for decades to come.

Microsoft is one of the largest purchasers of renewable energy in the world (totaling 19 gigawatts (GW) of contracted renewables capacity to date) and manages a $1 billion Climate Investment Fund to accelerate technology development and deployment of new climate innovations.

Our mission is to empower every person and every organization on the planet to achieve more.

We advocate for energy and climate policies across the globe and innovate technology solutions for our customers, suppliers, and partners. Our investments and actions have been, by design, the steps of a first move to help broaden market availability of clean energy resources.

Building on these efforts, this brief outlines the importance of carbon-free electricity, the role advanced nuclear and fusion energy may play in a decarbonized energy future, and the priorities that guide our policy advocacy. We are focusing on advanced nuclear and fusion energy technologies because of their potential and because these technologies are rapidly evolving and face a different set of regulatory considerations than other carbon-free technologies.

Why carbon-free electricity

At Microsoft, we seek to enable a decarbonized grid for our company, our customers, and the world. Our long-term vision is that on all the world's electric grids, 100 percent of the electrons, 100 percent of the time, will be generated from carbon-free resources. Central to our long-term vision for decarbonization is growing the carbon-free electricity resources serving grids around the world.

To enable this vision, we endeavor to address the suite of challenges confronting grid decarbonization through our role as an electricity consumer, buyer, thought leader, technology innovator, policy collaborator, and supply chain participant. The challenges confronting grid decarbonization include building transmission infrastructure to transport electricity from generation sources to end consumers, ensuring equitable access to energy across the globe, and developing carbon-free generation that both replaces carbon-emitting resources and serves growing energy needs. The pace and scale necessary to meet electricity needs and address climate change exacerbates these challenges. Policy is a critical tool not just to enable decarbonization but also to facilitate progress at the pace and scale our world needs. At Microsoft, our policy advocacy spans these challenges, as they are all critical in the pursuit of decarbonization.

Carbon-free electricity solutions

As new technologies emerge, and we are confronted with new information and evolving landscapes, there is both a need and an opportunity to address the significance of carbon-free electricity generating resources in progressing grid decarbonization.

Firm electricity:
Electricity that can be generated on demand.

Carbon-free resources/technologies:
Wind; solar; geothermal; clean hydrogen; sustainable biomass; nuclear; fusion; energy efficiency; storage; carbon capture and storage.

Complete grid decarbonization will require a multi-technology approach that considers a range of carbon-free technologies such as wind, solar, geothermal, clean hydrogen, sustainable biomass, nuclear, fusion, energy efficiency, storage, and carbon capture and storage.[1] A carbon-free energy future must also advance economic inclusion, enable clean energy access and affordability for all, and facilitate community-led solutions to the climate crisis.

To date, Microsoft has signed procurement agreements for 19 GW of renewable energy capacity as we make progress toward our goal to match 100 percent of our carbon-emitting electricity use with renewable power purchase agreements by 2025. Our commitment to renewable energy will not stop there. Renewable energy will continue to be instrumental to reaching our long-term vision for decarbonization.

Renewable energy alone, however, will not get us all the way there. The variability of renewable energy has necessitated the development of

[1] IEA | Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach

complementary advanced carbon-free technologies. Firm carbon-free technologies will be pivotal, as a complement to renewables, both to provide reliable electricity access across the globe and to progress decarbonization to mitigate the worst impacts of climate change. Facilitating the pace and scale of the deployment of carbon-free technologies is critical.

There is no one technology or solution that will meet the vast electricity and decarbonization needs of the markets, societies, and communities across the globe. Electricity is global in that we all rely on or can benefit from electricity as a resource in some capacity. However, it is incredibly local as well—influenced by the local context, needs, physical environment, and social and economic landscape. No two technologies are the same, either. As advanced carbon-free energy technologies are developed, each comes with its own set of considerations, benefits, risks, regulatory dynamics, and acceptance. In this paper, we focus on advanced nuclear and fusion energy technologies.

The role of advanced nuclear and fusion energy in a decarbonized grid

Advanced nuclear technologies

Traditional large nuclear reactors have long been a source of carbon-free, firm energy.

Traditional nuclear reactors: Existing large nuclear reactors that generate energy through the process of fission, where the nucleus of an atom splits into two or more smaller nuclei, releasing energy. Traditional nuclear reactors have long been a source of carbon-free, firm electricity. (IAEA)

Advanced nuclear technologies, such as microreactors and small modular reactors (SMRs), seek to radically improve the safety, efficiency, cost, and environmental impact from traditional nuclear reactors.[2] The designs for advanced nuclear reactor technologies provide new options for power generation with a broad suite of reactor types that have the potential to provide firm power in a variety of sizes

[2] IAEA | What are Small Modular Reactors (SMRs)?

and configurations (such as SMRs). Advanced nuclear technologies can offer a range of generation volume options (megawatts), smaller land and transmission requirements, closed loop systems, and enhanced safety and nonproliferation systems to complement renewables.[3]

Advanced nuclear reactors:
Advanced fission technologies (microreactors and small modular reactors (SMRs)) that produce heat through the physical process of fission, with radical changes in safety and design approaches. (IAEA)

Fusion technologies

Fusion energy has the potential to provide nearly limitless carbon-free electricity with low levels of waste products that are not highly radioactive or long lived. According to the International Atomic Energy Agency (IAEA), fusion could generate four times more energy per kilogram of fuel than fission (used in nuclear power plants) and nearly four million times more energy than burning oil or coal.[4] The reality of fusion is progressing as scientists achieve major breakthroughs and commercial companies reach milestones for attaining viability in the years to come.

Fusion energy:
Energy generated through the process of fusion, which combines nuclei and releases energy in the process (like the sun). (IAEA)

How digital technology can support development and deployment

Digital tools play an important role in accelerating the development and deployment of these technologies in an effective, responsible, and equitable transition to a carbon-free grid. Digital tools, including AI, can model the resource needs for grids as they transition their generation assets and serve as a tool to facilitate the

[3] IEA | Nuclear Power and Secure Energy Transitions

[4] IAEA | What is nuclear fusion?

development, licensing, and deployment of new generation sources. Modeling outputs can enable the accelerated integration of firm electricity sources, such as geothermal, advanced nuclear, and fusion, as a complement to renewables.

The importance of local considerations

The social, political, economic, and community context on a local level is critical to determining whether, where, and how advanced nuclear and fusion energy technologies are utilized. National and local regulators are key to determining the role advanced nuclear, fusion, and other energy technologies may play and the energy mix appropriate to their grid.

Policy advocacy priorities

Achieving carbon-free grids in the time needed to meet climate targets will require strong policy support. Government policy will play an essential role in enabling and expanding the safe development, deployment, and oversight of advanced nuclear and fusion energy technologies in countries where nuclear is a growing part of the grid mix.

Here, we outline the focus areas that guide our advanced nuclear and fusion policy advocacy, building on Microsoft's electricity policy principles in favor of (1) accelerating the transition to clean electricity generation; (2) modernizing and improving grid infrastructure; and (3) encouraging an equitable energy future. It is important to note that advanced nuclear technologies and fusion technologies do not have the same exact regulatory needs and considerations. We outline the following policy priorities to guide our advocacy in a way that uses consistent principles across technologies, recognizing that the principles may be applied in different ways for advanced nuclear and fusion technologies as well as carbon-free electricity technologies more broadly.

Development

Advance research, development, and demonstration (RD&D)

In the development stage, new technologies are tested, analyzed, and refined for safe, effective, and optimized use. Government investments in programs and funding mechanisms that support research, development, and testing and integrate local consideration will help to ensure advanced nuclear and fusion energy technologies can provide cost-effective, safe, and firm carbon-free electricity that meets local needs.

Accelerate RD&D: *Support programs, funding, and investment opportunities that support research development and demonstration.*

Research and development are fundamental to driving technological innovation to solve the most complex and daunting challenges of our time. The RD&D process assesses and enhances the technological capabilities, versatility, capital and operational costs, resource intensity, social and environmental impacts, efficiencies, and safety of new technologies. Together, businesses and governments can support resourcing RD&D programs including public-private partnerships, funding including pilots and demonstrations, and investment opportunities to support new energy technologies that enable a carbon-free energy future.

> Microsoft example: Helion and Microsoft announce world's first fusion energy purchase agreement

Test and analyze: *Advocate for programs that enable testing, grid analysis, and modeling of new carbon-free energy technologies that integrate local considerations, needs, and opportunities and optimize grid performance (including the integration of digital services to enhance tracking, reporting, and desired outcomes).*

Energy systems across the globe are different—comprising different needs, risks, and opportunities. Through programs, governments and regulators can collaborate with energy service providers, system operators, and large energy consumers to test, analyze, and model the integration and optimization of new technologies within the local grid to ensure smart, efficient grids. Local considerations such as infrastructure, social, community, environmental, political, technological, and economic landscapes must be understood and accounted for.

Include as carbon-free: *In countries that support advanced nuclear and fusion as part of the growing mix, support the inclusion of advanced nuclear and fusion as a low-carbon or carbon-free generation option.*

Including advanced nuclear and fusion energy technologies as a low carbon or carbon-free energy option signals to innovators, developers, and market participants that advanced nuclear and fusion energy technologies are a tool to progress decarbonization. Doing so will help ensure technologies are developed, tested, and evaluated from the beginning to provide safe, cost-effective, and carbon-free electricity in the countries in which it will be a part of the growing grid mix.

Deployment

Enable safe deployment of advanced nuclear and fusion energy technologies (in geographies where those are permissible)

Renewable energy project deployment has highlighted process hurdles that increase costs, introduce uncertainty, and delay project deployment. As advanced nuclear and fusion energy technologies move from development to deployment, government support is essential to update, streamline, and modernize how projects are deployed to ensure cost-effective, safe, and grid optimized outcomes.

Accelerate project deployment: *Accelerate programs to assist first-of-a-kind (FOAK) projects through each stage of the deployment process.*

Advanced nuclear and fusion energy projects will require new project deployment and regulatory processes. It is critical to understand and address regulatory hurdles within and across local governments to support comprehensive, streamlined, and efficient project deployment (such as project financing for FOAK projects).

As an example, first units will be the most expensive to deploy, with costs stabilizing as the technologies are deployed more broadly. It is important to consider ways to finance first-of-a-kind projects—for example, the US Department of Energy Loan Program Office has the Title XVII loan authority to finance loans for innovative nuclear projects.

Modernize process: *Modernize the permitting and licensing processes for new energy technologies.*

Permitting and licensing are fundamental regulatory processes for the safe and effective deployment of energy infrastructure projects across the globe. These processes require robust applications that consider things like environmental impact and safety. In many cases, project permitting and licensing includes manual steps, and the process must clear multiple agencies and sometimes multiple jurisdictions and levels of government. This can cause inefficiencies and uncertainty for project developers, investors, and other stakeholders.

> Microsoft example: We are working with our customers and partners in the nuclear energy industry to streamline the permitting process using digital platforms and AI to reduce the cost and time for completing licensing and permitting activities. Such activities are crucial to unlocking the full potential of the industry for carbon abatement and economic benefit.

As advanced nuclear technologies are developed, governments and regulators can modernize permitting and licensing processes to enhance the efficiency and effectiveness of project deployment. For fusion technologies, policymakers are working to develop and establish distinct regulatory frameworks suitable for fusion system designs.

Utilize digital technology: *Facilitate the use of digital technology to manage and optimize new energy technologies and the overall grid.*

Digital technology is vital to managing and optimizing the energy technologies of the future. Microsoft is a global leader in developing and delivering digital technologies that drive innovation, streamline processes, and optimize the integration of carbon free electricity. We are working with the nuclear industry and our partners to enable the integration of advanced nuclear energy technologies into energy systems in countries that support it.

Microsoft example:
TerraPraxis enters strategic collaboration with Microsoft to decarbonize coal

Regulatory oversight

Encourage the oversight of advanced nuclear and fusion energy technologies to enable safe, cost-effective, safe, and grid-optimized outcomes that consider the local context.

Regulatory oversight is a critical, overarching advocacy priority that spans the development, deployment, and operation of advanced nuclear and fusion energy technologies. Effective oversight must account for the unique energy system, stakeholders, policies, regulations, economic, community, and environmental considerations. Regulatory oversight of advanced nuclear energy technologies will be different than fusion technologies.

Assist regulatory pathways: *Advance regulatory pathways that ensure safe, cost-effective, and grid-optimized deployment and operation.*

Regulatory pathways are a tool to oversee supply chain management, siting, fuel and waste management, rigorous safety and security standards, as well as environmental and community impacts. Regulatory agencies require resources to develop regulatory pathways that ensure safe, cost-effective, and equitable development, deployment, and ongoing operation of advanced nuclear and fusion energy technologies. Bilateral and multilateral efforts play a role in advancing the safety and security issues surrounding civilian uses of nuclear energy. It is important to utilize, modernize, and coordinate processes as the development and deployment of advanced nuclear technologies grow.

Prioritize community engagement: *Ensure robust community engagement.*

Community engagement is critical for the effective oversight of energy technology development, deployment, and ongoing operation. Government and private investment, regulatory frameworks, and efficient permitting and planning mechanisms must include inclusive decision making and robust engagement with local communities and stakeholders.

Manage costs: *Support the oversight and management of costs associated with the development, deployment, and operation of new carbon-free energy technologies.*

Cost is a critical consideration in enabling the carbon-free energy generation resources necessary for decarbonization. As mentioned in the Deployment section earlier, cost is especially challenging for first-of-a-kind projects like advanced nuclear and fusion energy technologies. Central to our policy advocacy is ensuring electricity costs are affordable and equitable as we strive for a decarbonized energy future for all. Therefore, it is essential to support regulatory oversight and management of costs through policy, legislation, programs, and financial incentives that ensure equity, access, and affordability for all energy system participants (consumers, providers, system operators, governments, and regulators alike).

Conclusion

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At Microsoft, we strive to enable a decarbonized electricity future for our company, our customers, and the world. To do so, we support an inclusive, decarbonized energy system that is made possible by a multi-technology approach and does not compromise the health and safety of communities. We are investing in a broad range of initiatives, technologies, and solutions that seek to enable progress for decades to come. This is an enormous challenge that requires global, urgent, and collective action supported by government policies and resources. At Microsoft, we will use our voice to support policies that enable the research and development, deployment, and oversight of new carbon-free electricity technologies that help to ensure safe, healthy, efficient, equitable, and locally optimized outcomes for all.

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