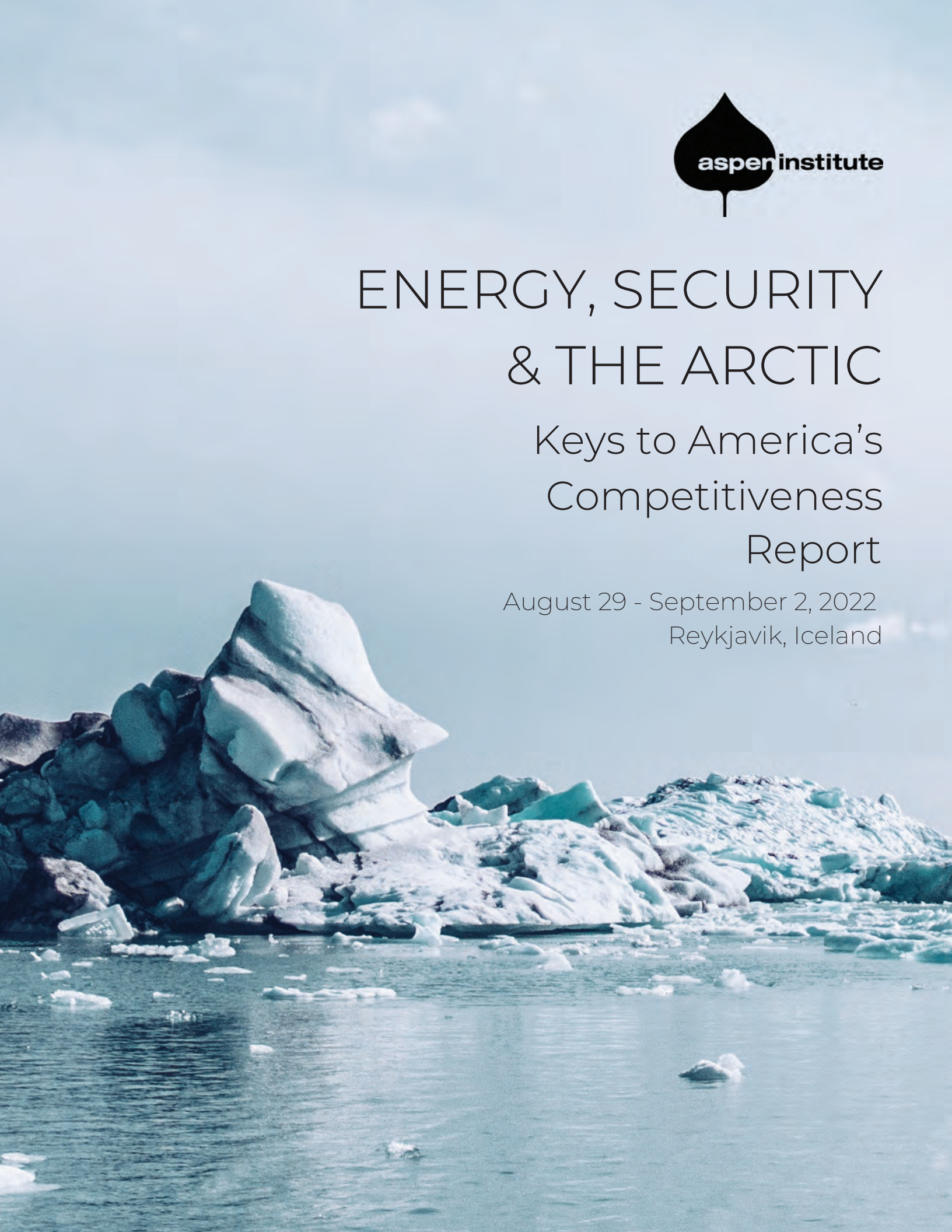

ENERGY, SECURITY & THE ARCTIC

Keys to America's Competitiveness Report

August 29 - September 2, 2022
Reykjavik, Iceland

ENERGY SECURITY & THE ARCTIC: KEYS TO AMERICA'S COMPETITIVENESS

The Aspen Institute Congressional Program
August 29 – September 2, 2022
Reykjavik, Iceland

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ENERGY SECURITY & THE ARCTIC: KEYS TO AMERICA'S COMPETITIVENESS

The Aspen Institute Congressional Program
August 29 – September 2, 2022
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CONFERENCE AGENDA

MONDAY, August 29:

Participants travel to Reykjavik

TUESDAY, August 30:

Participants arrive in Reykjavik on early morning flights.

11:00 AM – 11:55 AM Lunch

12:00 – 4:15 PM
Educational Site Visits

We will visit four examples of addressing energy and climate challenges, all demonstrated at the commercial-scale geothermal power station at Hellisheidi, Iceland. The U.S. currently has 14 large-scale carbon capture and sequestration facilities based on similar scientific principles. These examples in Iceland are a convenient way to demonstrate that carbon extraction is one potential method of reducing the amount of CO2 in the atmosphere.

COMMERCIAL-SCALE GEOTHERMAL POWER STATION

We will visit the third-largest geothermal powerplant in the world, which provides renewable geothermal heating for 7 out of 10 homes in Iceland. This plant, which opened in 2006, is the most recent addition to Iceland's fossil fuel-free energy production. This visit will help participants understand the significance and history of the geothermal heating and power generation that puts Iceland in the forefront of renewable energy use. Participants will have opportunities to engage with the Hellisheidi Power Station staff to assess applicable lessons for U.S. policy.

Bjarni Bjarnason, *CEO, Orkeveita Reykjavikur (Reykjavik's energy utility)*

Brynhildur Davidsdottir, *Board Chair, Orkeveita Reykjavikur*

Bergur Sigfússon, *Geochemist, Orkeveita Reykjavikur*

INNOVATIVE CARBON CAPTURE AND MINERALIZATION

Participants will visit CarbFix, a unique carbon removal operation, which extracts carbon dioxide from the geothermal power plant, mixes it with water, and pumps it underground, where it bonds with porous basalt rock and becomes solid. This project was originally partially supported with research grants from the U.S. Department of Energy and the National Science Foundation and is seen as one potential tool for mitigating the impacts of climate change by reducing the amount of carbon in the atmosphere.

Kristinn Ingi Lárusson, *Head of Business Development, CarbFix*

WORLD'S LARGEST DIRECT AIR CARBON CAPTURE PROJECT

Climeworks, a Swiss clean technology company, operates a pilot project to test the viability of extracting carbon dioxide from the air with the world's first commercial direct air capture carbon removal technology.

Christoph Gebald, *Co-CEO, Climeworks*

INNOVATIVE AGRICULTURE USING CAPTURED CO2

VAXA Technologies, founded by an MIT scientist, converts clean energy into food using vertical cultivation of microalgae. This process converts CO2 emissions from the adjacent geothermal powerplant into edible organic carbon (essential amino and fatty acids in algae edible by people and livestock), using less than 1% of the land and water of conventional agriculture, in a controlled indoor growing environment.

Isaac Berzin, *Founder and Chief Technical Officer, VAXA Technologies*

Kristinn Hafliðason, *General Manager, VAXA Technologies*

5:15 – 6:15 PM
Pre-Dinner Remarks

ICELAND'S VIEWS ON ENERGY & CLIMATE

The last decade was the hottest on record. As a country just below the Arctic Circle, Iceland faces some of the most direct impacts of climate change. For example, two years ago, one of its prominent glaciers melted away. Prime Minister Jakobsdótter will provide her insights on Iceland's energy and climate policies.

Katrín Jakobsdóttir, *Prime Minister of Iceland*

6:30 – 8:30 PM
Working Dinner

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and lawmakers are rotated daily. Discussion will focus on the opportunities, challenges, and potential solutions regarding America's energy future.

WEDNESDAY, August 31:

7:30 – 9:00 AM

Breakfast is available for all participants

9:00 – 9:15 AM

INTRODUCTION AND FRAMEWORK OF THE CONFERENCE

This conference is organized into roundtable conversations and pre-dinner remarks. This segment will highlight how the conference will be conducted, how those with questions will be recognized, and how responses will be timed to allow for as many questions and answers as possible.

Charlie Dent, *Executive Director, Aspen Institute Congressional Program*

9:15 – 11:00 AM
Roundtable Discussion

THE CHANGING GLOBAL ENERGY PICTURE: CHALLENGES FOR SECURITY, GOVERNANCE, CLIMATE AND TRADE

The war in Ukraine has upended global energy presumptions. The sanctions motivate Europe to wean itself off Russian energy, causing impacts on global supply and price, re-aligning energy flows. The war has sparked a new focus on lessening dependence on foreign oil. The impacts of climate change are also adding pressure on energy policies. The Arctic is warming two to three times faster than the global average, which has environmental, economic, and geopolitical implications. In the last five years, Arctic air temperatures

have exceeded all previous records since 1900. The amount of Arctic ice has shrunk from 3 million square miles to 2 million square miles since 1980. Melting ice makes the Northern Sea Route across Russia's northern coast 5,000 miles shorter and therefore more viable to ship goods from China to Europe with two weeks less transit time. Expanded activity in a melting Arctic highlights an important disparity: Russia has 53 arctic-capacity icebreakers, China has four, and the U.S. only two. In an area of undefined borders, governance issues will become more challenging, with eight countries on three continents all making claims to Arctic resources. Even China, which labels itself a "near-Arctic state," is increasing its arctic involvement: It has invested $154 million in Iceland since 2012 and launched an Arctic Science Observatory in northern Iceland. Making communities resilient in the face of the changing environment is a challenge that will be faced worldwide. For example, the Army Corps of Engineers has identified 31 Alaskan communities that need to be relocated because of environmental change.

- What are the global impacts for energy policy from the war in Ukraine?
- What are the implications of an opening Arctic Ocean to commercial use and shipping?
- What are the impacts of Arctic warming on the environment and humanity, and are they irreversible?
- What are possible policy solutions to the challenges outlined in this session?

Sherri Goodman, *Secretary General, International Military Council on Climate & Security; former Deputy Undersecretary of Defense*

Joseph Majkut, *Director, Energy Security & Climate Change, Center for Strategic and International Studies*

11:00 – 11:15 AM Break

11:15 AM – 1:00 PM
Roundtable Discussion

THE CHALLENGE OF RESPONSIBLY ENDING GLOBAL ENERGY POVERTY

Billions of people, primarily in the developing world, lack access to a source of reliable electricity. This "energy poverty" contributes to lack of health care, limited heating and cooking capabilities, minimal telecommunications, and a poor quality of education which crimps economic opportunity. Bringing a reliable source of energy to these communities is a huge challenge, one made more acute in the aftermath of the global pandemic. A massive expansion of electrical access around the globe is an opportunity to further the reach of sustainable technologies. Raj Shah, formerly director of the U.S. Agency for International Development, will analyze the challenge ahead with its global implications.

- What role should the U.S. play in providing access to reliable, affordable, and clean electricity around the world?
- How does the goal of alleviating poverty and supporting clean energy intersect?
- Is access to electrical power a shared multilateral concern?
- How does ending global energy poverty impact climate concerns?

Rajiv Shah, *President, The Rockefeller Foundation*

1:00 – 2:00 PM
Working Luncheon

Discussion continues between members of Congress and scholars on challenges for U.S. energy policy.

2:30 – 4:00 PM
Individual Discussions

Members of Congress and scholars meet individually to discuss U.S. energy policy. Scholars available to meet individually with members of Congress for in-depth discussion of ideas raised in the morning sessions include Sherri Goodman, Joseph Majkut, and Rajiv Shah.

7:00 – 9:00 PM
Working Dinner

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and lawmakers are rotated daily. Discussion will focus on the opportunities, challenges, and potential solutions regarding America's energy future.

THURSDAY, September 1:

7:30 – 9:00 AM Breakfast is available

9:00 – 11:00 AM
Roundtable Discussion

GEOPOLITICS OF ENERGY: EXPANDING AMERICA'S GLOBAL COMPETITIVENESS & ECONOMIC VITALITY

Market forces and technological development drive international commerce of energy resources. The shipment of energy across international boundaries—cross-border pipelines and powerlines, as well as maritime commerce of oil and liquid natural gas—has geo-strategic economic and security consequences which are further compounded by climate change. Europe's desire to cut back its dependence on Russian oil and gas has also disrupted the energy sector. Energy supply and demand are the drivers of global commerce and are also a key security concern as the energy impacts of the war in Ukraine illustrates. The International Energy Agency predicts that wind and solar could provide 70% of power generated by 2050, compared to 9% in 2020. Progress in addressing climate change requires new technologies that offer opportunities for American ingenuity to develop low carbon sources, enhancing international competitiveness.

- What are the investments required now to ensure international competitiveness in a low carbon future?
- What kinds of carbon pricing mechanisms are there, and what are their advantages and disadvantages? Which are politically viable?
- If some countries impose a "carbon tax" and others don't, what are the economic consequences of this dichotomy?
- What kind of energy mix best positions the U.S. economy going forward?
- Does climate change impact economic growth?
- Will a growing renewable energy mix cause economic challenges?

Carlos Pascual, *Senior Vice President, Head of Geopolitics & International Affairs, S&P Global Commodity Insights*

11:00 – 11:15 AM Break

11:15 AM – 1:00 PM
Roundtable Discussion

GEOPOLITICS OF ENERGY:
THE NEXUS OF SECURITY & CLIMATE

The security of the United States is inextricably linked to the global supply and demand of energy sources. Between geopolitical chokepoints of fuel transportation, and the importance of maintaining a reliable source of energy, there is a need to stay abreast of emerging threats and opportunities for cooperation. The threats of energy flow disruptions due to security concerns such as the war in Ukraine and climate change impacts that aren't limited to international boundaries compel energy policy to be a top priority for governments. Warmer average temperatures can lead to the spread of pandemic diseases, forced migration and unforeseeable collateral impacts. America's newfound status as a global energy superpower provides greater flexibility in foreign policy decisions and can allow decision makers to redirect foreign policy strategy. Advancements in renewables and energy efficiency impact consumption patterns with implications for producers, consumers, and government policy. Multilateral action is required because climate change does not limit its impact to national boundaries. The energy impact of the war in Ukraine has widespread implications, and potential sanctions will force hard choices for some European countries that are highly dependent on Russian energy.

- What are the global strategic implications of the U.S. having achieved "energy independence"?
- Is it in the security interest of the U.S. to help promote and fund Green Energy projects in other countries because greenhouse gases know no boundaries?
- How will human and animal migrations from climate change impact the international order?
- Is the United Nations the best organization for managing international climate agreements?
- What is the benefit of the U.S. adopting renewable energy strategies if the rest of the world doesn't?
- Is there a geopolitical benefit to taking the lead on global discussions on managing climate change?
- Will the war in Ukraine spark more or less demand for Green Energy innovation?

Ray Mabus, *former Secretary of the Navy, former Mississippi Governor, former U.S. Ambassador to Saudi Arabia*

1:00 – 2:00 PM
Working Luncheon

Discussion continues between members of Congress and scholars on the challenges for U.S. energy policy.

2:30 – 4:00 PM
Individual Discussions

Members of Congress and scholars meet individually to discuss U.S. energy policy. Scholars available to meet individually with members of Congress for in-depth discussion of ideas raised in the morning sessions include Carlos Pascual and Ray Mabus.

6:00 – 7:00 PM
Pre-Dinner Remarks

ICELAND'S INNOVATIVE APPROACHES TO ENERGY CHALLENGES

Iceland has a plan to become carbon neutral. Approximately 85 percent of its primary energy comes from renewable sources—geothermal and hydropower. It has charging stations for electrical vehicles throughout the country, as well as filling stations for hydrogen fuel cars powered by fuel cells. Iceland remade itself from one of Europe's poorest into a nation that is financially and environmentally secure. Former Iceland President Ólafur Grímsson has said: "It's about the economic transformation of the country to realize that the move from fossil fuels over to clean energy is fundamentally good business—the road to prosperity and economic achievement."

Ólafur Ragnar Grímsson, *former President of Iceland,*
Chair, the Arctic Circle and
Chair, International Renewable Energy Agency's
Global Commission on the Geopolitics of Energy Transformation

7:00 – 9:00 PM
Working Dinner

Seating is arranged to expose participants to a diverse range of views and provide the opportunity for a meaningful exchange of ideas. Scholars and lawmakers are rotated daily. Discussion will focus on the opportunities, challenges, and potential solutions regarding America's energy future.

FRIDAY, September 2:

7:30 – 8:30 AM Breakfast is available

8:30 – 10:30 AM
Roundtable Discussion

STRATEGIES FOR EXTREME WEATHER EVENTS: ADAPTATION AND PREVENTION

The need for resiliency caused by the impacts of climate change is increasingly apparent in every state, from coastal flooding in Gulf states to droughts and wildfires in California to widespread excessive heat causing soaring demand for high-cost energy-consuming air conditioning. The recent UN Intergovernmental Panel on Climate Change report states that steps necessary to avoid catastrophic consequences require more than incremental policy changes. Adapting to these challenges requires innovative methods of retrofitting building and energy infrastructures, emergency preparation, and dramatic reforms to the insurance industry—all with implications for policymakers and the marketplace. Bringing electric grids up to a high standard of efficiency, reliability and performance is a core building block in having a greater mix of energy sources to meet our electrical demand. As renewable energies are more widely used, their per unit costs drop making their adoption more affordable. Climate change can impose damage to unprotected infrastructure, with detrimental economic consequences if both preventive and resiliency strategies are not deployed to minimize the impact.

- How is research and development properly sorted out between the public and the private sector as it relates to finding innovative solutions to energy and climate challenges that will ultimately be used for the public good?
- How can government best promote continued technological improvements that provide reliable, safe, resilient energy at an affordable cost without heavy intervention in the marketplace?
- What role does retrofitting current infrastructure play in mitigating or reversing carbon emissions?
- What can be done to support communities that have historically relied on traditional fuel sources? What role do these communities play in the future?
- How should the U.S. best prepare for the future considering irreversible climate change impacts, continued growth in demand for energy, and a constantly changing mix of energy sources?
- Are reducing carbon pollution while expanding economic growth compatible goals?

- What are the dividing lines between federal and local governments and private property owners in both preventative and adaptive strategies to deal with the impacts of climate change?

Neil Chatterjee, *former Chair, Federal Energy Regulatory Commission*

Hal Harvey, *CEO, Energy Innovation*

10:30 AM – Noon
Roundtable Discussion

POLICY REFLECTIONS

Members of Congress will reflect on the week's discussions and chart potential paths forward for federal legislation.

12:15 – 1:15 PM Lunch

1:45 PM Participants depart for the airport for late afternoon flight departures to return to the U.S.

CONFERENCE PARTICIPANTS

MEMBERS OF CONGRESS

Rep. Nanette Barragán
and Veronica Barragán

Rep. Ami Bera
and Janine Bera

Sen. Tom Carper
and Martha Carper

Rep. Sean Casten

Rep. Lou Correa
and Esther Reynoso

Rep. John Curtis
and Sue Curtis

Rep. Ted Deutch
and Jill Deutch

Rep. John Garamendi
and Patti Garamendi

Sen. Martin Heinrich
and Julie Heinrich

Rep. Ann Kuster
and Brad Kuster

Rep. Darin LaHood
and Kristen LaHood

Rep. Doug Lamborn
and Jeanie Lamborn

Rep. Rick Larsen
and Tiia Karlén

Sen. Roger Marshall
and Laina Marshall

Rep. Greg Murphy
and Wendy Murphy

Rep. Chellie Pingree

Rep. Deborah Ross
and Steve Wrinn

Rep. David Rouzer

Rep. Jan Schakowsky
and Bob Creamer

Rep. Fred Upton
and Amey Upton

Rep. Brad Wenstrup
and Monica Wenstrup

SCHOLARS

Neil Chatterjee	Former Chair, Federal Energy Regulatory Commission
Sherri Goodman	Secretary General, International Military Council on Climate & Security
Hal Harvey	CEO, Energy Innovation
Ray Mabus	Former Secretary of the Navy, former Mississippi Governor, former U.S. Ambassador to Saudi Arabia
Joseph Makjut	Director, Energy Security & Climate Change, Center for Strategic and International Studies
Carlos Pascual	Senior Vice President, Head of Geopolitics & International Affairs, S&P Global Commodity Insights
Rajiv Shah	President, The Rockefeller Foundation

SPEAKERS

Ólafur Ragnar Grímsson	Former President of Iceland; Chair, The Arctic Circle
Katrín Jakobsdóttir	Prime Minister of Iceland

RAPPORTEUR

Michael Conathan	Senior Policy Fellow, Ocean & Climate, Aspen Institute Energy and Environment Program

FOUNDATION REPRESENTATIVES

Sharon Davies	President, Kettering Foundation
Jay Faison	Founder, ClearPath
Adelaide P. Gomer	President, Park Foundation
David Lane	President, Annenberg Foundation Trust at Sunnylands
Holly Harris	President and Executive Director, Justice Action Network
Robin Millican	Director, U.S. Policy and Advocacy, Breakthrough Energy
Michael Northrup	Program Director, Sustainable Development, Rockefeller Brothers Fund
Eileen O'Connor	Senior Vice President for Communications, Policy, and Advocacy, The Rockefeller Foundation
Jonathan Pershing	Program Director for the Environment, William and Flora Hewlett Foundation
Rich Powell	Executive Director, ClearPath
Maxine Thomas	General Counsel, Kettering Foundation

ASPEN INSTITUTE

Charlie Dent and Pamela Dent	Executive Director, Congressional Program
Bill Nell	Deputy Director, Congressional Program
Carrie Rowell	Conference Director, Congressional Program
Tyler Denton	Deputy Director, Congressional Program
Ketevan Chincharadze	Nathanson Fellow, Joseph Korbel School of International Studies, University of Denver, Congressional Program
Sajan Shah	Conference Volunteer

RAPPORTEUR'S SUMMARY

Aspen Institute Congressional Program
Reykjavik, August 29 - September 2, 2022

By Michael Conathan

Against the backdrop of Russian President Vladimir Putin's invasion of Ukraine, and the subsequent security aftershocks that have reverberated across the European continent, into and across its bordering oceans, 21 bipartisan members of Congress came together in Reykjavik, Iceland, the same city where Presidents Ronald Reagan and Mikhail Gorbachev met in a historic summit 36 years ago. On the day our conference kicked off, we received the news of President Gorbachev's death—a sad reminder of how the international landscape has changed in the decades since American and Russian leaders shook hands on the steps of Höfði House.

In many ways, Iceland represents a model for how nations can modernize their policies, metrics, and operations to take advantage of their resources and meet the challenges of our age. As an island nation of fewer than 400,000 people, its problems may not be as diverse in nature as those of a larger country such as the United States, but it has acted aggressively to take advantage of its abundant natural resources, most notably for purposes of this discussion, an abundance of readily available geothermal energy. As a result, 85 percent of its energy needs are now met with cheap, domestic, carbon-free production, and the remainder is mostly in the transportation sector that is rapidly transitioning. Iceland is second in the world per capita in electric vehicle use, and a pathway to decarbonization is a priority for seven of its eight political parties. Members of Congress had the opportunity to see first-hand how these systems work in site visits to one of the world's largest geothermal plants at Hellisheidi, and three affiliated businesses that have taken advantage of the industrial development around the plant: ClimeWorks, a facility that applies direct air capture technology to suck carbon dioxide out of the atmosphere; CarbFix, a separate entity that is injecting carbon dioxide back into Iceland's basalt bedrock where it bonds to the substrate and resolidifies, keeping it out of the atmosphere; and Vaxa, a company using abundant carbon dioxide to fuel growth of algae as a protein source and dietary supplement. Some participants also visited Running Tide, a US-based

company whose work includes growing kelp in the deep ocean as a carbon sequestration method.

These private entities are part of Iceland's vision as a hub for sustainable business development. As the country's Prime Minister Katrín Jacobsdottír conveyed to participants in remarks at Iceland's Parliament House, through conscious policy-driven decisions, her country is now also a global leader in issues of gender equality—a transition that has dramatically expanded their talent pool and "changed the way we make decisions." They are pioneering new societal metrics, in addition to classic barometers such as gross domestic product, to increasingly measure and track traditionally more nebulous concepts such as happiness, waste, and work/life balance, because "that which is not measured cannot be changed." This approach overall is bringing a broader perspective to policy decisions and greater satisfaction to the population.

Iceland, like the United States, is also one of eight Arctic nations, and as the region warms at a rate as much as four times the global average, economic opportunities in shipping lanes and resources such as fish, oil, and minerals are emerging from beneath the rapidly melting ice. With them come massive security challenges. And yet, the United States remains woefully under-resourced and unprepared for the challenges, opportunities, and threats of operating in the remote global north. Jakobsdottír specifically called out her country's interest in keeping the Arctic a "low-tension area" internationally.

Meanwhile, standing at the doorstep of the polar north and proclaiming itself to be a "near-Arctic state," is the other current global superpower, China. While investing in an Arctic strategy and supporting it with a growing fleet of icebreakers and Arctic-ready vessels, China continues to methodically advance its interests there as it does around the globe from gradually increasing its grip on marine territory in its own backyard of the South China Sea through dubious sovereignty claims and the construction of artificial islands to the slow, steady creep of its Belt and Road initiative across the developing world and much of the global south in the wider Pacific, Africa, and increasingly into South and Central America. Fundamental to this expansion is an unquenchable thirst for resources, including strategic minerals and rare earth metals, vital in building the energy engines that will be required for an accelerating transition to a renewable energy economy.

As conflict in Europe portends economic and energy insecurity, climate change driven extreme weather events overtax electricity grids and jeopardize people's lives in their own

homes. In Bangladesh, historic flooding left as much of a third of the country underwater, while droughts intensify across much of North America and Europe. Glaciers and sea ice are melting at unprecedented rates, in some cases a full 50 years ahead of predicted rates of change.

The discussions that were part of the Aspen Institute Congressional Program's Iceland conference from August 30 through September 2 emphasized the need for bipartisan leadership as fundamental to America's ability to be seen as a global leader on topics of energy, security, and climate change. As one participant succinctly put it: "if we can't get our own [priorities] together, no one will trust us with the world's."

Immediate Threat: Global Implications of Putin's War in Ukraine

One scholar launched the groups' discussions by commenting that "climate change is a threat multiplier in the Arctic and around the world," and that threat is exponentially greater in the aftermath of Putin's invasion of Ukraine and the subsequent implications for energy security on the continent. Europe is already seeing this play out most predominantly in energy markets, but as the conflict drags on, food will become an increasingly urgent issue as well. Combined with increasing frequency of extreme weather events, this could lead to destabilization in developing countries and an increased immigration and refugee crisis impacting areas already overburdened by refugees fleeing Ukraine and other recent conflicts in eastern Europe and north Africa. Energy cost spikes could also threaten stability in European countries, particularly if they are exacerbated by an especially cold winter season, potentially leading to unrest and weakening of resolve to hold the line against Russian aggression.

Even absent the immediate threat of the energy crisis created by Russia's invasion, the transition to renewables was already going to be a massive challenge to entrenched systems. As one scholar put it, "we do not have the resilience in our energy systems to sustain massive shocks as we make our transition to a net-zero world. This will take time and we will go through volatility." The presenter went on to suggest that given the global nature of the oil and gas markets, the scenarios in Europe beginning in the coming months could mean oil prices ranging from $150 per barrel or higher if sanctions blocking Russian oil to Asia are effectively implemented, to $65 per barrel or lower if Russian and Iran negotiate a nuclear treaty that could allow Iranian oil to fill some of the void, and other factors such as a resurgence of Covid-19 leading to economic slowdowns. That volatility means we must prepare for incredibly varied outcomes and be ready with "plans B, C, and D."

This upheaval in the energy market is also taking place as much of Europe—particularly countries such as Germany and France, which had been heavily reliant on Russian natural gas to meet energy demand—is already mid-stream on a relatively aggressive shift to a cleaner energy future. While delinking from Russian fossil fuels may ultimately accelerate the transition, western Europe must survive in the meantime as they head into a winter when energy prices are expected to triple or quadruple from what they were a year ago. It was noted that while the U.S. has become a net energy exporter, increased American natural gas production will not ease the strain for our NATO partners, because gas must be liquified to make the trans-Atlantic journey, and our liquid natural gas (LNG) export capacity is currently maxed out, with no additional facilities due to come online until at least 2024-25. As a result, the dramatic increase in energy prices is poised to seriously damage Europe's competitiveness internationally.

While there are no easy solutions in the short term, we can take some heart that this is likely be a "two-year problem, not a ten-year problem," according to one scholar. Because of the acceleration of alternative energy sources, these countries should see about a 40 percent reduction in demand for natural gas as of 2025, enough to wean them from reliance on the Russian supply. But in the interim, this will mean a higher likelihood of major problems for Europe's heavy industries. Products like steel, automobiles, and even fertilizer are all major drivers of the western European economy and carry a huge energy demand. As Europe corners the market on the few options available, the reverberations will inevitably cause secondary shock waves throughout less developed countries that already operate at a fiscal disadvantage.

Those countries are, of course, also at highest risk from another insidious implication of Russia's invasion of Ukraine—a looming food shortage. The regions of Ukraine that have experienced the fiercest fighting and greatest destruction also happens to be the country's richest agricultural area, a literal bread basket for much of the eastern hemisphere. Roughly a third of the world's wheat travels through the Black Sea along with high volumes of corn and sunflower oil, and Russia's newly wrested control over Ukraine's ports is poised to allow it to choke this supply, starving volatile regions of North Africa and the Middle East.

While the two warring nations struck a deal in July to allow at least some food shipments to continue, there is no guarantee this pact will hold, and even if it does, next year will surely be worse. Fighting in the region has meant that fall planting has been all but impossible, and energy shocks have also led to a dramatic reduction in fertilizer supply, in part because natural gas is a major ingredient used to produce ammonia and urea in many synthetic

fertilizers.[1] As a result, crop yields are expected to crater in 2023. Fertilizer production is one area where the U.S.'s supply of natural gas can perhaps help alleviate the looming shortage by using it to ramp up production of fertilizer which could then be exported, but these increases must begin immediately.

Implications for the Developing World: Accelerating the Energy Transition

Of course, the issues of food and energy distribution and the other cascading impacts of President Putin's war in Ukraine are factors that only add to an already inequitable playing field in developing countries. It is well known that these places are in many cases already bearing the brunt of a climate crisis that they had the least responsibility for creating. Extreme weather events over the past decade "have killed 15 times the number of people in low-income coastal countries as they have in wealthier costal countries," according to one briefer's presentation. Further, "3.6 billion people in 81 countries live well below what is considered the modern energy minimum, around 1,000 kilowatt hours of consumption per capita per year. And 768 million people around the world have no electricity access." In light of these challenges, leaders in these nations must focus first on survival for their people and a pathway to elevating their standard of living, regardless of energy source. If that source can be renewable, so much the better, but it is by no means their primary focus.

Microgrid scale renewable energy projects have the potential to help alleviate energy poverty—and in turn economic poverty—if they can be deployed at scale. One presenter demonstrated a compelling example of a village in India plagued with spotty electrical service from the national grid that hampered development, stifled education opportunities, and led to unsafe conditions for residents. Work in this village to bring online a localized solar-based microgrid, in partnership with India's largest integrated power company, has allowed schools to remain open longer, small businesses to thrive, and brought stability of service all without contributing to the climate crisis. Philanthropic engagement is helping to replicate this example in other locations, but accelerating the pace of implementation presents both an economic and logistical challenge.

Participants quickly grasped this concept and focused the discussion on the issue of scalability—how to accelerate the uptake of these kinds of solutions given the paradigm shift that they would require, transitioning from the mentality of public-scale, often monopolized,

[1] https://context.capp.ca/articles/2020/pirl-fertilizers/

utility-based projects to the microgrid model which would have to be private sector driven, competitive, and have significant upfront capital investment. The discussion focused on two key points. First was the role of development banks, such as the World Bank and the International Monetary Fund, which would need to shift their mindsets and traditional approaches to add flexibility in access to capital and create a long-term instrument such as a resilience trust. It was estimated that such a mechanism could provide up to a third of the funding needed to scale to success in all 81 nations.

And second, that this work with development banks would have to be complimented by public-private partnerships. One participant asked whether this would be feasible when as a foundational principle of partnerships, the business community expects to be able to rely on a functioning utility grid in a given location, but in this case the project itself would be the means of providing that stability. One answer put forth was to accelerate partnerships first with the utilities in the region combined with leveraging the United States' "unique instrument of guarantees to local banks to facilitate development projects." Another participant pointed out that there would likely be a training gap that would need to be addressed to create the workforce necessary to implement the change. "The internal combustion engine is universal, and people know how to work on them. This is not." The presenter acknowledged this gap but suggested that remote monitoring and communications could help resolve this issue.

Ironically, such remote communication options have been made possible by a similar technological leapfrog many developing countries were able to make a generation earlier—foregoing landline telephone infrastructure and moving directly into mobile phone technology. Now the challenge is to ensure that people in remote locations have sufficient electricity to charge those phones to access remote training options, thereby illustrating the circular challenge of implementation.

Implications for U.S.-China Relations

Across these regional discussions, one topic that continued to arise was that of U.S.-China relations and its so-called Belt and Road Initiative as a means to continue expanding its global reach and influence. Members from both political parties expressed concerns about China's increasing role on the world stage, and its implications for American prominence. There was broad agreement among the group with the sentiment expressed by one presenter that U.S. policy toward China must be seen as bipartisan. That this is not an issue just of climate

change or energy security, but more prominently that we are engaged in, as one presenter put it, "a U.S.-China battle for global leadership."

The Sino-American competition and the real potential for ideological conflict that it represents became a topic of discussion in each session. The energy supply chain issues led to discussion of the rise to prominence of new trade agreements in the Pacific region that have facilitated Chinese efforts to minimize the U.S. trade presence there. Yet at the same time, China continues its reach into the western hemisphere. One participant noted that the vast majority of electric vehicles in Latin America, for example, are Chinese, and if Chinese investment in the region swells to include electric vehicle infrastructure, "watch out; it will be Belt and Road all over again."

The suggestion was made that a coalition of multilateral development banks could be deployed as a counterweight to the Belt and Road Initiative, and, as a scholar suggested, that is already taking place in Africa. Another good example could be seen in Puerto Rico as part of redevelopment following the hurricanes of 2017. Further, the blueprint could already be in place in the form of $100 billion in commitments to support developing countries' transitions to renewable energy that the international community made in Copenhagen in 2009 but had still not been met as of the most recent Conference of Parties in Glasgow in 2021.

Several participants pointed out how one pathway to simultaneously meeting China's challenge, bolstering the U.S. domestic economy, and accelerating the increased rollout of climate solutions to developing countries would be to increase our domestic supply chain—the primary focus of the bipartisan Infrastructure Investment and Jobs Act and CHIPS and Science Act which President Biden signed into law in 2021 and 2022 respectively. "The starting point of competition is what we do at home," one member of Congress pointed out. Another suggested we take account of where in our supply chain China is the only domestic source of components or products and ensure we are diversifying the supply. It was further noted that these weak points exist even in our military.

Another participant observed that we may have a better opening to recapture some of this global market share now, when China is struggling on many fronts including artificial intelligence policies, Covid-19 response, and human rights issues. We can adopt a series of tools to exploit these weaknesses. This reinforces the need for bipartisan efforts for strong performance and durable results.

From the North: Implications of a Warming Arctic

Despite not having a direct border on the Arctic Ocean, China has made no secret of its desire and intention to be considered an Arctic country, referring to itself as a "near-Arctic state" in international forums. As the eventuality of an ice-free Arctic draws ever closer, China has expressed its desire to establish a "Polar Silk Road" to take advantage of shorter shipping routes to major markets.

Multiple experts in discussions reminded participants that strategic developments along Russia's northern border in the Arctic Ocean also must not be ignored, while most Russian experts are focused on the war in Ukraine. Following the Russian invasion, the other seven Arctic States (Canada, Denmark (via Greenland), Finland, Iceland, Norway, Sweden, and the United States) jointly suspended Russian participation in the Arctic Council during Russian Chairmanship. However, the Arctic States continue to seek "limited resumption… of projects that do not involve the participation of the Russian Federation."[2] In her remarks, Prime Minister Jakobsdottír noted that Russia has not been expelled from the Arctic Council as it was from the Council of Europe because the Arctic Council leadership opted for a "cooling period" given the magnitude of Russia's Arctic holdings and the influence the Russian Arctic has on the overall region.

Meanwhile, one expert presenter expressed significant concern for the future of this heretofore peaceful polar area: "Russian militarization of the Arctic is very troubling, but [the potential for] nuclearization of the Arctic keeps me up at night." This Arctic anxiety is due in no small part to what several participants described as the "woefully inadequate" capabilities of the U.S. to operate in the Arctic. Another described the "long list of concerns" in the region headlined by the stark differences in operating capacity between Russia, which has upgraded over 500 military facilities along its northern border, and the U.S., which lacks even a single deepwater Arctic port. Russia's fleet of polar icebreakers is more than 10 times greater than that of the United States, which currently has only two operational icebreakers. In a rare point of agreement, both the Heritage Foundation[3] and the Center for American Progress[4] have published papers calling for America to urgently address this shortfall in polar operations and defense. The same lack of capacity extends to maritime domain awareness, and ability to

[2] https://www.state.gov/joint-statement-on-limited-resumption-of-arctic-council-cooperation/

[3] https://www.heritage.org/global-politics/commentary/us-needs-icebreakers-keep-china-and-russia-arctic

[4] https://www.americanprogress.org/article/icebreakers-essential-assets-for-a-changing-arctic/

monitor vessel traffic in a part of the globe where traditional communications capabilities do not function well due to the complications of operating in extreme latitudes.

Multiple participants pointed out that the Arctic is warming dramatically faster than the rest of the planet, a reality that, in addition to driving sea level rise and potentially disrupting ocean currents with potentially dramatic implications for global weather patterns, will also lead to a new gold rush for resources including minerals, shipping routes, and fish. Again, this is an area where Russia and China are preparing to dominate the landscape in ways the U.S. has not adequately considered. While the Arctic Council has implemented a moratorium on commercial fishing in Arctic waters, China's drive to continue providing protein for its growing population means it will be motivated to break this prohibition. With Russia being frozen out of future Arctic Council deliberations, its willingness to continue playing by the Arctic Council's voluntary rules for operating in international waters will be tested, particularly given new and developing partnerships with China.

While the U.S. and our allies in the region can't cooperate with Russia in the same way as in the recent past, we also can't ignore the increase in Russia and China's activities and their interests in the Arctic. The UN Convention on the Law of the Sea stipulates that the High Seas—the area of the ocean beyond any single nation's jurisdiction is "the common heritage of [hu]mankind," so any move to exploit the resources of the far north must be regulated under this treaty's stipulations. Yet even in the face of near-global consensus that additional scientific research is needed to understand the implications of resource exploitation in an unexplored region of the planet, actions by individual states to get ahead of international interests are difficult to regulate other than through diplomatic channels. One option is looking to past relationships such as cooperation during the Cold War. This is also a region where traditional and indigenous knowledge and understanding of harsh and challenging natural conditions must play a significant role.

As troubling as the warming of the Arctic Ocean is, there are equally concerning climate developments on land. One participant raised the issue of methane escaping as permafrost melts across the tundra, describing the assessments of the massive potential for methane release as "game over" for the climate. The presenters responded that methane capture from permafrost is a prime example of a topic on which the Arctic Council was making significant, collective progress prior to Russia's Ukraine aggression and which has now been lost to that

conflict. Given the sheer scale of Russian territory and potential contributions to methane emissions, there are now "massive data gaps" without its participation in deliberations.

Presenters were unanimous in their assessment that as both China and Russia have developed long-term strategic visions for the future of the region, the U.S. must follow suit. One noted that the Biden administration is developing a new U.S. Arctic strategy that will be released later this fall, and it's an area where Congress should conduct major oversight through hearings and take appropriate legislative action to upgrade our capabilities across the spectrum.

A Climate-Ready Military: Implications of Decarbonizing the Department of Defense

As the U.S. considers expanding its military operations in the Arctic—including the U.S. Coast Guard which one presenter described as "chronically underfunded"—it should do so in a way that does not exacerbate the effects of climate change. Energy, of course, is essential to military operations, and one presenter stipulated that fuel consumption by the U.S. armed forces represents 2 percent of all global fuel use. Presenters agreed that opportunities for military decarbonization could drive change in key areas including microgrids and distribution of decarbonization infrastructure, electric vehicle and charging station infrastructure, expansion of geothermal energy supply, safe deployment of nuclear power including micro-reactors, and acceleration of demand for sustainable shipping and aviation fuel.

Conversely, continued reliance on traditional fossil energy sources has negatively affected force readiness as the fuel price spikes can literally cost the Department of Defense billions of dollars in unforeseen and unbudgeted expenses. One participant acknowledged "that's a big number, even for D.o.D."

As one presenter put it, "climate change is not a new issue for the military." The Department of Defense has seen and felt its implications from sea-level rise threatening infrastructure like the world's largest naval base in Norfolk, Virginia to the spike in humanitarian assistance and disaster relief missions related to extreme weather events. Today, military operations are already at the cutting edge of U.S. renewable energy implementation. Two-thirds of energy consumed on bases, 1.2 gigawatts annually, comes from renewable sources and saves $400 million per year in energy costs. And leadership believes that accelerating the transition to renewables in the long-term will "give us a war-fighting advantage and protect national security from the biggest threat we face: climate change."

U.S. Energy Choices

Of course, climate change is not just a challenge for military operations; it also threatens global society as a whole. So, what energy choices should the United States make now to address the threat and pivot to a clean energy future? On these points, experts presented on technologies that can accelerate America's transition and ways to optimize our energy grid to handle new sources of electricity and avoid the extreme weather-fueled breakdowns we have witnessed in recent years, most notably in Texas and California. On the former point, one expert broke the challenges down to six factors: scalability, affordability, reliability, carbon and "traditional" pollution reduction, position on the learning curve, and position on the price curve. Of the options currently under consideration, this presenter ranked solar, wind, offshore wind, EVs, batteries, and heat pumps as technologies that are ready today for large scale deployment. However, there are key constraining factors, such as siting and deployment challenges for solar and wind, and minerals and installer/labor availability for the others. Solar thermal energy, geothermal energy, hydrogen, and storage tech were in the next tier, with the main challenges to deployment being research and development investment. The presenter ranked other options in the "future" (4th generation nuclear and carbon capture and storage) and "pipe dream" (nuclear fusion and direct air capture) categories.

The Inflation Reduction Act took significant steps to begin addressing many of these challenges, yet the major blockade to rapid deployment, particular for the "ready" suite of technologies, comes down to issues of siting and permitting. Across the spectrum of members of Congress and presenters alike, there was clear agreement that the pace of permitting is a major hurdle, and it should be addressed if the U.S. is to keep up with other developed countries in renewable energy deployment.

In addition to permitting and siting, another expert cited "adding a price on carbon" as "the most efficient way to allow the market to do its job" in building out renewable energy infrastructure and modernizing the grid to efficiently distribute electricity from multiple intermittent sources. This expert also espoused the perspective that inaction at the federal level, particularly through legislation which provides a more stable foundation for durable policy action than executive orders, has led to an environment where states were forced to take these decisions upon themselves. In turn this "created conflicts in multi-state markets when neighboring state policies didn't align."

When a member of Congress noted that the U.S. needs a more resilient grid but questioned who would bear the cost which traditionally has been borne by ratepayers, one expert suggested that regulatory certainty would "enable private capital to drive the buildout." This policy should have bipartisan support to ensure that it lasts beyond a single administration or shift in congressional leadership. The Federal Energy Review Commission provides one good model because it is specifically required to be comprised of bipartisan appointees.

How U.S. Policy-Makers Can Lead: A Suite of Solutions

Across the themes discussed over the four days of the conference, several concepts emerged that can help inform U.S. policy decisions related to energy security and the Arctic. On the international front, scholars made a strong case that despite the urgent need to transition to a renewable energy economy as rapidly as possible, complications of deployment and economic and political realities make it clear that in the short term the world will need continued fossil fuel production and consumption to maintain stability. This need is particularly urgent in Europe and other regions that are bearing the brunt of sanctions against Russia and subsequent action to turn off the flow of natural gas, including via the Nord Stream 1 pipeline. As one expert put it, moving to shut off the fossil fuel tap immediately "would be like saying you're going to go on a diet and then buying a new wardrobe and wearing it tomorrow. It won't look very good."

The role of American production in helping to meet this demand is made more difficult by the reality that the market in Europe is driven by natural gas, while our capacity to export to the region via liquid natural gas facilities is currently operating at maximum capacity. Expanding or developing new export terminals takes years under the best circumstances, and the onerous permitting process for such facilities will make it virtually impossible for additional export capacity to come online in the next 2-3 years before Europe can sufficiently reduce its dependence on gas as an energy source. Given this reality, several participants discussed the complications of the messaging this sends to communities and regions that have been reliant on fossil fuel production to drive their economy and now feel threatened by the looming energy transition.

No matter the rationale, if the U.S. seeks to incentivize greater production of fossil fuel in other regions of the world while simultaneously mothballing production facilities at home, this

will be a bitter pill for oil, gas, and coal communities to swallow. Conversely, on the international stage, the optics of increasing production domestically while simultaneously asking less developed countries to decarbonize are complicated at best. One participant suggested that the messaging needs to be more agnostic about the source and focus on the concept that "if you can be clean, you can have a role" in our energy future.

In developing countries, creative solutions are leading to abundant opportunities to accelerate localized, often micro-scale, renewable energy solutions. However, there is also a need for large-scale planning and smaller projects must also be supported by innovations in developing a grid to ensure reliability and equity of access. Opportunities exist to accelerate leveraging existing financial mechanisms that can drive implementation of these solutions, including through multilateral development banks. As in developing countries and economies that were able to "leapfrog" the step of installing landline telephone infrastructure and move straight to mobile technology, a similar leapfrogging is poised to take place with electricity deployment in regions where centralized distribution has not yet taken hold. U.S. investment in accelerating this transition can also have the triple benefit of reducing global emissions, lifting people out of poverty, and serving as a counterweight to China's creeping geopolitical influence.

In the Arctic, oversight and monitoring needs enhancement to protect against incursions and resource exploitation, particularly by Russia and China. There was some discussion of the complementary roles of the Coast Guard and the Navy in executing Arctic operations. The two services must continue to develop a joint strategy to move forward in partnership as Arctic sea ice retreats, trade and military operations become more feasible in the coming decades, and a race accelerates for access to resources including oil and gas and fisheries. Several participants called out America's dire lack of operating capacity in the region, with no deepwater port facilities and only two functional icebreaking vessels currently in our fleet. While Congress has authorized construction of six additional icebreakers, delivery of the first new icebreaker in over 40 years has recently been pushed back to 2025. Even should all six eventually be built, the Russian fleet of 46 icebreakers, will still dwarf our capabilities. Participants noted that not all Arctic regions are created equal, and the geology of Alaska's north slope makes port construction more difficult than in most of the Russian Arctic; but given the investment other competitors are making in this region, many participants felt that greater U.S. attention and investment in the region was warranted.

Participants warmly received the perspective espoused by Iceland's Prime Minister in her remarks to the group, particularly around the importance of gender equity in driving Iceland's prosperity and the use of additional metrics to measure the nation's progress and success. Notably, during the site visit to the Hellisheidi geothermal power station, the power plant's CEO dedicated nearly half of his talk to the company's purposeful transition to gender parity among its employees and leadership. He presented numerous metrics pointing out dramatic gains in the company's bottom line profits and employee satisfaction that have come as a result. And one member specifically called back to the need for the U.S. to develop additional economic and societal metrics of success akin to those now being used at the highest levels of Iceland's decision-making.

On the domestic front, two points garnered the most attention and agreement. The first is the challenge of a snarled, bureaucratic permitting process that leads to massive delays in virtually any major domestic infrastructure project. There was broad agreement that we should find ways to streamline permitting to take advantage of the opportunity to revamp our electricity grid and build out renewable energy solutions, including to take advantage of provisions in the Inflation Reduction Act. Many participants stipulated that this should not mean weakening environmental standards, while others suggested that environmental advocates might need to relax their often-blanket opposition to new construction if decarbonization is the highest priority. Yet there was broad agreement that regulators should create a much faster process for saying yes or no. One participant pointed out that most developers would much rather have a rejection in one year than an acceptance in ten years. Some suggested pre-zoning areas with a red, yellow, green system, and consolidation of permit applications across the spectrum of agencies. This could also be facilitated by creation of a White House ombudsman position to help coordinate across agency jurisdictions.

And finally, as a means of underlining the critical need for convenings such as this conference, participants espoused the importance of bipartisan leadership to deal with the challenges of energy, climate, and the Arctic as a national security issue. Many members reflected that while the Inflation Reduction Act was passed without bipartisan support, there are numerous provisions within the larger package that have significant support from both sides of the aisle. With it now being the law of the land, successful implementation of these provisions is certainly in our national interest. One scholar pointed out that this is the first piece of comprehensive energy legislation to be signed into law since the Energy Policy Act of 2005. This

led to discussion of the importance of public-private partnerships to take advantage of this opportunity as the country did in building out the major infrastructure projects of the 1930s and 40s. As one participant put it, "what we learned then was the power of the federal government to get things done. We can't wait for the states to do it on their own, or we will miss the future."

Conclusions:

Participants' summarizing remarks indicated the themes reflected above as well as the inherent value of the convening for building relationships, exploring opportunities, sharing perspectives, and ultimately accelerating progress toward solutions. One participant noted that the starting point of international competition is what we do at home. In contrast to what China's economic colonialism demonstrates, "America has the resources to show the world a different form of leadership and economic development that includes sustainability of our planet, and a democratic system that reflects different heritage and respects human rights."

Throughout, politicization of energy issues was seen as an obstacle. At its core, one presenter stated that "this is about saving lives and protecting the country," and in telling the stories that help build that case, "language matters. Perspective matters." The potential exists to use energy—a universal need—to build pathways to cooperation across party lines. In many cases, this can take the form of "red state supply meeting blue state demand," gaining community buy in and personal engagement.

A Republican member of Congress spoke about the perception of recalcitrance on climate action and a renewable energy transition among much of their party's caucus, suggesting one key to engaging them would be "more conversation about obtaining and retaining the materials we need to get where we're going." One area where this will be critical is access to minerals required for battery manufacture and many components of renewable energy technology where China was largely perceived to be "eating our lunch." But at the end of the day, the demonization of the fossil fuel industry is felt on a personal level by the communities built on generations of blood, sweat, and labor. "These communities would request one thing above all else," the member said. "No handouts, just a little respect for the decades that they risked their health and safety to help build our country."

In the end, despite an abundance of challenges from polar security to a looming energy crisis in Europe, to the rise of Chinese influence in the developing world, to the ongoing Russian

invasion of Ukraine, and the existential threat of global climate change, the tone leaving these discussions was optimistic. "I was afraid of leaving here depressed," one participant said in a concluding session, "but instead I am inspired."

NEW SECURITY DYNAMICS IN A RAPIDLY CHANGING ARCTIC

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The Arctic, once a Cold War staging ground, is now the backdrop for Great Power Competition and the scene of a Hot Climate contest. The Arctic region is warming at more than four times the global average.[5] In addition to having serious implications well beyond the Arctic (Greenland's ice storage keeps our coastal cities, like Miami and Houston, above water), this warming has created an increasingly accessible ocean, and with it, an increasingly competitive geostrategic environment—particularly between the U.S. and its Arctic allies, Russia and China. This new Arctic landscape hosts an ever-more dangerous convergence of security risks related to energy, climate and geopolitics. On top of these rapid climatic changes, Putin's war on Ukraine has had spillover effects on the Arctic, once considered the last region of peaceful cooperation among erstwhile competitors. Now, the Arctic is not only a region where adversaries may seek claims to valuable resources and vital trade routes, it is also a region where hybrid and gray zone warfare are made more likely by the Russian aggression in Ukraine and subsequent Russian absence at the Arctic Council.

This new Arctic landscape has significant implications for U.S. security. This includes challenging homeland defense (via Alaska), complicating U.S. support for Nordic and NATO allies in the European Arctic, driving an increase in strategic competition, and enabling Russia's militarization of the region.

[5] Los Alamos National Laboratory. "Arctic temperatures are increasing four times faster than global warming." Phys.org. July 5, 2022. https://phys.org/news/2022-07-arctic-temperatures-faster-global.html.

As the Navy likes to say, here is the Bottom Line Up Front, in case you don't make it through the whole paper!

1. **Putin's war on Ukraine has reshaped Arctic security dynamics, further strengthening Allied cohesion and weakening cooperation with Russia in the region.**
2. **Putin's weaponization of energy in the Ukraine conflict underscores the urgency of the energy transition.**
3. **Climate change is a threat multiplier, reshaping the strategic operating environment for the U.S. in the Arctic and around the world.**
4. **In the Arctic, a changing climate is emboldening our competitors and adversaries (Russia and China), creating new risks and complicating navigating conditions for U.S. forces, commercial and civilian actors.**
5. **Leadership on Arctic security is essential to America's overall security and strategic interests. The U.S. should coordinate with allies, partners, communities, the private sector, and others, to reinforce the rules-based order and support Arctic resilience**.
6. **We have a "Responsibility to Prepare and Prevent"[6] for changing Arctic conditions and the U.S. needs to enhance both its presence and its operating capabilities in the Arctic, to include enhanced diplomatic engagement, updated icebreaking, and improved domain awareness, communications, mapping, and research capabilities.**

#1: Putin's war on Ukraine has reshaped Arctic security dynamics, further strengthening Allied cohesion and weakening cooperation with Russia in the region.

[6] Werrell, Caitlin and Francesco Femia. "The Responsibility to Prepare and Prevent." The Center for Climate and Security. October 2019. https://climateandsecurity.org/2019/01/31/interview-with-sherri-goodman-aresponsibility-to-prepare/.

Putin's invasion of Ukraine has fundamentally reshaped security dynamics in the Arctic, strengthening allied cohesion and bringing Finland and Sweden into NATO. The Baltic is becoming a NATO lake—with Finland and Sweden in NATO, then the Arctic will become half a NATO ocean, with Russia dominating the other half. Changing security dynamics in the Arctic due to Russia's invasion of Ukraine mark a profound shift in European and transatlantic security, and a significant psychological shift for Sweden and Finland. With increasingly interconnected risks between climate and security in the Arctic, relations with Russia are unlikely to return to normal—even when "normal" means post-2014 relations. In March, 2022, all Arctic 7 countries—Canada, Denmark, Finland, Iceland, Norway, Sweden, and the U.S.—suspended most of their Arctic Council participation under Russia's chairmanship in response to Putin's invasion of Ukraine. This current exclusion of Russia from Arctic multilateral diplomacy is an important signal, as it is hard to justify business as usual in Arctic cooperation under current circumstances. The diplomatic quandary greatly contrasts with the importance of past Arctic 8 cooperation in resilience building and stabilizing the security environment.

NATO ups its Arctic presence

At a global level, direct security responses from the West include changes in the strategic orientations of NATO, with more resources going into military capabilities. In the Arctic, the U.S. remains committed to advancing its military capabilities and to strengthening coordination with Canadian forces through the joint U.S.-Canadian North American Aerospace Defense Command (NORAD). The UK has announced a permanent Marine strike group in the Nordic countries, strengthening cooperation among NATO allies in response to a potential spillover scenario into the Arctic.[7] The Kingdom of Denmark secured a $240 million package to increase its presence in the Arctic, and Danish Foreign Minister Jeppe Kofod announced that Denmark had committed to strengthen surveillance, command, control, and communications in the region from 2023 onward.[8] Additionally, Denmark voted to get rid of its opt out for European defense, thereby signaling a bolstered European unity. With Finland and Sweden's

[7] Fouche, Gwladys. "Britain to boost its military presence in the Arctic." ArcticToday. March 29, 2022. https://www.arctictoday.com/britain-to-boost-military-presence-in-arctic/.

[8] Kofod, Jeppe. "Reducing Risks in the Arctic During a Time of Increased Volatility." The Wilson Quarterly. Winter 2022. https://www.wilsonquarterly.com/quarterly/the-new-north/reducing-risks-in-the-arctic-during-a-time-of-increased-volatility?utm_medium=email&utm_source=newsletter&utm_campaign=wilson&emci=817d62ba-cba6-ec11-a22a-281878b85110&emdi=0fb8fb8c-dda6-ec11-a22a-281878b85110&ceid=337714.

integration to NATO, Nordic security will be strengthened and further coordinated. The two countries' NATO applications further mark a major shift in Nordic neutrality and will give increased credibility to NATO's defense posture in the High North. Finland and Sweden are vital additions to NATO's Arctic capabilities, with strategic and tactical naval experience in sub-zero temperatures as well as the technological expertise to revamp NATO's naval assets and accelerate the energy transition.[9]

Consequences of weakening cooperation with Russia

Damaged relations with Russia have significant implications around the world. The aggression of an authoritarian state against a democratic state has weakened the stability of the international order, emboldening the expansion of authoritarianism and disinformation. While sanctions and other diplomatic measures of deterrence are important to restrict Russia's platform on Arctic affairs, the urgency of action required in such a rapidly changing region necessitates keeping open the possibility of future scientific cooperation.

We should not forget that Russia has its own climate security vulnerabilities, and Putin likely wants to distract domestic attention away from this problem he is unable or unwilling to address.

At a press conference in January, President Biden noted that one of the challenges Putin was facing was, "a burning tundra that will not freeze again naturally."[10] President Biden was referring to the climate insecurities within Russia itself. Putin himself has acknowledged that permafrost melt could be disastrous to northern cities. The 2022 Intergovernmental Panel on Climate Change (IPCC) Working Group II Sixth Assessment Report underscored this risk, noting that 85 percent of large settlements on permafrost worldwide are in Russian territory. The report said that the "...ability of foundations to support structures has decreased by 10 to 40% relative to the 1960s in the majority of settlements on permafrost in Russia...and [are] further

[9] Khorrami, Nima and Andrea Raspotnik. "Great Power Competition Is Coming for the Arctic: NATO Should Prepare." World Politics Review. March 29, 2022. https://www.worldpoliticsreview.com/articles/30434/for-nato-russia-ukraine-war-forecasts-tensions-in-the-arctic.

[10] Remarks by President Biden in Press Conference January 19, 2022. https://www.whitehouse.gov/briefing-room/speeches-remarks/2022/01/19/remarks-by-president-biden-in-press-conference-6/.

expected to decrease..."[11] At the same time, Arctic ice melt eliminates a natural defense of Russia's northern borders, which could spur increased military buildup.

As climate risks go unaddressed in Russia, they pose serious threats to the Russian economy that add to the woes the Russian people are already facing today. When it comes to responding to the climate crisis and preventing climate risks, Russia lags behind much of the world.

With the Arctic Council in limbo, there is no unified body continuing time-sensitive environmental security negotiations. As one of the few functioning groups, the Arctic Council Emergency Prevention, Preparedness, and Response (EPPR) Group is resuming limited cooperation (on International Maritime Organization implementation, search and rescue and on nuclear incidents). Cooperation on maritime risk-reduction agreements, especially on encounters at sea, is paused, as is scientific cooperation on the extent and impact of Siberian permafrost thaw. Without these bodies and mechanisms holding Russia accountable, environmentally harmful Russian activities will go unmonitored. The erosion of political cooperation in the Arctic presents major environmental risks and dangerous opportunities for Russia to engage in gas flaring, extractive mining activities, or other climate-harming actions that would previously be monitored by the Arctic Council.[12]

Potential impacts on Arctic science and security

Arctic science cooperation is important to Arctic environmental and national security. The pause in Russia's participation in Arctic Council activities weakens that collaboration. However, the commitment of the remaining Arctic 7 to Arctic science cooperation continues and becomes even more important with Russia's absence. The U.S. and its Arctic partners should continue robust programs of Arctic science and technology. The Arctic 7 should also anticipate and plan for a future where scientific cooperation with Russia is restarted. Russia's geographic importance in the Arctic, combined with retreating sea ice and collapsing permafrost, mean the absence of data on Russian environmental and climate change will affect Arctic domain

[11] Intergovernmental Panel on Climate Change WGII Sixth Assessment Report. February 27, 2022. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FinalDraft_FullReport.pdf.

[12] Baker, Aryn. "Ukraine's Conflict Has Rippled All the Way to the Arctic Circle." Time. March 9, 2022. https://time.com/6156189/russia-ukraine-conflict-risks-arctic-climate/.

awareness overall. Cooperation on Arctic security will be hard fought, and opportunities are few and far between. Even during the Cold War, while we "contained" Russia, we still cooperated in areas such as science and research. If the Ukraine war drags on, as looks likely, we may need to do the same now.

#2: Putin's weaponization of energy in the Ukraine conflict underscores the urgency of the energy transition, with key Arctic nations leading the way.

The conflict in Ukraine hastens the importance of the energy transition in Europe, which would create geopolitical benefits. The European Union is the biggest purchaser of Russian energy, making up a staggering 40% of Russian gas imports, 27% of Russian oil imports, and 46% of coal imports in 2021.[13] Fossil fuel overdependence is a threat multiplier: in the context of the war in Ukraine, dependence on the Russian fossil fuel industry threatens Western energy security and finances the continuation of war, in addition to contributing to climate change.

The energy transition offers an opportunity to free Europe from the tether of Russian oil and gas, establishing an energy independence that does not rely on or reinforce volatile fossil fuel markets. European energy independence would destabilize Russia's economy, bolstering U.S. and EU Russian oil embargos. U.S. short-term interventions to guarantee secure energy (e.g., releasing fuel from strategic reserves or increasing natural gas exports) should not undermine longer-term clean energy strategies. Transatlantic cooperation is a crucial component of decarbonizing energy, as a unified approach to renewable energy innovation and investment will spur the implementation of clean energy at a global scale.

The Arctic 7 nations, particularly Iceland, are leading the West towards a decarbonized future. As we look to further develop clean energy pathways, the examples of the technologies we will see in Iceland offer potential opportunities for the U.S. Other Arctic nations, such as Norway, are also major oil and gas producers like the U.S. Norway also provides examples of decarbonizing, through carbon capture and other methods, while diversifying energy sources

[13] "In focus: Reducing the EU's dependence on imported fossil fuels." European Commission. April 20, 2022. https://ec.europa.eu/info/news/focus-reducing-eus-dependence-imported-fossil-fuels-2022-avr-20_en.

and advancing net zero emissions goals.

A major challenge for the energy transition is securing access to critical minerals for renewable energy production, and some of these reserves lie in Russia and Ukraine. Accelerating the transition to net-zero is about establishing new, cleaner sources of energy as well as a robust effort to increase energy efficiency and reduce energy consumption.

The Western allies, from NATO to the EU, will need to consider the role of decarbonized energy and emissions reduction as a powerful lever for global security.

#3: Climate change is a threat multiplier, reshaping the strategic operating environment for the U.S. in the Arctic and around the world

The Intergovernmental Panel on Climate Change Special Report on Oceans and Cryosphere in a Changing Climate found that climate change is evident in the furthest reaches of the globe—from the highest mountain peaks to the deepest oceans.[14] Greenland is now melting from the top down as well as the bottom up.[15] Here are the key Arctic findings that shape the strategic operating environment for the U.S.:

- **Arctic sea ice extent in September (when sea ice extent is at its minimum) has declined about 13% per decade** (during the satellite era from 1979 to 2018). The Arctic's older, thicker sea ice, which acts as a bastion against the melting of other sea ice, has almost completely disappeared. Only about 10% of sea ice is five years old or older. Fifteen to 20 years from now, the Arctic could be ice-free in summer months.[16]

[14] Maddox, Marisol. "Two Divergent Paths for Our Planet Revealed in New IPCC Report on Oceans and Cryosphere." New Security Beat. November 18, 2019. https://www.newsecuritybeat.org/2019/11/divergent-paths-planet-revealed-ipcc-report-oceans-cryosphere/.

[15] Buckiewicz, Amanda. "How the Greenland Ice Sheet is melting from the bottom up." CBC News. March 13. 2020. https://www.cbc.ca/radio/quirks/mar-14-coronavirus-epidemiology-greenland-glaciers-melt-and-more-1.5495007/how-the-greenland-ice-sheet-is-melting-from-the-bottom-up-1.5495011.

[16] "New study suggests climate models may underestimate rate of melting." National Oceanic and Atmospheric Association. February 28, 2020. https://www.ncei.noaa.gov/news/arctic-ice-study#:~:text=Measurements%20last%20year%20revealed%20the,during%20summer%20within%20fifteen%20years.

- **Ice sheets and glaciers are losing ice around the world.** The volume of melt from the Greenland ice sheet in 2019 was not expected by climate models until around the year 2070. Highlighting the extent to which this is concerning, during the month of July 2019, 12.5 billion tons of ice was lost from the Greenland ice sheet, which was enough to cover all of Germany with almost 7cm of water. Antarctica's ice sheet lost 155 gigatons (Gt) per year, and glaciers around the world (beyond Greenland and Antarctica) lost 220 Gt a year. Combined, the ice loss between Greenland, Antarctica, and other glaciers not part of ice sheets was 653 Gt per year. For context, a single gigaton of water would fill about 400,000 Olympic pools.[17]
- **The Arctic has warmed more than four times the global average in the last two decades.** During the winters of 2016 and 2018, surface temperatures in the central Arctic were 6 degrees C (10.8 degrees F) above the 1981-2010 average.
- **From 2007 to 2016, permafrost temperatures increased by about 0.3 degrees C (0.5 degrees F), a record level of warming for permafrost.** Warming of permafrost can be a ticking time bomb. Arctic and boreal permafrost contains 1440-1600 Gt of carbon.[18] As permafrost thaws, carbon dioxide and methane are emitted into the atmosphere, fueling more warming." According to a recent report, "Methane traps heat in the earth's atmosphere at more than 25 times the rate of carbon dioxide. Thawing permafrost has been shown to release ancient microorganisms such as viruses, bacteria, and fungi, which also presents potentially grave issues in public health."[19] Arctic communities have already experienced disruptions to their freshwater supply, infrastructure, transportation, tourism, and cultural traditions, due to a melting cryosphere. The Arctic region is described by the IPCC as a "global hotspot of high human vulnerability".[20]

[17] Walbolt, Kristen. "10 things: All about ice." NASA's Jet Propulsion Lab. March 28. 2018. https://sealevel.nasa.gov/news/114/10-things-all-about-ice.

[18] Levin, Kelly and Ezra Northrop. "4 Things to Know About the IPCC Special Report on the Ocean and Cryosphere." World Resources Institute. September 25, 2019. https://www.wri.org/blog/2019/09/4-things-know-about-ipccspecial-report-ocean-and-cryosphere.

[19] Maddox, Marisol. "Climate-Fragility Risk Brief: The Arctic." Climate Security Expert Network. July 2021. https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/csen_risk_brief_arctic.pdf.

[20] "Climate Change 2022: Impacts, Adaptation and Vulnerability." IPCC AR6 Report. March 2022. https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf.

- **Increasing frequency and intensity of heat waves across Europe demonstrate the growing contrast between land and ocean temperatures in the Arctic.** Changing jet streams related to warming land temperatures create a heat dome across Western Europe and could pose more extreme weather risks.[21]

Arctic methane presents one of the greatest obstacles to mitigation of greenhouse gas emissions. The current carbon budget lacks substantial research on and heavily undercounts methane emissions, reinforcing overly optimistic estimates for warming that do little to mobilize the necessary resources to regulate and monitor the carbon budget. A commitment to bolster monitoring tools and analytical approaches is critically important to reduce uncertainties in understanding across communities of interest. Arctic methane emissions pose significant scientific and policy challenges to geopolitical cooperation on climate security, most of which are exacerbated due to ripple effects of the Ukraine conflict. Difficulty monitoring emissions seasonally, at night, and pairing remote sensing and in situ capabilities complicate a systematic integration of data. Key policy challenges include data sharing across borders, the impact of thawing permafrost on existing communities, and stagnant Russian cooperation. If challenging dynamics continue, air and space assets will become even more critical for monitoring the permafrost and methane emissions. The U.S. national laboratories, including Sandia, along with NASA and NOAA, are developing increased capability to monitor and manage Arctic methane emissions.[22]

#4: In the Arctic, a changing climate is emboldening our competitors and adversaries (Russia and China), creating new risks and complicating navigating conditions for U.S. forces, commercial and civilian actors.

The Arctic has emerged as a region of geostrategic competition, primarily because rising temperatures, melting sea ice, and collapsing permafrost now grant access to this region previously locked in ice most of the year. While the Arctic has, since the end of the Cold War,

[21] Rousi et al., "Accelerated western European heatwave trends linked to more-persistent double jets over Eurasia." Nature Communications. July 4, 2022. https://doi.org/10.1038/s41467-022-31432-y.

[22] Section informed by conclusions from a Wilson Center/Sandia National Laboratories event held under the Chatham House Rule on June 23, 2022.

been a region characterized by cooperation and diplomacy, it has more recently become a zone of increased tensions, heightened even further by Putin's war in Ukraine, over potential offensive military capabilities, global interests in valuable energy, mineral resources, and access to shipping routes. The retreating and thinning of Arctic ice have given rise to exponential growth in economic and military activities, including shipping, resource extraction, and other commerce.

As I stated in a *Foreign Policy* essay, "China has large ambitions throughout the Arctic."[23] This includes the advancement of both commercial and military objectives. For instance, China is aiming to use Russia's Northern Sea Route to ship goods and other materials between ports in Asia and Europe. This will shorten travel times compared to traditional routes through the Straits of Malacca and the Suez Canal, offering China a new strategic advantage in terms of global trade and freedom of navigation. In January 2018, this ambition was formalized in China's first public Arctic policy, wherein China declared itself to be a "near Arctic State," and articulated its intention to build a "Polar Silk Road" that will stretch from Shanghai to Hamburg, first across the Northern Sea Route, and potentially later, across the central Arctic Ocean.[24] In the long term, China foresees using the even shorter Transpolar Sea Route across the very top of the Arctic, when that opens in a few decades due to melting sea ice. This route, which might be available for several months each year, would save China from having to depend on Russian-controlled waters. As Li Zhenfu, director of Dalian Maritime University's research Center for Polar Maritime studies, noted, "whoever has control over the Arctic route will control the new passage of world economics and international strategies."[25] China also is deepening its Arctic presence through foreign direct investment in several Northern European Arctic States.[26] China is exploiting climate change and the very real need for Arctic-based infrastructure investment to assert itself as a key partner in economic development and scientific exploration.

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[23] Goodman, Sherri, and Elisabeth Freese. "China's Ready to Cash in on a Melting Arctic." Foreign Policy. May 01, 2018. https://foreignpolicy.com/2018/05/01/chinas-ready-to-cash-in-on-a-melting-arctic/.

[24] State Council Information Office of the People's Republic of China. "Full Text: China's Arctic Policy." The State Council of the People's Republic of China. January 26, 2018. http://english.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm.

[25] Jakobson, Linda. "China Prepares for an Ice-Free Arctic." Insights on Peace and Security. March 2010. https://www.sipri.org/sites/default/files/files/insight/SIPRIInsight1002.pdf.

[26] Rosen, Mark E and Cara B. Thuringer, "Unconstrained Foreign Direct Investment: An Emerging Challenge to Arctic Security." CNA. November 2017.

This presence enhances its own domain awareness, and investments could plausibly be leveraged to influence policy to be more desirable for China's long-term strategic interests.[27]

Russia has been increasing its military presence and assertiveness in the Arctic—and a significant amount of it is proportionate to its vast Arctic territory—but the ambitions of Russia and China have political, military, and commercial dimensions. On the political side, Russia has the longest Arctic coastline of any Arctic coastal state, and Russian identity has historically been tied to the Arctic. Commercially, approximately 20 percent of Russia's gross domestic product is derived from Arctic activities, primarily energy, industrials, and mining.[28] Russian President Vladimir Putin has set ambitious cargo shipping goals which would quadruple the volume to be shipped through the Northern Sea Route from 20 million tons to 80 million tons by 2024.[29] Of course, that shipping is directly affected, and likely reduced, by the war in Ukraine. Putin was seeking to monetize the Northern Sea Route as a new access route from China to Europe and was increasing its capability to operate the route year-round.[30] However, with a prolonged ground war in Ukraine, these goals will almost certainly be delayed, as both resources and labor to enable this route have been diverted to the Ukrainian war. President Putin had described the Northern Sea Route as a future "global, competitive transport artery" that is "the key to the development of the Russian Arctic and the regions of the Far East."[31]

Militarily, Russia has been upgrading its bases along the Northern Sea Route and exerting increasingly aggressive behavior against the U.S. and our allies and partners. Air Force Gen. Glen VanHerck told the Senate Armed Services Committee that in 2020 "NORAD responded to more Russian military flights off the coast of Alaska than we've seen in any year

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[27] Goodman, Sherri and Marisol Maddox. "China's Growing Arctic Presence." China-US Focus. November 19, 2018. https://www.chinausfocus.com/finance-economy/chinas-growing-arctic-presence.

[28] Devyatkin, Pavel. "Russia's Arctic Strategy: Aimed at Conflict or Cooperation? (Part I)." The Arctic Institute. February 6, 2018. https://www.thearcticinstitute.org/russias-arctic-strategy-aimed-conflict-cooperation-part-one/.

[29] Staalesen, Atle. "It's an order from the Kremlin: shipping on Northern Sea Route to reach 80 million tons by 2024." The Barents Observer. May 15, 2018. https://thebarentsobserver.com/en/arctic/2018/05/its-orderkremlin-shipping-northern-sea-route-increase-80-million-tons-2024.

[30] Koreneva, Marina. "Russia Races to Build Giant Icebreakers for Arctic Dominance." *The Moscow Times*. July 1. 2021. https://www.themoscowtimes.com/2021/07/15/russia-races-to-build-giant-ice-breakers-for-arctic-dominance-a74531

[31] Staalesen, Atle. "Russia's Putin to turn Northern Sea Route into global shipping artery." Eye on the Arctic. May 15, 2018. https://www.rcinet.ca/eye-on-the-arctic/2018/05/15/arctic-shipping-russia-policy-international-kremlin/.

since the end of the Cold War."[32] Russia has violated Swedish[33] airspace, simulated attacking northern Norway[34] and tested electronic warfare capabilities, including the jamming of GPS systems during the NATO exercise Trident Juncture, and routinely since then as well.[35] Russia has been testing increasingly sophisticated weapons in the Arctic, such as hypersonic missiles.[36] Russia plans to launch its first weaponized icebreaker, *Ivan Papanin* by 2023.[37] In short, China and Russia are opportunistically expanding their power and influence in direct response to a melting Arctic, and this will have significant consequences for U.S. interests.

The increased presence of Russian and Chinese vessels in Arctic waters near the U.S. presents other risks as well. Among the new risks in a rapidly changing Arctic, one that "keeps me up at night," is a potential nuclear shipping incident in Arctic waters. Russia's nuclear safety record is deeply concerning, from Chernobyl, to the Kursk submarine sinking in 2000 to the 2019 failed recovery of the Skyfall missile and the nuclear submarine which caught on fire. These incidents reveal a Russian tendency to not only withhold critical incident information about extent and severity of radioactive contamination but to cover the incidents up in an attempt to evade accountability. This irresponsible practice has implications for all regional actors involved in crisis response in the Arctic.

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[32] Shelbourne, Mallory. "NORAD: Russians Stay in Airspace 'For Hours' During Light Operations Near Alaska." March 31. 2021. https://news.usni.org/2021/03/31/northcom-russians-stay-in-airspace-for-hours-during-flight-operations-near-alaska.

[33] Sweden: Russian Military Planes Briefly Violated Airspace." Associated Press. January 24, 2019.

https://apnews.com/097a3fd978f14f4e9a7f4e5cb4d1d600.

[34] Nilsen, Thomas. "11 Russian Fighter Jets Made Mock Attack on Norwegian Arctic Radar." The Barents Observer. February 12, 2019. https://thebarentsobserver.com/en/security/2019/02/11-russian-fighter-jets-made-mockattack-norwegian-arctic-radar.

[35] Staalesen, Atle. "GPS Jamming on Agenda as Russian Defence Delegation Sat down for Talks in Oslo." The Independent Barents Observer. March 18, 2019. https://thebarentsobserver.com/en/security/2019/03/gpsjamming-agenda-russian-defence-delegation-sits-downtalks-oslo.

[36] Devitt, Polina. "Russia Tests Hypersonic Missile in Arctic, TASS cites Source." Reuters. November 30, 2019. https://www.reuters.com/article/us-russia-arctic-missiles/russia-tests-hypersonic-missile-in-arctic-tass-citessources-idUSKBN1Y40BB.

[37] "Russian Shipyard Launches Missile-Carrying Icebreaker." The Maritime Executive. October 28, 2019. https://www.maritime-executive.com/article/russian-shipyard-launches-missile-carrying-icebreaker.

#5: Leadership on Arctic security is essential to America's overall security and must be a whole of U.S. government and partnership effort, including allies, communities, private sector, and others, that serve to reinforce the rules-based order and support resilience.

The U.S. is not alone in the Arctic. The keys to American leadership on Arctic Security are partnerships and unity of effort. This term refers to an inclusive approach that marshals all elements of capability, including the joint and interagency community, state and local government, industry, non-profit and academic organizations. Key partnerships for the U.S. in the Arctic include:

- Alaska Native Community: those who live in the region are often best able to "ground truth" observations and will know what's happening long before many in Washington do. They observe trends and recognize patterns that may not be distinguishable to others. The experiences from the Alaskan Native communities should serve as a complement to science-based decision making. That is why it is essential to "co-produce" knowledge with those closest to the Arctic domain. Various interagency partners have been including the Alaska Native Community in developing both research approaches and improving domain awareness. The Alaska Native communities are also on the frontlines of climate disruption, from coastal erosion occurring at many villages, to permafrost thaw disrupting traditional livelihoods, to harmful algal blooms harming fish stocks and megafauna, to extreme weather storms disrupting the critical supply chain of fuel and food delivery. These changing conditions increase demands for U.S. support and response and stretch scarce resources even further.

- Arctic Coast Guard Forum: Another important security layer in the Arctic is the partnership the Coast Guard has with the Arctic Coast Guard Forum. Appropriately characterized as a bridge between "diplomacy and operations," the Arctic Coast Guard Forum enables the Coast Guards of the eight Arctic nations both to strengthen working relationships, conduct exercises and combined operations, and coordinate emergency response, which becomes more necessary as climate challenges mount.

- Innovation and Technology: The U.S. has always been a technology and innovation leader. As the Arctic changes, we need to harness that capability to advance low-carbon and sustainable systems for Arctic operations, observations, and planning. For example,

wind and solar-powered ocean drones are now helping to map the Arctic. Other types of autonomous systems and advanced technologies will help keep America at the forefront of Arctic, low carbon and resilience innovation in the Arctic.

- International agreements and institutions are the backbone of the rules-based order. America's security in the Arctic benefits from the success of key international organizations and agreements.

  -**Arctic Council**: The Arctic Council has been the region's most important intergovernmental forum. It engages the eight Arctic nations, Indigenous People's organizations and other permanent participants such as non-governmental organizations, as well as observer states on a wide range of Arctic issues (other than military security). It has also helped develop important agreements on search and rescue, oil spill preparedness and response, and scientific cooperation, that serve to strengthen cooperation in uncertain times. The pause in Arctic Council work under Russia's chairmanship has direct consequences for Arctic governance and security.

  - **Law of the Sea Convention**: The U.N. Convention on the Law of the Sea continues to be a crucial legal framework for the Coast Guard, the U.S. military and others operating in the region. The U.S. has not ratified it but does view it as customary international law.

  - **International Maritime Organization:** The IMO's Polar Code, adopted in 2014, establishes important standards for design, construction, equipment, operation, training and environment protection and safety for ships operating in polar regions.

#6: We have a Responsibility to Prepare for changing Arctic conditions and the U.S. needs to enhance its operating capabilities in the Arctic, from additional ice breaking, to improved domain awareness (mapping and charting), communications and research capabilities.

Among the emerging needs the U.S. has in a changing Arctic is a strategic deep draft port. Currently the closest deep draft port to the U.S. Arctic is 1,000 miles from the Chukchi Sea in Dutch Harbor, Alaska.[38] That is inadequate in the climate era with increased navigation, tourism, and other sea-based traffic and the accompanying risks for search and rescue. An Arctic deep draft port is a strategic initiative that the U.S. government, engaging the private sector in a financially meaningful way, needs to plan for future maritime safety and other operations.

The U.S. is modernizing its aging Arctic capabilities. There are three key components to the U.S.'s operational capability in the Arctic.

1. Deploy additional ice breaking capability in the form of the "polar security cutter (PSC), aviation assets…[and] autonomous systems."[39] Today, the U.S. has limited ice breaking capability that must fulfill missions at both poles, including Antarctica. As the 2019 Coast Guard Arctic Strategic Outlook diplomatically states: "This national fleet does not currently have the capability or capacity necessary to assure access in the high latitudes."[40] The Administration and Congress have authorized three new PSCs; however, the Coast Guard needs at least six, of which three are "medium" and three are "heavy," according to its own requirements. In 2021, Commandant of the Coast Guard Admiral Karl Schultz stated that the "Coast Guard would ideally like to have a fleet of six PSCs and three new medium polar icebreakers (which the Coast Guard in late 2020 began referring to publicly as Arctic Security Cutters, or ASCs), for a total fleet of nine

[38] U.S. Army Corps of Engineers. "Draft Integrated Feasibility Report, Draft Environmental Assessment (EA), and Draft Finding of No Significant Impact (FONSI)". Alaska Deep-Draft Arctic Port System Study. February 2015.

[39] U.S. Coast Guard Arctic Strategic Outlook. April 2019. https://www.uscg.mil/Portals/0/Images/arctic/Arctic_Strategic_Outlook_APR_2019.pdf.

[40] Ibid.

PSCs and ASCs."[41] As polar ice diminishes due to warming, there will be increased mission demands for polar ice-breakers—multimission cutters will provide essential operational support for scientific research capabilities in both polar regions.

2. Improve Arctic Domain Awareness and Communications capabilities. Given the rapidly changing Arctic environmental and operating conditions, it is essential that we improve U.S. Arctic capacity, including maritime, domain awareness capabilities. Additional capabilities needed include improving national communications infrastructure for broadband and satellite coverage to support security as well as commercial, recreational, and subsistence-based activities.
3. Ensure the U.S. maintains its competitive edge in Arctic research and development. For decades, the U.S. has supported extensive research on the Arctic, from marine to terrestrial systems, from space to ecosystems. This research, conducted by leading universities across the nation as well as federal agency laboratories, is a core component of America's competitive edge in the Arctic. The U.S. icebreakers are host to the science missions conducted aboard to gather direct observations and data about Arctic conditions. America's scientific enterprise, and research and development capabilities, have long supported both our overall security posture and our global engagement strategies, as well as enabling us to better understand the natural world. Nowhere is this more important than in Arctic research. Today, China, Russia, and others are increasing their research capabilities both within and about the Arctic.

Recommendations

To summarize my recommendations above, here are the key areas where Congressional support and action is needed:

1. Combating Putin's weaponization of energy against the West by speeding the transition to a low-carbon future.

2. Increasing America's presence to operate in the Arctic with allies and partners.

[41] Congressional Research Service. "Coast Guard Polar Security Cutter (Polar Icebreaker) Program: Background and Issues for Congress." Congressional Research Service. Updated April 29, 2022. https://crsreports.congress.gov/product/pdf/RL/RL34391.

3. Increasing Arctic Domain Awareness capabilities.
4. Supporting continued cooperation on Arctic research and development.
5. Mapping and charting Alaskan waters and near shoreline for maritime safety.

Conclusion: Arctic leadership for the 21st century

America's leadership on climate security is the other essential element to advancing America's Arctic interests in the 21st century.

The globally devastating Second World War precipitated the creation of an international system led by the United States, designed to protect the sovereignty of states against external aggression and decrease the likelihood of conflict between nations. This is the world order we are trying to preserve today. However, the rapid rate of climatic change combined with other global threats including Russia's invasion of Ukraine and the increasing stress on security that follows means that this system must adapt and adapt quickly. The U.S. should lead that effort, to ensure a stable and sustainable Arctic future.

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IDEAS TO ENHANCE ENERGY SECURITY AND ADVANCE CLIMATE GOALS

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When Russia invaded Ukraine on February 24, 2022, it precipitated a global energy crisis. The crisis has its roots in the strategic and economic decisions that countries and firms have made over the past years and decades. But the acute nature of this crisis came from fears that Russia, the largest combined exporter of oil and natural gas into global markets, will withhold energy supply or be subject to sanctions. As the world's largest oil and gas producer, the United States can play a unique role in shoring up energy security in the coming months and years, without sacrificing on climate change. This can be accomplished by increasing U.S. oil and gas production, reducing domestic consumption of oil and gas through deploying alternatives, and developing a more diverse and resilient energy system to avoid the mistakes that brought on this crisis.

A successful U.S. response will require a ramp-up in oil production to help loosen markets and replace Russian oil shut-in by sanctions. This is best done without committing to long-term infrastructure that will increase global emissions—a function which shale wells are uniquely suited to perform, because individual wells produce for only a few years. On the gas side, it calls for additional U.S. liquefied natural gas (LNG) exports to displace Russian gas (and, later, Asian coal). The impact of increased U.S. production of oil and gas on the climate will be lessened to the extent that (1) domestic consumption falls to supply exports and (2) U.S. production is relatively cleaner than the alternatives it replaces.

These steps must be accompanied by efforts to increase consumption and exports of clean energy from the United States. The European strategy to reduce gas imports from Russia envisions a sharp increase in deploying renewables and using clean hydrogen. This hydrogen could be produced in and exported from the United States. Likewise, efforts to build the critical mineral and clean technology supply chains in the United States, and amongst our allies, could make the United States a clean technology powerhouse and reroute energy supply chains that are currently running predominantly through China.

Help Boost Oil Production to Allow Greater Sanctions on Russia

Current sanction efforts have not reduced Russian oil revenues. The country still has a willing market in China, India, and elsewhere. High global prices mean that Russia makes more money on total sales, even though its products sell at a discount, and it sells smaller volumes. The Biden Administration has proposed a price cap on Russian oil exports that aims to curtail the country's hydrocarbon revenue without reducing its oil exports, avoiding an even tighter oil market. But there are many remaining questions about the viability of this plan, including Russia's response as well as the participation of India and China in enforcing the scheme. Without new supply, it will be very hard to effectively reduce Russian revenues because high prices create political backlash and incentives for countries to work around sanctions or cheat the price cap.

U.S. production is not rising fast enough to fill the gap expected late this year and in early 2023, when the EU's partial embargo on Russian oil and product exports take effect. This is largely because capital discipline—using higher revenues to pay down debt and increase dividends and share buybacks—is helping shale companies to deliver record profits. Companies have strong incentives to return cash to shareholders, not to ramp up drilling and capital expenditures. In a recent survey by the Dallas Federal Reserve, over half of the companies that responded cited investor pressures as the primary reason for not increasing oil production. Unclogging the U.S. oil system would yield significant strategic benefits.

There has been some policy response to soften markets and encourage U.S. industry to ramp up production. President Biden released up to 1 million b/d from the Strategic Petroleum Reserve (SPR) for 6 months, starting after the March 31 announcement and with sales currently announced through September. The unprecedented size and duration of this SPR release helped to calm the oil market. Then in July, the White House announced a proposed rulemaking

that will allow the government to refill the SPR with fixed-price forward contracts. Under a fixed-price contract, the DOE can agree to buy crude oil from a producer at a set price months or years in the future. Such price certainty relieves one of the key factors that prevents oil producers from investing in more supply, which is fear of a collapsing price. While these mechanisms are developed, other efforts can help the shale industry deliver.

Recommendation #1: Regularly Convene Shale Companies and Investors.

Since the war began, the Biden administration has extended an olive branch to the oil and gas industry, encouraging the sector to invest more. White House officials have hosted banks and companies to discuss the market implications of Russia sanctions. But more could be done. The administration should invite shale companies and investors to the White House to talk about ways to boost domestic production.

The objective would be threefold. First, it would send a strong signal that more investment in oil and gas is needed and welcomed. Despite the rhetorical support, the Administration's messaging has been mixed. Second, it would help companies make the case to their investors that they can pursue moderate growth while retaining strong profitability (which should be achievable with prices close to $100 per barrel). And third, it would allow stakeholders to discuss workable solutions to the genuine constraints on growth.

If shortages of personnel and oilfield services equipment are the major problem, targeted lending may help. The reconciliation bill negotiated between Sen. Joe Manchin and Sen. Chuck Schumer would include a commitment to continue holding lease sales on public lands, including in the Gulf of Mexico and Alaska. But ongoing dialogue with companies can help inform future leasing plans. The White House can use the bully pulpit to remind key actors, especially investors, of the economic and strategic stakes of increased production.

Help Europe's Search for Alternatives to Russian Gas

The European Union wants to reduce its dependence on Russian gas, which made up 40 percent of EU gas consumption and 45 percent of EU gas imports in 2021. Russia is exploiting the EU's dependence on its gas supply, throttling pipeline deliveries over the summer to limit the volumes that the EU has in storage ahead of winter. This year, Europe will have to get by with

conservation and alternatives, like coal and diesel, as it develops a more diverse supply over the next few years.

In its new energy plan, REPowerEU, the European Union said it wanted to secure an additional 50 billion cubic meters (bcm) of LNG supplies between 2022 and 2030. In a March 25 joint statement with the White House, the European Commission committed to "work with EU Member States toward ensuring stable demand for additional U.S. LNG until at least 2030 of approximately 50 bcm/annum." The volumes would help Europe eliminate Russian oil and gas imports by 2027, a key objective of Europe's war effort and drive for energy security.

U.S. LNG exports have been essential for Europe in late 2021 and 2022, and the United States is now Europe's largest LNG supplier. But more export capacity will require more LNG terminals to be built in the U.S. A number of long-term supply deals signed since March have created strong momentum behind several, permitted but unfinanced, North American LNG projects, but most of those contracts are being signed by Asian buyers and not Europeans. To date, European policymakers have been reluctant to commit to LNG imports extending beyond 2030, to keep with their longer-term climate ambitions.

These are ways for Europe to enable new LNG projects in the United States without sacrificing climate ambition. One appealing option is to find a financing structure that would allow for back-to-back contracts with European and Asian customers, delivering energy security for Europe for a decade and then decarbonization in Asia over the next decade (crucially, this gas would need to reach Asia at a discount; otherwise, this LNG would struggle with the competitive challenges from existing coal). And with public financing, European firms could put in strict conditions on methane emissions—ensuring that this expanded infrastructure has the best climate footprint possible.

Recommendation #2: Convene major players to help manage the gas market.

The global LNG market will come under immense pressure as Europe relies heavily on LNG imports without new capacity. The volumes that Europe wants to import are hard to find without major adjustments and dislocations. In the first quarter of 2022, Europe imported more LNG mostly at the expense of imports into China, Japan, India, and Korea. But there are numerous reports that economies are struggling to secure gas. Pakistan has faced electricity shortages due, in part, to insufficient fuel supplies. Such crises will become more common and widespread. Even

wealthier countries are deeply concerned that competition for LNG is driving up prices. Should the Chinese economy recover from COVID, demand for gas will cause even more price pressure for Europe and other importers.

In normal times, markets are the best instruments to allocate scarce supplies. But the additional demand from Europe will be hard to accommodate. Some coordination among buyers and sellers would make sense, avoiding the "free-for-all" approach that would otherwise take place. This table would need to include the United States, Australia, and Qatar, among exporters, and China, Japan, Korea, India, and the European Union among importers—at least at first. Such a forum would be imperfect—it could supplement markets, not replace them. But it could be an important forum to share information, streamline purchasing decisions, and find ways to reduce price shocks in the EU and elsewhere. Limiting price shocks will add confidence in LNG as an energy security solution with a better emissions profile than coal.

Support Clean Energy Exports

As Europe diversifies away from Russian gas and oil, it also plans to significantly increase the deployment of renewable power sources and the consumption of clean hydrogen. Recent developments in the United States, including the passage of the Infrastructure Investment and Jobs Act and the Inflation Reduction Act of 2022, are set to make the United States into a clean energy manufacturing and production powerhouse. Integrating U.S. efforts to develop clean energy supply chains with Europe's efforts for rapid diversification away from Russian energy dependence will provide early markets for U.S. clean energy products and trans-Atlantic strategic benefits.

Recommendation #3: Build Export Hubs for Hydrogen.

REPowerEU aims to replace 25-50 bcm per year of European natural gas consumption with 20 million tons (mt) of renewable hydrogen. Of that 20 mt, 10 mt will be domestically produced and 10 mt will be imported. Such an expansion in low-carbon hydrogen consumption will need supply to grow rapidly. Today, under 1 mt per year of low-carbon hydrogen is produced globally.

The U.S. Department of Energy is currently designing a program to support the formation of clean hydrogen innovation hubs. The H2hubs program is faced with the challenge of matching willing U.S. producers of clean hydrogen with viable buyers and end users. A lack of market demand is one of the biggest risks that the program faces. Here, the European energy plan could offer an early market for exports of clean hydrogen, ammonia, or electrofuels, as long as prospective hubs include exports as a large part of their business model. With at least four regional hubs slated to come online before 2026, the U.S. program could make a significant contribution to global low-carbon hydrogen supply.

Exporting low-emissions hydrogen from the United States to Europe will raise some challenges. In particular, the European Union may resist importing hydrogen produced from natural gas, even if the associated emissions of CO_2 are captured and stored. This class of hydrogen, known as blue hydrogen, can be produced with low lifecycle emissions, but may still be treated as nonrenewable by the European Union. This potential reluctance could be addressed with best practices from U.S. industry for methane emissions upstream, CO_2 capture at plants, transparency, and disclosure, as well as diplomatic support from the U.S. government. The production of hydrogen through electrolysis powered by renewables or nuclear power would not face the same resistance.

THE CHALLENGE OF RESPONSIBLY ENDING GLOBAL ENERGY POVERTY

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The sun was setting when I stopped by a remote village market in the Indian state of Bihar. It was a typical evening, so the central power grid would shut off around dusk. Market stalls would close, and darkness would fall across town. A bustling village would become more menacing in the dark.

But not on that night. I was there to see a Rockefeller Foundation project that had recently installed a network of solar mini grids to bring reliable, sustainable electricity to areas that had never had it before—part of a much larger drive to do the same for communities across India and around the world. It is one of thousands of projects the Foundation has supported for more than a century to leverage science and technology to advance the well-being of humanity.

That night in Bihar, the lights kept shining, market stalls stayed open, and customers shopped. I caught a glimpse of a more sustainable and equitable future when I met Ruby Kumari, a widow, a mother of two girls, and an expert seamstress. The new electricity empowered Ruby to walk the streets more safely. It helped her connect with the world, including through a new Twitter account. And it allowed Ruby to transform her skills into a viable business: a sewing school.

Not long after my visit to Bihar in late 2019, Covid-19 hit that region of India, as it did Beijing, Brooklyn, and everywhere in between. Today, Covid-19 is just one of many crises

increasing the number and suffering of vulnerable people around the world: the poor, hungry, unhoused, under-educated, and infirm. Russia's invasion of Ukraine, and the fuel and food crises it has caused, has ignited the gravest global hunger emergency since World War II. But even before that conflict began, climate change was threatening food supplies, not to mention lives and livelihoods.

The food crisis is just one way climate change is already hurting the most vulnerable first and worst. Heat waves, droughts, floods, hurricanes, and wildfires are making life harder for hundreds of millions of people and reversing progress the world was making toward achieving the United Nations Sustainable Development Goals (SDGs). If the world continues with business as usual, and the planet grows warmer by 3 degrees or more, life will become unbearable for billions of people like Ruby—particularly those living in emerging and developing economies.

Climate change poses a singular threat to humanity. We must confront it directly. Fortunately, as the Bihar story demonstrates, there is a way to make the climate project a vehicle for uplifting the world's most vulnerable people, to make the 21st Century brighter for people like Ruby. By scaling technologies like solar mini grids, the world can finally end energy poverty, empower millions to compete in the global economy, and reduce the likelihood of a climate catastrophe.

The Risks of a Changing Climate

Today, the world's most vulnerable people face a future of diminished prospects and increasing risks. Without significant action, too few people will be connected to the electricity required to compete in the 21st Century economy and too many will remain exposed to the ravages of climate change, which are growing more severe. As a result, the future looks less safe, healthy, and prosperous, especially for the most vulnerable.

Despite the fact that electricity was discovered 142 years ago, energy access remains inequitable and unsustainable today. Approximately 3.6 billion people in 81 countries live well below what is considered the modern energy minimum, around 1,000 kilowatt hours of

consumption per capita per year. And 768 million people around the world have no electricity access, still living in the dark in 2022.

This level of energy poverty makes it virtually impossible for people to lift themselves out of poverty. According to the Oxford global Multidimensional Poverty Index, which tracks 10 different elements of well-being along with access to core and basic resources, energy access is the most cross-cutting indicator for whether people remain trapped in poverty. In other words, people cannot access the modern economy, let alone improve their economic status, if they do not have access to reliable, affordable electricity.

Additionally, too many vulnerable people are, or will soon be, exposed to climate risks. Over the last decade, floods, droughts, and storms have killed 15 times the number of people in low-income coastal countries as they have in wealthier coastal countries. Without a radical reversal, the earth's temperature will eventually increase, according to The Rockefeller Foundation's analysis and other data, by about 3 degrees Celsius. For the most at-risk people, this means:

- Those living in Africa, South Asia, and elsewhere will grow hungrier. Yields of essential crops like maize, wheat, rice, and soybeans will be reduced as growing seasons shift, temperatures rise, and floods and droughts become more frequent. In addition, livestock and fisheries will be lost due to heat stress, shifting and declining stocks, and extinction. Fisheries alone provide the main source of protein for about 30 percent of Africa's population.

- Those with preexisting health conditions will risk dying prematurely. Heat waves, floods, and food insecurity will make many people more vulnerable in many ways, particularly to death and illness. For example, more than 2.25 billion additional people will be exposed to dengue fever and other diseases.

- Residents of coastal and low-lying communities will lose their homes. Sea levels are projected to rise as much in the next 30 years as they did over the last century. It will be even worse without climate adaptation and mitigation efforts. Coastlines and even some low-lying island states could disappear, leaving millions house-less and many country-less.

- And many low-wage workers and manual laborers will lose jobs and work hours. Extreme heat and sunny-day flooding events will severely limit labor productivity because people either will not get work or be unable to complete it without access to fans or air conditioning. In the United States, reports suggest Blacks and African Americans are 23 percent and Hispanics and Latinos are 43 percent more likely to live where work hours are expected to be lost due to intense heat.

A warmer world will not just be less secure and stable, it will also be less just. The emissions driving the climate crisis have been, for the most part, produced by wealthier countries that have built their economies with fossil fuels. But it is women, marginalized populations, and low-income countries and communities that have been, and will continue to be, most harmed by climate change.

This deprivation will not be felt only by the most vulnerable.

History suggests that as people become hungry and lose jobs and homes, the world will become more violent and unstable. When governments struggle to meet the basic needs of their citizens, democracies regress, states fail, and people migrate to neighboring countries. In 2008 and 2010, for example, higher food prices contributed to 48 episodes of instability and political violence around the world. The United States will not be immune to such instability, nor the mass migrations, pandemics, and conflicts that will increase as the world warms.

A Global Green Energy Revolution

This future is not inevitable.

Today, it remains possible to stabilize global temperatures well below 2 degrees of warming. But only if people around the world believe that a sustainable future will also afford them the chance to realize their full potential. They must believe that even as the planet is saved, their children and grandchildren will have the opportunity—to live, work, and dream of better lives.

To unlock that future, the world requires a green energy revolution that can lift everybody above the modern energy minimum of 1,000 kilowatt hours of consumption per

capita per year. And a very high percentage—perhaps 90 percent—of that total energy mix would come from renewable sources.

Some countries are well on their way to that level of clean energy adoption. Germany, for example, has among the largest share of renewable electricity in the world: 49 percent of its total energy mix was from renewable sources in the first half of this year. In general, across the world, renewables accounted for 76 percent of total new power capacity additions in 2020.

But this does not hold true in developing countries. While some emerging economies like India and Vietnam have become destinations for mega solar projects, almost all new wind power is concentrated in China and OECD countries. Germany alone has more wind and solar energy installed than the 81 energy-poor countries that are home to half the world's population.

The Rockefeller Foundation's research suggests that eliminating energy poverty with 90 percent renewable energy will require a 50-times increase in generation from wind and solar by 2040. Such an increase is possible, but only with tremendous investment and growth.

At The Rockefeller Foundation, we believe philanthropy can play a unique role in facilitating that growth. And we have decided our Foundation will take specific actions to transform how humanity farms and eats, powers its communities and homes, prevents and protects against disease, and lives and works in a changing climate.

There is some irony here. Our namesake, John D. Rockefeller, founded Standard Oil and made his fortune by fueling a growing United States with carbon. But with that money, Rockefeller also established a foundation dedicated to advancing humanity through what he called "scientific philanthropy" — leveraging the latest in science and technology to improve the well-being of each and every person, opening up opportunity for all.

In the years ahead, we will apply this approach to the global fight against climate change—and make that fight central to the Foundation's future. In fact, we have already begun working to ensure all our climate efforts are aimed at protecting the world's most vulnerable, while retaining our mission and our commitment to scientific philanthropy.

A New Platform for Collaboration

That commitment can be seen in some of our existing initiatives. At COP26 last year, we joined our partners in launching the Global Energy Alliance for People and Planet. The Alliance is a collaboration between three philanthropies—The Rockefeller Foundation, the IKEA Foundation, and the Bezos Earth Fund—as well as multilateral development banks, development finance institutions, technology providers, and delivery partners. Together, Alliance members committed more than $10 billion, with the goals of reaching a billion people with reliable, renewable electricity, creating or supporting 150 million green jobs, and reducing at least 4 billion metric tons of carbon over the next decade.

The Alliance has already established partnerships with more than a dozen countries across Africa, Asia, Latin America, and the Caribbean to accelerate just, clean energy transitions. In order to succeed, we believe we need to have countries take the lead in developing plans, constructing programs, and implementing them. We need to bring significant outside capital to the domestic resources committed to major projects and activities. And we need to make sure that projects get done well and get done quickly.

The Global Energy Alliance could achieve extraordinary results by scaling innovations in the world's energy-poor countries—mitigating emissions while increasing access to energy and, therefore, economic opportunity. We are exploring metro grids that can provide power to entire towns in the Democratic Republic of Congo, where 85 percent of the population lives without electricity. We are supporting 15 countries in Latin America and the Caribbean in identifying, addressing, and ultimately, helping overcome barriers to large-scale renewable energy investment at the national and regional levels. And we are working with the Indonesian government to determine how the country could begin to transition away from its planned and existing coal fleet, which could emit up to 10 billion tons of carbon alone.

Making Opportunity Universal and Sustainable

Today, for the first time in history, the technology exists to reliably and affordably empower those who lack access to electricity, boost human development by creating jobs, and cut emissions enough to avert the climate crisis—all at the same time. We must seize this

opportunity. If we do so, not only will we safeguard our planet and save lives, we will also improve the livelihoods of hundreds of millions of vulnerable people around the world. And we will help them become more resilient in an era of crises.

When Covid-19 hit Bihar in 2020, the mini grid kept humming—and so did 119 others like it built by The Rockefeller Foundation and our partners. They powered diagnostic tests for Covid-19 and other illnesses. They enabled Zoom calls and WhatsApp messages, connecting families kept apart by pandemic restrictions. They kept town streets illuminated.

And that mini grid helped Ruby Kumari pivot after the pandemic closed her sewing school. To make a living and support her daughters, Ruby stitched masks and sold them to her neighbors.

Ruby and her village in Bihar represent the opportunity before us. The world can not only make people less vulnerable with science and technology, but also help them confront the crises they are facing and pursue their dreams in this still young century. Even if one life may seem small in the sweep of history, Ruby's story is a guide for how we can finally make opportunity universal and sustainable.

Today is a moment of incredible risk, in which inertia and business as usual could have existential consequences. But it is also—for the first time in a long time—a moment of real opportunity. With world leaders set to gather this autumn at the UN General Assembly meetings, COP27, and the G20 summit, there is not a moment to lose. By taking bold steps today, the world can establish a development model robust enough to help vulnerable people prevent, or at least overcome, the crises of tomorrow.

GEOPOLITICS OF ENERGY: COMPETITIVENESS AND VITALITY IN AN ERA OF VOLATILITY

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On February 24, 2022, Russia's invasion of Ukraine shattered the post-World War II equilibrium that for seven decades had driven global prosperity. Volatility will dominate global politics, economics and security as the world enters an era of reshaping the international order.

The shocks to the international system are pervasive. In the face of a blatant violation of Ukraine's national sovereignty and territorial integrity, the UN, NATO, OSCE, United States and European Union could not combine the diplomatic tools to prevent Russia's incursion. Since then, the world has been thrown into a commodity shock for energy, food, metals, and minerals that has broken global supply chains and fueled inflation to the point that central bank actions to tame it threaten a global recession. Our global energy systems, launched on a course of transition to a net-zero emissions world, has found that it does not have the resilience to keep the world supplied with the resources needed to sustain jobs and economic growth.

As the United States seeks to expand its global competitiveness and economic vitality in this era of re-shaping the international order, it must navigate the inevitable volatility of a global system in shock, and that will reverberate in the politics of every nation.

Destruction for Longer

In Ukraine we will likely see yet greater devastation for months, if not longer. Vladimir Putin will not halt his assault without claiming some form of victory. Ukraine, now supplied with

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more sophisticated arms and outraged by Russia's brutality against civilians, has no interest in halting the war before it consolidates territorial claims.

Ukraine's valiant resistance forced Russia to retreat from its attempted capture of Kyiv and focus on controlling eastern Ukraine. Russia's reconsolidation in the east and its ability to supply its troops by train shifted the dynamics of the war, at least in May and June. The capture of Luhansk was grueling, with Russia clawing forward 1-2 kilometers a day over almost 4 months. Russia has directed 70 percent of its ground forces to Ukraine. Relentless aerial attacks made it untenable for Ukrainian forces to hold the last shreds of Luhansk.

But the next stage in the war will see another shift. By unofficial military accounts, Ukraine has destroyed one third of Russia's tanks. As Russia moves away from train lines, equipment and supplies must be reloaded onto trucks, and Ukrainian forces will attack those supply lines relentlessly. New equipment—particularly High Mobility Artillery and Rocket Systems (HIMARS)—are allowing Ukraine to reach further behind Russian lines to attack arms depots and to slow or potentially stop the Russian advance. Ukraine will seek to retake areas in Kherson and Zaporizhia (where Europe's largest nuclear power station is located). Russia will respond with intensified bombing of civilian centers. As the winter approaches, expect Russia to cut natural gas supplies to Europe.

Even if a ceasefire is feasible, a sustainable peace is far from reach. Russia persists in its original demands to "de-nazify and demilitarize Ukraine" and seems intent to claim more territory beyond the Donbass region of Donetsk and Luhansk. A recent Wall Street Journal-NORC poll, conducted with a Ukrainian polling firm, found that 89 percent of Ukrainians say they oppose any territorial concession to Russia. Some form of war in Europe, with the devastation it brings to Ukraine and the polarization and economic pain it foments internationally, could drag on for years.

Price Shocks & Volatility: The Worst is Coming

Russia's indiscriminate bombing of civilian territories and atrocities on the ground unified the United States and Europe in unprecedented sanctions on Russia that froze $284 billion (45%) of its central bank foreign reserves.[43] Major companies withdrew or froze their operations in Russia, including major energy companies like BP, Total Energies, Exxon Mobil

[43] Bank of Russia Foreign Exchange and Gold Asset Management Report

and Shell—even though Russian energy exports were carved out from initial sanctions. But volatility and the threat of scarcity in oil and natural gas sparked massive price increases, in effect increasing Russian revenues. For natural gas, Russian daily revenues shot up from $100 million a day in January 2022, hitting $500 million per day in March, with massive volatility since then.

The EU, despite depending on Russia for 24% of its oil, agreed to phase out 90% of Russian oil imports starting with crude oil by December 5, 2022, and with bans on refined products and shipping insurance soon to follow. The ban on shipping insurance (launched together with the UK) may cause the biggest shock. Even as Europe has cut its oil imports from Russia, principally mainland China and India have absorbed the balance; as of July, Russian crude oil imports remained at pre-war levels. When shipping insurance sanctions come into effect, banks and ship owners will find it riskier to accept Russian reinsurance of Russian oil shipments to Asia and ports may not take the cargoes. While the U.S. leads a G7 initiative to put a price cap on Russian oil purchases, myriad logistics must still be worked out, assuming Russia is even willing to sell at the desired discounts.

By the end of 2022 and into 2023, the world may lose 2-3 million barrels of Russian oil per day. Potentially, Chinese demand could emerge from its COVID-19 contractions. An extension of the U.S. Strategic Petroleum Reserve release could extend current SPR supplies on the market but would not increase them. An agreement with Iran on its nuclear program, once anticipated to release 1.3 million barrels per day, seems out of reach in the near-term.

In June, this scenario would have implied global oil prices soaring to $130-150 per barrel. Since then, July's announcement of 9.1 percent inflation in the U.S., sparking further increases in U.S. interest rates have thrown the prospect of a recession into the equation. According to the American Automobile Association, national gasoline prices on July 31, 2022 averaged $4.22 per gallon, which represents a 16% drop compared to the average for June 2022, but that is still 33% higher than the average price on July 31, 2021. If the Federal Reserve misses the magical balance between curtailing inflation and supporting economic growth, a U.S. recession may loom with global reverberations that could send oil prices tumbling. In that context, the U.S. appeal to Saudi Arabia and the United Arab Emirates to produce more oil hangs in abeyance; they will not risk boosting supply if prices may contract.

Natural gas presents a very different scenario. As of the end of July, Russia had cut exports to Europe through the Nord Stream 1 pipeline by 80 percent. A winter stalemate in the

Ukraine war will likely drive Russia to seek leverage to rattle Europe's support for Ukraine and unity with the United States. The risk will heighten that Russia will cut all gas exports to Europe. There is not sufficient Liquid Natural Gas (LNG) globally to fill the gap. Europe and Asia will enter a price war for LNG, sending prices already in the range of $45-50/MMbtu into unprecedented territory. For comparison, the US Henry Hub price is ranging from about $6.50 to $9.00/MMbtu.[44] Europe will struggle to compete.

Politics and Net Zero: Impending Disarray

The global volatility in energy prices is not divorced from politics. Europe is already planning to ration natural gas. With European natural gas and electricity prices potentially 7-10 times higher than in the United States in the winter, Europe will shed jobs, households will be cold, and bills for heating and electricity will skyrocket. Europe has committed—to protect its national security—to cut dependence on Russian oil in the coming months and on natural gas by 2027. As the impact on European jobs, households and consumers comes into focus, will it weaken Europe's resolve to accelerate its transition to net zero? Will this shift the debate between energy transition and energy security?

Depending on whether EU sanctions curtail Russian oil exports and send oil prices skyrocketing, or whether further increases in U.S. interest rates create a recession, energy price volatility and economic uncertainly will rock U.S. politics. Already the U.S. energy debate has shifted—from a focus on the drive to net zero to a rebalancing of energy security and energy transition. High gasoline prices could dominate the dynamics of the midterm elections. At the time of writing, passage of a major Democrat-supported climate package in the Inflation Reduction Act looks strong, but prospects to forge a bipartisan consensus on energy look bleak. Regulatory measures to curb emissions will be more challenging since the Supreme Court decision in West Virgina v. EPA. What is clear is that the United States needs both energy security and energy transition. Can the U.S. achieve both of these goals in the current climate of polarized politics?

In this political equation, the United States and Europe cannot dismiss the directions of mainland China and developing economies. Mainland China leads the world in investing in

[44] The United States is already at peak export capacity for LNG exports. Global price increases for LNG will not significantly move prices in the United States as US demand is currently capped by the capped US capacity to export LNG. Additional US capacity is not expected to come online until the end of 2024.

renewable energy, it supplies 80% of the world's solar panels and leads the production of electric vehicles. For mainland China, these are strategic choices to curtail oil and gas imports and lead the world commercially in the 21st Century. The developing world has few such options and faces higher commodity prices for oil, natural gas and food. Emerging economies risk capital flight and debt vulnerability as interest rates rise in the United States, the dollar strengthens, and their dollar-denominated debts become more expensive to repay in local currency terms. Will mainland China entrench its competitive lead in renewable energy and electric vehicles? Will we see a deepening North-South divide that upends consensus on Paris Agreement goals?

While the energy strategy options in this paper focus on the United States, the global context matters. Here are three core assumptions:

- Europe: The threat of Russian external manipulation has shocked European politics and industry. Europe will take every measure to meet its immediate energy needs: reopening coal plants, whatever LNG it can import, exploring any possible regional natural gas supplies and utilizing all available nuclear power. Emissions will rise in the short-term, but Europe will seek to accelerate new wind and solar plants, develop hydrogen and battery technologies, and diversify oil supplies. Europe's goal to de-link from Russia in 2027 may be aspirational, but it will not abandon the course.

- Mainland China: Political disarray in Europe and the United States present an opportunity to deepen its leadership on solar panels, EVs and batteries. Mainland China will likely seek to entrench further its ownership of lithium, cobalt and other metals and minerals. Copper, the metal of electrification, will be a key target. This drive to lead on renewables may very well co-exist with greater consumption of coal if needed to keep driving mainland China's economy.

- Developing World: Access to energy will dominate the focus. By 2030, young Africans are expected to make up 42 percent of the world's youth. Developing economies will seek to increase energy supplies to create jobs and meet the aspirations of burgeoning populations or face internal unrest and conflict. Increased migration may seem inevitable. For the developing world, energy access will be a far greater issue than the $100 billion

pledged by OECD countries for climate mitigation and adaptation. They will seek access to trillions of dollars in financing on terms they can afford.

Energy Security and Transition in an Era of Volatility

The International Energy Agency, World Bank, most oil and gas majors, and countless consultancies, think tanks and universities have produced roadmaps on how to reach Net Zero by 2050. They are helpful to understand the depth of the challenge to transform our global energy systems. The war in Ukraine and the shocks that have ensued have also demonstrated that these roadmaps are not resilient. They are premised on assumptions on what needs to "go right". They fail to outline alternatives on what should occur when things "go wrong"—or simply not as planned.

This paper addresses a limited set of pragmatic actions that the United States can take in the coming 5 years to advance a bipartisan consensus on how to address the immediate and continuing demands for both energy security and energy transition. The paper does not address the issue of carbon pricing in the United States. Experts have argued for decades that CO2 emissions must bear a cost that reflects their damage to society in order to change investment patterns toward low and zero emission technologies. Setting a national carbon price in the United States, either through a cap-and-trade system or a carbon tax, is not realistic in the current political environment. Most conservatives oppose it. Many liberals now object on the ground of increasing energy prices for the poor.

The recommendations here are not a rebuttal of Net Zero roadmaps, but suggestions on how to complement them through near-term actions focused on competitiveness and resilience.

1. **Planning and Investing for Resilience.** Perhaps the simplest lesson for U.S. policy is the need to institutionalize within government, ideally in cooperation with industry and the financial sector, a publicly credible mechanism to model our energy futures and the resilience of roadmaps to Net Zero. The war in Ukraine was a massive geopolitical shock. There will be others, and not just geopolitical. Technologies may fail, others may never reach commercial viability, minerals and metals may not meet the demands of electrification, supply chains could become unreliable as the U.S. and China compete to reset the global terms of trade. Transitional energy strategies cannot ignore fundamental requirements to supply the full spectrum of energy demand. Nor can the imperative of

energy security ignore the imminence of climate change. Focusing the U.S. energy debate on balancing energy transition and security to achieve competitiveness and sustainability is fundamental to a bipartisan consensus on energy strategy and investment.

2. **Transparency and Capital Flows.** Various estimates put the cost of a Net Zero world by 2050 at $275 trillion with the need to invest $9.2 trillion annually.[45] The Glasgow Financial Alliance on Net Zero that emerged from COP 26 estimates that private actors could provide up to 70% of this financing globally. The United States has the world's most developed financial markets and is best positioned to drive this shift in global finance. To support that, the U.S. government should offer investment incentives and support critical research. But perhaps most important in influencing private capital will be regulatory actions that create transparency and accuracy in emissions reporting, which guides the financial sector's move to ESG investing. Today, there are no common standards for emissions reporting. Virtually all reports are estimates. There is no basis for comparability and consistency between companies. Setting regulatory guidelines for emissions reporting—from baselines to units to timeframes—will instruct the course of capital investment. For hydrocarbons, it will make emissions reduction strategies a license to operate. Other industries will need to build emissions reductions and verifiable reporting into their corporate practices.

3. **Permitting for Renewable Energy Projects and Pipelines.** If there is an issue that evokes consensus between renewable energy and pipeline developers, it is the slow pace of issuing permits. The federal government must fill a critical gap and work with developers and state and local agencies to set criteria where projects can be fast-tracked and to establish limits for legal review. Permits are generally required from multiple federal, state and local entities, with delays often dragging into years. Offshore wind projects take an average of nine years globally from lease to full commissioning. Delays in oil and natural gas pipelines could leave parts of the country at risk in emergencies that require a rapid repositioning of supplies. Tens of thousands of miles of new pipelines will be required to carry hydrogen or captured carbon dioxide. The existing system of electricity transmission is

[45] McKinsey & Co., https://www.mckinsey.com/business-functions/sustainability/our-insights/the-net-zero-transition-what-it-would-cost-what-it-could-bring

insufficient to move growing clean power supplies, often due to local battles over permitting. These combined investments could be larger than building the federal highway system at the time of President Eisenhower.

4. **Hydrogen and Carbon Capture, Utilization and Storage (CCUS) Projects.** Delays in technologies, commercial viability and infrastructure investments in renewable power could undermine the decarbonization strategies for hard to abate sectors such as steel, cement and glass. Hydrogen can reach parts of the energy sector that other sources struggle to serve. In contrast to direct electricity, hydrogen can be stored long-term and used in industrial heat applications. Yet outside of chemicals and refining, very little blue or green hydrogen exists in the world today. Similarly, CCUS can play a central role in global decarbonization, but that will require innovation and rapid delivery at scale. The potential levels of carbon capture represent 50-200 times increase from today's use; CCUS capacity would need to double every 4-6 years for the next 30 years. For the U.S. government, the critical role in these areas is to sponsor research and reduce risk. The Build Back Better Act provides a $9 billion down payment on hydrogen research. Both hydrogen and CCUS offer the potential to partner with the engineering and deployment capacity of the oil and gas industry, potentially bridging a partisan divide that would put hydrocarbon producers squarely in the realm of decarbonization.

5. **Tax Incentives and Clarity on Renewables, Carbon and EVs.** Tax policy is usually controversial, but there have been areas of bipartisan consensus in energy policy that can serve to accelerate investment. Passage of the tax credits in the pending Inflation Production Act would give a new momentum to zero-carbon technologies.

    - *Wind and Solar*: The Production Tax Credit for wind and the Investment Tax Credit for solar have been strong tools to encourage investment in both Republican and Democrat-led states. As both measures phase out, a further extension could incentivize significant investment, including from oil and gas companies that are generally cash-rich and seeking to diversify their portfolios.

- *45Q Tax Credit*: It provides a credit for each metric ton of carbon that is captured and sequestered, at present for projects that begin construction prior to January 1, 2026. Given the long lead time of such projects, an extended timeframe is critical to foster investment in CCSU and blue hydrogen. Like PTC and ITC, 45Q is scheduled to phase out without new legislation.
- *EV Tax Credit*: The potential for an extended credit for EVs now hangs in the balance with the potential passage of the Inflation Reduction Act. While the issue is controversial, it has not been viewed in the context of U.S. competition with China, where EVs now account for 17 percent of new vehicle sales, in contrast to 5 percent in the U.S.

6. **Supply Chains.** U.S. strategy in diversifying and de-risking supply chains is central to American competitiveness with China on renewable energy and electric vehicles. As the International Energy Agency expressed it, the net-zero target "will supercharge demand for critical minerals, as the world moves from a "fuel intensive to a mineral intensive energy system."[46] An EV uses six times more minerals than a conventional car; a wind plant, nine times more minerals than a gas-powered plant. A great deal of copper will be required to upgrade electric power grids for reliability, large-scale EV power demand, and management of intermittent wind and solar. Demand for minerals will skyrocket—lithium by as much as 43 times and cobalt and nickel as much as 25 times. For many of these metals and minerals, China controls 80 percent of the processing (e.g., lithium) or ownership (e.g., cobalt) in third countries. Aspirational roadmaps to net zero should provoke questions about disruptions, dependence and national security that could dwarf today's concerns over microchips. For Congress, there is a critical role in oversight—to seek detailed plans from the Administration to de-risk supply chains for the energy transition and diversify investments for critical minerals and metals. This is an area where the Development Finance Corporation could play a key role.

Conclusion

[46] IEA (2021), *The Role of Critical Minerals in Clean Energy Transitions*, IEA, Paris

Global developments since 2020 have shocked the global economy and global politics: the pandemic, a global economic collapse, collapsing supply chains, a nationalist backlash on trade, American retrenchment in the Middle East, conflicts and near clashes with China, a growing North-South divide, rising populism, the war in Ukraine, and the move to isolate Russia. As COP 26 ended in November 2021, there was a seemingly inexorable push to Net Zero as countries representing 90 percent of global GDP committed themselves to a net-zero emissions future. The commodity shock since then has added a cloud of uncertainty over energy security—and just how fast zero-carbon technologies can be deployed.

Energy policy continues to navigate this international environment. And the energy world has its own uncertainties: about technologies, stranded assets, investment flows, production constraints, and the laws and regulations that will govern incentives to invest in and transform global energy systems.

Not in doubt is the looming reality of climate change and how it drives the financial sector to assess investments for their resilience to climate scenarios. Quite simply, regulations to create transparency, consistency and comparability between companies could be the most powerful guide to investments in energy transition.

There are two other core challenges: resilience and competitiveness. Our energy strategies need to withstand risk. They cannot be premised on everything that "goes right". Testing our assumptions on net zero and establishing our plans B and C is not a step away from climate action but creating the safety net to make it possible. U.S. energy strategies need to be competitive, most significantly with China, which is setting the pace for a net-zero future. No country matches China's dominance of renewable energy and the supply chains to support it.

Aspiration in policy goals is never misplaced. But in this era of uncertainty as we rebuild the international order and an American bipartisan consensus, pragmatism on energy policy to incentivize private investment, resilience and competitiveness should be our watchwords.

CLIMATE CHANGE AS A NATIONAL SECURITY ISSUE

RAY MABUS

Former Secretary of the Navy

Climate change has emerged as one of the most serious, and even existential, national security threats of our time. The use of fossil fuels is the major cause of climate change. Greenhouse gas emissions caused by burning these fuels trap the sun's heat leading to global warming and climate change and this ominous trend is accelerating. Today, the world is warming faster than at any point in recorded history.

Although this issue is far larger than the military and its response, this essay looks at how climate change affects the United States military today and the potential effects in the future. The American military's attention to climate change is not a new undertaking. In the early 2000s, during the George W. Bush Administration, military experts and organizations began writing about and planning for the dangers of climate change to the military. The Quadrennial Defense Review (QDR) then was done after each presidential election and looked to the threats the nation would face in the future. The 2010 QDR specifically called out climate change as one of the trends "whose complex interplay may spark or exacerbate future conflicts." The 2014 QDR was even more explicit: "The impacts of climate change may increase the frequency, scale and complexity of future missions, including defense support of civil authorities, while at the same time undermining the capacity of our domestic installations to support training activities."

In 2017 the QDR was replaced with the National Defense Strategy (NDS). Shortly after taking office in January 2021, Secretary of Defense Lloyd Austin announced that the Pentagon will incorporate climate change into its future NDS saying: "There is little about what the Defense Department does to defend the American people that is not affected by climate change. It is a national security issue and we must treat it as such."

Bases

For Americans, the most visible manifestation of climate change to our military is on bases. As storms, flooding and wildfires become more powerful and occur more often due to the effects of climate change, the destruction inflicted on military bases is stunning in its scope and cost.

A few examples: In September 2018, Hurricane Florence slammed the Marine Corps' Camp Lejeune, North Carolina. Thirty-one buildings were destroyed or damaged beyond repair, seventy percent of homes on the base were damaged, and the storm caused an 84,000-gallon sewage spill. The bill to repair just the buildings was $3.6 billion.

Scarcely a month later, Hurricane Michael struck Tyndall Air Force Base, Florida, with even wider destruction. Nearly every one of the base's 500 buildings were damaged and 300 had to be torn down. Several F-22 fighters costing $140 million each were casualties and all 11,000 people connected to the base had to be evacuated. Getting Tyndall back to full operational level will cost somewhere in the vicinity of $5 billion and take years to accomplish.

It's not just hurricanes or places along the coast. In March 2019, Offutt Air Force Base, Nebraska, was inundated with floodwaters from two nearby rivers which submerged a third of the base including much of its runway, causing flight operations to be halted. The cost of repairing the base will almost certainly top $1 billion. Offutt is the headquarters of United States Strategic Command which oversees the nation's nuclear arsenal.

There are more enduring problems than storms or isolated weather events. The largest Naval base in the world, Naval Station Norfolk, Virginia, and the shipyards which support it, are already being battered with increasing frequency by "king tides"—tides much higher than normal. The roads leading into the base are often flooded and made impassable so, if the Navy needed to get the ships at Norfolk to sea in an emergency, it's possible that, even today, sailors could not reach their ships. If sea level rise is not arrested, the entire base will go under water in the next few decades. If a major storm hit the base today, projections say the entire area with the base and shipyards could be submerged.

Outside the continental United States, many American bases are threatened: Naval Support Facility Diego Garcia in the Indian Ocean and the Army's Ronald Reagan Ballistic Missile

Defense Test Site on Kwajalein in the Pacific by rising sea levels; Al Udeid Air Base in Qatar by extreme heat; and Cape Lisburne Long Range Radar, Alaska, by erosion.

In 2019, the Congressionally mandated "Report on Effects of a Changing Climate to the Department of Defense," found that two-thirds of the "mission assurance priority installations" of the American military were threatened by climate change. Even though this report was far from a complete survey (no Marine bases and only 79 of the hundreds of bases were included), its findings were stark and frightening.

Disaster Response/Humanitarian Assistance

Apart from bases, climate change has major implications and impacts on the American military. The United States Navy and Marine Corps are the world's first responders. As storms get more frequent and more intense; as floods get more frequent and more destructive; and as droughts get more frequent and more catastrophic, American Sailors and Marines are the tip of the response spear. During my tenure as Secretary of the Navy from 2009-2017, we got a request for humanitarian assistance or disaster relief an average of once every two weeks, and this trend is accelerating.

When Super Typhoon Haiyan hit the Philippines in 2013 killing more than 6,000, leaving 1.9 million homeless and spurring violence in places, Sailors and Marines were among the first to arrive bringing relief supplies, helping clear the devastation and assisting in restoring order. When Hurricane Matthew dealt a crushing blow to Haiti in 2016 killing nearly 600, displacing hundreds of thousands, causing a cholera epidemic, and destroying many food crops, Sailors and Marines responded with medical care, food assistance and many other forms of help.

Where there are these climate events of ever-increasing frequency and ferocity, instability often follows. Instability can lead to chaos and chaos to conflict. Prior to the Syrian Civil War, a diplomatic cable titled "Potential for Social Destruction and Political Instability" warned that drought could be the catalyst for this prediction.

These types of climate events strike every corner of the planet, but Africa is particularly vulnerable. Extreme climate events ranging the spectrum from droughts to floods have all caused food and water shortages leading to social breakdowns, forced migration and recruiting by terrorist organizations. In early 2019, the United Nations magazine African Renewal said:

"Climate change is already considered a threat multiplier, exacerbating existing problems, including conflicts." In March 2019, the most powerful cyclone in history in the southern hemisphere, Cyclone Adai, struck Mozambique, Malawi and Zimbabwe. Soon after, a U.S. Air Force contingency response group arrived to distribute medical supplies, food and water.

These situations are not confined to areas outside the United States. When Super Storm Sandy struck the east coast of the United States, the American military responded in myriad ways. The 26th Marine Expeditionary Unit flew from aboard the amphibious ship USS Wasp to provide medical, logistical, engineering, and heavy airlift support. Units from all service branches provided a dizzying array of help ranging from dewatering to fuel deliveries to millions of meals.

In a more permanent situation, there are already internal climate change refugees in the United States. Today, at least 17 communities, mostly Native American or Native Alaskan, are in the process of relocating for climate related reasons. Even if climate change is arrested in its tracks, it is estimated that 414 cities and towns will have to relocate. The one relocation program currently being run by the federal government is the moving of Isle de Jean Charles in Louisiana. Not a buyout program, this effort aims to move the 99 residents together to another location at a cost of $48 million. Even with this small number of people, it is a complex and daunting task.

As climate events intensify and are more frequent, all the U.S. armed forces, particularly the Navy and Marines, will be increasingly called on to respond and to be put in harm's way because of the conditions following the event or the resulting chaos or conflict. Answering the call of these cataclysmic events is a dangerous undertaking as is any mission into uncertain and unknowable conditions. The more often the military is tasked to provide humanitarian assistance and disaster relief, the more military lives are put at risk.

The Arctic

The Arctic is warming twice as fast as any other part of the Earth. With the ice melting all across the Arctic as a direct result of this much warmer planet, the area is quickly becoming a potential flashpoint. A summer ice-free Arctic opens up possibilities unimagined only a short time ago. Already the fabled Northwest Passage is being used and a previously unreachable treasure of minerals on and beneath the sea floor are becoming available.

I personally saw these effects when, in March 2016, I went to the North Pole aboard the submarine USS Hampton. We had been warned that, if the ice was too thick, we might not be able to surface at exactly the pole. When we arrived 800 feet below the surface, radar showed a mile-wide area of thin ice around the pole. We came up through ice only eight inches thick and had to have someone with a long stick go ahead of where we walked to make sure the ice could handle even our weight. According to the civilian "ice pilot" who had done this many times, it was by far the thinnest the ice had ever been.

As new Arctic possibilities open up, the security and military implications increase as quickly. Cruise lines with little or no experience in the far north and no ships which are ice capable, are advertising cruises to "this magical land." It is not hard to imagine the international incident and probable tragedy if one of these cruise ships hit an iceberg and became disabled or sank. The search and rescue options available come only from the military and are extremely limited. A case in point: the U.S. Coast Guard has only one more than forty-year-old icebreaker.

Exploring for the mineral riches of the Arctic also involves incredibly high risk. The harsh environment means that much standard equipment does not work and, for example, if there was an oil spill such as Deepwater Horizon in the Arctic, the difficulties in containing such a spill would be far greater than it was in the Gulf of Mexico (and it took several months in far closer and more hospitable conditions to stop that spill) and the damages would be exponentially larger.

In direct military terms, Russia has built or rebuilt almost 500 military facilities across the Arctic many with radars and weapons that work in extreme cold. The only possible explanation for these is, in Pentagon-speak, Anti-Access/Area Denial (AA/AD). Russia wants to be able to control which shipping passes through the Arctic. Because of the increasing traffic through these waters, if it shut down passage to only its ships or those of its allies, it could do great harm to the world's economy. It claims that the waters to its north are inland waterways and thereby subject to their exclusive control. Under international law, this is not the case but enforcing this international law is a different matter and may not be possible without a military solution. Russia's potential use of military force in the Arctic must be taken extremely seriously since its horrific invasion of Ukraine shows that it will resort to military action without justification or logic.

Even after accounting for the nations which border the Arctic (United States, Russia, Canada, Norway and Denmark—through control of Greenland), a nation far away—China—is making one of the largest plays in the Arctic. Through its "Polar Silk Road" China is investing billions (if not trillions) in energy and mineral projects and in setting goals for Arctic shipping routes. It has and is building icebreakers and is giving a great deal of attention to the region.

The United States' activity both in commercial and military terms has not been very significant. Every two years, the Navy runs ICEX, a multi-national military training exercise in the Arctic. The last several ICEX's have been truncated because the thinning ice could not support the base camp. The U.S. Navy put out an "Arctic Road Map" in 2009 which was updated in 2014 and 2019 and "Blue Arctic: A Strategic Plan for the Arctic" in January 2021. Every service and the Department of Defense has put out an arctic strategy. Among the goals of these documents are to ensure the Arctic as a stable and conflict-free region and preserve freedom of the seas. Because of the immense and fast-moving alterations to the Arctic due to climate change and the potential for isolated clashes or open conflict, these goals will add increasing burdens to our military in the near term and will have to be part of America's national security discussions and policy.

The Pentagon's Role in Mitigation

Because of its tremendous size and the fact that it uses more fossil fuels than any organization on earth, the Pentagon can be a very big player in combating climate change. In 2009, as Secretary, I issued energy goals for the Navy and Marines, the largest of which was that, by no later than 2020, at least half of all Naval energy would come from renewable, non-fossil fuel sources. Today, two-thirds of the energy for our bases in the United States comes from these sources, mainly solar and wind. Coupled with microgrids, this meant that, even if the grid went down, our bases could still perform their military missions. As a bonus, moving to renewables on these bases yielded a net present value savings of $400 million. Today, these renewables have become cheaper still costing far less that any fossil fuel. At sea, when I left office in 2017, approximately forty percent of naval energy came from renewables. In the five years since then, far more sustainable aviation fuel and green diesel are being produced and becoming much more cost competitive.

Among myriad other examples, DOD has a non-combat vehicle fleet of about 170,000 vehicles with about twenty percent being replaced each year. Moving these to electric would substantially reduce the greenhouse gas emissions of the Pentagon and would also be a strong demand signal for manufacturers of these vehicles.

The Navy and Marines also aggressively sought out new technologies for sources of energy and energy conservation. As a result of these and other measures, at the end of my eight years, oil usage had declined sixteen percent in the Navy and sixty-two percent in the Marines.

While these started as warfighting initiatives, with the increasing recognition of climate change as a threat to national security, they became ways for the Department of the Navy to fight climate change. Secretary Austin made this a Department of Defense mission when, again in January 2021, he stated that "...by changing how we approach our own carbon footprint, the Department can also be a platform for positive change, spurring the development of climate-friendly technologies at scale."

Update

The major event that has shown the urgent need to quit using fossil fuels as fast as possible is Russian President Vladimir Putin's unprovoked and brutal invasion of an independent Ukraine. Putin believed that, because of its reliance on Russian oil and gas, Europe and NATO would not take any strong, united action against this terrible act. The fact that this was a gross miscalculation by Putin doesn't negate the fact that it was a calculation that helped start an unjust and horrific war.

Oil and gas prices are set globally. The thing that drives up the price is instability. The kind that's caused by an irrational war in the heart of Europe waged by an unstable leader. Instability is also driven by the results of climate change: climate refugees, hurricanes, famine and drought which will be ever more common in a hotter, stormier world.

Fossil fuels keep Putin, and other despots, affluent, armed and arrogant. The way to fight Putin and protect our national security and our economy is to urgently and rapidly shift away from fossil fuels.

Conclusion

Climate change acts as a threat multiplier and alters the military operating environment impacting our security, our safety, our economy and our ability to remain a global leader. It is an issue which must be at the very top of our national security concerns alongside such threats as cyber, space, and near peer-competitors. It can even be persuasively argued that it must top the list since a failure to deal with it in dramatic, effective and timely ways may make other concerns moot.

ACHIEVING GRID RELIABILITY AND DECARBONIZATION THROUGH CARBON PRICING

NEIL CHATTERJEE AND GREG BERTELSEN

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EXECUTIVE SUMMARY

Extreme weather events are increasing in frequency and duration, placing unprecedented strains on the U.S. electric power grid. When the grid fails, the human and economic toll can be staggering, amplifying the already-catastrophic costs associated with climate change. At the same time, extreme weather events have heightened the urgency to rapidly decarbonize the U.S. and global economy—including the power sector— to address climate risks.

The hard truth is that rapid decarbonization poses a challenge to grid reliability. The entity charged with safeguarding grid reliability in North America, the North American Electric Reliability Corporation (NERC), reports that managing the pace of change in the power sector, as we move away from traditional to zero-carbon variable energy resources, is the greatest reliability challenge we face today.[47]

And even as extreme weather and decarbonization put the grid to the test, we are moving toward an even more grid-dependent future. To meet decarbonization goals, many experts agree that we must electrify much of the transportation, building, and industrial sectors.

[47] N. Am. Elec. Reliability Corp., 2021 *Long-Term Reliability Assessment* 5 (2021) ("NERC LTRA") ("Governmental policies, changes in comparative resource economics, and customer demand for clean energy are driving the rapidly changing resource mix within the BPS; the BPS has already seen a great deal of change and more is underway. Managing this pace of change presents the greatest challenge to reliability.").

By some accounts, electrification will triple our nation's dependence on the grid. This adds pressure on federal leaders to promote policies that support reliable, clean electricity at low cost.

As we face these converging challenges, we need to be clear-eyed. Despite rapid innovations in the power sector, we have not yet reached the point where we can move to a 100% carbon-free power sector—at least not today. Large-scale infrastructure investment and technology advancements in the areas of long-duration storage, next-generation nuclear, hydrogen, advanced grid-management tools, and carbon capture, among many others, will be required to support the carbon- free grid of the future. In the near- and medium-term, we will continue to rely on some traditional generation resources, including nuclear and natural-gas power plants, to support grid reliability while we integrate increasing levels of zero-carbon resources.

We also have a finite amount of taxpayer and investment dollars to usher in the grid of the future—and consumers' tolerance for surging utility bills has a limit. As electrification puts upward pressure on electricity demand and American families and businesses rely on electricity to meet more of their energy needs, we need to transform the grid while protecting consumers from unpredictable or unsustainably high electricity prices.

In this moment, policymakers face a pivotal question: How can we best support rapid decarbonization… while maintaining the reliability of our power grid… and accomplish these twin goals at least cost to the American people?

Fortunately, there is a clear answer: Federal legislation to implement an economy-wide carbon price.

Consensus is growing that economy-wide carbon pricing is the most effective (and cost-effective) pathway toward deep decarbonization:

There are three primary policy pathways to tackling carbon emissions: regulations, subsidies, and carbon pricing. A gradually rising carbon price will unleash market forces to drive consumers and businesses across all sectors of the economy to increase energy efficiency, substitute higher emitting activities with lower emitting activities, and pursue innovation and investment in a carbon-free future. Every dollar contributes to emissions reductions, and dollars

can also be returned to American taxpayers and families through carbon dividends.[48] By contrast, regulations and subsidies can sometimes take the form of inflexible, costly programs that reward specified policy outcomes (e.g., deployment of targeted technologies) without regard to other important considerations such as whether they support grid reliability, whether they are cost efficient, and whether there is a correlation between dollars spent and emissions reduced.

Economy-wide carbon pricing stands apart because it is naturally aligned with grid reliability:

Grid reliability is, in its simplest form, the ability of grid operators to meet electricity demand today and in the future. With a predictable price on carbon emissions, the resources that will enter or remain in the market over the long-term—and that will be dispatched by grid operators in the near-term, moment-to-moment—will be the resources that can meet electricity demand where and when it arises in the manner that has the lowest costs, including carbon costs. More simply: carbon pricing inherently supports grid reliability at least cost while we decarbonize.

Other regulation- or subsidy-based policy tools may lack the key features of carbon pricing that place it in alignment with efficiently supporting grid reliability.

Here's Why:

- **Carbon pricing values all emissions reductions**. Carbon pricing flexibly values all emissions reductions, including emissions savings that result from optimizing existing zero- and low-carbon resources; incremental emissions improvements, such as those associated with fuel switching or improved thermal efficiency; and energy efficiency and demand response measures. Policies that fail to recognize the full suite of emissions reductions that can be unlocked today leave them on the table, along with reliability-enhancing attributes and possible cost savings.
- **Carbon pricing is technology- and location- neutral.** Because carbon pricing does not pick which zero- and low-carbon options contribute to the resource mix, or choose

[48] The Baker Shultz Carbon Dividends Plan would return all net revenue raised by the carbon fee to American families in the form of per capita dividends. For more information on the plan and its impact to families, visit clcouncil.org

where new generation is located, it efficiently moves the power sector toward the right set of resources to deliver emissions reductions and ensure sufficient energy supply and operating reliability to meet customer demand, all at least cost. Policies that favor certain energy resources over others or require new resources to be sited in certain locations can drive investments in a manner that may be out-of-sync with reducing emissions efficiently while supporting grid reliability.

- **Carbon pricing sends price signals that work together to drive emissions reductions and support reliability.** Carbon pricing sends a price signal to reduce emissions; it is also added to the existing price signal to serve energy demand where and when it is needed (or, where possible, to reduce demand). These clear economic signals seamlessly work together to drive decarbonization while supporting reliability.
- **Carbon pricing supports long-term infrastructure investments, innovation, and market reforms.** Infrastructure investments and innovation are critical to decarbonization. Carbon pricing sends a steady, predictable economic signal. This provides investors, grid operators, and power system planners with better data to forecast supply and demand trends and accommodate emerging and new technologies with a variety of attributes to build out the grid of the future. Predictable price signals also support organized market reforms, which may be required to efficiently value reliability attributes as our resource mix evolves. A patchwork of other, constantly evolving policies lacks the long- term clarity and stability required to support durable investments, innovation, and market structures.
- **Carbon pricing is economy wide.** Reliability experts are clear: squeezing carbon entirely out of the power sector is a long-term goal; it will take innovation and investment in the years ahead. Because economy- wide carbon pricing spurs emissions reductions across all sectors and fosters innovation, it allows the U.S. to decarbonize its entire economy rapidly while creating headroom for the power sector to decarbonize in a manner that supports reliability.

In this paper, we first highlight three converging forces that create urgency for policymakers to coalesce around a federal decarbonization policy that promotes grid reliability at least cost.

Next, we unpack the basics of grid reliability and how these three converging forces create new reliability pressures.

Finally, we walk through why carbon pricing is the optimal policy tool to achieve the twin objectives of promoting reliability at least cost and pursuing economy-wide decarbonization.

THREE FORCES CONVERGE: EXTREME WEATHER, THE EVOLVING RESOURCE MIX, AND ELECTRIFICATION

In the United States and around the globe, there is urgency to reduce carbon emissions. However, there must also be urgency and focus on supporting grid reliability at least cost as we rapidly decarbonize. We highlight three forces that are converging to create this urgency.

Three Challenges to Grid Reliability:

1. Extreme weather that is pushing the grid to the brink at staggering costs;
2. The rapid changes already occuring as competitive forces and government policies drive to a new resource mix;
3. The accelerating push toward electrification which will increase electricity demand while also amplifying the importance of grid reliability

Extreme Weather:

The U.S. electricity grid is increasingly battered by extreme weather events. In 2021 alone, the U.S. experienced 20 weather-related events that caused an estimated $145 billion in damage. In the last five years, the cumulative financial toll of extreme weather events has reached nearly $750 billion.[49]

[49] Nat'l Oceanic and Atmospheric Admin., *Billion-Dollar Weather and Climate Disasters*, https://www.ncdc.noaa.gov/billions/ overview (last visited Jan. 13, 2022).

This coast-to-coast trend cannot be ignored:

In February 2021, a cold weather event pummeled Texas and the South-Central U.S., plunging more than 4.5 million Texas residents into the dark and taking at least 210 lives.[50] Texas suffered estimated financial losses ranging from $80 to $130 billion.[51]

Later in 2021, record-breaking heat waves in the Pacific Northwest blacked out thousands of customers,[52] becoming the most-deadly weather event in Washington state's history.[53]

Extreme heat in California in August 2020 spurred rotating blackouts.[54] Wildfires fueled by heat and drought also have ravaged California's infrastructure, prompting utility Pacific Gas & Electric to announce in summer 2021 that it would underground approximately 10,000 miles of power lines at an expected cost of $15-30 billion.[55]

The East Coast also is vulnerable, as became clear during the polar vortex of 2014.[56] New England's grid operator calls energy adequacy the most critical risk facing the region, warning that extreme weather events exacerbate the system's vulnerabilities.[57] NERC leadership identified New England as one of three primary regions of concern for reliability risks, alongside California and Texas.[58]

Policymakers must prioritize grid reliability when considering decarbonization policies.

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[50] Fed. Energy Reg. Comm'n and N. Am. Elec. Reliability Corp*., The February 2021 Cold Weather Outages in Texas and the South Central United States* 15 (2021)

[51] Comptroller of the State of Texas, October 2021 Fiscal Notes: Winter Storm Uri 2021, https://comptroller.texas.gov/economy/ fiscal-notes/2021/oct/winter-storm-impact.php.

[52] Kavya Balaraman, "*Imagine the Unimaginable*": *How the Pacific Northwest Is Trying to Build a Reliable Grid in a Changing Climate*, Utility Dive (Nov. 8, 2021), https://www.utilitydive.com/news/pacific-northwest-reliable-grid-changing-climate/608959/.

[53] John Ryan, 2021 *Heat Wave is Now the Deadliest Weather-related Event in Washington History*, Nat'l Pub. Radio (July 19, 2021, https://www.kuow.org/stories/heat-wave-death-toll-in-washington-state-jumps-to-112-people

[54] *See generally* Cal. Indep. Sys. Op., Cal. Pub. Utils. Comm'n, & Cal. Energy Comm'n, Preliminary Root Cause Analysis: Mid-August 2020 Heat Storm (2020).

[55] *PG&E Will Bury 10,000 Miles of Power Lines so They Don't Spark Wildfires*, Nat'l Pub. Radio (July 21, 2021), https://www.npr. org/2021/07/21/1019058925/utility-bury-power-lines-wildfires-california.

[56] N. Am. Elec. Reliability Corp., *Polar Vortex Review* 8 (2014).

[57] ISO New England Inc., Pre-Technical Conference Comments, Fed. Energy Reg. Comm'n Docket No. AD21-13, at 2 (filed Apr. 15, 2021).

[58] *Power Struggle: Examining the 2021 Texas Grid Failure: Hearing Before the Subcomm.* On Oversight and Investigations of the H. Comm. on Energy and Com., 117th Cong. 6-7 (2021) (testimony of James B. Robb, President and CEO, N. Am. Reliability Corp.).

Evolving Resource Mix:

A profound shift in our generation mix, from primarily fossil-fuel resources to increasing reliance on zero- carbon resources, is already happening. And it is happening fast—even faster than anticipated.[59] Despite the lack of a cohesive, long-term federal climate policy,[60] the recent pace of change in the power sector has been striking.

Let's look at the numbers: According to NERC, as reported in 2021 as compared to 2020, the nameplate capacity of solar generation projects in all stages of development for the next decade increased 30 percent; the nameplate capacity of wind generation projects in all stages of development for the next decade increased 44 percent; and battery projects in interconnection queues increased 240 percent through 2024.[61] NERC also reports that year-over-year, from 2020 to 2021, confirmed retirements of coal, nuclear, and natural- gas generation resources through the year 2026 have increased by 126%.[62]

These trends are driven in part by market forces, like decreased costs associated with renewable generation and increased consumer demand for clean energy. Federal tax incentives have driven investments in variable power resources like wind and solar power. States have adopted a series of regulations, subsidies and carbon pricing regimes to reshape the generation mix.[63] Similar trends likely will continue in the coming decades, further accelerated by energy policy choices.[64] The U.S. Energy Information Administration's reference-case modelling predicts that as coal and nuclear generating units continue to retire, they will be replaced by natural gas

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[59] *See, e.g.*, Rupert Way et al., *Empirically Grounded Technology Forecasts and the Energy Transition* (2021) (study suggesting that cost savings from the energy transition are themselves accelerating the energy transition); Kingsmill Bond, Int'l Renewable Energy Agency, *The Renewable Spring*: *The Interplay Between Finance and Policy in the Energy Transition* (2021) (showing how capital markets continue to reward new energy technology in a way that outperforms much of the rest of the market, in a sign that the transition will continue to accelerate); see also id. at 14 ("COVID has likely brought forward the moment of overall peak fossil fuel demand to 2019 because it has damaged demand for fossil fuels but not held back the growth of renewables.").

[60] The Biden Administration has staked a goal of zero carbon pollution in the power sector by 2035 and net-zero emissions economy-wide by 2050. *President Biden's Whole-of-Government Effort to Tackle the Climate Crisis*, The White House, Nat'l Climate Task Force, https://www.whitehouse.gov/climate/. However, recent decades have been marked by an absence of a durable, bi-partisan federal climate policy.

[61] NERC LTRA at 29

[62] *Id.* At 35.

[63] See Advanced Energy Economy, Prepared Remarks of Jeff Dennis, Fed. Energy Reg. Comm'n Docket No. AD21-12-000 (describing myriad state clean energy policies); *U.S. State Carbon Pricing Policies*, Ctr. For Climate & Energy Sols. (May 2021), https://www.c2es.org/document/us-state-carbon-pricing-policies/.

[64] Robert Walton, *Biden Decarbonization Goals Could Triple Reliance on Electric Grid: EPRI*, Utility Dive (Jan. 14, 2022), https:// www.utilitydive.com/news/biden-decarbonization-goals-could-triple-reliance-on-electricity-grid-epri/617188/ (citing expert projections that electricity's share of end-use energy consumption in the U.S. could rise to 60% by 2050–from the current 20%--and that this will need to be met by the addition of significant new capacity to the grid).

and renewable resources, with renewable resources accounting for approximately 60% of capacity additions between 2020 and 2050.[65] Other models predict that renewable resources will make up almost 70% of grid-connected power generation by 2050, with fossil-fuel resources accounting for just 13%.[66]

Power sector decarbonization is happening. The emerging and urgent question today is how to support and accelerate rapid decarbonization in the power sector in a manner that also best serves American families and businesses by supporting grid reliability at least cost.

Electrification:

Electrification—generally defined as the substitution of electricity for fuel combustion to provide similar services[67]—is viewed by many as essential to successful decarbonization.[68] As environmental advocates and some observers call on the nation to "electrify everything," an increasing number of tools, devices, buildings, vehicles, appliances, and other energy-dependent items will begin to rely on electricity instead of other fuels. Widespread electrification across the transportation, building, and industrial sectors is poised to profoundly change our nation's electricity system.[69] The Biden Administration has adopted electrification as a central tenet of its climate policy, with the 2021 Infrastructure Investment and Jobs Act including historic investments in a national electric vehicle charging network and electric school and public transportation buses.[70] States also are leaning-in to electrification. As just one example, New York recently has released a comprehensive framework for electrification in its residential, commercial, and industrial sectors.[71]

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[65] Energy Info. Admin., *Annual Energy Outlook* 2021 16 (2021)

[66] DNV, *Energy Transition Outlook 2021* 4 (2021), https://eto.dnv.com/2021/about-energy-transition-outlook. The report also predicts that fossil fuels will retain 50% of the overall energy mix, with renewables accounting for the other 50%. Id. At 5.

[67] *See* Nat'l Renewable Energy Lab'y, *Electrification Futures Study: Operational Analysis of U.S. Power Systems with Increased Electrification and Demand-Side Flexibility* iv (2021) ("Electrification Futures Study").

[68] *See*, e.g. Caitlin Murphy, et al., *High electrification futures: Impacts to the U.S. Bulk Power System*, The Electricity J. 33 (2020) ("[E]conomic potential estimates that are rooted in energy system decarbonization (e.g., with a carbon price) often include significant shares of electrification."); Midcontinent Indep. Sys. Op., 2021 *MISO Transmission Expansion Planning* 9 (2021) ("[C] ustomer, utility and state efforts to decarbonize will employ increasing electrification of the economy as an important tool to meet those goals.").

[69] Electrification Futures Study, supra note 21, at 1.

[70] *Fact Sheet: The Bipartisan Infrastructure Deal*, The White House (Nov. 6, 2021)https://www.whitehouse.gov/briefing-room/ statements-releases/2021/11/06/fact-sheet-the-bipartisan-infrastructure-deal/.

[71] New York State Climate Action Council, *Draft Scoping Plan* 264 (2021) ("Under all scenarios, the vast majority of current fossil gas customers (residential, commercial, and industrial) will transition to electricity by 2050.").

Though there are inherent difficulties in predicting how electrification will affect electricity demand, we can expect a significant rise in electricity demand—potentially doubling by midcentury[72]—and a potentially significant shift in demand profiles.[73] One grid operator has concluded that electrification could have such a profound effect that it could shift the region's peak demand from summer to winter due to the electrification of space heating systems.[74]

Electrification not only increases grid reliability pressures, but also increases the importance of remaining laser-focused on reliability, because a larger portion of our daily lives will become grid-dependent. Electrification also amplifies the importance of decarbonizing efficiently and at least cost so that increasingly grid-dependent families and businesses can make ends meet.

THE CHALLENGE: KEEPING RELIABILITY IN FOCUS

Converging trends require our focus on the brass tacks of grid reliability. The two primary components of grid reliability are (1) resource adequacy, which means having sufficient generation available to meet current and future demand, and (2) operating reliability, which means having tools in place to ensure the grid continuously maintains the delicate balance of real-time electricity supply and demand.

To achieve resource adequacy, the grid must have enough available generation resources to continually meet the electricity customer requirements, taking into account scheduled and expected outages.[75] As a general matter, states are responsible for ensuring resource adequacy, though myriad actors at the federal, regional, state, and local level play a role in shaping the resource mix.

To achieve operating reliability, grid operators must ensure that a diverse set of generator attributes are available day-to-day and moment-to-moment to guard against sudden disturbances such as the sudden loss of generation or transmission that lead to uncontrolled

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[72] The White House, *United States Mid-Century Strategy for Deep Decarbonization* 30 (2016) (projecting an increase in electricity generation of between 60 to 113 percent between 2005 and 2050); Electric Power Research Institute, *U.S. National Electrification Assessment* 7 (2018) ("With efficient electrification, the study projects cumulative load growth of 24% by 2050" compared to 2015 levels, with the higher end of the spectrum resulting in the event of the widespread adoption of carbon pricing) ("EPRI Report")

[73] Midcontinent Indep. Sys. Op., *MISO Electrification Insights* 27 (2021) ("MISO Electrification Insights").

[74] *Id.*

[75] NERC LTRA, *supra note* 1, at 11.

blackouts.[76] Generator reliability attributes include frequency response (the ability to stop sudden frequency changes caused by an imbalance between generation and demand), voltage control (the ability to inject or absorb reactive power to maintain system voltages), ramping (the ability to increase or decrease real power to maintain system balance), fuel assurance (the ability to maintain generator output for a duration of time due to the availability fuel), flexibility (the ability of a generator to flexibly come online and offline), and black start (the ability to independently start up in order to restart the grid after a widespread blackout).[77]

The converging forces of power-sector decarbonization, extreme weather, and electrification create new resource adequacy and operating reliability pressures. These converging forces also create new complexities for grid operators and power system planners, who must forecast future supply and demand in order to ensure the grid's ability to meet future needs.

Resource Adequacy Challenges:

NERC identifies potential capacity shortfalls due to expected retirement of power plants and uncertainty that sufficient replacement capacity will come online.[78] Even where capacity-based estimates project there will be sufficient resources in the future, the reality on the ground may be more complex. NERC has emphasized that we will face resource adequacy shortfalls if variable resources are not supported by sufficient fuel-assured and weatherized dispatchable resources—resources that can be fired up quickly and reliably regardless of wind, solar, or other weather conditions.[79]

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[76] *See* id.

[77] See generally PJM Interconnection, L.L.C., *Reliability in PJM: Today and Tomorrow* 4-6 (Mar. 11, 2021), https://pjm.com/-/media/ library/reports-notices/special-reports/2021/20210311-reliability-in-pjm-today-and-tomorrow.ashx; PJM Interconnection, L.L.C., *Energy Transition in PJM: Frameworks for Analysis* 13-18 (Dec. 15, 2021) ("PJM Frameworks"), https://pjm.com/-/media/ committees-groups/committees/mrc/2021/20211215/20211215-item-09-energy-transition-in-pjm-whitepaper.ashx (both generally describing reliability attributes).

[78] *See* NERC LTRA, *supra* note 1, at 5-9 (explaining that "[c]apacity shortfalls, where they are projected, are the result of future generator retirements that have yet to be replaced with new resource capacity," and detailing regional findings); *see also generally* Nat'l Ass'n Regul. Util. Comm'ns, Resource Adequacy Primer for State Regulators (July 2021) ("NARUC Primer"); id. at 60 ("The evolving resource mix throughout the country – particularly in areas such as California – can impact the timing of the net peak and create challenges in maintaining system reliability. . . . Ensuring that there are sufficient resources available to serve load during the net peak period and other potential periods of system strain could require more comprehensive resource adequacy analysis.").

[79] NERC LTRA, *supra* note 1, at 5 ("Capacity-based estimates, however, can give a false indication of resource adequacy. Energy risks emerge when variable energy resources (VER) like wind and solar are not supported by flexible resources that include sufficient dispatchable, fuel-assured, and weatherized generation.").

What do these challenges look like across the United States? Resource adequacy challenges vary from region to region but echo the same themes. NERC warns that in the Midwest, power plant retirements are accelerating projected capacity shortfalls, which could begin in 2024. In California, a nuclear plant retirement is exacerbating already-existing energy risks that arise from multiple factors, including resource inefficiency during widespread heat events and the temporal limitations of solar output. And in the Northwest and Southwest, quickly dispatchable resources are making up a smaller share of the resource mix and, with that trend, so is the risk of energy shortfalls.[80]

Extreme weather exacerbates these challenges because it can reduce available electricity supply and, due to factors like extreme temperatures, can push demand up beyond forecasts (which, as explained below, are becoming harder and harder to get right).[81] Extreme atmospheric conditions like smoke from wildfires that can dampen solar generation and abnormal "wind drought" can exacerbate supply uncertainty.[82] Some modelling indicates that significant reliability challenges could arise in the future during multi-day periods of reduced variable energy supply if energy storage and demand response are insufficient to balance supply and demand. Extreme weather has also impaired traditional energy resources by damaging infrastructure and freezing equipment and on-site fuel supplies, further contributing to reliability challenges.[83]

Electrification also will amplify these resource adequacy challenges. Load growth and shifting load patterns "exacerbate the flexibility challenges that renewable generation already causes on the supply-side of the grid."[84] If electrification unfolds without sufficient focus on potential reliability impacts or support for energy efficiency measures, the negative impacts of severe weather events and outages will worsen, because building heating and transportation will be grid dependent.[85]

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[80] *Id.*

[81] NERC LTRA, *supra* note 1, at 23; see NARUC Primer, *supra* note 32, at 60 ("[F]orecasting electricity usage (or demand) has become more complicated due to changing load profiles, behind-the-meter resources, and increasing occurrences of extreme weather events.").

[82] *See* NERC LTRA, *supra* note 1, at 6.

[83] Fed. Energy Reg. Comm'n and N. Am. Elec. Reliability Corp., *The February 2021 Cold Weather Outages in Texas and the South Central United States* 167-172 (2021) (detailing how freezing issues and fuel issues across all resource types caused "75.6 percent of the 4,124 total unplanned generating unit outages, derates, and failures to start" during the February 2021 cold weather event in Texas and the South Central United States).

[84] MISO Electrification Insights, *supra* note 27, at 7.

[85] *See id.* at 9.

Operating Reliability Challenges

The nation's largest grid operator has concluded that, absent reform, the increased penetration of renewable resources will lead to declines in essential reliability services available to the grid.[86] As more and more variable resources penetrate the resource mix, the need for additional flexible, dispatchable capacity on the system increases, particularly to meet increased needs for ramping, load-following, and regulation capability. Risks associated with fuel and energy assurance rise as variable resource penetration increases.[87] Inverter-based resources, like most solar and wind resources, along with new battery resources, can create reliability challenges because they respond to grid disturbances with programmed logic,[88] meaning that they can sometimes trip offline "instantaneously and erroneously," which can further exacerbate grid disturbances.[89]

Battery storage resources are zero-carbon tools capable of bolstering certain essential reliability services, including voltage support, frequency response, and system inertia, just as traditional resources do.[90] However, much more storage capacity—and much longer duration storage capacity—is required.[91] Storage resources will increasingly support operating reliability and resource adequacy. But we need to find ways to expedite the process of bringing storage online: As of the end of 2020, there were almost 200 gigawatts of storage waiting in interconnection queues,[92] as grid operators waded through the lengthy, iterative study processes that are required to bring new resources online.

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[86] PJM Interconnection, L.L.C., PJM Frameworks, *supra* note 31, at 2; see also S. *Cal. Edison, Reimagining the Grid* at 1 (Nov. 2020) ("The growth of inverter-based resources (i.e., solar, wind, storage) to replace conventional generation will lead to loss of system inertia and other grid services that ensure system reliability today.").

[87] N. Am. Elec. Reliability Corp. & Cal. Indep. Sys. Op. Corp., *2013 Special Reliability Assessment: Maintaining Bulk Power System Reliability While Integrating Variable Energy Resources – CAISO Approach* 13 (2013).

[88] 2021 NERC LTRA, *supra* note 1, at 6.

[89] *See generally* Sandia Laboratories*, Momentary Cessation: Improving Dynamic Performance and Modeling of Utility-Scale Inverter Based Resources During Grid Disturbances* 11 (January 2020), https://www.osti.gov/servlets/purl/1593544.

[90] 2021 NERC LTRA, *supra* note 1, at 39.

[91] *See, e.g.,* Julian Spector, *Pumped Hydro Grid Storage Could be Poised for a Comeback*, Canary Media (Jan. 25. 2022), https://www. canarymedia.com/articles/long-duration-energy-storage/pumped-hydro-grid-storage-could-be-poised-for-a-comeback

[92] Lawrence Berkeley Nat'l Lab'y, Q*ueued Up: Characteristics of Power Plants Seeking Transmission Interconnection as of the End of 2020* (2021). Because storage is a limited-duration resource, as more and more storage resources come online, their marginal contribution to resource adequacy also declines. Energy + Env't Econ., *Capacity and Reliability Planning in the Era of Decarbonization: Practical Application of Effective Load Carrying Capability in Resource Adequacy 5* (2020).

Planning and Forecasting Uncertainty

Decarbonization, extreme weather, and electrification are among the factors creating new complexity and uncertainty for grid operators and power system planners. Uncertainty arises on the supply side as more variable resources and distribution-connected resources penetrate generation portfolios. Demand- side uncertainty also persists. Extreme weather creates volatility in demand forecasting, which is of particular concern during peak demands that accompany extreme weather events.[93] Electrification is expected to lead to significant changes to electricity demand, both by increasing the total amount of annual demand and altering demand profiles, such as by yielding more pronounced daily demand peaks.[94] Uncertainty regarding the pace of electrification and advancements in demand-side technologies add to the list of "unknown unknowns" facing grid operators.[95]

The energy transition is underway and unfolding rapidly—if unevenly—across the country. Key to accomplishing the decarbonization of the U.S. electricity system is ensuring that reliability stays in focus. Practical and political challenges may impede the uptake of low-carbon and renewable resources unless policies are designed to explicitly support decarbonization, affordability, and reliability.

THE SOLUTION: CARBON PRICING SUPPORTS BOTH GRID RELIABILITY AND DEEP DECARBONIZATION AT LEAST COST

As the energy transition continues in full swing, policymakers must identify a pathway to continue and accelerate decarbonization while supporting grid reliability in the most efficient way possible. Enter carbon pricing. Carbon pricing is uniquely positioned to directly and efficiently address the primary cause of climate change—carbon emissions—without skewing incentives away from grid reliability. Though other policy interventions may play a role in the collective effort, an economy-wide carbon price is the optimal policy tool to advance the twin objectives of decarbonization and grid reliability at least cost.

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[93] See 2021 NERC LTRA, *supra* note 1 at 8, 23.

[94] Electrification Futures Study, *supra* note 21, at 1.

[95] *See* MISO Electrification Insights, *supra* note 27, at 49; see also NARUC Primer, supra note 32, at 60 ("Some have questioned if traditional load forecasting methods based on historic averages of seasonal extremes capture these trends and the ongoing electrification of space and water heating.").

Carbon pricing values all emissions reductions in real time:

As we push toward the grid of the future, we must do what we can to maximize emissions reductions while supporting reliability today. This will require retaining existing zero- and low-carbon resources needed for reliability; creating incentives for the deployment of new renewable and other zero carbon resources; and supporting energy efficiency and demand response. Carbon pricing is the only policy tool for decarbonization that naturally (and efficiently) sends price signals to incentivize all of these things. Carbon pricing creates an incentive for reduced power sector emissions in real time, in every single hour of the day, no matter what form they take. This supports reliability. Here's how: Throughout the day, grid operators and utilities must select and dispatch the set of resources capable of meeting electricity demand and reliability needs moment-to-moment, and they seek to do so with the least expensive set of resources. This is generally referred to as "economic dispatch."[96] Grid operators identify and dispatch the least expensive set of resources in the "resource stack" that can meet system needs. As demand increases, operators call on more expensive resources higher up in the resource stack. Putting a price on carbon changes the economics of individual resources, pushing higher-emitting resources higher in the resource stack (making them relatively more expensive and less likely to be dispatched, but still available if needed) and pushing lower- and zero carbon resources lower in the resource stack (making them relatively less expensive and more likely to be dispatched). Importantly, carbon pricing also creates a price signal to reduce demand, which affects how high up in the resource stack grid operators must reach to maintain grid reliability. With a price on carbon embedded in economic dispatch decisions, there is a natural mechanism for grid operators to chase all forms of emissions reductions, regardless of why and how they arise. The grid will, in every hour of every day, lean towards the lower-carbon set of resources that can most efficiently and reliably serve demand – and will do so without the immediate need for any significant market reforms. Other decarbonization policies do not similarly embed the full suite of emissions reductions in dispatch decisions.

[96] For a helpful primer on economic dispatch in the organized market context, see ISO-NE, How Resources Are Selected and Prices Are Set in the Wholesale Energy Markets, https://www.iso-ne.com/about/what-we-do/in-depth/how-resources-are-selected-and-prices-are-set

Carbon pricing creates incentives to retain existing clean resources an unlocks incremental emissions reductions:

There are low- and zero-carbon resources operating today that are critical to both grid reliability and emissions reductions. This includes zero-carbon nuclear resources that can steadily serve demand and flexible natural gas resources that can follow shifts in load and are required to support the integration of renewables. However, some of these resources are at risk for retirement because the market does not currently and accurately value their contributions to emissions reductions and reliability. As described above, carbon pricing is a straightforward way to ensure that existing resources are dispatched (and thus compensated) for their zero- and low-emissions attributes. In the same way, carbon pricing rewards plant owners that deploy emission-minimizing technology and make thermal efficiency improvements. Regulations and subsidies may not similarly recognize and create an incentive for these types of incremental emissions reduction. Without a carbon price to capture very real, moment-to-moment opportunities to reduce emissions, these emission reductions will be lost.

In Focus: NUCLEAR GENERATION

Nuclear power is the most reliable source of zerocarbon electricity on our grid and is needed to reach decarbonization goals. Yet the outlook for nuclear power, in the U.S. and across the globe, has been bleak, in part because nuclear power currently faces a competitive disadvantage relative to natural gas and renewable energy, which have experienced significant cost decreases in the past 10-15 years. In the U.S., twelve nuclear power reactors have permanently closed since 2012, with more closures anticipated in the future. A carbon price, however, would create dependable, long-term market demand for nuclear resources' low-carbon attributes. Thus, a carbon price would help head-off nuclear plant closures, avoid the need for less economically efficient subsidies, and potentially displace the need for new, higher-emitting resources to enter the marketplace to support reliability.

See Mass. Inst. Tech., *The Future of Nuclear Energy in a CarbonConstrained World* xvi (2018); Suparna Ray, Nuclear and Coal Will Account for Majority of U.S. Generating Capacity Retirements in 2021, Energy Info. Admin. (Jan. 12, 2021), https://www.eia.gov/ todayinenergy/detail.php?id=46436.

Mark Holt & Phillip Brown, Cong. Rsch. Serv., R46820, *U.S. Nuclear Plant Shutdowns, State Interventions, and Policy Concerns* (2021).

Carbon pricing drives energy efficiency and demand reduction:

There can be no question that the cleanest and most reliable megawatt is the one that does not need to be generated to meet demand. Energy efficiency and demand response thus are powerful tools to reduce emissions while supporting grid reliability. A carbon price sends an economic signal to improve energy efficiency and take other measures to reduce demand, especially during peak demand hours when the grid is most strained and grid operators are most likely to reach toward higher-emitting resources. Because carbon pricing helps ensure that lower-emitting resources are called on to meet demand, and higher-emitting resources are avoided when demand drops, carbon pricing amplifies the emissions reductions associated with demand reductions. As electrification unfolds across our economy, the importance of, and opportunities for, energy efficiency and demand response will grow.[97] Decarbonization policies that fail to reward efficiency and demand reductions (and instead simply reward clean generation, which may drive inefficiencies) are designed for yesterday's grid, not the grid of the future.

In Focus: OPERATING RELIABILITY

PJM Interconnection, the regional transmission organization for much of the Mid-Atlantic, in December 2021 concluded the penetration of variable resources will lead to a decline in essential reliability services absent any reforms. Earlier studies and modeling conducted by PJM conclude that "[a] marked decrease in operational reliability was observed for portfolios with significantly increased amounts of wind and solar capacity," including reduced levels of frequency support and fuel assurance. PJM concluded that with coal and nuclear unit retirements, reliability was most supported where the "predominant" replacement resource was natural gas, which provides a broad range of generator reliability attributes. These realities underscore that, as the grid transitions, resource-neutral policies are needed to support the near-term entry or retention of the lowest-emitting resources required to support operating reliability.

PJM Interconnection, L.L.C., *Energy Transition in PJM: Frameworks for Analysis* 2 (Dec. 15, 2021), https://pjm.com/-/media/committees-groups/committees/mrc/2021/20211215/20211215-item-09-energy-transition-inpjm-whitepaper.ashx

[97] *See* Electrification Futures Study, *supra* note 21, at 7-8 (discussing demand-side flexibility); *The White House, United States Mid-Century Strategy for Deep Decarbonization* 30 (2016).

PJM Interconnection, L.L.C., *PJM's Evolving Resource Mix and System Reliability* at 5, 29 (Mar. 30, 2017), https://www.pjm.com/~/media/library/ reports-notices/special-reports/20170330-pjms-evolving-resource-mixand-system-reliability.ashx

Carbon pricing is technology—and location—neutral:

Carbon pricing does not favor one type of emissions reduction over another type of reduction, which means that it does not favor specific resource types or specific resource locations. Rather, carbon pricing creates a price signal to promote investment in the diverse set of resources and infrastructure that have the most value: namely, those that are needed to serve demand and that also are associated with the highest level of emissions reductions. For this reason, carbon pricing emerges as the superior policy tool to both decarbonize the power sector and systematically support reliability at least cost.[98]

Other policies based on subsidies or regulation may contribute to achieving policy goals like the development of more renewable resources. But unlike carbon pricing—which also creates a strong incentive to increase the level of renewable resources—such policies could over time become out of step with the goal of efficiently supporting reliability.

For example, federal tax credits for renewable energy may steer investment dollars toward new variable resources in the geographic regions where they are most cost-effective to develop.[99] And renewable portfolio standard (RPS) programs may steer investment dollars toward new variable renewable resources located in specific states. But such policies may fail to account for other factors adequately, like whether such new resources are sited near customer load or are located in areas with already-high levels of variable resource penetration.[100] These factors can affect whether new variable resources efficiently support grid reliability. When new

[98] A clean energy standard, such as one that values incremental emissions reductions, can potentially come close to the efficacy of a carbon price if properly designed. See Energy+Environmental Economics, Least Cost Carbon Reduction Policies in PJM at 8 (Oct. 28, 2020) ("E3 PJM Paper"), https://epsa.org/wp-content/uploads/2020/10/E3-Least_Cost_Carbon_Reduction_ Policies_in_PJM-FINAL.pdf.

[99] E3 PJM Paper, *supra* note 54, at 13 (explaining that some state policies "require development in specific geographic areas, even if the resources in those areas are more costly than resources in other locations").

[100] See S. Cal. Edison, *supra* note 41, at 5 ("[H]igh-load density relative to local supply capacity, as well as limited land availability, will make it challenging to build sufficient clean resources close to load to meet peak customer demand.").

generation sources are built far away from customer load, infrastructure uncertainty and costs follow, potentially straining the grid's ability to deliver power to load in the absence of new grid upgrades.[101] And when variable resources are built in locations that already feature high levels of penetration, the ability of new variable resources to contribute to grid reliability (and incremental decarbonization) may be diminished. A methodology called Effective Load Carrying Capacity (ELCC) illustrates this phenomenon. Grid operators and planners use ELCC to evaluate the ability of a resource to contribute to resource adequacy, i.e., its ability to produce electricity during periods when the grid is likely to experience a shortfall.[102] Generally speaking, as the level of one type of variable resource increases in a region, new resources of that type have a decreased ability to support reliability.[103] The often discussed solar "duck curve" is a common reference point. The duck curve refers to the shape of net customer demand that arises in regions where there are high levels of solar penetration.[104] Throughout the day, as the sun rises and solar output increases, there is a steep decline in net demand; as the sun sets at the end of the day—when demand naturally rises—there is a steep increase in net demand. This spike in demand cannot be met by additional solar resources.[105]

This is more than just a resource adequacy challenge; it is an emissions reduction challenge. Only those low- and zero-carbon resources that can contribute to grid reliability can displace the higher-emitting resources that are needed for reliability. Policies that are bluntly designed to promote specific resource types, sometimes in specific locations, are not calibrated to efficiently support both emissions reductions and reliability over time. Modelling has shown

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[101] *See id*. at 1 ("Since the bulk of future renewable resources will be located far from customers, the uncertainty and cost of building transmission lines may stretch the grid's ability to deliver power to urban load centers.").

[102] ELCC relies on loss-of-load probability modeling, which simulates the electricity system under various load and resource conditions to project expected reliability events on a system with a given portfolio of resources. ELCC is a "method to express the capacity contribution of intermittent and energy-limited resources in terms of equivalent 'perfect' capacity (capacity that is always available). In this respect, ELCC is technology-agnostic: a system with a given quantity of ELCC megawatts will achieve the same level of reliability, regardless of what types of resources are providing those megawatts." Energy + Env't Econ., *Capacity and Reliability Planning in the Era of Decarbonization: Practical Application of Effective Load Carrying Capability in Resource Adequacy* 4 (2020)

[103] Mark Specht, Union of Concerned Scientists, ELCC Explained: The Critical Renewable Energy Concept You've Never Heard Of (Oct. 12, 2020), https://blog.ucsusa.org/mark-specht/elcc-explained-the-critical-renewable-energy-concept-youve-never-heard-of/ ("[]he quantity of a resource affects its own ELCC. For example, holding all other variables constant, as you add more solar to the grid, the ELCC of that solar goes down.").

[104] Because solar resources are not dispatchable, they are often modelled as an offset to demand.

[105] *See generally* David Roberts, Solar Power's *Greatest Challenge Was Discovered 10 Years Ago. It Looks Like a Duck*, Vox (Aug. 29, 2019), https://www.vox.com/energy-and-environment/2018/3/20/17128478/solar-duck-curve-nrel-researcher

that prescriptive policies like RPS become less cost-effective relative to neutral policies like carbon pricing as we reach for deeper cuts in emissions.[106]

To be clear, the decarbonization of our economy requires the deployment of substantially more renewable resources. We won't get there without them. The key is bringing these resources online in the most efficient way that also ensures grid reliability

In Focus: THE DUCK CURVE AND RELIABILITY

"The very first solar power plant you add to the grid is a reliability rockstar, tackling daytime reliability shortfalls with ease. But as you add more and more solar plants that are all producing electricity at the same time, it reaches a point where all those solar plants are preventing daytime reliability issues so effectively that the remaining reliability challenges move into the evening hours when solar can't help. At this point, adding more solar does very little to prevent electricity shortages."

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Mark Specht, Union of Concerned Scientists, *ELCC Explained: The Critical Renewable Energy Concept You've Never Heard Of* (Oct. 12, 2020), https:// blog.ucsusa.org/mark-specht/elcc-explained-the-critical-renewable energy-concept-you've-never-heard-of

Carbon pricing sends price signals that work together to drive emissions reductions and support reliability.

As detailed above, carbon pricing sends a price signal to avoid emissions; it is also added to the existing price signal to serve energy demand where and when it is needed (or, alternatively, to reduce demand). These clear economic signals seamlessly work together to drive decarbonization while supporting reliability. Other decarbonization policies effectively separate the price signals for reducing emissions and meeting customer demand, creating opportunities for those price signals to work at cross purposes, driving down efficiencies.

In hours where variable resources cannot meet demand, grid operators must lean on a variety of resources and tools to manage the steep shifts in net demand and avoid strains on the grid. As we decarbonize, this will require an economic signal to support, among other

[106] E3 PJM Paper at 54 (arguing that "[p]rescriptive policy mechanisms, such as RPS policies, will become less and less cost-effective as policy targets reach higher levels" revealing the "significant value in more technology-neutral approaches").

things, a diverse resource mix[107] with broadly-deployed storage technologies, robust demand response, and increased grid interconnectedness. Carbon pricing sends a neutral price signal to support all of these tools in the locations where they are needed. And when variable resources cannot adequately meet demand, grid operators should have an economic signal to draw from the lowest-carbon energy mix available (e.g., by dispatching natural gas—potentially with carbon capture technology—before dispatching a traditional coal resource). Carbon pricing provides that economic signal.

Carbon pricing stands apart as the policy tool that sends clear price signals that work together to drive decarbonization while supporting reliability.

Carbon pricing supports infrastructure, innovation, and market reforms.

The clean and reliable grid of the future will require significant investment and forward thinking. Carbon pricing paves the path to the future by injecting clarity and predictability into long-term infrastructure planning, research and development processes, and market reforms.

Globally, the clean energy transition will demand new generation capacity, an expanded and modernized transmission and distribution system, and expanded storage resources, at an estimated price tag of $4 trillion by 2030 and more than $100 trillion when all is said and done.[108] In the U.S., some estimates show that in the next eight years, between now and 2030, we need to quadruple wind and solar electricity generating capacity, and in concert, expand our high voltage transmission capacity by 60% to connect the renewable electricity with load centers.[109] Bolstering grid interconnectedness is critical. The fact that the isolated Texas grid went dark in February 2021, while more interconnected portions of the grid did not, paints a stark picture.[110]

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[107] Specht supra note 60 (explaining that "different types of generating resources interact with each other and create 'diversity benefits' that can boost ELCC values").

[108] See Int'l Energy Agency, *Net Zero by 2050 83* (2021); *see also David Carlin, The $100 Trillion Investment Opportunity In The Climate Transformation*, Forbes (June 2, 2021), https://www.forbes.com/sites/davidcarlin/2021/06/02/the-ieas-net-zero-climatepathway-is-a-100-trillion-investment-opportunity/?sh=5e1978b45597

[109] Eric Larson et al., Princeton University, *Net-Zero America: Potential Pathways, infrastructure, and impacts (Interim Report)* 14 (Dec. 15, 2020).

[110] Joshua W. Busby et al., *Cascading Risks: Understanding the 2021 Winter Blackout in Texas*, 77 Energy Rsch. & Soc. Sci. at 7 (2021) ("It is worth examining whether additional regional interconnections could potentially compensate for production shortfalls in the state and enhance the system's overall resilience. Most of the time, Texas would likely be able to sell excess power

Despite the urgent need to invest in long-lived power sector assets, long-term resource and infrastructure planning is becoming more and more complex.[111] Grid planners, system operators, and investors need predictable data to project supply and demand trends and identify where and when infrastructure investments are needed to serve demand in future years. One grid operator has explained that when variable generation begins serving more than 30% of annual load, successful transmission planning and expansion requires "transformative thinking."[112] Federal legislation to implement an economy-wide carbon price with a clear long-term trajectory would deliver the data and predictability needed to support transformative thinking.

An economy-wide carbon price is built for the long-term and can begin shaping long-term investment decisions immediately. Emerging and new innovative resources will compete to maintain reliability in a deeply decarbonized grid. The resource mix in the future will have complex and evolving carbon emission and reliability profiles. Carbon pricing will allow these technologies to compete on a level playing field. Other regulatory pathways that rely on federal agency implementation may overlook decarbonization and reliability benefits, and be subject to delays, partisan programmatic shifts, and protracted litigation.

Organized market reforms also require data and predictability. As zero-marginal-cost renewable resources make up a larger share of the marketplace and are increasingly dispatched to serve demand, pushing down market clearing prices to sometimes negative levels, organized market structures will need to evolve. In particular, market reforms will be needed to improve price formation so that organized markets can more accurately and transparently value the reliability attributes provided by flexible resources.[113] However, meaningful market reforms require a stable policy environment. If policies to address carbon emissions frequently shift, and

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from its rapidly growing renewables capacity to other states, which implies that there might be significant economic benefits to interconnection along with resilience benefits. Several cities in Texas . . . suffered little or no power outages during the 2021 freeze in part because they are not part of ERCOT and are connected to other grids.").

[111] See *supra* notes 49-51 and accompanying text (describing current planning challenges).

[112] Midcontinent Indep. Sys. Operator, *MISO's Renewable Integration Impact Assessment* 4 (Feb. 2021), https://cdn.misoenergy.org/ RIIA%20Summary%20Report520051.pdf ("Beyond 30%, transformative thinking and coordinated action between MISO and its members are required to prepare for the significant challenges that arise" with respect to transmission expansion, operations, market, and planning practices).

[113] *See* PJM Interconnection, L.L.C., PJM Frameworks, *supra* note 31 at 2 ("[A]dding zero-marginal-cost renewable resources decreased the average locational marginal pricing (LMP) in all scenarios . . . . The study underscored the need for PJM and stakeholders to continue to work on price formation initiatives to ensure that the flexibility needs of the system are transparently priced in the market.")

if state- and federal-level policies conflict, meaningful market reforms are harder to achieve. A stable price on carbon would diffuse these challenges.

Carbon pricing supports infrastructure, innovation, and market reforms.

We cannot decarbonize the U.S. economy through the electricity sector alone. The electricity sector accounts for only about one-quarter of greenhouse gas emissions across our economy, with the transportation, building, and industrial sectors also playing a large role in emissions.[114] Economy-wide carbon pricing reaches all sectors.

Deep decarbonization likely will depend on multi-sector electrification, which carbon pricing can help unleash and maximize. A 2018 report by the Electric Power Research Institute studied electrification in a future scenario in which a carbon price is implemented and found that a carbon price amplified the benefits from electrification.[115] This is not only because carbon pricing shapes the generation mix to be less carbon-intensive,[116] but also because carbon pricing actually drives toward a more rapid expansion of electrification.[117]

Fundamentally, economy-wide carbon pricing supports both deep decarbonization and grid reliability because it spurs emissions reductions across all sectors not just the power sector. It will rapidly achieve the least-cost emissions reductions first, in whichever segment of the economy they occur. This is key because reliability experts have been clear that moving to a zero-carbon power grid is a long-term goal rather than a near-term possibility. Economy-wide carbon-pricing thus helps create a runway for the steady decarbonization retrofit or replacement of the carbon-emitting resources that currently are needed to support grid reliability as we lean more heavily on our grid. Phasing out power sector emissions rapidly and reliably is the goal; carbon pricing is the pathway.

There are a number of other benefits of carbon pricing that make it particularly well-suited for the U.S. economy. Carbon pricing can raise hundreds of billions of dollars in revenue

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[114] *See Sources of Greenhouse Gas Emissions*, Env't Prot. Agency, https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (last visited Feb. 17, 2022).

[115] EPRI Report, *supra* note 26, at 5.

[116] *See id.* at 42 (explaining that in the scenarios that assume a carbon price "the electric generation portfolio becomes less carbon-intensive").

[117] *See id.* at 38 (explaining that the scenario with the highest assumed carbon price shows "substantial additional electrification in both buildings and industry").

that can be distributed to households ensuring the majority of Americans see an increase in household income from climate policy.[118] Additionally, a carbon price is easily pared with a border carbon adjustment, which not only ensures a level playing field for American businesses, but a competitive advantage for those domestic firms that are more carbon efficient than their less efficient overseas competitors.[119]

THE TIME FOR CARBON PRICING IS NOW

Reliable, affordable electricity is vital to our economy, our daily lives, and the health and safety of Americans. In this moment, extreme weather, power sector decarbonization, and electrification, among other forces, are converging to create unprecedented tests for our grid. Grid reliability must remain sharply in focus as we decarbonize. Carbon pricing is the optimal federal legislative pathway to achieve both reliability at least cost and deep decarbonization.

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The Climate Leadership Council *is a research and policy organization founded in 2017 to promote effective, fair, and lasting climate solutions based a carbon dividends framework. Learn more at www.clcouncil.org*

[118] Oxford Economics, *National & State Level Household Income Distributional Analysis of Baker-Shultz Carbon Dividends Plan*, The Climate Leadership Council, September 2020, https:// clcouncil.org/report/oxford-economics-analysis/

[119] CRU International, Ltd., *Leveraging a Carbon Advantage: Impacts of a Border Carbon Adjustment and Carbon Fee on the US Steel Industry*, The Climate Leadership Council, May 2021. https:// clcouncil.org/report/leveraging-a-carbon-advantage/

SOLVING BOTH ENERGY SECURITY AND CLIMATE

HAL HARVEY

CEO, Energy Innovation

The Dual Imperative

Political leaders today have two challenges: to ensure that the country has sufficient reliable, affordable, and secure energy, and to swiftly cut greenhouse gas emissions. Mishandled, or handled as business-as-usual, will put these goals in sharp tension. Conversely, the right policies and the right technology can achieve both goals.

The Russian war on Ukraine put this tension in sharp relief. Olaf Scholz's new government in Germany was just 11 weeks old when Russian leader Vladimir Putin invaded Ukraine. Energy staffers in the new German government had joined up with a charge to reduce climate change gasses. Their mission changed almost overnight, as they were suddenly charged with acquiring as much fossil fuel as possible to enable Europe to wean itself from Russian gas and oil. The irony is thick; the dangers are thicker.

Modern industrial society simply cannot tolerate unreliable energy. Blackouts shut down the entire economy and can cost many lives. Texas' grid was unprepared for cold weather in 2021, a statewide blackout ensued, and more than 200 people died. The bill for this debacle: nearly $200 billion.[120] New York City's infamous 1977 blackout culminated in riots, robberies, and mayhem.

The same supply imperative goes for gasoline and diesel fuel, and for natural gas to run our industries and heat homes. This economy of ours simply requires abundant, affordable, and reliable energy.

[120] City of Austin & Travis County, *2021 Winter Storm Uri After-Action Review: Findings Report.* https://www.austintexas.gov/sites/default/files/files/HSEM/2021-Winter-Storm-Uri-AAR-Findings-Report.pdf

But in the meantime, the climate clock is ticking. It is hard to understand just how big a threat climate change is, but the reckoning is upon us, and it will be severe. America was built on a propitious climate—vast agricultural lands that are the envy of the world, three coasts for navigation and cities, waterways for commerce, rivers for irrigation and industrialization, and vast natural systems that make America "the beautiful." We are stressing these systems: Epic fires make summers smoky from California continuously to the Rockies. A thousand homes burned in one night in *December* in Colorado. Droughts are leaving Lake Powell and Lake Mead mostly dry, threatening the viability of southwestern cities, including Phoenix, Las Vegas, and Los Angeles. The impact is starkly visible in the bathtub rings spanning hundreds of miles and idle hydropower stations of Lake Mead and Lake Powell.

Bureau of Reclamation Commissioner Camille Calimlim Touton said during a Senate hearing [on June 14, 2022] that sustaining the country's largest reservoirs, Lake Mead and Lake Powell, and ensuring water supplies for 40 million people living in the southwest will **require drastic reductions in water deliveries.**

The commissioner's testimony followed a weekend of **record-breaking temperatures in the southwest** in the midst of the **worst drought in 1,200 years**. "A warmer, drier West is what we are seeing today," Touton told the Senate Energy and Natural Resources Committee. "And the challenges we are seeing today are unlike anything we have seen in our history."

It gets worse: By mid-century, there will be 10,000 additional heat-related deaths every year in Florida and Texas alone.[121] Floods will spill up and down the Mississippi. Ecosystems in the Rockies are simply disappearing. Florida is becoming uninsurable.

[121] Risky Business, *Come Heat and High Water: Climate Risk in the Southeastern U.S. and Texas* (2015). https://riskybusiness.org/report/come-heat-and-high-water-climate-risk-in-the-southeastern-u-s-and-texas/

And beyond our borders, things are worse. Scientists are projecting that 250 million people may experience severe water shortages in Africa due to drought and up to 700 million people displaced as a result.[122] There is no political system in the world that can handle that flow of desperate humans.

So how do we reconcile this need for abundant, reliable energy with the unspeakable costs of climate change? **The short answer: technology**. There are now technology options that are reliable, affordable, and clean for every sector. We don't have all the technology we will ultimately need, but with today's technologies, the world can reach about 80 percent of our energy needs free of greenhouse gases. And we can stimulate research and development to invent the last 20 percent. Good technology requires sound policy. This memo covers both.

Four Zeros: A Path to a Clean Energy Future

Energy is used in four sectors of our economy: the electric grid, transportation, buildings, and industry. Each sector has different requirements and different characteristics, and so each requires different technology and policy pathways. I sometimes summarize this as the "Four Zeros":

1. Zero-carbon grid.
2. Zero-emission vehicles.
3. Zero-emission buildings.
4. Zero-waste manufacturing.

There is no strategy to sufficiently reduce energy insecurity or climate change that does not address these four sectors. In turn:

1. Zero-Carbon Grid

Clean energy technology for the grid has gone from a boutique business to the mainstream. The cheapest electricity in the world is now solar power, with onshore wind as a close second. Offshore wind promises another huge source of zero-carbon electricity. The

[122] IPCC, "Chapter 9: Africa," in *IPCC WGII Sixth Assessment Report* (2021). https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_Chapter09.pdf

challenge is to rapidly convert the grid to these existing, low-cost technologies—while *increasing* grid reliability and stability.

For decades, utility managers have believed that because renewable energy sources are variable, their contribution to the grid can only be modest. But new grid management strategies have proven that 80 to 90 percent carbon-free operation is entirely feasible, and that there are technologies on the horizon that can drive the total to 100 percent. In fact, Germany and California, the fourth and the fifth largest economies in the world, have ultra-reliable grids that are more than 60 percent decarbonized already.[123] California recently hit more than 100 percent renewables for a day.

How can nighttime, clouds, cold weather, and low winds produce a reliable grid? The answer to this conundrum is to deploy a large variety of clean energy supplies across a broad geography—and ensure that they combine to meet all demands. For example, *offshore* wind turbines run more than 60 percent of the time, and they run at higher speeds and different hours than onshore wind. So, combine the two, and they deliver a baseload-like supply pattern. The grid itself is a great system balancing tool. San Diego and Seattle never have the same peak demand or peak supply. Hook them up with transmission lines, and they balance each other out. Solar thermal stations, geothermal, biomass, existing nuclear power, existing hydro, and energy efficiency technologies are dispatchable and zero-carbon, so they can be combined to deliver smooth, uninterrupted power. Fossil fuels play a role too. With carbon capture, fossil can be part of a clean energy future. And during the transition, using fossil for grid backup will not generate huge emissions but will have high system value.

This is not just theory. Steve Berberich, the engineer who ran the California grid for almost a decade, said: "The key takeaway from [California's experience] is that it is very possible to operate a power grid with high levels of renewable production without sacrificing reliability." Berberich had to keep the lights on. His words are backed up by real-world experience.

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[123] California Energy Commission, "New data shows nearly two-thirds of California's electricity came from carbon-free sources in 2019," 2020. https://www.energy.ca.gov/news/2020-07/new-data-shows-nearly-two-thirds-californias-electricity-came-carbon-free

"Electricity sector in Germany." Last accessed June 24, 2022. https://en.wikipedia.org/wiki/Electricity_sector_in_Germany#:~:text=In%202019%2C%20Germany%20generated%20electricity,%25%20biomass%2C%203.7%25%20hydroelectricity.

If carefully handled, this transformation can be rapid, can boost economies, and can save consumers money. Five policies are required:

1. Set strong, serious, steadily increasing targets for zero-carbon electricity generation. Give utilities the certainty and lead time they need for planning and execution. Every utility should be on a pathway that is faster than today's route. Setting a clear standard sends a powerful market signal to industries.
2. Eliminate barriers to renewable energy. Make it straightforward to get permissions for siting, transmission access, and construction.
3. Restructure the way the grid is managed, so that lowest marginal cost technologies get dispatched first.
4. Rethink and restructure grid management, so that the grid operator's key job is to be a system optimizer, using both demand- and supply-side technologies.
5. Design the electric grid for a future where it is also powering most of the transport, building and industrial sectors.

Together, these five policies enable a rapid and cost-effective transformation. Conversely, holding on to old grid technologies and old grid management strategies will cost money, strand assets, and continue with carbon and conventional pollution.

2. Zero-Emission Vehicles

An electric car powered by a clean grid is a (near) zero-emissions car. It is still early days for this transformation. Media headlines trumpet the electric car and truck revolution; and announcements aplenty from manufacturers, cities, and states have sparked a sense that this is a rapid and inevitable future—but it is far too early to declare victory: We need to be clear-eyed on the challenges of electrifying all vehicles, including off-road construction equipment. Global electric vehicle (EV) sales are still single-digit fractions of total automobile sales, and a significant price gap and infrastructure problems mean the EV challenge is not yet solved. The electric vehicle revolution requires a mixture of steadily declining incentives to sell EVs, steadily rising requirements to produce them, and utility programs to build the infrastructure to charge them. Incentives in the early days set off a virtuous cycle, driving down prices and supporting new technology development. This enables gradually increasing market share requirement for

zero-emissions vehicles. Building charging stations can be a utility, private sector, or municipal responsibility. Together three policies—incentives, fleet sales requirements, and mandated construction of charging infrastructure—can get the job done, and rapidly.

The benefits are vast: lower CO_2 emissions, which get even lower every year as the zero-carbon grid comes closer. Lower conventional pollution, with huge human health benefits. Quieter streets. And less imported fuel, which is good for economic and national security reasons.

That's not all that has to be done for transportation, of course: The world will still build a couple billion new internal combustion engines, even with the fastest EV growth curves, so it is crucial that these engines be super clean and super-efficient. Strong fuel efficiency standards and strong tailpipe standards, based on real-world performance, are the only proven ways to get this done at scale. That agenda must be pursued with vigor.

3. Zero-Emission Buildings

Strong all-electric building codes, properly enforced, create extremely efficient and zero-emission new buildings, which are an environmental asset for decades.

Building technology has come a long way in recent years. Heat pumps convert electricity to heat—and can deliver up to four units of heat for every unit of electricity! That multiplier makes electric heat much more cost-effective. Low-emissivity glass can increase heat gain in the winter, and slash it in the summer. LED lights last thousands of hours and use 90 percent less energy than incandescent bulbs. Residential solar has dropped in price so it is now competitive with grid electricity, and there is a booming business in home batteries to increase homeowner reliability. In short, it is increasingly feasible and economical to slash building energy consumption, and to meet the remaining demand with zero-carbon sources.

The opposite is also true: A poor building code that locks in fossil-fueled appliances/boilers, or no thermal building code at all, condemns the world to decades of carbon pollution.

The first essential policy is to have a state-of-the-art thermal building code. The best examples cut energy use to near zero. Standards for LED lighting, improved HVAC systems and heat pumps, and super-efficient refrigerators add on to help deliver the zero-emission building.

Replacing fossil-fueled appliances and boilers in existing building is also a cornerstone to meeting our climate goals. Electrification of existing buildings also provides enormous cost and health benefits if coordinated around the end of life of existing appliances and boilers. Air conditioners and home appliances are of course already electric—and they should be replaced over time with the most efficient new models. Add in heat pumps and induction stoves, which are super-efficient and clean, and you have the makings of a zero-carbon building.

4. Zero-Waste Manufacturing

This brings us to the final zero: zero-waste manufacturing. Manufacturing is not really a sector, but rather an agglomeration of many sectors, each with specific opportunities and challenges. Concrete, steel, chemicals, fertilizers—these energy-intensive industries are capital-intensive, have long lives, and must meet exacting standards. The transformation to zero- or low-carbon production is not a trivial business.

But there are some great head starts. Renewable-generated hydrogen can be used to make zero-carbon steel, albeit at a price premium. Several cement and concrete companies have formulations that slash their carbon footprint. There is work underway to use clean hydrogen in specialty chemicals and fertilizer.

Virtually every industrial transformation plan requires copious amounts of hydrogen produced from renewable resources, using electrolysis to split off the hydrogen from water. Wind or photovoltaic solar cells can power electrolyzers—and all three of these technologies have sharply dropping costs.

Public policy can drive this transformation with a mix of incentives, performance standards, and research and development (R&D). All three are required—and at robust levels. Success in these realms portends well not just for climate, but for national security and national competitiveness.

The particulars:

1. Robust, steady, multi-year R&D support, both through direct federal R&D and support of private R&D.
2. Incentives, probably in the form of "contracts for differences," whereby the federal government pays the difference between the cost of green production and what the

market will offer for conventionally produced goods. Filling the gap will become cheaper as technologies evolve.

3. And, steadily strengthening carbon performance standards—such as tons of CO_2 per ton of cement—which will help manufacturers re-invent their processes.

These policies can help ensure that U.S. technological progress is not undermined by our competitors.

Supporting Policies

Clear standards for each sector will drive the most change the fastest, but they can be helped with: 1) more vigorous energy R&D, and 2) a price signal on carbon emissions. The nations of the world grossly underspend on clean energy research and development. In the United States, tech companies spend 10 percent of their revenues on R&D, and pharmaceutical companies spend a full 20 percent. But energy companies spend about half of one percent. That is far too little. The winners will invent the future.

Economists recognize that setting a price on carbon and other pollutants can bend the economy toward ever-cleaner products and create a revenue stream to accelerate the transition. A price is not sufficient policy, but it is helpful.

Summary: The Policy Imperative

The Four Zeros are feasible and cost-effective. What would drive their speedy adoption? The answer is quite clear and is grounded in experience. Here is the crib sheet:

Zero-Carbon Grid

1. Steadily increasing requirements for utilities to deliver zero-carbon electricity.
2. Concurrently, eliminate regulatory barriers to facilitate grid transformation. Add transmission, set up markets for broad trading of electricity, clear out obstacles to renewable energy permitting, and retain sufficient flexibility to increase reliability.

Zero-Emission Vehicles

3. Strong, but steadily declining subsidy for electric vehicles.

4. Steadily increasing sales requirement for electric vehicles.
5. Mandates and incentives for utilities and cities to install charging points.
6. Strong fuel efficiency standards and tailpipe standards for new internal combustion vehicles.
7. Reformed urban planning and public transportation to reduce dependence on autos and offer many more options for access and mobility.

Zero-Emission Buildings

8. Building codes that prohibit onsite use of fossil fuels and require efficient building shells.
9. Strong, but steadily declining subsidy for heat pumps and electric appliances/boilers.
10. Steadily increasing sales requirements for electric appliances/boilers that are grid-enabled and demand flexible.

Zero-Waste Manufacturing

11. Incentives for clean production (e.g., contracts for differences) to accelerate market transformation.
12. Steadily increasing efficiency and carbon standards, e.g., tons of CO_2 per ton cement.
13. Required recycling takeback of all waste, starting with major appliances and plastic waste.

Supporting Policies

14. Triple clean energy R&D funding.
15. Ensure all policies are designed to promote equity and justice, including funding for low-income households.
16. Steadily add a price on carbon.

POLICY MEMORANDUM FOR MEMBERS OF CONGRESS

ENERGY, SECURITY AND THE ARCTIC: KEYS TO COMPETITIVENESS

The Aspen Institute Congressional Program

Reykjavik, Iceland

Note: Below is what we call a "policy action memo" from the recent congressional conference in Iceland. It is intended to be a resource and the aim is simply to list policy ideas that emerged in the conversations. We want to re-emphasize that our role is as a neutral convener, and we are not advocating any of these policies; we are merely cataloging the ideas that came forth

Implications on Global Security:

- Climate change is a threat multiplier, reshaping the strategic operating environment for the U.S.in the Arctic and around the world.
- With Putin's war on Ukraine, Arctic cooperation has begun to give way even more to competition for energy, shipping and global influence.
- The U.S. should increase natural gas and clean energy exports to Europe to help it become less dependent on Russian energy.
- China's Belt and Road Initiative is an outreach to bring electricity to developing countries, particularly in Africa. Amid increasing Chinese global competition, the U.S. could also take a more proactive role (e.g. increase development aid) in electrifying economically marginalized communities.
- Around 10% of the world population lives without electricity. Arguably, an increase of US foreign aid could be a step forward towards addressing energy poverty.
- Continue development of a formal U.S. Arctic Strategy and appoint an Arctic Ambassador.

Domestic Concerns:

- DoD has aggressive goals for achieving net zero energy in the coming decades, and its scale can leverage and jumpstart clean energy solutions. Five technologies where military buying power can help are:
    - Grid resilience through microgrids and distributed energy resources;
    - Electric vehicles and EV charging station infrastructure;
    - Geothermal energy;
    - Nuclear energy and nonproliferation advanced small modular reactors and micro modular reactors;
    - Sustainable aviation and shipping fuels.
- There is a great potential for energy efficiency across the military. Congress should direct DoD acquisition of non-tactical vehicles to be electric. Moving off fossil fuels gives the military a competitive edge and protects it from worsening climate risks.
- Congress can help DoD streamline energy contracting under the Power Purchasing Agreement.
- The U.S. government could map the needs for critical minerals required for green energy sources, catalog those that are currently sourced primarily or entirely from a single nation (*i.e.* China), and work with allies to diversify supply and accommodate the increasing demand.
- The U.S. should reconcile the need for abundant, reliable energy by promoting investments in new technology. Tech companies spend only around 10% on R&D, while energy companies spend less than 1%. Funding could be tripled.
- There are Four Zeros that the U.S. should aim for: zero-carbon grid, zero-emission vehicles, zero-emission buildings, and zero-waste manufacturing. The U.S. government should introduce clear guidelines and standards for each of these sectors to drive fast change.
- Price should steadily be added on carbon and other pollutants to encourage companies to shift to green energy.
- The government permitting process could be streamlined for energy projects to allow quicker deployment for energy needs.

Congressional Reflections:

- Increase expenditure on further research and development of carbon capture and carbon dioxide removal projects.
- Reinforce bills that will require proper collection and recycling of batteries.
- Work on making climate security a bipartisan issue through holding more hearings, increasing Congressional oversight of executive branch policy implementation, paying more attention to climate change and security, reinforcing discussions on the Arctic, and assessing where critical metals come from and how the process affects local communities.
- Make E1 (Treaty Traders) and E2 (Treaty Investors) visas more accessible for energy businesses to attract more foreign capital and encourage innovation.
- Increase Naval and Coast Guard activity in the Arctic, including icebreaker capacity and development of port facilities.
- Maintain and reinforce educational exchange programs for climate innovation.
- Utilize existing resources and technology to the maximum potential and develop a future action plan.
- Support developing a matrix/formula to measure U.S. energy productivity based on various indicators. The government could benefit from having a better idea about how effective the country is in terms of green energy consumption, transition, and waste management.
- Review the policies that prevent U.S.-based companies (such as Running Tide whose work we saw during the site visit in Akranes, Iceland) from operating in the U.S., including consideration of trade policy with Iceland.
- Analyze how Scandinavian countries have achieved greater reliance on green energy and see how some practices can be adapted to the U.S. reality.
- Encourage investments and research in more renewables and green technology.