SOLUTIONS BRIEFS

CED
COMMITTEE FOR ECONOMIC DEVELOPMENT
THE PUBLIC POLICY CENTER OF
THE CONFERENCE BOARD

SUSTAINING CAPITALISM

A series focused on nonpartisan, reasoned solutions in the nation's interest to the central challenges we face in order to provide prosperity for all Americans.

A Road Map for a Sustainable Clean Energy Transition During Economic and Geopolitical Uncertainty

Overview

Climate change is a defining and urgent 21st century global challenge which threatens global security, economic prosperity, environmental sustainability, and public health. The United Nations reported earlier this year that the world has only a "brief and rapidly closing window" to act.[1] In an effort to address this challenge and prevent these major disruptions, 196 nations have agreed to limit the rise in the average global temperature to 1.5 degrees Celsius above pre-industrial levels and to achieve "net zero" greenhouse gas emissions by mid-century.

Key to achieving these goals is a sustainable energy transition strategy that sets out a realistic pathway for net-zero emissions by 2050. This has only become more difficult with the energy security of the US and its allies threatened by Russia's weaponization of energy, which Russia has intensified in the wake of its invasion of Ukraine. The consequent supply disruptions have further fueled inflation, setting back the global economic recovery.

As a result of this geopolitical and economic turmoil, US leadership becomes even more critical. This report delineates a realistic US energy transition plan to meet the 2050 goal of net-zero emissions that accelerates the transition to renewable and other zero-carbon energy at the fastest rate while also recognizing that fossil fuels are a necessary energy source today and will continue to be part of a net-zero energy strategy that can increasingly rely on alternative technologies now under development.

A comprehensive and resilient US strategy must build on the foundation of market principles, accelerate innovation, and preserve US competitiveness in the global economy. To ensure

success, and a cohesive and comprehensive transition, government leaders must work in close partnership—not in conflict—with business leaders. Every sector has a very important role in addressing climate change; none can do it alone, particularly given the global scope of the problem and the urgency of the task. Every company must play a role to mitigate its environmental footprint, and every nation must play a role, particularly those that are the largest emitters of greenhouse gases (GHG). And among nations, the most important collaboration is between the US and China, without which progress will be limited.

Goals For Tackling Climate Change

Global Paris Agreement goals

- Limit the rise in global temperature to 1.5 degrees Celsius above pre-industrial levels
- Achieve "net zero" greenhouse gas (GHG) emissions by mid-century
- Reach global peak of GHG as soon as possible
- 70+ countries of 196 signatories have set a net-zero target, covering about 76 percent of global emissions
- 4,000+ businesses are working with the Science-Based Targets Initiative to reduce their emissions
- Global Methane Pledge to reduce methane emissions 30 percent from 2020 levels by 2030

US goals

- Net zero GHG emissions no later than 2050
- Reduce economy-wide net GHG emissions 50-52 percent by 2030 based on 2005 emissions levels
- Global Methane Pledge

Goals of other major emitters

- **China**: Net zero emissions by 2060
- **India**: Net zero emissions by 2070
- **EU**: Net zero emissions by 2050

Insights for What's Ahead—Solutions

CED's work promotes "sustainable capitalism." A core component of sustainable capitalism is a sustainable strategy on climate, energy, and the environment. The challenge before us is broad and sweeping, and requires addressing the outsized threat of climate change with an energy transition strategy that supports our national security, our economic vitality and our health and well-being. To achieve the net zero emissions goal by 2050, CED recommends the following solutions for a sustainable energy transition that are based on these principles:

- recognize and plan for the role of fossil fuels in ensuring energy security and stable energy prices through the transition, discourage the use of coal and encourage the use of natural gas as a transition fuel;
- further accelerate the clean energy transition through incentives and R&D;
- implement a smart regulation strategy to promote innovation and growth; and
- provide international leadership.

A successful US energy transition is only achievable through collaboration among public and private sector leaders at home and abroad.

Ensure energy security through reliable supplies of fossil fuels and collaboration with the private sector through the transition to net zero 2050

- **Reliable supplies**: The US should be a reliable supplier to our allies, increasing production of oil and gas to help stabilize prices around the world, meet the demands of current market disruptions, and avoid releasing resources from the Strategic Petroleum Reserve (SPR) as we transition to a clean energy, decarbonized future. Reforming permitting to increase production quickly is essential to meet this goal.
- **Natural gas as transition fuel**: The US should encourage the use of natural gas as an alternative to the increasing global use of coal and as a transition fuel to net zero to reduce emissions of carbon dioxide and air pollutants. Accordingly, to address the global energy disruptions, the US should incentivize the private sector and encourage our allies to build new LNG export terminals, pipelines to get LNG to those terminals with dual capacity for hydrogen, and other infrastructure for energy security.
- **Collaboration with fossil fuel producers**: The Administration should collaborate more closely with fossil fuel producers, as partners—not adversaries—responding together to the great geopolitical challenges of our time. The White House should establish a public/private leadership Task Force on Climate, Energy and the Environment to develop a strategic plan for achieving our net-zero objectives while maintaining energy security for the US and its allies. The Task Force should include Congressional leadership.
- **Partnerships with private sector**: The Administration should develop public-private partnership working groups across all government agencies implementing climate and energy policy, including those looking at alternative technologies for producing cement, steel and fertilizer.

Accelerate the clean energy transition: promote R&D and reductions in carbon and other greenhouse gases

- **Increase investment in clean energy R&D**: Public and private sectors should use the Inflation Reduction Act (IRA) as a catalyst for increased investment in R&D to build American global leadership in nuclear, hydrogen, wind, and solar power and energy storage but without picking winners and losers among technologies.
- **Encourage use of nuclear power**: Federal and state governments should encourage use of nuclear power, including newer designs such as small modular reactors. The Administration should change current US climate policy, which refers only to "existing nuclear," to promote new plants.
- **Increase incentives**: The federal government should promote tax credits for R&D to encourage the private sector to invest more in clean energy. The US should fund basic R&D in clean energy, including efforts in storage of renewable energy, in order to develop a more reliable grid.

- **Carbon reduction**: In collaboration with the private sector, federal public policy leaders should seek to develop a US carbon market plan on the principles of revenue-neutrality, net-zero carbon, regional coordination, and a border adjustment mechanism to maintain US competitiveness.
- **Carbon capture and storage**: The public and private sectors should accelerate investments in carbon capture and storage and prioritize efforts to scale and promote carbon capture and storage as solutions for major emitters during the energy transition to new sources.
- **Reduce emissions of methane and hydrofluorocarbon**s: The federal government should increase emissions reduction efforts focused on methane and hydrofluorocarbons, which are even more destabilizing and could deliver quick overall emission reductions.
- **Prioritize power grid reliability**: The federal government should prioritize using Infrastructure Investment and Jobs Act (IIJA) and IRA funds and increase those funds as necessary to build power grids for reliability and resilience.
- **Circular economy**: Private businesses should find ways to promote the circular economy, particularly by reducing waste in business operations and supply chains, and by encouraging recycling.

Implement a smart regulation policy

- **Promote innovation, avoid market distortions**: Government should avoid regulatory mandates that could stifle productivity and inhibit research into other promising technologies, distort markets, and require reliance on outdated technologies.
- **Private/public collaboration**: The Securities and Exchange Commission (SEC) should engage collaboratively with business in determining appropriate disclosure requirements on sustainability goals.
- **Regularly review and update regulation:** The Administration should conduct periodic regulatory reviews of regulation related to climate transition goals and make sure that standards are kept up to date, including a review by Federal Energy Regulatory Commission of its regulations to ensure that those affecting the power grid take account of renewable energy.

Provide international leadership to achieve collaboration

- **Global cooperation with China and India**: The Paris Agreement goals cannot be met without true global collaboration and to achieve this, US leadership is critical. The US should work to restart climate talks with China, which is responsible for 27 percent of global emissions. Cooperation is also needed with India, where demand for energy is expected to grow faster than any other country over the next couple of decades. Global climate cooperation is essential not only to reduce emissions, but also to preserve US competitiveness. An important strategic goal is to ensure the achievement of net zero GHG emissions by the world's largest economies and leading emitters of GHG.

- **Provide assistance**: The US should lead with allies and partners to push for legally binding commitments from "non Annex 1" developing countries, including major economies such as China and India, on emissions reduction and, in return, be willing to provide technical assistance with climate adaption and energy transitions, while respecting US intellectual property. For less developed economies, the US and its allies should be willing to assist financially.
- **Prioritize the Global Methane Pledge**: The Administration should continue progress both at home and abroad to meet the Global Methane Pledge.

Ensure Energy Security Through Reliable Supplies of Fossil Fuels and Collaboration with the Private Sector Through the Transition to Net Zero 2050

The Russian invasion of Ukraine has upended geopolitics, transforming global energy markets and climate efforts, and prompting a reassessment of energy policy. The result: energy security has superseded climate goals at least in the short term as a major priority for nations across the globe, and dependence on fossil fuels is increasing, most troubling in the rising use of coal, which will only increase carbon emissions.

Russian exports comprised 45 percent of Europe's gas needs before the war and more than one-quarter of its oil needs. Europe was Russia's main market for its oil and natural gas exports, and by extension, Europe was its main source for revenues. This has now changed dramatically. Europe is not only reducing its dependence on Russian fossil fuels but is also increasing its use of fossil fuels to meet immediate needs.[2]

To respond to the Russian weaponization of its gas exports, the EU sharply increased imports of LNG from the US and Algeria as from Norway and Azerbaijan.[3] With regards to oil, thus far, the US has replaced about half of the lost Russian supplies, with Norway providing about one-third. It is possible the US could surpass Russia as the EU's largest supplier soon. To replace an additional 1.4 million barrels of Russian oil, the IEA forecasts that an additional 300,000 bpd could come from the US and 400,000 from Kazakhstan, with additional supplies coming from Norway (possibly by up to 220,000 bpd), Azerbaijan, and other sources.[4]

Given rising prices for natural gas, the search for fuel has extended to European import of coal from countries such as Tanzania, South Africa, and Colombia[5]—raising questions about countries' ability to maintain[6] their climate goals. Even the German Green Party endorsed increased coal use in Germany in the absence of Russian gas supplies.[7]

Europe's effort to switch rapidly from Russian supplies contributed to falling prices for natural gas in mid- and late October and to storage reaching about 94 percent full.[8] But Europe has not escaped the inflationary and recessionary impact overall of the energy

crisis. However, it is important to note that the energy crisis, while a short-term disruptor in Europe to climate goals, may be a longer-term opportunity for clean energy transition. Europe, in its struggle to find energy alternatives as supplies contracted and prices increased, was able to increase the share of electricity from renewable sources by 15 percent to nearly 38 percent.[9] It is estimated that switching from a reliance on Russian fossil fuels will require investment of 300 billion euros by 2030[10]—virtually all focused on clean energy. This is a significant feat to accomplish in times of economic growth and an even larger one with recessions looming.

At the same time, as Europe reduces dependence on Russia, China's imports of Russian oil have dramatically increased, up 28 percent in August year-on-year to 8.342 million tonnes (1.96 million barrels per day) even as imports from traditional suppliers such as Saudi Arabia have kept pace. China is Russia's largest oil customer, gaining access to cheaper energy as Russia offsets revenue losses from the decline in EU purchases.[11] India increased imports of Russian oil from 0.66 tonnes in the first quarter of 2022 to 8.42 million tonnes in the second quarter,[12] raising revenue for Russia. In short, since the war, China's oil imports from Russia have doubled, Turkey's more than tripled and India's quintupled. In addition, India is expected to double its import of Russian coal this year.[13]

For China, energy security and the stresses on economic growth are the priority rather than a rapid reduction in emissions, and this has impacted China's policies on coal. China, with 51 percent of coal-fired capacity globally, is continuing to build new coal plants, commissioning more than the rest of the world combined in 2021 and approving construction of 8.63 gigawatts of coal power plants in the first quarter of 2022. China has said that it will cut power from coal only after 2025, and emissions are rising; it is possible the country could have built up to 150 megawatts of new coal-fired power capacity by then. China's Electricity Council published forecasts in July that the country expects to have 3000 gigawatts of power capacity by 2025, with fossil fuels accounting for 49 percent of the total, "which implies a 261 GW increase in coal- and natural-gas fired power" compared to 2021.[14] An additional 37 percent of the world's coal-fired capacity under construction is in South and Southeast Asia.[15]

In addition, China has currently suspended cooperation on climate issues with the US, a very different approach than that in May 2021, in which President Xi Jinping said that "[w]e must be committed to multilateralism. China looks forward to working with the international community, including the United States, to jointly advance global environmental governance."[16] The disparity in commitment is vast; China has pledged to reach peak emissions in 2030, the year in which the US has pledged to reduce emissions by half from 2005 levels. Ironically, adding to the setbacks to the climate agenda, Russia, before the war, was moving towards a transition to more sustainable power sources to develop an economy beyond hydrocarbons.[17] Now the Russian economy relies to a greater extent on revenue from fossil fuels, hurting global climate change goals.[18]

One of the main lessons of the geopolitical disruption is that a successful climate policy must have as its foundation a realistic energy policy that acknowledges that fossil fuels will be an energy source for years to come, and in the near-term, the increase in supply of fossil fuels will be necessary to respond to Russia's weaponization of its energy exports. The cut in production by the OPEC+ cartel (which includes Russia) put even more pressure on Western countries to find alternative supplies at a time of sharply rising prices.

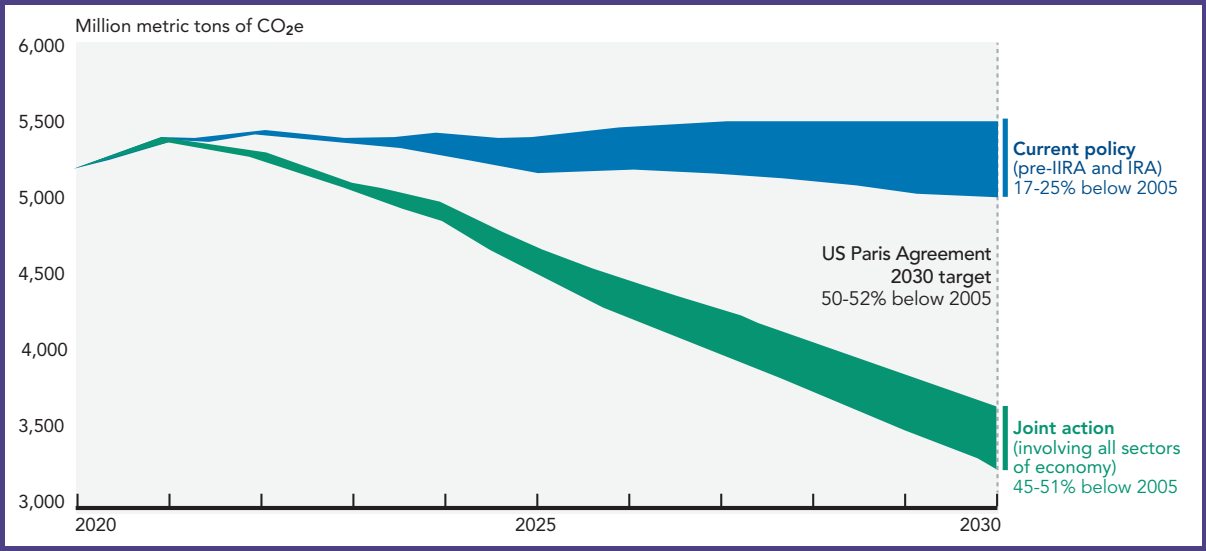
For now, the simple reality for the US is that the exploration, production, consumption, and export of fossil fuels will have to increase at least in the short term to provide energy, economic, and geopolitical security for the US and its allies. The direction for fossil fuel policy should be toward increasing the usage of natural gas and discouraging the turn to coal. The US has more capacity to export LNG and is the world's largest exporter, averaging 11.1 bcf per day in the first half of 2022.[19] But that effort is still falling short of Europe's needs, as well as its capacity to import LNG. The US also needs to continue to build export capacity, which will take time. Much of the effort is focused on the Gulf Coast, which will add export capacity for an additional 5.7 bcf per day by 2025.

With regards to oil, as noted above, the US has made up about half of Europe's needs from falling Russian imports and could soon become the EU's largest supplier. Similarly, US oil production will continue to remain essential to our energy security. In addition, this year, the Administration has authorized drawdowns of up to 180 million barrels from the SPR to address high gasoline prices in the US, leaving it with just over 400 million barrels.[20] The SPR is intended to be used for supply emergencies, not price management.

With regards to both oil and gas production, making permitting quicker and more efficient, adding refinery capacity (currently about one million barrels per day lower and five refineries fewer than before the pandemic)[21] and continuing exploration will be necessary to meet our continuing needs, particularly in the short term as we transition to a greener energy sector and economy.

Solving critical energy security problems such as these requires close cooperation between the public and private sectors, responding together as partners to the great geopolitical challenges of our time, or the opposite of the contentious relationship that

US net GHG emissions trajectory, 2020-2030



Source: Rhodium Group, 2021, The Conference Board, 2022

currently exists. The stakes are high for US national security and economic growth. Businesses which want to make these investments need the confidence that they can make a return on their investment and an acknowledgement from policymakers that they are playing an important role in energy security and in national security. Collaboration is critical as the government and the private sector also pursue an energy transition that will lead, over time, to greater decarbonization. Addressing these problems together is a far better alternative than turning to pariah states such as Venezuela and Iran for energy supplies.

Accelerate the Clean Energy Transition: Promote R&D and Reductions in Carbon and Greenhouse Gases

Cornerstones of a US transition plan are greater and accelerated development and integration of renewable and other net-zero carbon energy sources; better ways to address carbon use; and additional steps to promote emissions reduction and innovation.

Progress in addressing climate change, particularly in this time of greater focus on energy security, requires measurable targets and goals. The US rejoined the Paris Agreement in January 2021. Saying that "climate change poses an existential threat," in April 2021, President Biden set a goal of a 50-52 percent reduction in "economy-wide net greenhouse gas emissions" by 2030, based on 2005 emissions levels, and two additional goals: a "carbon pollution-free power sector" by 2035, and a goal of net-zero emissions "no later than 2050"—consistent with the Paris Agreement goal of limiting global warming to 1.5 degrees Celsius. The National Climate Strategy released in April 2021 is the US' nationally determined contribution (NDC), a formal US submission under the United Nations Framework Convention on Climate Change. The President recommitted to the goals at COP-27.

Some emissions reduction efforts are already occurring through market or other forces. But while emissions have fallen in recent years based on actions by both the government and the private sector, it is extremely unlikely that the US will achieve its ambitious goals without further specific action. The Rhodium Group research firm estimates that the current US path would only reduce emissions by 24-35 percent by 2030,[22] not enough to reach the goal.

The US has recently embarked on further significant efforts to reduce emissions to approach the goals with the passage of two important bills. The IIJA, enacted in November 2021, allocated $75.8 billion for climate change-related spending, including $14.9 billion on power grid resilience, $12.2 billion for carbon capture and storage, $16.1 billion for energy efficiency and renewables, $9.5 billion for hydrogen, and funding for electric vehicle charging infrastructure and clean energy research.[23] The Department of Transportation (DOT) will also help states track GHG reductions through a system by which states and municipalities can set targets for declines in "on-road GHG emissions" from highway travel.

The IRA, enacted in August 2022, contains ambitious provisions relating to climate and energy policy worth $384 billion. Most of this ($271 billion) consists of tax credits and incentives for adoption of cleaner energy sources. Tax incentives for cleaner domestic energy production apply to sources including nuclear, biodiesel and renewable diesel, as well as zero-carbon sources and carbon capture, with a bonus for businesses that pay workers a

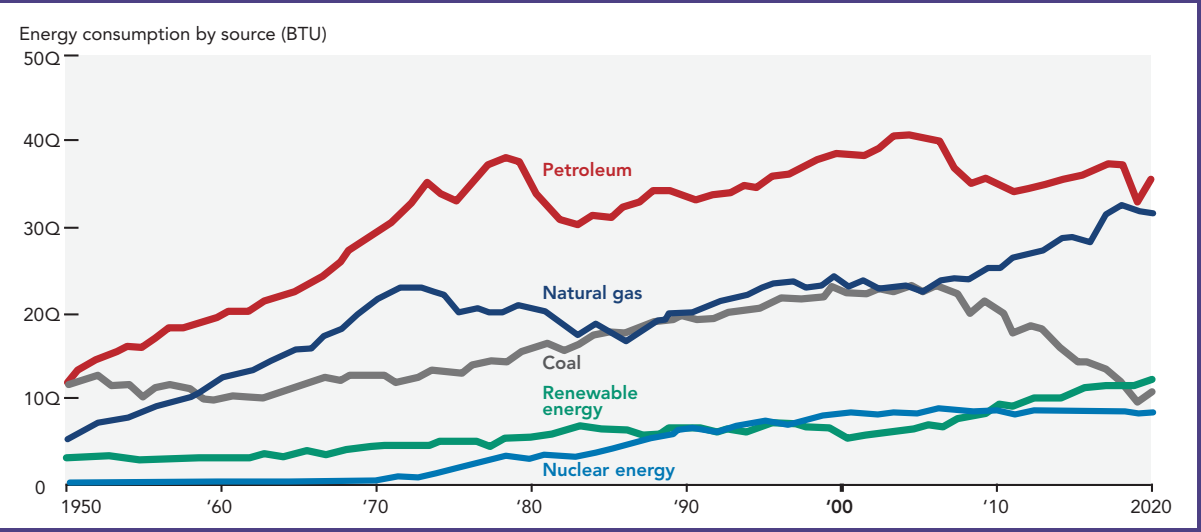
prevailing wage and use registered apprenticeship programs; another provision offers up to $20 billion in loans and $2 billion in grants to switch to clean manufacturing of vehicles.

The law also includes tax provisions related to cleaner buildings, tax credits for biofuels including sustainable aviation fuel, for personal vehicles (a $7,500 credit for new electric vehicles, and $4,000 for used ones), a 30 percent tax credit for home solar panel installation and rebates for heat pumps and energy efficient home appliance, and about $30 billion in targeted grant and loan programs for states and electric utilities to accelerate the transition to clean electricity.

Overall, the Administration expects that the provisions will reduce US carbon emissions by roughly 40 percent by 2030, with total GHG emissions declining by about 1 gigaton (one billion metric tons). That 40 percent, though, does not reach the 50-52 percent target in the US' NDC[24] and presumably relies on full utilization of the credits and incentives. The Climate Action Tracker, another estimator, more cautiously suggests that the true reduction in emissions on all current policies could be as low as 26 percent or as high as 42 percent below 2005 levels.[25]

With the IIJA and the IRA, the US has embarked on an industrial policy-type approach to climate, which raises significant questions about the direction of US climate policy. Tax incentives are designed to help direct investments, but they should not become ways of distorting markets. Consequently, that makes effective and efficient implementation of the provisions of the law key to whether the money spent achieves its goals of spurring innovation and advancements in technologies or whether it leads to selections of intended winners that end up losing. As implementation of these laws continues, the Administration and policymakers need to speak with one consistent unified voice, as conflicting statements or signaling have a material adverse impact on capital investment decisions.

Renewable sources and coal each accounted for 11% of energyconsumption in 2019



Source: Energy Information Administration, The Conference Board, 2022

To further accelerate the clean energy transition, the following measures should be undertaken:

Increase R&D Investment

Both the public and private sectors should use the IRA as a catalyst for further investment in R&D to build American global leadership, harnessing the capabilities of our science parks and universities in hydrogen, wind, and solar power, but without causing market distortions. The US should redouble its efforts, both public and private, on research in technologies related to the clean energy transition. This will give the US a competitive edge globally and provide jobs in these industries, increasing US exports to encourage other nations to adopt cleaner technologies to meet the Paris Agreement goals. Technological innovation will also lower the costs to US producers of adopting clean energy technologies, making them more reliable as well as making energy more affordable for consumers. The urgent question, then, becomes how to encourage the investments necessary for the energy transition, and deploy them in ways that make it smoother and easier for both businesses and consumers.

This can happen through both private investment and direct funding of basic science, tax credits for research, and other incentives. Investors should also examine closely how supply chains may transition as part of the energy transition and build new supply chains that are themselves ideally fueled by clean power in a virtuous cycle. It will take all types of investments throughout the value chain for the energy transition to be smooth. In this regard, the recent difficulties with battery and storage projects are a worrying sign,[26] calling for further research to overcome technological barriers. Reliable access to critical minerals such as copper, nickel, and rare earth elements will be another important part of achieving a resilient supply chain.[27]

Nuclear power: Greater use of nuclear power is an enormously powerful tool the US and other countries cannot afford to underutilize in the energy transition. Currently, the US has 93 commercially operating nuclear reactors at 55 plants with a combined generation capacity of about 95,492 MW, down from a high of 104 operating reactors in 2012 generating about 102,000 MW of power.[28] The US gets about 19-20 percent of its electricity generation from nuclear plants and about 50 percent of its carbon-free electricity.[29]

However, only two reactors are under construction and those in operation are aging, with the average age about 40 years. On current trends, because of decommissioning and reductions in capacity, the US will have less electricity generation capacity from nuclear in 2050 than in 2021.[30] This makes little sense, as electricity generated from nuclear power is carbon free. As countries such as France and Japan embark on ambitious revived programs for nuclear power,[31] and Germany reconsiders its policy on nuclear energy, the US should do likewise. An important part of this will be educating the public on the benefits of nuclear power to reduce fears, show how nuclear power is an essential tool for decarbonization, and explain some of the technological advances in this field. Reforming permitting to speed the approval process for essential infrastructure projects without compromising safety will be essential to bring new nuclear reactors online, providing clean energy.

Strengthening R&D in all areas of nuclear power in this area is critical. Small modular reactors (SMRs), many of which rely on sodium and have longer-lasting fuel producing

less waste, are much safer than existing water-cooled reactors. The technology for SMRs comes from the US Government, and the Department of Energy (DoE) has many existing projects to further enhance the technology. Advanced modular reactors could be used to produce clean hydrogen as well.

Hydrogen: Hydrogen, the most abundant element on earth, is a carrier of energy. Nations including Japan and South Korea and the EU have made commitments to move radically towards use of hydrogen, and the US has made a similar commitment with tax incentives included in the IRA. But, in these early stages of development, the US should more narrowly focus on hydrogen as a useful tool for decarbonizing some of the most difficult parts of the economy to decarbonize, including heavy transportation, trucking, rails, shipping, and agriculture. In the future, if clean hydrogen technology proves scalable, hydrogen could substitute for natural gas for processing fertilizers, for instance, and in the flow of energy into power plant turbines in partial or full substitution for natural gas. While traditional methods of processing hydrogen using steam methane reforming are carbon intensive, new technologies offer sharply reduced use of carbon and a carbon-free future.

Now the US' challenge is to promote R&D and innovation in the field. The potential is vast, but even if clean hydrogen were limited to replacing natural gas and diesel fuel as a feedstock in industrial processes, this would have a tremendous impact on emissions reduction—and build a new American industry. Hydrogen can also be converted to ammonia for export, then converted back. The first liquefaction hydrogen tanker ship sailed from Australia to Japan earlier this year.[32]

In the switch to advanced renewable energy and other net zero-carbon technologies, the US can learn lessons from other nations that are building at scale, including economies that have typically depended heavily on fossil fuels such as Saudi Arabia for hydrogen and the United Arab Emirates for solar energy production. Texas, too, is another hydrocarbon-focused region now seeking to seize the potential of hydrogen.[33] And the UK and Canada are partnering with Germany for hydrogen exports.[34]

Wind: Texas is also the current leader in US wind power—in amounts sufficient to fully power the Dallas-Fort Worth (DFW) Airport, the nation's second busiest by passenger boarding. Two proposed wind farms in the Gulf of Mexico alone—one occupying an area larger than the city of Houston—could power 2.3 million homes.[35] Another major project would generate 30 gigawatts of power off the Atlantic coast. The US has made significant progress in wind, which the DoE estimates accounted for 32 percent of US energy capacity growth in 2021. But increases in capacity still need to be combined with other efforts, such as energy storage.

Energy Storage: The most important of those other efforts is concerned with how to ensure that renewable energy is more reliable—that power is available when people want it rather than only when the sun shines or the wind blows—through dependable storage systems over simply relying on fossil-fuel linked portions of the electric grid. While storage of energy from renewable sources has improved in recent years, it will take more R&D efforts to make renewable power truly reliable at scale.

Much research in this area is underway, particularly in advanced batteries that can store power from wind energy. Other innovative projects include the Dutch "Ocean Battery," which stores energy in tubes under pressure and directs it through turbines when needed; this technology is similar to pumped hydro energy storage solutions on land, in which water flows from a higher to a lower reservoir when needed to generate power.[36] But much more research needs to be done. R&D is an indispensable part of the energy transition.

Carbon Reduction

There can be no real progress on addressing climate change unless the economy shifts more firmly to a clear path of carbon reduction. Around the globe, many businesses are leading the way, for instance with 4,016 companies recorded by the Science Based Targets initiative (SBTi) as taking action to reduce their GHG emissions, with 1,926 of those companies setting specific science-based goals, and 1,493 with net-zero commitments.[37] Individual companies have also taken aggressive steps towards greater use of renewable energy, including nearly 50 US utilities that have pledged to reach low carbon goals.[38]

In this context, many economists have suggested that one powerful way to encourage reduced carbon use through market principles is to set a price on carbon, incentivizing market forces. As of May 2022, there were 68 carbon pricing instruments, including taxes and emissions trading systems (ETS) operating around the globe, including a recently established ETS in China, with three more scheduled for implementation, according to the World Bank's "State and Trends of Carbon Pricing 2022" report. While differences in geography, demographics and governing need to be taken into account, several examples show the wide variety of approaches for moving forward in this area:

Canada: Canada, which has a strong federal system, introduced a price on carbon in 2019.[39] Every province or territory can either design its own system or opt into the federal pricing system. Acceptable systems include a carbon tax (British Columbia), a carbon levy and performance-based system (Alberta), and cap-and-trade (Ontario and Quebec). Price based systems put the price at Cdn$50 per tonne of CO2-equivalent this year. Revenues from the system remain in the jurisdiction.[40] The system also includes a regulatory charge on fossil fuels including gasoline and natural gas (the fuel charge) and a performance-based system for industries (the Output-Based Pricing System).

European Union: The EU's system, established in 2005, was the world's first international ETS.[41] In 2021, the EU ETS was the largest carbon market by traded value. It sets a cap, falling over time, on the total amount of GHG that can be released and permits installations to buy or receive emissions allowances, which they may trade or keep for future use. The system covers most major emitters of carbon dioxide, nitrous oxide, and perfluorocarbons (PFCs) from aluminum production. As the EU notes, "[t]rading brings flexibility that ensures emissions are cut where it costs least to do so. A robust carbon price also promotes investment in innovative, low-carbon technologies." The system is aligned with the EU's 2030 emissions reduction goals (40 percent relative to 1990). It is also quite dynamic, with prices occasionally rising and falling sharply based on market demand and external events (such as fluctuations in the price of natural gas).[42] But issues connected

with the war in Ukraine and inflation have made strengthening the EU's plan difficult, jeopardizing the EU's efforts to adopt a border adjustment mechanism.[43]

EU Cross-Border Adjustment Mechanism and international exchanges: One important issue in carbon pricing is that companies in countries that price carbon will face higher prices than companies in jurisdictions which do not, leading to distortions in trade, a situation termed "carbon leakage." To address this, one solution is a cross-border adjustment mechanism. The EU's Carbon Border Adjustment Mechanism (CBAM) is a proposed border tariff, beginning in 2023, covering products in the sectors of iron and steel, cement, fertilizers, aluminum, and electricity generation. Importers will be subject to the EU's carbon emissions calculations and reporting requirements, allowing collection of data on emissions from external producers. Beginning in 2026, importers will need to obtain authorizations for imports in these sectors, including "carbon certificates which will be priced in correspondence to carbon prices that would have been paid to produce" the product in the EU.

This mechanism would directly apply to many products produced in Asia, including from large-emitting countries such as China and India, and sharply increase the costs of exports from them, with a particular impact on India.[44] (China is less affected because it already has a domestic cap-and-trade carbon pricing system, although Chinese credits are considerably cheaper than those in the EU; they were only 8.5 percent the price of EU credits in late June 2022, and the price had increased only 10 percent in the previous year in contrast to a 53 percent increase in the price of EU credits.)[45]

Another way to address international carbon reduction is through credit exchanges. Intercontinental Exchange, Inc. operates a carbon credit futures market to improve price signaling for credits, which could be particularly useful for large emitters required to make rapid net reductions in emissions.[46] Along this line, Singapore will permit its large emitters to purchase "high-quality, international carbon credits" to offset up to 5 percent of taxable emissions starting in 2024, to "moderate the impact for companies" and "catalyze the development of well-functioning and regulated carbon markets."[47] Globally, partnerships such as that between Singapore's AirCarbon Exchange and Indonesia's Carbon X to develop Indonesia's carbon market point the way forward in cross-border cooperation and add transparency to the process because the market operates on a public exchange rather than between private parties alone.[48]

China: China has pledged to reach peak emissions by 2030. In May 2022, China's Ministry of Finance announced an outline of plans to use fiscal and tax tools to promote shifting towards carbon neutrality, including carbon and pollution discharge trading. But the plans would not be in place until 2030, and China does not propose to be carbon neutral (net zero) before 2060—ten years after the Paris Agreement goal. The plan would also reduce import tariffs to promote low-carbon requirements (presumably China's version of a carbon border adjustment mechanism).[49]

India: In November 2021, Indian Prime Minister Narendra Modi pledged that India would be net zero by 2070—20 years after the Paris Agreement target. At the same time, India said it would develop 500 gigawatts of renewable power, get 50 percent of its energy from renewable sources by 2030 (it currently gets more than half of its energy from coal), and reduce total emissions by one billion tonnes by 2030. In exchange, India

seeks $1 trillion in climate finance from the developed world to pay for its clean energy transition—a figure that will certainly not be provided.[50]

US Climate Leadership Council plan: The Climate Leadership Council, a bipartisan group including economists and leaders in business and financial services, offered a plan to jumpstart discussions in Congress on a carbon market. The plan has four pillars. First is a gradually rising carbon fee, starting at $40/ton in 2017 dollars and rising 5 percent per year above the inflation rate. The Council believes that if the plan had been implemented in 2021, US emissions would have been cut in half from 2005 to 2035 and exceed the Paris Agreement targets. The fee would increase faster if emissions reductions targets are not met. Second, "all net proceeds from the carbon fee will be returned to the American people on an equal and quarterly basis," which the Council estimates would give a family of four approximately $2000 in the first year of the fee, ensuring that "the vast majority of American families will receive more in carbon dividends than they pay in increased energy costs." Third, because the rising fee would serve to displace carbon use, regulations governing carbon use would be streamlined or eliminated. Finally, "border carbon adjustments will enhance the competitiveness of American-based firms that are more energy-efficient than their foreign competitors, while preventing carbon leakage and free-riding by other nations. This will put America in the driver's seat of global climate policy and encourage other large emitters, such as China and India, to follow America's lead and adopt carbon markets of their own."[51]

Principles for a carbon market: The Climate Leadership Council plan is ambitious and includes several essential elements for successful introduction of a carbon market in the US. Any plan for a carbon market should be based on several principles:

First, it should not be a traditional tax but rather revenue neutral, with carbon fees refunded directly to Americans on a per capita basis to compensate for higher prices for products from the levy, which will mitigate impacts on lower- and middle-income consumers. This would combine a carbon market with addressing the needs of those least able to bear the burden of higher prices. For it to work properly, ensuring the refunds as part of the plan is critical to ensuring that these fees remain revenue neutral and do not become a tax.

Second, a carbon market should not serve to pick winners and losers among technologies but rather work to promote all efforts at decarbonization, letting the market work in this area.

Third, it would also, however, require regional coordination to address concerns over domestic carbon leakage, given that some states are far more intensive producers of carbon. A plan could be designed to favor regions of the country that currently produce the most fossil fuels, not only for economic reasons but to accelerate decarbonization more broadly.

Fourth, to maintain US competitiveness, a plan would have to include a border adjustment mechanism of some sort, likely as a rebate on taxes being paid for exports from countries that do not have a carbon pricing mechanism. Implementing such a system fairly will require strong measurement systems in both the US and exporting countries to avoid market distortions. Professor William Nordhaus, an economist at Yale University,

has proposed a climate club to put border adjustments in the context of an international policy to reduce free-riding.[52]

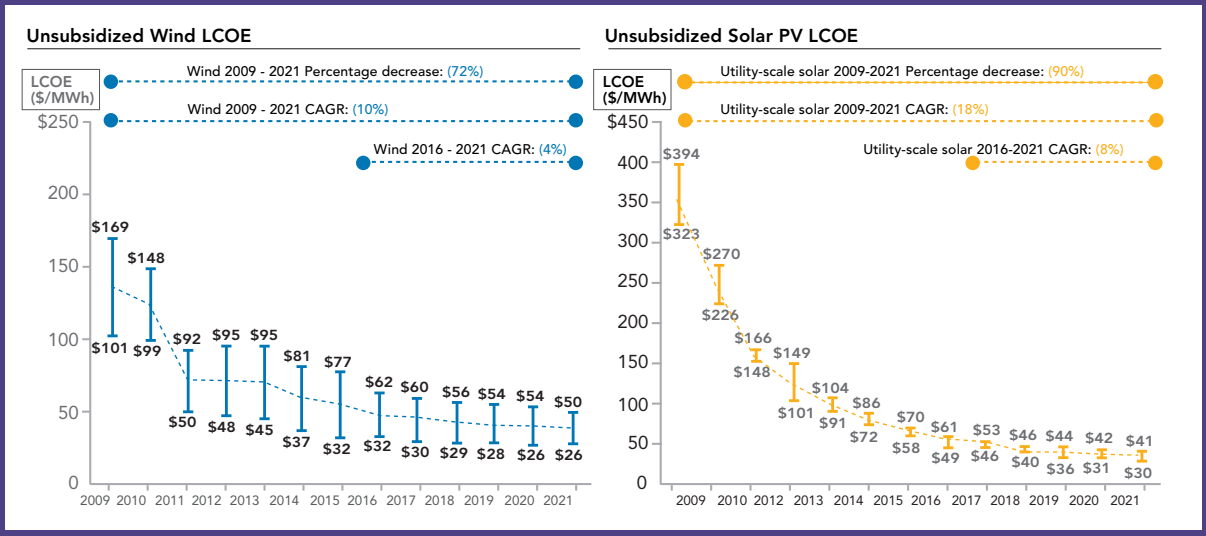
Carbon capture: Carbon recapture, by definition, is carbon reduction from removing carbon[53] from the atmosphere or preventing its emission. Most projections for decarbonization assume substantial carbon recapture, including sequestration. This technology may become even more important after *West Virginia v. EPA*, as some have argued that the Environmental Protection Agency (EPA) may retain its authority to promote carbon capture technology (as distinct from regulating uncaptured emissions of GHG).

Both the IIJA and IRA contain provisions promoting carbon recapture. The DoE responded to the IIJA with a request for information that will guide the carbon capture investments in that law.[54] The tax credit of $85 per ton for burial of carbon and $180 per ton in the IRA for removing carbon from the air offers a strong incentive for major emitters to invest more in these areas,[55] building carbon capture and storage hubs.

Methane Emissions Reductions

Most attention in emission reduction focuses on carbon dioxide—the biggest GHG by volume and one in which atmospheric effects last for thousands of years. But rapid progress on reducing emissions can also occur from focusing on other pollutants, in particular methane. Methane emissions have many sources, including oil and gas production (flaring), decomposing garbage, and animal production. Methane traps about 80 times the heat of carbon dioxide but has one benefit: it remains in the atmosphere for only about nine years.[56] Reducing methane emissions now, therefore, can deliver quick impacts, well before the 2050 net zero goal. The rules the EPA announced last year to implement Congress' policy to reduce methane emissions have the potential to reduce

Productivity impacts: Costs of renewables have fallen and become competitive



Source: Lazard, The Conference Board, 2022

total US GHG emissions by 100 to 250 million metric tons by 2030, a sizable contribution to overall emissions reduction.[57]

Globally, the Global Methane Pledge[58] is an important target, under which countries pledge to reduce methane emissions 30 percent from 2020 levels by 2030, with a global goal of avoiding 0.2 degrees Celsius of warming. Over 120 countries representing over 50 percent of human-generated methane emissions, including the US and all EU countries, have signed the Pledge. China and India have not signed, but major oil and gas producers including Iraq, Qatar, Saudi Arabia, and the United Arab Emirates have, offering opportunities to reduce methane emissions from routine flaring. The US' current plans on methane emissions reduction should help meet the Global Methane Pledge commitment.

Hydrofluorocarbons

Hydrofluorocarbons (HFCs), potent greenhouse gases used in refrigerators, air conditioners, and other appliances, offer another target that can reduce emissions levels quickly. The Administration has pledged to work in this area as well, and Congress instructed the EPA to issue regulations in the Consolidated Appropriations Act, 2021, while the recent bipartisan Senate ratification of the Kigali Amendment to the Montreal Protocol is a strong signal that bipartisan efforts on addressing climate change are possible.[59] The EPA's new regulations are strong, following Congress' instructions to phase down use of HFCs by 85 percent over the next 15 years, action on which could avoid warming of up to 0.5 degrees Celsius by 2100 on the global level.[60] A system of trading allowances for HFCs could be a good model for a workable carbon trading system in the US as well. Adding methane and HFC emissions cuts to progress in reducing carbon dioxide emissions will bring the US considerably closer to achieving the 2030 emissions reduction goal.

Critical infrastructure

The energy transition will be a success only to the degree that critical infrastructure is both resilient and reliable. This should be a top priority for the federal government. Achieving the goal will take cooperation from both the public and private sectors.

The stresses on the power grid, notably in Texas in both extreme cold and extreme heat (with record demand in summer 2022),[61] show the importance of focusing on grid reliability, an emphasis in both the IIJA and IRA. Texas is a unique case because its grid is not connected to that of other states, but the broader principle applies: as temperatures rise, the grid will come under increasing stress. Variability of supply, which has been an issue with renewable sources, will need to be addressed as a part of a successful energy transition.

The federal government should prioritize using IIJA and IRA funds and increasing those funds as necessary to build power grids for reliability and resilience. Expanding the capacity of the electric grid is imperative for meeting the needs of electric vehicles and home heating, among other factors. Doing so will also support efforts to combat extreme weather and climate change. Variable renewable sources of electricity, such as solar and wind, benefit from long-range transmission lines, connecting people to power sources which are often remotely situated, and connecting regional grids can help mitigate variability in demand and supply.

The circular economy—promoting recycling

A circular economy "keeps materials, products, and services in circulation for as long as possible."[62] Important work in this area is already being done. In November 2021, the EPA published its National Recycling Strategy,[63] focusing on efforts to reduce municipal solid waste. But recycling is only one part of achieving a circular economy. The National Renewable Energy Laboratory has done economic modeling of a circular economy for energy materials to show how to provide even greater climate benefits from the shift to clean energy technologies.[64]

The European Union has taken this a step further with an action plan for the circular economy that includes long-term recycling targets for municipal waste and packaging waste, including strong requirements for product producers.[65] But Europe's requirements may be too stringent. A better approach is to use market forces to encourage the growth of the circular economy by finding new opportunities to reduce waste and new markets for recycled products. Europe's proposed "innovation deals" fund for the circular economy is potentially significant, particularly as it also seeks to reduce regulatory obstacles to innovation in this area.

Every company can adopt a sustainable approach not only to reduce its own environmental footprint but also to ensure that its products will have a better environmental impact, introducing environmental considerations early in the design process. But in promoting the circular economy, policymakers should proceed very cautiously with proposals for outright bans of products, as the bans can lead to unintended consequences, such as removing paper and plastic from the circular economy, increasing costs.

Energy efficiency

Implementing programs for increasing energy efficiency, particularly in older buildings, will also assist greatly in reducing emissions.[66] Improved energy efficiency offers high impact, low cost, and broad social benefits, whether in older buildings or in new buildings with updated building codes that both reduce emissions and can offer protection from some effects of climate change, such as buildings built to withstand stronger hurricanes.

Implement a Smart Regulation Policy

CED has promoted "smart regulation"—the idea that regulation should achieve the purpose for which it was imposed at the lowest possible cost and with the maximum possible benefits. Smart regulations are well designed, using actual appropriate subject matter experts at the outset, and must be reviewed, revised, or sunsetted, particularly given the rapid pace of technological change. CED has previously described this process as "turning speed bumps into guardrails." The process of adopting these regulations requires strong input from all stakeholders who have expertise in how they would be implemented in practice, including from those who would be subject to the regulations, and the process of reviewing regulations likely requires data on how those regulations are implemented in practice over time. These principles should be the guardrails for regulation on climate policy. Smart regulation will ensure that we are implementing an energy transition plan that promotes innovation, leverages market forces, and promotes cost-effective and efficient permitting processes while providing important guardrails for the transition.

A recent example of overbroad regulation is the SEC proposed rule[67] this year that would dramatically expand the disclosures that public companies would be required to make about climate-related financial risks in new securities offerings and annual reports. Drawing heavily on disclosure frameworks such as the Task Force on Climate-Related Disclosures and the Greenhouse Gas Protocol, the rule would require companies to disclose information about their Scope 1 and 2 emissions (direct GHG emissions and indirect emissions from purchased energy, including carbon offsets) and Scope 3 (upstream and downstream activities in their value chain) "if material or if the registrant has set a [greenhouse gas] emission target or goal that includes Scope 3 emissions" either publicly or through participation in a group such as the Science-Based Targets Initiative.

From one perspective, the proposal is to be welcomed. Investors should have the assurance that ESG (environmental, social, and governance) funds accurately portray what they purport to sell. Rules in this area would protect both investors and businesses. And initiatives that seek to improve consistency and comparability of information are beneficial. It is important that investors who seek to invest in companies promoting clean energy and strong environmental goals are able to be careful that their investments do not distort market forces inadvertently as a result of standards not being uniform.

But from another perspective, the rule as proposed does not meet the test of "smart regulation." Leaving aside the question of whether the proposal truly falls within the SEC's jurisdiction, it is overbroad. Along with financial disclosures comes a serious risk of legal liability. Smaller companies may have difficulty accurately measuring Scope 1 and 2 emissions, and this may push them away from the public markets, causing capital market distortions. The proposal to move towards measuring Scope 3 emissions as a part of financial disclosures may discourage companies from pursuing this goal, lest they face liability, and thus miss an opportunity to understand emissions in their value chain.

Strong, reliable data on emissions is essential for understanding progress in addressing climate change. But it is also essential to get the data correct in the first place without the risk of the heavy hand of legal liability for simple errors in measurement.

Provide International Leadership to Achieve Collaboration

The Paris Agreement goals and US interests cannot be met without true global collaboration, including the active participation of the US[68] in concert with China. China is now responsible for 27 percent of global emissions—more than emissions from countries in the Organization for Economic Cooperation and Development. (The US is second at 11 percent; India is third at 6.5 percent, just ahead of the 27 countries of the European Union at 6.4 percent).[69] If anything, this figure understates the rise in China's emissions, as the Rhodium Group firm has noted, "China's emissions were less than a quarter of developed country emissions in 1990, but over the past three decades have more than tripled, reaching over 14 gigatons of CO2-equivalent in 2019."[70]

Global climate cooperation is essential not only to reduce emissions, but is also needed to preserve US competitiveness, so that more expensive US exports do not face crowding out on global markets compared with products from major emitters that do not face similar restrictions on fossil fuels. In the absence of concerted global action, some reaction by the US will be necessary, perhaps in the form of a carbon border adjustment mechanism.

The US must lead with our allies in diplomacy and trade negotiations, and most immediately, should work to restore climate talks with China. Cooperation is also needed with India, whose demand for energy is expected to grow faster than any other country over the next several decades. The US should also lead with allies and partners to push for legally binding commitments from all other "non Annex 1" developing countries, and, in return, be willing to support with technical assistance on climate adaption and energy transitions, while respecting US intellectual property. For less developed economies, the US and its allies should be willing to assist financially. Accurate measurement is also essential for true progress both in a carbon border adjustment mechanism and to understand overall GHG emissions trends.

Public-private partnerships are essential. Government alone cannot bring about the energy transition; the bulk of investment will come from the global private sector. Businesses have the ability to innovate and move flexibly in ways the government is unable to do. Finding ways to work together on projects of both regional and national importance will help smooth the transition. At the same time, the general public and consumers need to be educated in order to have an impact on reducing demand for energy consumption and should be part of a sustainable transition plan to a cleaner, more resilient economy.

Conclusion

Seven years after the Paris Agreement, in a time of geopolitical turmoil, with progress on this urgent global issue slowing, it is clear that even very large investments from government alone will not ensure that the energy transition can or will happen in time. Only the private sector, in the US and around the world, can marshal sufficient economic resources to shift entire economies away from carbon and towards the net-zero future. And however urgent the task of reducing GHG emissions to address present effects of climate change and avoid future effects, it is also clear that decarbonization is not the work of a moment but of decades. That is why the official net-zero goal is not until 2050; even as emissions rise in the meantime, they will fall if insufficient investment is brought to bear on the problem in all its aspects.

Indeed, no one path may be better than another so long as all paths arrive at the same end. The point is simply to decarbonize as rapidly as possible consistent with US energy security and that of our allies.

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