AMERICA in ONE ROOM
CLIMATE and ENERGY

September 2021

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Dear Participants:

It is our pleasure to welcome you to this remarkable experiment in American democracy, *America in One Room: Climate and Energy*. You have the privilege of being one of more than 500 Americans scientifically selected to represent the entire country in deliberations about the choices America faces for confronting our climate problems. These deliberations will take place on the eve of the international summit in Glasgow (Cop 26) in which the nations of the world will confront this global challenge together.

You will discuss the issues online, using the Stanford Online Deliberation Platform. You should find this very easy to use. It has been tested successfully not only in the US, but already in several other countries.

To help prepare you to discuss the issues, we have produced this briefing book. It contains background analysis and competing arguments for and against different policy proposals. The document has been vetted for balance and accuracy by distinguished experts who hold different perspectives.

We recognize this is a long document, but we have tried to make it as useful as possible. First, we have sent you a video summary of the document. Second, we present short summaries for each part of the discussion. We recommend that you watch the videos and read these summaries first. We hope all of you will read the entire document, but we realize people's time will vary. Please do not worry if you do not get the chance to read the entire document before we start.

The longer issue briefings are organized so that the background analysis of each issue comes first, followed by a set of boxes that list each issue proposal and the arguments for and against. These are the issues that you were surveyed on recently and will be again at the end of the event. We hope you will read the competing arguments in the boxes before your group deliberations on the issues, but you can also make reference to them during the group discussions. You will be sent a hard copy of this document if you request it.

We realize that you are giving up several hours to participate in this unique dialogue. In past events of this kind, participants have really enjoyed the experience. We thank you deeply for your time and for the commitment you are expressing to our democracy.

With best wishes,

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WHAT IS DELIBERATIVE POLLING?

Ordinary polls provide a snapshot of the public's impressions of sound bites and headlines. However, most citizens do not have the time or opportunity to become well informed about complex public issues. Deliberative Polling provides a neutral ground where citizens can address the question: what would a representative sample of the public think about policy issues if it were more informed and could weigh the pros and cons of different policy options under good conditions for thinking about them? Those good conditions include balanced briefing materials, moderated small group discussions, questions that the small groups pose to panels of competing experts in plenary sessions, and an opportunity for each participant to express their opinions in confidential questionnaires both before and after the deliberation.

Pioneered by James Fishkin at Stanford University's Center for Deliberative Democracy, Deliberative Polls have beaen conducted more than 110 times in 32 countries and jurisdictions under the direction of the team at the Center for Deliberative Democracy at Stanford University. For this Deliberative Poll, our partners include Helena, California Forward, Greater Houston Partnership, In this Together, Center for Houston's Future, and NORC at the University of Chicago.

EXECUTIVE SUMMARY

There is a great deal of scientific evidence that shows global temperatures are rising, increasing the frequency, duration, and intensity of floods, droughts and heat waves, and causing sea levels to rise.[1] The most recent report of the United Nations Intergovernmental Panel on Climate Change (IPCC), which is based on input from hundreds of climate scientists, states that these changes are the result of a temperature rise of 1.1 degrees Celsius (about 2 degrees Fahrenheit) over the last century and that they will become more frequent and severe if global temperatures rise above 1.5 degrees Celsius (about 2.7 degrees Fahrenheit) in the next two decades.[2] These changes in the climate are the direct result of increasing greenhouse gas (GHG) emissions, which include water vapor, carbon dioxide (CO_2), methane, ozone, nitrous oxide, and hydrofluorocarbons.[3] The United States is the second largest emitter of GHGs after China.[4] Current global commitments are believed to be inadequate to prevent temperatures from rising above 1.5 degrees Celsius.[5] There is broad agreement in the scientific community that to avoid these impacts would require reaching "net zero", meaning the total of all greenhouse gases released into the earth's atmosphere each year equals the amount removed by nature or by human engineering. In this deliberative event, you will consider how the United States might address climate and energy issues both in small group discussions and in sessions with subject matter experts who can answer questions that arise during this process. This executive summary provides an overview of the discussion topics.

Small Group 1

Greenhouse Gases - Where Are They From,Why Do They Matter, and Can They Be Reduced?

The first session will focus on various energy sources and their contributions to greenhouse gas emissions. The United States uses three types of primary energy sources: fossil fuels, nuclear energy, and renewable energy. There are three types of fossil fuels: oil, natural gas, and coal, and together they accounted for 79% of United States' energy usage in 2019.[6] Oil is a liquid, primarily used as fuel for gas-powered engines and as a raw material for many familiar products such as plastics and pharmaceuticals. Natural gas is the cleanest burning of the three fossil fuels, although one extraction method for it, known as fracking, is often debated.[7] Oil and gas leaks, along with the agriculture industry, are the primary sources of methane emissions, which are a stronger greenhouse gas than CO_2 but remain in the atmosphere for far less time. Coal is the dirtiest burning of the fossil fuels.

Among the alternatives to fossil fuels, nuclear power is now the most widely implemented source of clean energy; however, it produces dangerous nuclear waste for which the United States currently has no viable storage mechanism.[8] While some argue that nuclear power is very clean and has a better safety record than fossil fuels, nuclear meltdowns are dangerous and nuclear power may facilitate nuclear proliferation, although technological advances are mitigating those risks.

Solar energy and wind energy are both clean, renewable energy sources that have become substantially more economical in some locations. However, they are not consistent (the sun doesn't always shine; the wind doesn't always blow), and they require vast amounts of land. In addition, converting sun and wind to energy requires scarce non-renewable resources.[9]

Geothermal, which uses the Earth's heat, is another alternative that can provide power on-demand and doesn't have much impact on the land surface, but it may cause small earthquakes and may only be viable in certain areas. Hydroelectric, which uses the movement of water to turn a generator to produce electricity, is one of the most widely-used renewable energy sources, but building hydroelectric dams can disrupt rivers and their environment.[10] Biofuels, a carbon-neutral energy source made from plants, are another alternative; environmentalists are divided on whether land currently used to grow food should be diverted to grow biofuels.[11]

Finally, hydrogen provides an emissions-free way to move and store energy from other sources for on-demand use. This could make solar and wind power more flexible in the future, but cost-effective production of hydrogen currently requires natural gas. Also, using it would require new, expensive infrastructure.

One last option for expediting the transition to "net zero" is capturing carbon before it reaches the atmosphere or removing carbon that has already been emitted. One way to do the capture of carbon is by increasing the number of trees and plants that naturally store carbon in forest biomass and soils. Stopping deforestation (removal of trees) is one of the most effective methods available to prevent greenhouse gasses from entering the atmosphere. Carbon can also be removed from the atmosphere through carbon capture, use and sequestration (CCUS), a process that captures CO_2 emissions from industrial processes and either reuses or stores (sequesters) them deep underground.[12] Direct Air Capture (DAC) is another technology that can remove CO_2 from the atmosphere.

Small Group 2

Influencing Ghg Emissions Through Incentives and Regulations

During the second session, you will consider market incentives and regulations designed to reduce emissions in high-energy sectors of the economy. Since the transportation sector accounts for 29% of GHG emissions in the United States, some propose stricter emissions standards and more incentives and regulations to increase the number of electric and plug-in hybrid vehicles. Others want the United States to eliminate sales of gas-and diesel-powered vehicles by 2035. Buildings are another major source of GHG emissions, and energy efficiency programs, which make buildings and appliances more energy efficient, reduce the amount of time that inefficient appliances run in buildings, and reduce energy use during peak times.[13]

One prominent policy proposal to reduce GHG emissions is a carbon price, which charges companies that produce emissions a price per ton of CO_2. This is usually accomplished with either a carbon tax, which is a direct tax on carbon emissions, or a cap-and-trade system, which allows for issuing emissions permits that can be traded between companies. Under both systems, emissions would decline over time as the tax rate increases or the number of permits issued decreases. Some supporters of carbon pricing favor one policy over the other. On a related issue, how government uses the money collected from carbon pricing is also a subject of debate, with some supporting policies that would dedicate all such funding to help low-and-middle-income earners make the transition to a low-carbon economy.

There also is discussion of a “carbon border adjustment”, a tax that foreign producers would have to pay at the U.S. border if they do not pay a carbon price in their own country, equivalent to what the U.S. charges its own producers. The purpose is to level the playing field for U.S. producers of goods and services.

Small Group 3

Global Considerations, and How Different Priorities Affect the MIX of Energy Sources That Can Produce Net Zero GHGs

In the third session you will first consider the global efforts on climate and energy. Since the U.S. emits only 13% of global GHG, it cannot solve these problems without participation from the other major GHG emitters. China, which produces 30% of GHG, is the largest emitter and India (7%) emits almost the same amount of GHG than all the European countries combined (9%). However, per capita emissions in the U.S. are substantially higher than those in China or India, and China's emissions partially reflect that it is the world's largest manufacturing center for, and exporter to, the rest of the world.

In this session, you will also consider a number of potential combinations of energy sources, called pathways, that would bring the United States' emissions to net zero by 2050: "a Renewables Only pathway," "a Nuclear Complement pathway," "a Mixed Technology pathway," and "a High Biofuels pathway."

- The "Renewables Only" pathway only includes renewable energy sources such as solar, wind, hydroelectric, geothermal, and biomass (that does not divert land from food). This pathway does not use carbon sequestration.
- The "Nuclear Complement" pathway adds a new, safer generation of nuclear power plants as a complement to the renewables.
- The "Mixed Technology" pathway is similar to the "Nuclear Complement" pathway, but it allows for some continued use of fossil fuels as long as those emissions are offset by direct air capture or carbon capture and sequestration.
- The "Heavy Biofuels" pathway is similar to the "Mixed Technology" pathway but also requires a significant shift in land use from food crops to energy crops.

Proponents of the "Renewables Only" pathway argue that it is the cleanest and has the highest potential for job growth, but others argue that it is unrealistic given the required land use and the quadrupling of current electricity supply that would be required by 2050. The other three pathways, which require only about half as much of an increase in electricity supply and far less land, have their own drawbacks. Some point out that there is no viable option for disposal of nuclear waste, and some say that carbon capture is just an excuse to continue to using fossil fuels. Meanwhile, converting land from food crops to biomass is controversial since it may raise the cost of food, and some have suggested that it could also result in further destruction of forests.

In addition to the question of what energy source to use, there is a question of how to organize and implement a particular pathway. Some people believe there should be a single national approach, while others believe that, so long as each U.S. state makes a fair share contribution to our national goals, these pathways should be implemented on a state-by-state or region-by-region level, based on local values as well as the unique energy assets available in each region.

Small Group 4

Practical Considerations in Crafting and Implementing a U.S. Plan to Reduce GHGs.

This session considers how (or whether) to construct a comprehensive transition to green energy, not just a technical pathway but one that anticipates all economic and social equity impacts for Americans. While some predict the cost of energy will be lower after the transition, many expect the cost to be higher during the transition and want to ensure that the transition doesn't disproportionately impact low- and middle-income earners. While some say many jobs are likely to be created, others argue that this will only happen if there is a comprehensive plan that ensures American manufacturing competitiveness.

Other challenges include transitioning states that currently rely on fossil fuel tax revenues to provide services to their residents. From the international perspective, we face the problem of coordinating our national plan with other countries, a concern that may be lessened by creating incentives and penalties to encourage other countries to create and implement their own climate standards.

Most studies have suggested 2050 is a difficult but achievable goal for getting to net zero, but some suggest earlier and others later. In reaching this goal, you will consider whether Congress should create a long-term climate and energy transition budget; whether there should be a coordinating national body; and whether the president should declare a state of emergency. The discussions will also focus on the role of the states and the federal government in creating a national plan as well as the role of the private sector in relation to the government. Another question is how the transition will affect lower-income individuals and communities who would be among the most affected by rises in the cost of energy or potential job losses that the transition might bring. Finally, what should we do about communities that have been harmed by past environmental practices?

These are challenging questions without easy answers. They pose difficult tradeoffs. We invite you to think about these issues, offer your ideas, and listen to the views of your fellow participants. You will have a chance to get more information and pose questions to leading experts. We only ask that the discussions be civil and respectful, so that all participants can be heard and everyone has the opportunity to learn from each other. At the conclusion, we will ask you to give us your opinions in a confidential questionnaire.

INTRODUCTION

During this Deliberative Poll you will have a chance to consider what many people believe is one of the most important topics facing societies and public officials worldwide today: the direct and indirect effects of greenhouse gas emissions on people's lives as well as the planet's environment, and whether it's possible to prevent these emissions from negatively affecting life in the U.S. and around the world.

For more than five decades, scientists and the public have debated three things related to data showing increasing greenhouse gases in the atmosphere: 1) whether those increasing levels of greenhouse gases would impact human quality of life and the natural world as a result of the heat they trap in our atmosphere; 2) if so then when; and 3) whether there were actions societies could and should take to reduce and manage them – in other words, did human behavior and choices matter.

Today, the vast majority of climate scientists around the world (97%) agree that human activity is causing increasing temperatures through greenhouse gas emissions, and both governments and business are already responding. Many business leaders in the U.S. and internationally—including those of major oil and gas corporations—have started changing their practices and economic models to try to prevent some consequences of a warming planet.[14] Policymakers and experts around the world have been meeting for years to discuss an international framework to reduce greenhouse gas emissions and promote financial support for developing countries to adapt to the challenges that comes with increasingly severe wet and dry weather and decreasing access to important resources like water. In the U.S., federal, state and local governments are working to prepare leaders, policymakers, organizations and communities to address climate-related issues.

It also should be noted that many people see a silver lining in this subject matter. A recent National Academy of Sciences report stated, *"The energy transition provides an opportunity to build a more competitive U.S. economy, to increase the availability of high-quality jobs, to build an energy system without the social injustices that permeate the current system, and to allow those individuals and businesses that are marginalized today to share equitably in future benefits." However, "the United States will need specific policies to ensure a fair distribution of both costs and benefits. Maintaining public support through a three-decade transition to net zero simply cannot be achieved without the development and maintenance of a strong social contract."*[15]

Civic, business, and labor leaders are coming to believe that action of some kind must be taken to prepare Americans for rising temperatures and their consequences, but there remains considerable uncertainty and political division about what exactly to do. **How —and how quickly— should we change our energy sources as well as our energy consumption and other behaviors to reduce greenhouse gas emissions, at what cost, and who should bear those costs? Additionally, what could be the cost to present and future generations if we do not act?**

Through this Deliberative Poll, you and your fellow participants will engage in small group discussions to explore your views on policy proposals for reducing greenhouse gases, whether and when to use certain types of energy, and what—if anything—the U.S. can and should do to tackle these issues. A key question you will consider during this event is whether and how the U.S. should initiate progress toward what is called **"Net Zero", which means humans only put as much greenhouse gas into the atmosphere in any year as we remove from it, naturally or through engineered methods.** This goal has already been adopted by most nations, and much of the private sector, so we use it as a reference point in these materials.[16]

> **Why Net Zero?**
> There are many products most people consider essential that use fossil fuels as a "feedstock", such as plastics, pharmaceuticals, building materials, agricultural fertilizers, and much more. Until new ways of making these products are developed, any plan to reduce greenhouse gas in the atmosphere needs to allow the emissions from this activity to be offset somehow. Net Zero allow for some low level of emissions to be produced, so long as they are also removed from the atmosphere – either through engineered methods like carbon capture technologies, also known as negative emissions technologies, or ensuring the health and proliferation of forests, soils, and geological formations that can store carbon dioxide (CO_2).

You need not be an expert to participate; come as you are. The materials here, along with the briefing videos, will provide background information as well as balanced and vetted arguments for and against proposed policies. The deliberations with your fellow participants will allow you to weigh the difficult tradeoffs for these policies, hear the views of your fellow Americans, and talk about why you may support or oppose (or be unsure about) various issues and proposals.

Background Information

IS THE CLIMATE CHANGING, AND IN WHAT WAYS?

Scientific evidence shows the earth is undergoing major changes in its climate. The most recent report of the United Nation's Intergovernmental Panel on Climate Change (IPCC), which is based on input from hundreds of climate scientists and other technical experts, concludes: "Each of the last four decades has been successively warmer than any decade that preceded it since 1850."[17] Here are some examples of these changes and their expected consequences:

- The rise in global temperatures is increasing the frequency, duration, and intensity of floods, droughts and heat waves, with record rainfall in some areas and record drought in others – including the western U.S.[18]
- Record-breaking temperatures and drought increase fire risk and intensity.[19] Where droughts persist, hundreds of millions of people globally are expected to struggle to survive, affecting migration, and many animal and plant species to become extinct.[20]

- The oceans are absorbing excess heat from greenhouse gas emissions,[21] and as ocean temperatures rise the volume of water expands, causing sea levels to rise (in addition to the effects of melting glaciers and ice sheets) impacting low-lying areas. This increases storm damage, coastline erosion and in many cases causes flooding.[22]
- Increasing ocean temperatures and changes in storm patterns and currents are also causing coral reefs to degrade significantly.[23] The death of coral reefs has the potential to create a domino effect up the food chain, leading to the extinction of many species of fish and other marine life, and affecting coastal communities most dependent upon those environments.

THE ROLE OF GREENHOUSE GASES (GHGS)

"Greenhouse gases" absorb heat radiating from the planet and trap it in the atmosphere, in much the same way as a greenhouse traps heat for the cultivation of plants. The major greenhouse gases are water vapor, carbon dioxide (or CO_2), methane (CH_4), ozone, and nitrous oxide. Other gases, including hydrofluorocarbons and chlorofluorocarbons are currently a much smaller portion of greenhouse gas emissions, but they are hundreds of times more potent that CO_2, and are expected to increase as people use more air conditioning and refrigeration in response to warmer temperatures.[24] Most greenhouse gas stays in the atmosphere for thousands (if not tens of thousands) of years, and the more of it there is, the more heat it traps (Methane dissipates much faster – in about 12 years – but also traps 84 times more heat than CO_2 over twenty years[25]). So, the greenhouse gas emissions we generate each year will continue to add to what is already there, for many generations.

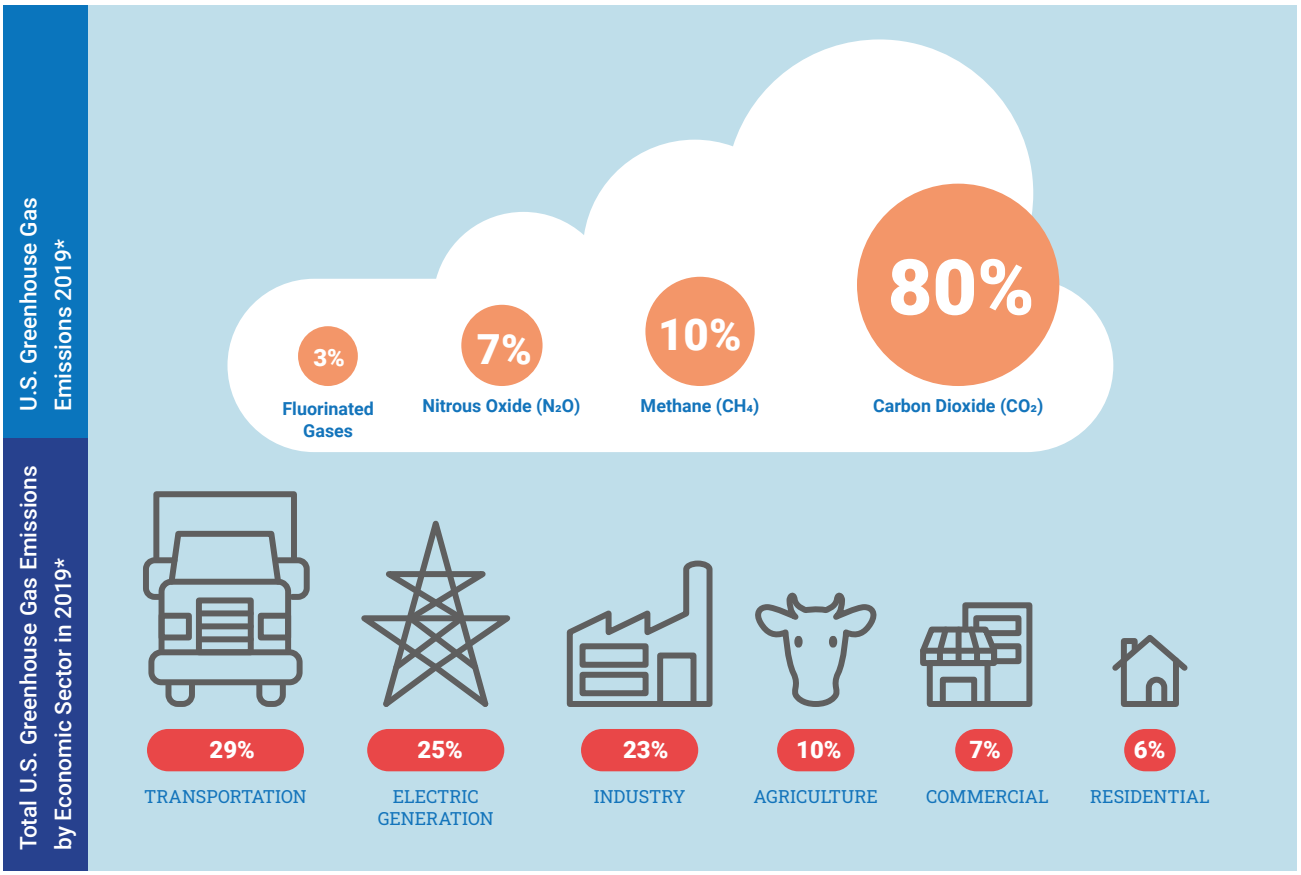
For many years, this effect has created a suitable climate for life on earth. But since about the 1950's, discoveries in energy production and technology that have done much to improve human quality of life have also been releasing greater volumes of greenhouse gases into the atmosphere – primarily through mining and drilling, processing, transporting and burning fossil fuels like coal, oil and natural gas, and clearing huge areas of forest (especially tropical forests). The planet's population has also been growing steadily over that time, which means more and more people have been consuming energy and contributing to this effect.

Is there a chance that all of this isn't quite right? That the earth isn't warming as much as all of these people say, or that it's just one of many natural cycles that will correct itself eventually? At the end of the day, each individual will weigh the information before them and decide what to believe for themselves. Some scientists argue that the models used to project global warming are not sufficiently sophisticated, that human activity is not a major factor, or that the harmful consequences of warming are exaggerated. However, what could be called an overwhelming majority of other scientists and science-led institutions express the highest levels of confidence, based on a data from many independent sources, that this analysis is accurate.[26] The United Nations Intergovernmental Panel on Climate Change (IPCC) warns that global temperatures will continue to rise and further intensify weather extremes unless nations take steps to dramatically reduce CO_2 and other greenhouse gas emissions in the next two decades, and states that it is now "unequivocal that human influence has warmed the atmosphere".[27]

This Deliberative Poll will enable you to spend some time evaluating the many dimensions of this issue and arrive at your *own* informed conclusions.

WHICH SECTORS OF THE U.S. ECONOMY PRODUCE THE MOST GREENHOUSE GAS EMISSIONS?

Transportation, electricity generation, and industry made up a majority (77%) of U.S. greenhouse gas emissions in 2019. Carbon dioxide (CO_2) makes up the vast majority of greenhouse gas emissions (80%). The majority of greenhouse gas emissions from the transportation sector results from burning petroleum-based products like gasoline in internal combustion engines. The largest sources of transportation-related greenhouse gas emissions include passenger cars, medium- and heavy-duty trucks, and light-duty trucks, including sport utility vehicles, pickup trucks, and minivans.[28] The largest source of greenhouse gas emissions from electricity-generation is also fossil fuels, specifically coal. In 2019, coal accounted for 61% of the CO_2 emissions from this sector yet represented only 24% of electricity generated. Natural gas accounted for 37% of electricity generation, and petroleum less than 1%. The remaining generation was from Nuclear (20%) and renewable sources (18%) including hydroelectric, biomass, wind and solar, most of which are non-emitting.[29]



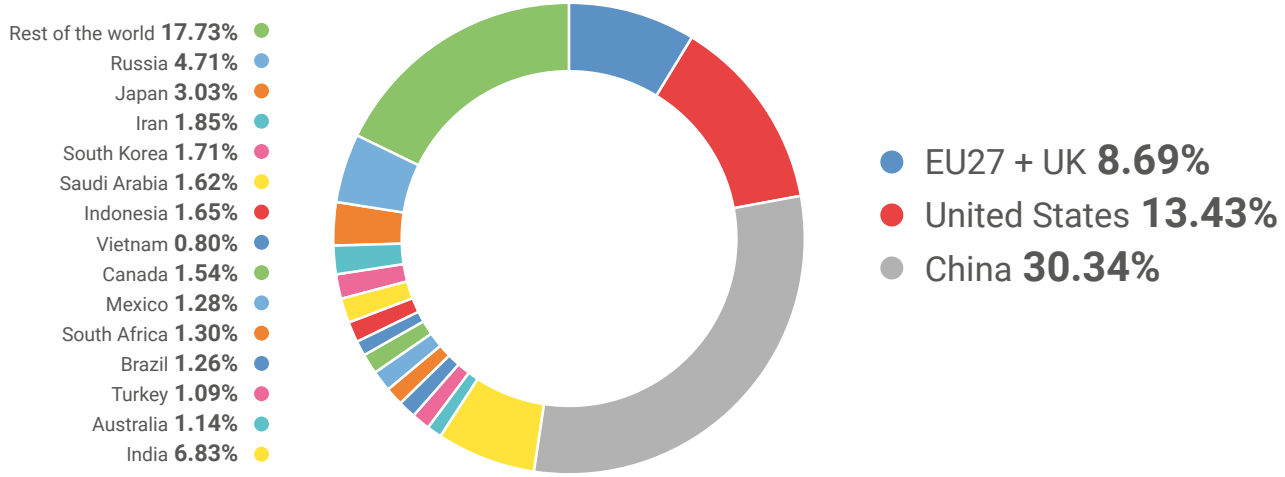
*Percentage may not add to 100% due to independent rounding and the way the inventory quantifies U.S. territories (not shown) as a separate sector.

Source: IPCC (2014); Exit based on global emissions from 2010. Details about the sources included in these estimates can be found in the Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

HOW THE UNITED STATES COMPARES TO OTHER COUNTRIES

The United States isn't the only major emitter of greenhouse gases. In 2020, the U.S. produced 13% of global emissions while China produced over twice as much (30% of total global emissions) and India is in third place, with 6.8% of global emissions.[30] However, based on per capita emissions, the U.S. is substantially higher than those in China or India, and China's emissions partially reflect that it is the world's largest manufacturing center for, and exporter to, the rest of the world.[31] Brazil and Indonesia also appear in the top ranks of greenhouse gas emitters because of the large-scale deforestation in those countries.[32]

% of Carbon Dioxide Emissions by Country, 2020



Source Data: Emissions Database for Global Atmospheric Research, https://edgar.jrc.ec.europa.eu/report_2020.

The U.S.'s contributions to global greenhouse gases differs from those of many other countries. For example, because much of the world is less reliant on personal transportation than the U.S., the transportation sector globally contributes 21% of greenhouse gas compared to 29% in the U.S. In contrast, electricity generation produces 40% of global greenhouse gas emissions compared to 25% in the U.S.[33] In less developed countries, agricultural activity and the logging of tropical forests accounts for a much larger share of emissions. The effect of greenhouse gas emissions, however, is global. India emits 7% of total global greenhouse gas, but hundreds of millions of people face the annual possibility of lethal heat waves; Vietnam emits a fraction or greenhouse gas so small it's typically not included in world reports, yet floodwaters engulfing Ho Chi Minh City will be extremely costly. The ongoing heat emergency in the western hemisphere, like the devastating flooding that recently swept towns in Germany (2% total emissions) and Belgium (too small to publish), represents the beginning of what experts predict could be a continuing string of very serious natural disasters caused by excess greenhouse gas emissions[34].

THE CURRENT STATE OF PROGRESS

In 2016, the US government along with 54 other countries approved the Paris Agreement, calling for nations across the world to limit the rise in average global temperatures by 2050 to well below 2 degrees Celsius over pre-industrial levels, and preferably to 1.5° C. Currently 191 countries are parties to the agreement.[35] This framework for addressing climate and energy across the globe was signed by nearly all the world's nations.[36] In 2017, the U.S. government announced it would withdraw from the Agreement, then it rejoined in 2021.

Progress towards the Paris Agreement goals has been limited. The number of countries committed to achieving Net Zero by 2050 continues to grow, but climate pledges by governments to date – even if fully achieved – would fall short of what is required to bring global energy-related carbon dioxide (CO_2) emissions to Net Zero by 2050 and position the world to successfully limit global temperature rise to 1.5 °C, or even to 2.0.[37]

Looking forward, U.S. policy makers are considering a wide range of possible steps to reduce our country's contribution to greenhouse gas emissions. These include offering incentives for the private and public sector to continue developing emissions-reducing technologies, as well as designing regulations that require reductions in greenhouse gas emissions throughout our economy and that also can motivate the development of new technologies, systems and behavior oriented around using what we have more efficiently. Finally, climate scientists are also planning for adaptation and resiliency: how to cope with a hotter planet with more severe weather, droughts, fires, and floods.[38]

SMALL GROUP 1
GREENHOUSE GASES
WHERE ARE THEY FROM, WHY DO THEY MATTER, AND CAN THEY BE REDUCED?

In this first session you will discuss various energy sources and which could be the best options for putting the U.S. on a path to Net Zero, meaning the point where the U.S. is not *adding* to the total amount of greenhouse gases in the atmosphere. In each case there are arguments for and against for you to evaluate. As background for this discussion, here is a quick overview of the types of energy that play a role in this section's proposals.

Different Types of Energy

The U.S. relies on a wide array of energy sources. The three types of energy are fossil fuels, nuclear power, and renewable energy (including wind, solar, biomass and hydroelectric). Electricity is a *secondary* source of energy that is produced from these *primary* sources. In 2019, the U.S. derived 79% of its energy from fossil fuels, 11% from renewable energy, and 10% from nuclear energy.[39] For transportation, the United States currently relies heavily on petroleum (gasoline and diesel). For activities that require electricity (heating, cooling, electronics and transportation to name a few), the U.S. currently primarily burns natural gas and coal.[40]

The ten energy sources below have been sorted into two categories: fossil fuels and fossil fuel alternatives. It is important to note that all energy sources have environmental impacts, including fossil fuel alternatives. Some sources of energy commonly referred to as "renewables," such as solar and wind, in fact depend on the availability of raw materials that are non-renewable.

FOSSIL FUELS

As the name implies, fossil fuels are the product of plants and animals that lived hundreds of millions of years ago and are used primarily to generate electricity, to generate heat for homes and industrial applications, and to power vehicles. Fossil fuels, especially oil, are also used as raw materials ("feedstock") to produce plastics, pharmaceuticals, fertilizers, packaging, clothing, tires, detergents, insulators, lubricants and many other familiar products. Fossil fuels generate electricity through burning.[41] In most cases fossil fuels are burned to release heat, the heat boils water to produce steam, the steam powers a turbine, and a generator inside the turbine converts mechanical energy to electric energy, producing electricity.[42] When burned, fossil fuels also release greenhouse gases such as CO_2.

Oil

Oil is a naturally occurring liquid that comes from ancient bacteria, algae, and plankton. It is extracted from the earth and then transported by pipeline, supertanker, or rail to refineries where it is refined into tar, asphalt, gasoline, diesel, kerosene, and other materials.

A major advantage of oil is that it is convenient to transport and suitable for burning in cars, planes, and trucks. Compared to coal, oil is also energy-dense and somewhat cleaner-burning, releasing about 80% of the carbon dioxide that coal does per energy unit when burned.[43]

On the other hand, the drilling of oil wells and construction of pipelines, as well as leaks and spills from production and transport, can destroy wildlife and other natural habitats. The oil extraction and distribution process can also release significant amounts of methane and other greenhouse gases. In addition to producing greenhouse gas, burning oil contributes to acid rain and releases toxins into the atmosphere like sulfur and trace amounts of mercury, lead, and arsenic.[44]

Natural Gas

Natural gas is also formed by pressure and heat applied to ancient plant and animal remains.[45] Because it is lighter than oil, it lies above oil in underground deposits. It is generally extracted through wells, often with fracking or horizontal drilling. Fracking is a procedure that splits open rock with high-pressure water, and then props it open with tiny grains of sand, glass, or silica, allowing trapped gas to flow more freely out of the well.

Natural gas produces about 60 percent less CO_2 per unit of energy than coal and has fewer impurities than coal or oil, producing almost no sulfur dioxide or particulate matter during combustion.[46] Like oil, it can be conveniently delivered through pipelines and burned in fluid form.

However, the production and transportation of natural gas produces methane (natural gas is 70 – 90% methane) as well as CO_2. For years experts said natural gas was a cleaner fuel option, without realizing how much of its methane was leaking into the atmosphere during production and transport. There is now an increased focus on understanding and controlling this leakage, but it is challenging and expensive.

Critics also note that natural gas extraction can create small earthquakes,[47] and drilling site set-up can fragment and destroy wildlife habitats. Fracking requires large volumes of water, disposal of which is very challenging because it becomes contaminated with radioactive material, salts, and heavy metals[48], and fracking liquid can contaminate groundwater with carcinogens and hydrocarbons.

Coal

Coal comes from ancient plants and trees. It is extracted through surface mining, stripping vegetation, soil, and rock to expose ore, and through subsurface mining.

Advantages to coal include its abundant reserves, the ease of surface mining, safe transportation as its solid form poses no threat of leakage, and its low cost compared to oil and natural gas.[49]

However, burning coal generates much higher CO_2 emissions per unit of energy than oil and natural gas. In addition, burning coal releases sulfur, mercury, lead, arsenic, and other airborne particulates that are dangerous to breathe; hundreds of thousands of people die annually globally from complications related to air pollution from coal combustion.[50] Coal mining is also environmentally destructive; subsurface mining requires excavating vast underground tunnel spaces, resulting in subsidence, or the sinking of the ground above. Subsidence alters the topography of animal and plant habitats, increases flooding, and restricts the ability of underground aquifers to store water, and coal mining waste can also contaminate streams, lakes and groundwater.[51]

FOSSIL FUEL ALTERNATIVES

Nuclear

Nuclear power plants produce energy through the splitting of (fission) Uranium-235, which releases heat. This heat is used to generate steam that turns a turbine.[52]

Nuclear power is "energy dense," meaning it delivers lots of energy per unit of volume. In addition, it produces no CO_2 emissions after power plant construction, and is an abundant energy source, as the U.S. has substantial uranium reserves.

Critics of nuclear power emphasize that its production creates waste that is radioactive for thousands years, disposal of which is very challenging and in the U.S. is not resolved.[53] Enriched uranium in waste can also be a security threat since it can be used to make bombs. Nuclear plants pose the potential for catastrophic meltdowns and accidents, as in Three Mile Island, Chernobyl, and Fukushima.[54]

Supporters emphasize that there are many options for dramatically improving safety, limiting risks of weapons proliferation, and limiting waste disposal concerns.[55] These include a new generation of lower-cost modular reactors and thorium-based nuclear fuel.[56] Another argument offered by supporters of nuclear power is that it facilitates the use of renewable energy by providing reliable, back-up energy during periods when there are interruptions in the supply of renewable energy because of no wind or sun power.

Critics also point out that nuclear plants are very expensive to construct, run, and decommission, while supporters emphasize that nuclear plants are inexpensive to operate, and costs could be significantly lowered by updating regulations to better align with newer technology and design as well as better construction and project management practices.

Solar

When the sun shines on a solar panel, energy from the sunlight is absorbed by the photovoltaic cells in the panel to create a flow of electric charge. This flow travels through a circuit of wires that connects multiple panels called arrays. The arrays feed into an inverter system that converts direct current (DC) to alternating current (AC) that matches the frequency of your utility grid.[57]

Solar energy does not release any greenhouse gases and solar energy is also renewable since the supply of sunlight is unlimited.

One drawback to solar power is that solar panels do not produce electricity all the time. Some regions are less sunny than others and of course the sun disappears at night. Until advances in technologies to capture and store energy (such as better batteries) are made, solar power must be combined with other energy sources that produce electricity on-demand or consistently.

While the cost of solar panels has declined significantly in recent years, and they are the fastest growing energy source in the U.S., some experts are still unsure about their viability if deployed on a large scale. Solar panels also take up a considerable amount of surface space per unit of energy produced. Finally, implementation of solar energy may be limited by the availability of raw, non-renewable minerals like copper, lithium, cobalt, and rare earth elements.[58]

Wind

Wind turbines generate electricity when wind turns the propeller-like blades of a turbine around a rotor, which spins a generator, to produce electricity.[59] Wind farms can either be land-based or located offshore in the ocean.[60]

Wind energy, like solar energy, does not release greenhouse gases, and since wind is an atmospheric condition rather than a material, it is a renewable energy source.

Wind turbines have low operational costs and the construction costs are paid back quickly. That said, wind turbines create visual and noise pollution and can endanger birds. Additionally, like solar panels, wind turbines are not reliable forms of energy when weather conditions vary.[61] Storage of electricity via batteries and other methods can address this problem, but that technology is not yet affordable at scale. Like solar panels, wind turbine production may be limited by the availability of necessary raw materials. Wind turbines require large quantities of steel and cement, the production of which creates greenhouse gas emissions, although this impact is far less than that of coal or gas emissions.

Geothermal

Geothermal energy derives from heat in the earth's interior. At geothermal power stations this energy heats water or another working fluid, creating steam that turns the turbine of a generator to produce electricity.[62] Proponents of geothermal energy argue that geothermal power does not itself release greenhouse gases, is naturally replenished, leaves a small footprint on land, and can provide power at any time to meet energy demands.[63]

Opponents highlight that acquiring geothermal power presents high upfront costs and can trigger earthquakes and tectonic shifts.[64] The pumps and digging mechanisms required to produce geothermal power also tend to release some greenhouse gases.[65] They also argue that geothermal is only available to people in certain areas where hot rocks or steam from the earth is readily available.

Hydroelectric

Hydroelectric power is produced by harnessing the movement of water. Most hydroelectric power comes from the potential energy of dammed water, which drives a water turbine and generator.[66] Water, after passing through a dam, will return to the river on the downstream side of the dam. Some hydroelectric power comes from tidal stream generators, which can be built into the structures of bridges or are submerged underwater, making use of the kinetic energy of moving water in a manner similar to how wind turbines are powered by wind.

Hydroelectric power is renewable, cost-competitive and flexible, as water flow can be adjusted to suit energy requirements.[67]

However, constructing dams involves expensive up-front costs, can displace local communities, can create flooding risk if water is released, and disrupts the natural flow of rivers, which can alter natural habitats.[68] Furthermore, a lack of available reservoirs places limits on where dams can be built and how many can be constructed. Water flow also varies greatly depending on local weather and precipitation trends, limiting the reliability of hydroelectric power.

Bioenergy

Bioenergy refers to biofuels, biogas and biomass, and is energy made from living (or recently living) plant or animal material such as wood waste, agricultural crops and their byproducts, municipal solid waste, waste

from food processing and aquatic plants and algae. Methane is a biogas that can be used as a renewable fuel. Biomass material can be burned directly for energy, as in burning wood logs or pellets, or refined into liquid or gas by using heat and pressure or by biological and chemical processing to create fuels like ethanol and biodiesel.[69]

While burning plant-derived biomass releases carbon dioxide, bioenergy is classified as a renewable energy source because living biomass takes in carbon as it grows, releases this carbon when used for energy, and then carbon is reabsorbed, in theory, by the next crop of biomass feedstock – creating a "net neutral" system for storing, using then recapturing that CO_2.

Critics point out that at this time fossil fuels may still be required for harvesting, processing and transportation of much biomass.[70] Bioenergy plants also are expensive to construct, and the seasonality of biomass supply reduces the reliability of this as an energy source.[71] Burning wood can cause significant air pollution.[72] Harvesting forest, particularly if it's not replaced in the right way, can release excess CO_2. There are promising new feedstock options being developed, but they are not yet viable at scale. There are also concerns that shifting farmland from food to biomass in the U.S. simply results in more land clearing for less efficient food production elsewhere.

On the positive side, there are many different sources of bioenergy and some seem to have real potential. Using methane or waste product from agriculture and forests that would have decomposed anyway is a more efficient use of our natural resources. Diverting existing croplands to biofuel crops such as switchgrass where it makes sense economically has the potential to be a CO_2-neutral energy source available to people wherever crops can be grown, but it must be balanced with food supply considerations.

OTHER LEVERS FOR ACTION

Hydrogen

Hydrogen, the most abundant element on Earth, is an energy carrier that can be used to store, move, and deliver energy produced from other sources such as natural gas, nuclear power, biomass, solar and wind. To become available as a carrier, hydrogen must be split from other substances such as hydrocarbons and water. This can be done using steam and methane; electrolysis that produces hydrogen from water molecules; biological reactions using microbes such as bacteria and microalgae; or even using sunlight.[73] Hydrogen can then be stored as a gas or liquid.

To use the energy stored in hydrogen, it needs to be oxidized, by burning it or using a fuel cell to produce electrons. At this stage, its only byproduct is water. This makes it an attractive option for cars, in houses, for portable power, and other applications. Not only is hydrogen renewable, but hydrogen fuel cells are reliable energy sources year-round. Fuel cells can also operate independent of the electricity grid, making them an attractive option for hospitals, emergency response systems and the military, and fuel cells in cars are twice as efficient as internal combustion engines, allowing more miles traveled per tank.[74]

Unfortunately, most hydrogen applications are still not cost-effective for widespread use, and hydrogen as a transportation fuel would also require expensive new fueling infrastructure. Additionally, any hydrogen that escapes during the production process can damage the Earth's ozone layer,[75] which is important to shield the planet from the Sun's ultraviolet radiation.

Methane Emissions

Methane is emitted during the decay of organic waste, for example of microorganisms in lake sediment and freshwater wetlands. The two main sources of methane emissions related to human activity are leaks during the production and transport of oil and gas (as noted above it is the main component of natural gas) and from animal agriculture --primarily from digestion by animals such as beef or dairy cattle, sheep or goats. After an animal consumes feed, the natural process of fermentation by microbes in the stomach produces methane.

Even though methane emissions account for a relatively small fraction of total greenhouse gas emissions by volume and it only stays in the atmosphere for about 12 years, they are one-quarter of the warming currently occurring.[76] The International Energy Agency estimates that the oil and gas industry around the world can reduce methane by 75% using technology already available and that 40% of the emissions could be reduced without extra costs, since the natural gas captured could then be sold.[77]

Methane also has the potential to be a renewable fuel. Currently many oil wells burn off methane in a process called flaring, which wastes huge volumes of this gas, not to mention releasing emissions. The reason is that special equipment is needed to process and transport methane gas and offshore oil platforms or remote oil fields are often far from the needed infrastructure. New methods of processing and transporting methane are in development.[78]

Electricity and Grid Reliability

As the U.S. continues to transition to electric vehicles and switches from gas to electricity to heat our buildings, the demands for "clean" electricity in the U.S. are projected to grow very significantly. Depending on how the U.S. produces its electricity, the sector is forecast to increase production by 100% to 400% by 2050 to meet demand.

Because the U.S. is expected to become heavily dependent on electricity, experts stress that our energy grid should be made as reliable, safe, efficient, and resilient as possible. Blackouts and brownouts will become even more intolerable because so much more of our daily lives will rely on electricity.

One question that remains unsettled is the degree to which the grid will be centralized, as it has been traditionally, or more distributed, with many homes, businesses and institutions generating electricity directly, for example from solar panels, without having to go through a centralized control point, and also able to store power on site and sell and transfer power directly to other users.[79]

It is also important to consider that demand for electricity is not constant over the course of a day; it typically peaks in the evening when people come home from work. This is relevant to which energy sources are prioritized and their relative availability at a moment in time. Finally, increased dependence upon electricity could pose national security risks if it makes us more dependent upon other nations for critical energy related inputs such as raw materials like lithium, cobalt, and copper.

Removing Emissions from the Atmosphere: Forests and Carbon Capture

This discussion has so far focused mostly on energy sources as a way of reducing emissions. But there is another tool at our disposal: capturing carbon before it reaches the atmosphere or removing carbon that has already been emitted. One way to capture carbon is by increasing the number of trees and plants that naturally store carbon. Reforestation involves planting trees to recover forests that have previously been cut down for other purposes. Afforestation involves planting trees and plants in areas where they did not exist before.[80] Globally, the most urgent priority related to forests is to stop the deforestation of tropical forests, which accounts for an estimated 8% of total global CO_2 emissions—more than from the entire European Union.[81] Stopping deforestation is one of the best methods to prevent greenhouse gasses from entering the atmosphere in the first place.

Carbon can also be removed from the atmosphere through carbon capture, use, and sequestration (CCUS), a process that captures CO_2 emissions from industrial processes and either reuses or stores (sequesters) them deep underground in geologically stable areas where they can remain for thousands of years.[82] Direct Air Capture is another technology that can remove CO_2 from the atmosphere. The CO_2 can be permanently stored in deep geological formations or used in the production of fuels, chemicals, building materials and other products. When CO_2 from direct air capture is geologically stored, it is permanently removed from the atmosphere, resulting in negative emissions. There are 15 direct air capture plants operating in the world today.[83] CCUS is considered by many experts to be practical and feasible. For example, Lawrence Livermore National Laboratories has recently developed and proposed a CO_2 removal plan for the state of California using currently available technology, and is identifying solutions to enable global-scale CO_2 removal.[84]

Conservation

Taking action to conserve what we have is also important to help determine the types of energy the U.S. prioritizes in the coming decades. Conservation is something individuals have the most personal control over day-to-day, especially if it is a priority. Most individuals can't decide to start upgrading the electric grid on their own, but their collective demands and behavior have a big impact on both the market for goods and services and policy action. What will Americans signal through their behavior and purchasing patterns when it comes to how much energy they use, in what way, and of what kind?

Energy Storage

For some types of energy to be most useful at scale, better energy storage options are necessary. Significant advances are being made in battery design. While long-lasting, quick-charging batteries will be essential to the expansion of the electric vehicle market, today's lithium-ion batteries are too heavy, too expensive, and take too long to charge. While not yet available commercially, solid-state lithium battery design has been demonstrated at laboratory scale that can be fully charged within 10 to 20 minutes and could increase the lifetime of electric vehicles.[85] Other storage options currently in use include hydraulic systems such as pumped hydro (typically used by utilities for energy load balancing); molten salt (used in solar thermal systems to let them provide energy after dark); and compressed air (used mainly as a way to improve the performance of gas turbines). For many researchers in this area, the real prize in storage technologies will be hydrogen from electricity, which promises potentially unlimited storage, over months to years but is still in development.[86]

Proposals and Arguments For and Against

FOSSIL FUELS AND SOURCES OF GREENHOUSE GAS EMISSIONS

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The US should eliminate **greenhouse gas emissions from coal** as soon as possible, ideally by 2035.	• Coal combustion produces more greenhouse gas emissions per unit of energy than any other energy source, both in the U.S. and globally. If the U.S. doesn't make eliminating coal as an energy source an urgent priority, there is no way the U.S. (or the world) can reduce greenhouse gas emissions rapidly enough to avoid catastrophic climate consequences. • By 2025, enough wind and solar power is expected to be generated at low enough prices in the U.S. that it could theoretically replace 86 % of U.S. coal with lower-cost electricity.[87] • The U.S. will lack the moral and political leverage to persuade other countries to phase out coal emissions unless it sets an example by moving quickly to do so itself.	• Many coal mining and generation jobs are in lower-income areas with few other jobs at comparable wages. Reducing or eliminating coal combustion could be disastrous to these local communities unless effective offsetting steps are taken. • There is no good reason for the US to give up coal if other big emitters, like China (which currently has three times more coal power than the rest of the world combined) and India, won't do the same.
The US should eliminate **greenhouse gas emissions from oil** as soon as possible, ideally by 2050.	• Even the big oil companies have started investing in sources of energy that do not emit greenhouse gases, and car companies have started setting deadlines for zero-emissions vehicles only (GM by 2035 and Volvo by 2030). • Alternative energy sources (including electricity from solar and wind) have become increasingly available and affordable for both transportation and buildings. • Setting an end date for oil emissions will encourage the private sector to develop alternatives to oil. Providing a runway of almost thirty years (i.e. by 2050) to make this happen should be enough.	• Oil is everywhere in our economy: it powers our cars, trucks, buses, airplanes, trains, and ships, and heats our homes. As other countries like China and India get richer, their citizens will want the same benefits of mobility and convenience. And even if some sources of oil demand can be replaced (for example, electric cars for gas-power cars), we don't have cost-effective substitutes for diesel to power trucks, bunker fuels to power ships, or jet fuel for airplanes. Eliminating it entirely is therefore impractical. • Transitioning too fast to alternative fuel sources in the quantities needed to fully replace oil will be very disruptive economically to millions of people in the U.S., including the impact on U.S. states heavily dependent on tax revenues from oil and gas production. • If the U.S. stops producing oil we would likely become a net importer, at least for some period of time. This would just shift greenhouse gas emissions to other nations with lower oil emissions standards, while reducing high-wage U.S. jobs.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The US should eliminate **greenhouse gas emissions from natural gas** as soon as possible, ideally by 2050.	• While natural gas is cleaner than oil or coal, it is still a significant source of greenhouse gas emissions (CO_2 and methane). • Natural gas transportation (for example through pipes) leaks damaging quantities of methane, and currently this is difficult and expensive to control. • Alternative sources of energy are developing rapidly in efficiency and cost competitiveness for all but a few applications, and so will be available to replace natural gas.	• Natural gas is the cleanest form of energy from fossil fuels and should be allowed the longest lifespan of use, provided the greenhouse gas emissions are offset with carbon capture technologies (such as direct air capture and carbon capture, re-use, or sequestration). • Of all the fossil fuels, natural gas is the simplest and cheapest to connect with carbon capture technologies. • Gas with carbon capture can help facilitate the transition to hydrogen (one of our best long-term options for renewable clean energy), as the price of hydrogen from electrolysis continues to fall. • Gas is the fossil source that most cheaply and effectively addresses the inconsistency of wind and solar. Gas is already allowing much higher penetration of renewables than would otherwise be the case.
The US should eliminate **the use of fossil fuels in the generation of electricity** as soon as possible.	• Shifting to non-greenhouse gas emitting electricity will enable the US to further reduce emissions by electrifying the transportation, building, and industrial sectors, which currently account for 63% of all U.S. greenhouse gas emissions. • The shift to non-greenhouse gas emitting electricity is expected to create millions of well-paying new jobs in the new energy industries.	• While it is desirable to phase out the use of fossil fuels to generate electricity, it is important to set realistic goals. The inconsistency of renewables, the high cost of 100% renewables, and the lack of currently available zero-carbon technologies other than renewables and nuclear makes a gradual transition more realistic. • Natural gas with "carbon capture" or using natural gas to produce hydrogen can allow us to preserve the benefits of on-demand power with very low greenhouse gas emissions.
The US should eliminate **the use of fossil fuels in cement, steel production** as soon as new technologies permit.	• The cement and steel industries combined are responsible for about 15% of all the world's carbon emissions every year.[88] • The U.S. can be a world leader in low-emission cement and steel if the U.S. provides clear standards and incentives for businesses to eliminate or capture greenhouse gas emissions in their production process.	• The U.S. should proceed with caution to avoid U.S. dependence on imports of such essential products as steel and cement. • Replacement technologies would need to be affordable to not make worse the already soaring cost of housing and infrastructure, which may not be a very realistic expectation.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The use of some fossil fuels should be allowed beyond a transition to Net Zero for the production of pharmaceuticals, plastics, agricultural chemicals and other products that currently can only be produced from fossil fuels.	• There is no known replacement for oil as a feedstock, and the U.S. should not be left behind in these critical industries. The U.S. can offset these emissions by using carbon sinks and carbon capture technologies. • Replacing the electricity *for the chemical industry alone* with renewables would require the addition of approximately two to three times as much renewable energy capacity as is currently expected to be constructed by 2030.[89] • Natural climate solutions and "direct air capture" provide technology paths for economies that have net zero emissions, even with residual fossil fuels.	• The U.S. can't expect the rest of the world to make these hard choices if the U.S. isn't willing to as well. • The U.S. should try to develop a crash program to replace as much of this feedstock as possible, and to reduce use of plastics as much as possible.

FOSSIL FUEL ALTERNATIVES AND GREENHOUSE GAS EMISSIONS

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. should dramatically accelerate the use of **solar energy**.	• Solar energy is a very clean source of energy and has become much more affordable in certain locations. • Technologies are already starting to be deployed at scale that allow solar energy to be stored for use when the sun isn't shining, along with power from other renewable energy sources. Further research and development will improve these technologies and make them more affordable. • Since the sun shines across the globe, it makes every country a potential energy producer, thus allowing for greater energy independence and security, and meeting global energy demands with solar power would require well under 1% of Earth's total land area. • Because solar can be connected directly to homes as well as commercial buildings, it does not have to be connected to a large electrical grid, allowing for increased energy independence and reliability.	• Solar energy is not consistent. This wouldn't be a problem if there were a cost-effective way to store solar energy, but that technology doesn't exist today at the required scale. • Solar panels require raw materials such as lithium, cobalt and copper that are mostly imported at present and for which global production capacity is limited, so prices are likely to increase as demand increases. • The US produces few solar panels domestically; 89% of shipments in 2020 were from imports and the current solar module tariffs are set to expire in February 2022[90]; being largely dependent upon other countries for energy infrastructure is a national security risk. • Solar energy requires large tracts of land -- about 50 times[91] more than nuclear energy per Gigawatt Hour (GWh), which may create conflicts with preservation of wildlife habitat and prime farmland.
The U.S. should dramatically accelerate the use of **wind power on land**.	• Wind is a clean, renewable energy source, and is one of the most cost-effective sources of electricity. • In combination with alternatives that compensate for its intermittency (the wind does not blow all the time), wind can be a significant part of the mix of clean energy sources the U.S. needs in order to phase out reliance on fossil fuels.	• Similar to solar power, wind power is intermittent, meaning that until affordable storage is widely available, wind turbines alone can't provide the reliable electricity communities need. • Wind power requires about 9 times more land per GWh (for example, to generate the same amount of electricity) than solar, and about 450 more times than nuclear.[92]

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. should dramatically accelerate the use of **wind power on land**.	• Wind turbines are getting both larger and more efficient while maintaining a similar footprint. These larger turbines have proven to reduce bird mortality, and though they need to be more spread out, the land between them can be used for other purposes, such as food production.	• Wind turbines require even more raw materials than solar energy and use a lot of steel and concrete (although this impact is less than that from the coal or gas emissions they displace).
The U.S. should dramatically accelerate the use of **offshore wind power**.	• Offshore wind is a clean, renewable energy source that doesn't require land use, and is one of the most cost-effective sources of electricity. • Wind is more abundant offshore than onshore, and many major cities are located along coast lines so offshore wind can provide power close to where it is needed. • Turbines can be placed far enough from land to avoid affecting views from shore.	• Offshore wind has the same disadvantages as onshore but makes even higher use of greenhouse gas-generating raw materials. • Offshore wind has significantly higher transmission costs than onshore wind.
The U.S. should dramatically accelerate the use of **geothermal** energy (hot steam from the earth).	• Geothermal energy is environmentally friendly, can provide power 24 hours a day (unlike wind and solar) and is cost-competitive with other renewables in locations where it is available. • There are abundant untapped sources of geothermal heat that can be used to generate electricity.	• Geothermal is location-specific and can't be economically transported long distances. • Geothermal will likely play a role in specific geographic settings in geologically stable areas where good steam resources are available, but these are limited.
The U.S. should dramatically accelerate the use of **hydroelectric** power (harnessing the power of water in motion, generally with dams).	• Hydroelectricity is one of the most efficient sources of clean, renewable energy and can be on demand. • Hydroelectric pumped storage is a proven large-scale energy storage technology currently in use. In addition, by providing on-demand, reliable energy, it can provide a supplementary source that makes solar and wind more viable.	• Dams use huge amounts of concrete and steel in their construction. • Dams produce significant environmental impacts, displacing both people and animals. Working through these issues (which is not always possible) can also make them very expensive to build.
The U.S. should greatly increase investment in innovation and deployment of new fuels made from plants and crops, called **biofuels**, for industries like aviation where electric power may not be an option.	• Biofuels, produced from plants and crops produce significantly less greenhouse gas emissions than fossil fuels. • Biofuels are currently the only viable alternative for certain applications, including aviation and ocean marine shipping. • Unlike some alternatives (for example, hydrogen), biofuel uses existing infrastructure and so can be deployed faster and more affordably than other renewable options.	• The indirect effects of biofuel production are controversial: A study from the American Association for the Advancement of Science concludes that, "as farmers worldwide respond to higher prices by converting forests and food crops to fuel crops, GHG [greenhouse gas] actually increases substantially." • While production costs of biofuels are declining, they are still quite expensive to produce, and are not currently available at scale. (The exception is ethanol from corn, which is widely used but also heavily subsidized, and ethanol is not suitable for some important uses, like aviation.)

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. should encourage building **new generation nuclear plants** that minimize waste and safety risks.	• Third generation nuclear reactors are much safer than first-and second-generation reactors; they are being deployed around the world, and the U.S. Department of Energy is funding prototypes of fourth generation reactors which will be even safer and produce significantly less nuclear waste. • It will be very difficult to get to Net Zero on a timely basis without nuclear power. • China is building new generation nuclear plants at much lower cost than the U.S.; the cost of plant construction in the U.S. has the potential to be greatly reduced through modular construction and updated regulations that account for the safer and less waste-producing newer generations of reactors. • Nuclear power is available on demand, making it a good complement to solar and wind power, which are not consistent.	• The catastrophic consequences of nuclear accidents may be lower, but they are still there. • While newer reactors produce less waste, the U.S still has not come up with a policy for permanent disposal. • Nuclear power plants are a tempting target for terrorists. • Until the U.S. updates regulations and construction codes to reflect the improved safety of new generation nuclear plants, nuclear power will remain more expensive that other forms of zero-emissions electricity and take much longer to build than is the case in other countries using new nuclear technology.
The U.S. should increase investment in affordable **hydrogen** as an alternative source of fuel and electricity.	• Hydrogen is the most abundant material on Earth, plentiful in sources such as water and natural gas, and does not emit greenhouses gas when burned. • Hydrogen is highly flexible and can be used for power generation, heat, and transportation and can be available at any time. • Hydrogen has the potential to be a zero-emissions fuel source, is two to three times more efficient than gasoline, and can fuel high temperature industrial processes like steel production as well as long-haul trucking, aviation and ocean shipping. • Major investments are being made by the U.S. and the E.U. to develop commercially available zero-carbon hydrogen for fuel cells, vehicles and heating buildings.	• While producing hydrogen from natural gas is cost-competitive, the greenhouse gas released in producing hydrogen from fossil fuels significantly reduces benefits to the climate (unless coupled with carbon capture technology). • The potential for splitting hydrogen from water, which would allow it to be produced without fossil fuels, is promising but not yet economically competitive. • The high flammability risk with hydrogen makes it more expensive to store and transport. • Hydrogen fuel for vehicles would require building a whole new refueling infrastructure.

METHANE AND GREENHOUSE GAS EMISSIONS

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. Government should issue **methane standards to reduce emissions from fossil fuel facilities**.	• While methane only lasts in the atmosphere for about a decade as opposed to centuries for CO_2, its impact is 84 times greater over 20 years, due to its increased potency. • About 46% of methane emissions comes from the production of fossil fuel products and results from inadequate detection and repair of methane leaks. As long as fossil fuels are produced, methane emissions should be reduced through stronger federal regulation.	• The projected decline in fossil fuel production will take care of the problem. • There will be a better response from industry to policies that encourage the reduction of methane emissions than to one-size-fits-all regulations.
In order to reduce **methane emissions** produced by **livestock**, the US should launch an educational campaign to encourage people to reduce their meat and dairy consumption.	• About 36% of U.S. methane emissions come from livestock farming (manure management as well as enteric fermentation, which means fermentation that takes place in the digestive systems of livestock).[93] The U.S. cannot get to Net Zero unless the U.S. substantially reduces these emissions. • The methane footprint of beef is much higher than from poultry or pork. Solutions do not require giving up all meat.	• Livestock producers are already pursuing several strategies to reduce methane emissions. An education campaign is a waste of taxpayer money. • This approach specifically targets the livelihoods of ranchers across the country, which could severely weaken rural economies in many states.
The U.S. government should **limit allowable greenhouse gas emissions including methane from large farms**, just as it sets limits for industrial sources.	• Combined, the world's top five meat and dairy companies emit more greenhouse gases than Exxon, Shell, or BP.[94]	• This will raise the cost of food production in the US, leading to greater imports that may actually increase emissions if they come from countries with lower emissions standards.

ELECTRICITY AND GREENHOUSE GAS EMISSIONS

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. Government, in coordination with all states, should make a major investment to expedite **expansion of a reliable and secure energy grid**.	• There are regions of the country that don't have enough electrical grid capacity now, let alone the capacity that will be required in the future. Only federal government assistance can get them there fast enough. • Typical utility rate structures do not provide sufficient incentives to generate grid investments on the scale required. Much of the nation's grid needs updating anyway. • Reliability and security of our electricity supply are indispensable for consumers, businesses, the public sector, and the military. Given the recent cyberattacks on the U.S., this is not just an economic issue but a national security issue as well.	• This all costs taxpayers a lot of money. The federal government should not be using our tax dollars to subsidize expansion of the energy grid. • Historically, grid responsibility has been regional rather than national; alternative approaches can also be productive, such as state compacts and other types of regional associations. • Securing access to the land that will be required for the physical infrastructure to increase transmission will be highly controversial and time consuming.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
Households and factories should be able to **generate their own electricity, store it**, and sell the excess back to the grid.	• A distributed power grid, with which consumers can generate their own electricity (for example with solar), store it, and sell the excess back to the grid or each other, will make energy supplies in the U.S. more reliable and secure. • A distributed grid will empower individual consumers and give them more control over their energy supply. • Distributed generation avoids transmission losses, thereby reducing costs to consumers.	• Centralized grids cannot be totally replaced. As the U.S. updates and upgrades its grid, it should ensure that it has enough capacity to ensure reliability for all users. • Enabling distributed grids could be costly for utility companies. If the cost of these upgrades cannot be recouped through standard pricing, this could result in rapidly rising rates that especially impact lower income households and areas where distributed generation is not as feasible.
The U.S. should prioritize **distributed energy resources**, like solar on rooftops or over parking lots.	• Putting solar on top of rooftops and/or over parking lots not only avoids conversion of important natural and working lands, but it also generates energy at the point where it is used and reduces energy loss that happens through transmission.	• Rooftop and parking lot solar produces energy during the time of day when there are gluts from commercial renewable generation and then relies on the traditional grid and generation sources the rest of the time. • Distributed grids don't work equitably for all. For example, homeowners with solar panels may pay less for energy, but that can result in renters paying more because utilities have to rely on a smaller group of paying customers to recover their fixed costs.
The US should enact standards for utilities that limit the amount of greenhouse gases emitted during the production of electricity.	• "Clean Electricity Standards" (which provide utilities with incentives for adding more clean power and impose penalties for failing to do so), have a proven track record. Since 2015, ten states have passed 100% clean electricity standards.[95] • The targeted subsidy approach of a Clean Electricity Standard provides funding for technological innovation that a carbon tax may not provide. • Clean Electricity Standards can be designed to include many types of clean energy sources, from renewables like solar and wind to hydroelectric power, nuclear, biomass, or fossil fuel-based power with carbon capture.	• Many economists believe that Clean Electricity Standards are more complicated to implement and less cost-efficient than a more market-based approach for reducing emissions (like carbon pricing). • Clean Electricity Standards only apply to the electric utility sector, which currently produces about 25% of U.S. emissions. U.S. strategy should instead cover all major U.S. emission sources – not just those from power plants. • Clean Electricity Standards can sometimes include fuels that some environmental groups may not consider "clean" (an example might be natural gas combined with some form of carbon capture to minimize greenhouse gas emissions).

REMOVING CARBON FROM THE ATMOSPHERE

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
Both at home and around the world, The U.S. should actively discourage **the destruction of major forests and encourage planting trees** and crops that absorb carbon.	• If deforestation continues unabated, and droughts and forest fires become more common, then tropical forests could become a large net source of greenhouse gas. Conversely, if deforestation slows, tropical forests could serve in the future as a large net sink to capture and store carbon.[96] • Deforestation and forest degradation contribute 15 to 20% of global carbon emissions.[97] Slowing and eventually stopping deforestation is one of the lowest cost, highest benefit strategies available for reducing emissions now. • The long-term conversion of grassland and forestland to cropland (and grazing lands) has resulted in historic losses of soil carbon worldwide, but there is great potential to increase soil carbon by restoring degraded soils and adopting soil conservation practices on a large scale.	• The U.S. doesn't have the resources or power to change what other countries do with their forests; we should focus on what we can do in the U.S. • As important as sustainability is, the U.S. needs to be able to feed a growing population worldwide which means achieving gains in agricultural productivity and/or increasing farmland. • Global warming is stressing forests through higher mean annual temperatures, longer-lasting droughts and more frequent and extreme weather events, so the U.S. shouldn't rely too heavily on this method of carbon capture in the future.
The U.S. government should create **financial incentives for capturing** and either reusing or storing carbon dioxide deep underground so it will not stay in the atmosphere.	• This is one of the most promising paths to achieving Net Zero without having to eliminate all use of fossil fuels; the federal government is already funding work in this area, and progress is being made quickly. • Carbon capture enables continued use of fossil fuels to retain competitiveness in critical industries such as pharmaceuticals, plastics and chemicals, as well as the ability to continue producing cement and steel. • Multiple scientific reports, including the UN's Intergovernmental Panel on Climate Change (IPCC), conclude the US will only be able to reach its climate goals by deploying multiple actions, including Carbon Capture and Sequestration.	• The U.S. must first reduce our emissions and only use carbon capture technologies as a last resort. The U.S. shouldn't use carbon capture as an excuse to extend the life of fossil fuels. • Sequestering carbon is simply a way to transfer the problem to future generations. • Technologies for carbon capture fail to address environmental justice concerns arising from the production and consumption of fossil fuels and associated emissions.

SMALL GROUP 2
INFLUENCING GHG EMISSIONS THROUGH INCENTIVES AND REGULATIONS

Market incentives and regulations designed to reduce greenhouse gas emissions frequently focus on specific "high-energy use" industries, including transportation and buildings. There is also growing policy interest in different forms of "carbon pricing," which seek to incentivize businesses to reduce their emissions by "imposing a price" for the cost to the public welfare of emitting greenhouse gases in the production of goods and services. Some of these policy approaches focus on "positive" financial incentives, such as government-sponsored discounts on hybrid or electric cars or energy-efficient light bulbs. Others seek to discourage polluting behavior through regulations, or by charging for it in the form of taxes or fees, or capping emission permits.

The overall question here is: Should U.S. policy encourage the private sector to reduce greenhouse gas emissions through positive incentives, regulations, carbon pricing, or some mix of these?

TRANSPORTATION

Today, the transportation sector accounts for the largest share of total direct greenhouse gas emissions in the U.S.: 29%.[98] Because so much of U.S. emissions are tied to the cars and trucks people drive, many argue the U.S. can't reach net zero without moving to zero emission vehicles. Much of the debate about this subject revolves around how soon this can happen. Policymakers are increasingly mandating, or incentivizing, zero or low-carbon emission cars, trucks, and buses. Currently, forty-five states and the District of Columbia provide incentives for certain electric vehicles (EVs) and plug-in hybrid vehicles (PHEVs), which range from tax credits to fleet acquisition goals to exemptions from emissions testing.[99]

Proponents of energy-efficient vehicles—including electric and hybrid cars—point to the fact that they can reach up to twice (and in some cases, higher) the fuel efficiency of the average gas-fueled car. Furthermore, advocates argue that automakers have proven able to innovate to reduce pollution every time governments have set standards requiring it.

However, so far only 7% of U.S. cars meet the standard of zero emission, and they remain more expensive than comparable fossil fuel-powered vehicles.[100] Achieving zero emissions for automobiles and passenger trucks implies not just all-electric vehicles but that the electricity to power them will be generated by renewables, and there are serious questions about whether the supply of raw materials can expand rapidly enough to generate enough electricity from renewables to meet this growing demand.[101] It should also be noted that battery-powered commercial long-haul trucks (a critical vehicle category in terms of emissions and the economy) have not yet been deployed at scale, let alone commercial aviation and maritime ocean shipping. Hydrogen and biofuels, or biomass, are options for these applications that are in early stages of adoption, but cost-effective generation of hydrogen today comes from natural gas, which also emits greenhouse gases. While some favor aggressive timelines for zero emission transportation, others argue that these should not be established without a comprehensive plan that considers the availability of raw materials and minimizes costly incentive programs funded by taxpayers. Meanwhile, virtually all auto manufacturers are already offering some emission-free vehicles. One major automaker has already committed to an emission-free fleet by 2030, and another by 2035.

BUILDINGS AND LARGE APPLIANCES

Buildings are a significant source of greenhouse gas emissions. Regulations and incentives that encourage or mandate energy efficiency in buildings and large appliances have proven to be increasingly popular among some policy makers as a way to minimize greenhouse gas emissions without dramatic changes in people's lifestyles. Energy efficiency programs aim to reduce energy use by: (1) making buildings and energy-using appliances (like those for heating, cooling and cooking) more efficient; (2) reducing the frequency with which energy-consuming devices are used (conservation); and (3) reducing energy use during times of peak demand (through load shifting, self-generation, or interruption).[102]

Energy efficiency programs are primarily paid for by customers through their electric rates or as a surcharge on their electric bills. Residential appliances are some of the largest energy users; as such, mandatory energy performance standards can be a cost-effective way to encourage greater efficiency in their design. Over the past few years, manufacturers have significantly increased the efficiency of many appliances including refrigerators, freezers, dishwashers, and washing machines. Energy efficiency in buildings can range from installing additional insulation and switching incandescent lights with LEDs, to installing computerized energy management systems in commercial buildings.

Advocates of energy efficiency believe it should be the first choice for reducing greenhouse gas emissions globally, while meeting U.S. electricity needs. Implementing energy efficiency standards, they argue, would result in rapid gains for consumers and industry through the availability of more energy-efficient products and cheaper energy bills.[103] While there is little opposition to energy efficiency as a concept, some are concerned about the cost-effectiveness and reliability of new infrastructure that would be needed to implement efficiency on a larger scale. Above all, critics assert that the timeline of a transition to all-electric homes, buildings, and appliances should be based on established availability of reliable, affordable electricity to avoid rate hikes for consumers and drastically increasing government spending.

CARBON PRICING

Carbon pricing is a climate policy approach used in a number of countries, regions, states, provinces and cities around the world. Carbon pricing works by charging per ton of CO_2 emitted (or an equivalent for other greenhouse gases). Most economists support carbon pricing as a more efficient mechanism for reducing emissions and encouraging conservation than regulations, technology mandates or subsidies.

There are two common methods of pricing carbon: a "carbon tax (or fee)" and "cap-and-trade".

- A carbon tax/fee is a price set per ton of CO_2 emitted. It can be structured to start small and increase annually, thereby creating an incentive for carbon emitters to "de-carbonize" their products and production processes before the price goes up.
- A cap-and-trade program limits the total amount of CO_2 that can be emitted by certain facilities, with allowed emissions generally declining each year until they reach a desired target level. In a cap-and-trade program, the government issues a limited number of emission allowances (also known as permits), each of which grants the holder the right to emit one ton of CO_2. Allowances can be traded, and the sales and purchases of allowances yield a market price for allowances – essentially the price of one ton of CO_2 emissions. The price of carbon is influenced both by

economic forces and when the government reduces the number of emission allowances, with a rise in price generally following a reduction in supply or an increase in demand.

Both methods are designed to provide incentives for businesses and consumers to reduce emissions by making low emissions choices less expensive than high emission choices.

Proponents of a carbon tax, or fee, prefer it to cap-and-trade because they claim it is simpler to understand and implement and because it provides price predictability that helps businesses and households plan their investment decisions. Proponents of cap-and-trade, on the other hand, argue that it provides greater assurance that emissions targets will be met (since total emissions cannot exceed the number of allowances available) and that it helps with cooperation among different states, countries, or regions that can allow trading across borders. Actual policies can include elements of both approaches; for example, California's cap-and-trade program includes a price "floor" and "ceiling."

Some proponents of carbon pricing favor an approach known as a "carbon dividend" that would distribute all or most of the revenues from the carbon fee (or from a government auction of allowances, in a cap-and-trade program) to low and middle-income earners to make sure they can afford any increased energy costs during the transition. Proponents of carbon pricing also often argue that it should be applied universally across the U.S. so as not to create unfair competition between U.S. states producing to different carbon standards, and for this purpose, a uniform national "carbon fee" (or national cap-and-trade program) would be easier to implement and administer.

Most proponents of carbon pricing, implemented through either a carbon tax or cap-and-trade, favor accompanying a carbon price with a "border carbon adjustment." This is a tax that foreign producers would have to pay at the U.S. border if they do not pay a carbon price in their own country equivalent to what the U.S. charges its own producers. This is intended to level the playing field for U.S. producers of goods and services. Proponents of a "border carbon adjustment" also argue that because other countries, notably the European Union and Canada, have already implemented carbon pricing and intend to implement a border carbon adjustment, U.S. exports could be disadvantaged if the U.S. does not follow and have similar climate policy.

Both forms of carbon pricing have been used in the real world. In the U.S., a dozen states have cap-and-trade programs, including California (since 2013, covering nearly 85% of the state's emissions), and eleven East Coast states (although only for the power sector); another three states are in the process of developing their own programs. Cap-and-trade programs are also underway in a number of other countries, including the European Union, whose Emission Trading System has been operating since 2005 and covers nearly half of the EU's GHG emissions. No U.S. state has implemented a carbon tax, although British Columbia has had one since 2008 and Canada has a form of national carbon fee as well.

Some people oppose carbon pricing, in either form, because it is "yet another tax". However, supporters make the case that Americans are already paying this tax in other ways, such as through taxpayer-funded services and programs to cover the cost of pollution from fossil fuels and disruptions caused by climate change, such as increased fires and floods. Some also express concern that carbon pricing proceeds could be used to fund programs and causes that are not directly related to climate change; which means that there should be a strict definition of how the money should be used.

Proposals and Arguments For and Against

INCENTIVES AND REGULATIONS: VEHICLES

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. government should reduce the level of allowable greenhouse gas emissions permitted from **vehicles**.	• Automakers have proven able to innovate to reduce pollution every time governments have set standards requiring it, and major automobile manufacturers are already committing to producing a wide variety of electric cars and trucks to meet consumer demand. • Foreign automakers are moving in this direction, and American companies must transform to remain competitive.	• Mandatory emissions reductions could impose high costs on our auto industry, hurting jobs and the economy. • More electric cars will require more recharging infrastructure, speedier recharging, and a substantial change in consumer acceptance of these technologies.
The U.S. government should expand financial incentives to vehicle manufacturers and consumers to accelerate development and adoption of **electric cars and trucks**.	• Vehicles account for a large share of U.S. emissions from fossil fuels. The U.S. currently has 270 million internal combustion engine cars and trucks in operation and only about two million that run on electricity. The U.S. can't get to Net Zero unless the U.S. moves expeditiously to electric cars and trucks. • Existing incentive programs have successfully helped create a market for electric vehicles but need to be expanded to make them accessible to low and middle-income Americans.	• This isn't necessary. The market should determine the pace at which consumers and businesses switch to electric vehicles without adding more expensive incentive programs that have to be funded by taxpayers. Every major vehicle manufacturer currently produces or plans to produce alternative vehicles, including some that plan to switch their entire line. • Current incentive programs largely benefit wealthier Americans who don't need government handouts. • The U.S. would need to expand electricity generation substantially in order to handle an increase in electric vehicles, and taxpayers will have to pay for a significantly expanded charging station infrastructure.
The U.S. should **eliminate the sale of new gas- and diesel-powered cars and passenger trucks** by 2035.	• The slow turnover in vehicles requires that all new models be zero-emission vehicles so we can get to net zero by 2050. • In addition to carbon dioxide, automobiles produce methane, nitrous oxide from the tailpipe, and hydrofluorocarbon emissions from leaking air conditioners. We need to prioritize eliminating all of these emissions. • Electric vehicles produce little or none of the traditional air pollutants that have plagued American cities for generations.	• As noted in the previous pros and cons, the U.S. would need to expand electricity generation substantially in order to handle an increase in vehicles, and taxpayers will have to pay for a significantly expanded charging station infrastructure. • The only way this will get the majority of gasoline-fueled cars and trucks off the road is if it is accompanied by a very generous subsidy to people who otherwise won't be able to afford new electric vehicles.

INCENTIVES AND REGULATIONS: BUILDINGS

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
Energy efficiency requirements for commercial and residential buildings should be increased, with mandatory annual energy-use reductions.	• The commercial and residential sector accounts for about 13% of U.S. emissions, so reductions in this sector could make a big difference in reaching Net Zero on a timely basis. • Upgrading homes to be more efficient saves homeowners money on their utility bills and quickly pays back the costs of upgrades.	• The market should determine how fast this transition takes place, based on affordability. • Housing costs are rising in many parts of the country. Even if there are potential long-term savings, this will contribute to increasing up front prices and make it harder for low- and middle-income households to buy.
All *new* buildings and major appliances should be required to use only electricity (not gas) by 2035.	• The U.S. must phase out use of natural gas for (both heat and air conditioning as well as for cooking, if the U.S. is to reduce greenhouse gas emissions rapidly enough. This requires replacing gas with electricity in all homes, buildings, and appliances. • Induction stoves and heat pump water heaters provide efficient, clean, and effective ways to replace gas appliances.	• This implies no more gas stoves, gas dryers or gas furnaces by 2035, when people have no assurance that the U.S. will have the requisite expanded electricity capacity. The timeline of this transition should be based on the availability of reliable, affordable electricity, including adequate battery storage. • Alternatives will reduce desired flexibility (e.g., cooking) and cost savings (e.g., gas vs. electric heating especially in colder regions of the country) now possible through current energy options. Natural gas has already contributed to emission reductions in the nation, and other alternatives such as biogas can achieve further reductions at lower cost.
The U.S. government should create financial incentives for the development of climate-safe alternatives to **Hydrofluorocarbons (HFC's)**, which are used primarily in refrigeration and air conditioning.	• Like methane, HFC's stay in the atmosphere less time than CO_2, but they are many hundreds of times more potent. • While HFC's currently contribute only about 2% of total carbon dioxide equivalent emissions, some studies project that could increase to somewhere between 9% and 19% by 2050, as warming continues and people increase their reliance on air-conditioning.	• HFC's contribute only 2% of total carbon dioxide equivalent emissions. The U.S. should be putting its limited financial resources into initiatives that have higher payoffs. • In addition to having to switch major appliances, this suggests consumers and businesses will also have to switch air-conditioning and refrigeration systems. This will significantly impact small businesses and low and middle-income Americans.

INCENTIVES AND REGULATIONS: CARBON PRICING

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. Government should establish a **uniform nationwide carbon pricing system**.	• The U.S. is already paying for the cost of carbon in ways that are not transparent to the average American. We all bear the health costs from fossil fuel pollution, and we increasingly bear the costs of climate disasters like droughts, fires, heatwaves, hurricanes, and floods. • Carbon pricing is better for taxpayers because it's more cost-effective than regulation as a way to encourage industry to design the most efficient products and processes to rapidly reduce emissions. • Proceeds from a carbon price can be directed in ways to reduce or offset any increases in costs for low and middle-income households. • If the US does not adopt a carbon pricing system when other countries are already doing so, it will be competitively disadvantaged and will likely have to pay border carbon adjustments to other countries.	• A carbon price is just another tax. We are already taxed enough. • Unless we take measures to cushion impacts, a carbon price will result in higher energy and fuel prices for Americans, especially for low- and middle-income Americans. Energy costs will increase directly and also feed into the cost of other goods and services. • Unless the tax proceeds are clearly directed toward specific purposes, the funds are likely to end up being allocated in ways that only benefit narrowly defined agendas, much like pork barrel spending.
If a price is attached to carbon, **the price should start small and then start to increase**.	• Starting small, but with predictable gradual price increases, will encourage immediate action by rewarding companies that quickly reduce emissions in their production systems. • Businesses and households need time to adapt and innovate to reduce emissions so we should proceed in a measured way to avoid shocks to the U.S. economy, while still meeting Net Zero targets.	• The price should start high and remain high to maximize the incentive for industry to decarbonize as quickly as possible. • The price should start high and remain high so proceeds can be used for a range of purposes including carbon dividends, mitigation of impacts to fossil fuel industry workers, and technological innovation.
If a carbon price is charged to companies operating in the U.S., the U.S. should **charge producers of imported goods** for the carbon they emit during the production and distribution of those goods that exceeds what we allow in the U.S.	• Including a border adjustment provision as part of a carbon price would ensure the policy has the intended effect. California policy, which has a price on carbon but no carbon border adjustment, has resulted in a transfer of manufacturing activity to other states and nations with lower carbon standards, reducing California's manufacturing competitiveness while potentially increasing global greenhouse gas. • Europe and Canada are already planning a carbon border adjustment. If the U.S. does not have a pricing system with a carbon border adjustment, U. S. exports to those markets are likely to suffer.	• A carbon border adjustment will make imports from poorer countries more expensive, harming their prospects for economic development. • A carbon border adjustment is a tariff on imports, which is ultimately a tax on American consumers. • Doing this will be very complicated. We should wait until other nations figure it out first, then implement what works.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
	• Other nations will be encouraged to accelerate reduction of their emissions by instituting their own carbon pricing; otherwise they will have to choose between not selling to the most affluent markets in the world or paying a carbon border adjustment.	
The U.S. should allocate some of the revenues from carbon pricing to **compensate low-and-middle-income earners** to offset the economic impact of the transition to net zero.	• Proceeds from a carbon price should be used to reduce or offset any increases in costs for low and middle income households that already pay a higher share of their income for energy and fuel costs. • California's carbon pricing program has produced the highest prices of electricity and fuel in the continental U.S., which are borne disproportionately by low- and middle-income earners; future carbon pricing policies should be crafted in ways that avoid this problem and carbon dividends are a good way to do that.	• This is yet another form of government redistribution of income. • If there is to be a carbon price, proceeds should be spent on innovation and infrastructure because that is the fastest way to transition to Net Zero.
The U.S. should allocate some of the revenues from carbon pricing to programs that **help workers displaced from jobs in traditional (carbon-based) energy industries**.	• As we transition to Net Zero, energy workers and communities built around traditional energy sources will need support, including effective job training programs and compensation for lost jobs. Towns, counties, and schools rely on money from fossil fuel production and everyone in those communities will suffer if we don't provide support.	• The world changes and people must adapt. The government should not intervene, particularly with job training programs like those that have proven to be largely ineffective at transitioning people to comparable-wage jobs in the past.
The U.S. should allocate some of the revenues from carbon pricing to **incentives for innovation and widespread adoption of technologies** to accelerate the U.S. transition to Net Zero.	• Innovation and scale-up is the best thing we can do to accelerate progress toward Net Zero. • China and other nations are pulling ahead of the U.S. in development of alternative energy technology because they are investing more than we are. • The 17 federally funded National Laboratories and the Defense Advanced Research Projects Agency (DARPA) are successful examples of how government and industry can work together to lead innovation, as they have done in the development of artificial intelligence, virtual reality, and the invention of the Internet.	• This is an important investment to make, however the U.S. is already doing so; it doesn't need also to be done with carbon pricing revenues. • Using carbon pricing revenue for other programs takes money away from carbon dividends that can help households afford a transition to Net Zero. • A price on carbon will unleash private sector investments, reducing the need for additional government incentives. Markets are better at picking winners and losers than the federal government, and the price alone will give businesses enough of a signal to innovate.

SMALL GROUP 3

GLOBAL CONSIDERATIONS, AND HOW DIFFERENT PRIORITIES AFFECT THE MIX OF ENERGY SOURCES THAT CAN PRODUCE NET ZERO GHGS

GLOBAL CONSIDERATIONS

Limiting the consequences of too much greenhouse gas in the Earth's atmosphere is a global issue; therefore, the path to Net Zero involves issues of cooperation among nations. Progress won't be achieved if some nations lower their emissions while others fail to act or even profit from continued greenhouse gas emissions. Additionally, the issues of international cooperation are complicated by poverty, inequality, and history. The world's poorest nations are still trying to achieve rapid economic growth and the most basic economic security for their populations. The burdens of climate change may also fall more on very poor nations that will suffer more from the rise in sea levels and be less able to cope with natural disasters than richer countries. Those poorer nations argue that they should not be held responsible for the prior excesses of others, and they should be allowed to increase their energy consumption from their current low levels as they develop even if that means they produce more greenhouse gases.

PATHWAYS TO NET ZERO

The Princeton Andlinger Center for the Environment recently completed a two-year research project to determine if and how the U.S. could achieve Net Zero greenhouse gas emissions by 2050.[104] They concluded that while it would require tremendous change in a very little time, it is both technically possible and there are multiple ways of doing so. To illustrate these alternatives, they project the amount of energy Americans will demand, regionally, by 2050, then offer possible energy source scenarios, called "pathways." These include relying purely on renewable energy sources, inclusion of "next generation" nuclear, and an emphasis on biofuels.

The analysis also notes that the U.S. may decide to pursue a fast transition to electrification or one that is more gradual, and also that different approaches to reducing emissions require different levels of electrification. For example, relying solely on renewable energy, with no role for fossil fuels or nuclear, would require a 400% increase in electrification in the U.S. over the next thirty years (until 2050). Approaches that allow for nuclear and some continued use of fossil fuels coupled with engineered carbon capture and sequestration (in addition to natural sequestration) to offset those emissions require only a 100% increase of electrification by 2050. Trade-offs for each of these approaches are described in the pros and cons, and a real way forward might include a new combination of options, or different approaches in different regions.

This section describes four potential "pathways" for the U.S., drawn from the Andlinger Center scenarios but significantly simplified, for the purpose of highlighting the different features of these different energy approaches while illustrating what a possible energy "pathway" might look like. The definitions of the pathways and their relative pros and cons are shown below.

In considering these options, the use of land deserves special attention in a nation with a long history of land use decisions being largely controlled by local governments. In a report titled "The Power of Place", The Nature Conservancy (TNC) recently modeled 61 different scenarios to meet California's ambitious electrification goals while limiting impacts on natural and agricultural lands. The report reveals that "*a large percentage of areas in the Western United States that would be prime spots for renewable energy development are also some of the most precious natural landscapes and important farmlands.*"[105] It also suggests California can achieve both better costs and conservation outcomes by pursuing renewable resource development and trade on a *regional* basis, i.e. in coordination with multiple neighboring states. TNC expects to be releasing a report analyzing land use scenarios at a national level later this year.

The "Renewables Only" Pathway

This pathway is transitioning by 2050 to "clean" energy sources only: solar, wind, geothermal, hydroelectric and some forms of biomass. The biomass included in this pathway is from agricultural and forest residues and existing non-food crop land only; it does not include diversion of land currently used for food or animal feed production. This path includes no new nuclear plants and assumes retirement of existing nuclear plants. It includes natural carbon sequestration (storing CO_2 in plants and underground) but does not allow engineered carbon capture technologies and sequestration, and allows no fossil fuel use after 2050.

The "Nuclear Complement" Pathway

This pathway includes renewable energy, biomass, and nuclear energy. It assumes that wind and solar generation do not expand as rapidly as in the "Renewables Only" pathway. Renewable electricity is therefore complemented by a new generation of nuclear power plants. As with the "Renewables Only" pathway above, the biomass referred to in this pathway is from agricultural and forest residues and existing non-food crop land only; it does not include diversion of land currently used for food or animal feed production.

The Mixed Technology Pathway

This pathway relies on a mix of energy supply sources including from renewables, nuclear, and biomass. It allows some use of fossil fuels past 2050 provided the resulting greenhouse gas is removed from the atmosphere through carbon capture technologies and sequestration as well as direct air capture of CO_2. As with the two above pathways, biomass in this pathway is supplied without changing of land currently used for food or animal feed production.

The High Biomass Pathway

This pathway adds to the Mixed-Technology Pathway a larger role for biomass by shifting some land use from food crops or animal pastures to energy crops.

BALANCING STATES VS. THE NATION

As noted above, these scenarios are offered to highlight the pros and cons of different approaches. With different weather patterns, energy assets and local values, what works in one state or region may not necessarily work in another. While California currently leads the U.S. in solar energy production, Texas and Iowa lead in wind energy production, Illinois and Pennsylvania lead in nuclear energy production, and North Dakota and Iowa lead in biomass production. What do you think of these different approaches? Do you think the U.S. should pick one pathway for all regions and states, or should each region choose a pathway that best suits their circumstances and values?

Proposals and Arguments For and Against

GLOBAL CONSIDERATIONS

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. should work with **other like-minded nations** to adopt strong policies to achieve Net Zero, and to encourage all nations to contribute to a Net Zero global economy.	• Since the U.S. only generates 12% of global greenhouse gas, the only way to reach Net Zero globally is to work effectively with other nations to achieve significant reductions in global emissions. • While most greenhouse gas emissions to date have come from wealthier nations, this is changing rapidly. Unless we get big emitters like China, India, and Russia to reduce their emissions, our efforts alone won't be enough.	• The US should provide a model for other nations by charting its own course on energy and climate and not be constrained by what other countries do or do not agree on. • The "rich" nations created this problem through excessive use of energy derived from hydrocarbons. Those rich nations have the primary responsibility for fixing the problem and should not place a burden on developing nations.
The US should increase **mining** of its own **essential minerals and metals** needed to manufacture the technologies to reduce greenhouse gas emissions.	• A recent report from the International Energy Agency shows that a concerted effort to hit Net Zero will increase demand for key minerals such as lithium, graphite, nickel and rare earth metals by anywhere from eight to 40 times by 2040. • China has a commanding lead on the supply of these essential raw materials, most of which originate from developing nations. While we should continue to import from these countries, the U.S. must also reduce its dependence on these imports.	• We should not despoil pristine U.S. habitats to increase mining. • Global markets will flow freely enough to take care of the problem. • We should instead invest in more efficient recycling of and development of alternatives to these metals and minerals.
U.S. policies to reduce greenhouse gas emissions should ensure we don't simply **shift emission-producing activities** to nations with lower emissions standards than our own.	• Any policy that transfers productive activity from the U.S. to other nations with weaker emissions standards, without including provisions to address the imbalance of standards (like a carbon border adjustment), will result in reduced economic competitiveness, fewer American jobs, and higher total global greenhouse gas emissions. • While a shift to a "green economy" will generate new jobs, the quantity and wages of those jobs is still uncertain.	• The U.S. must model good behavior even if in the short term it results in a loss of American jobs. • A shift to a "green economy" will also generate new jobs. • A carbon border adjustment is a tariff, which is a tax on consumers
A comprehensive plan for a transition to Net Zero should require wealthier nations to use less energy over time, while **recognizing that poorer nations need to increase** their currently very low energy consumption in order to develop.	• Advanced industrial nations use about ten times as much energy per capita as Kenya, five times as much as India and twice as much as China. The wealthier countries must make a determined effort to use less energy and allow poorer nations an opportunity to catch up.	• There is no shortage of energy globally. Enabling energy sufficiency in the developing world does not require (or even benefit from) decreasing energy consumption in the rich world. • The policy focus should be on reducing emissions regardless of the energy use level. Introducing social goals such as limits on economic growth in industrialized nations detracts from the fundamental purpose and potentially undermines public support.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
	• We cannot get a global bargain to limit greenhouse gas emissions unless it includes a realistic plan for poorer countries to develop economically. The absence of a comprehensive strategy including the need for development in poorer countries will drive mass migration affecting all nations.	• Rich nations like the U.S. developed through hard work and initiative. It is not fair to ask Americans to sacrifice their current levels of consumption so that poor countries can catch up.
International development assistance should work to **slow global population growth** by investing in initiatives that have been proven to lower birth rates, such as increasing women's access to education and contraception.	• Poorer countries have much higher rates of population growth. This means that as they develop and use more energy, there will be an enormous surge in greenhouse gas emissions, unless they reduce their population growth rates. • Extensive research shows that education and access to family planning services for girls are very effective at curbing population growth. Female education has been shown to have a very significant effect in raising the age of marriage and reducing the average number of children that women have.[106] • Globally today girls are 1.5 times more likely than boys to be excluded from primary school, and roughly two-thirds of illiterate adults are women;[107] a well-organized educational campaign could make a difference.	• Efforts to change the behavior of people in distant countries with very different cultures require many years, even decades, to work, if they ever do. The U.S. should focus its limited resources and time on actions with a more certain likelihood of producing timely results. • We shouldn't meddle in the cultural affairs of other nations.

NET ZERO PATHWAYS[108]

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. should plan to reach Net Zero by **only using renewable energy sources** (wind, sun, hydropower, geothermal and some forms of biomass).	• By eliminating the use of coal, oil, and gas by 2050, this pathway will remove the biggest source of our greenhouse gas emissions. • Energy from these renewable sources is the cleanest and safest option. • The cost of solar and wind energy is becoming competitive with the cost of fossil fuel energy and continues to decline. Battery costs are declining, and they are already starting to be deployed by some utilities. • This offers the greatest potential of any pathway to create good-paying jobs for Americans.	• This pathway to Net Zero will result in a quadrupling of electricity use by 2050, including increasing installed solar capacity by 39 times and wind capacity by 28 times in the three decades from 2020 to 2050, which will be very hard (if not impossible) to achieve. • The cumulative land area required by 2050 will equal the size of Arkansas, Iowa, Kansas, Missouri, Nebraska, Oklahoma and West Virginia combined, and interfere with wildlife habitat and prime farmland. • The degree to which a "renewables only" pathway will create more jobs than other pathways is partly dependent upon where relevant products are manufactured. While installation of solar panels and wind turbines will create U.S. jobs, nine of the ten largest manufacturers of photovoltaic solar panels are in China, which has a 60% global share of this market and 40% share of the global wind turbine market.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
		• While we should try to minimize fossil fuel use, we have to be conscious of unintended consequences, such as impacts on the production of pharmaceuticals, plastics and chemicals, on the cost of living, and U.S. jobs. If we can use carbon capture and similar technologies, we don't need to eliminate all fossil fuel.
The U.S. should include **new-generation nuclear energy that minimizes waste and safety risks** to complement renewable energy sources.	• Use of new-generation nuclear offers clean, flexible, reliable energy that will reduce the cost and accelerate the pace of the transition. Small, advanced reactors are regarded as a critical carbon-free technology than can supplement intermittent power sources like wind and solar. • If climate change is in fact an existential threat, then we should be pursuing all zero-emission options rather than just politically favored technologies. We can't get to Net Zero in time unless we use every available alternative to fossil fuels. • Contrary to conventional wisdom, new-generation nuclear is much safer than carbon-based energy. And there is an abundant supply of some of the newer nuclear materials, such as Thorium.[109]	• Even if the timetable and cost to Net Zero are adversely impacted, we should not continue to rely on energy sources that could be unsafe and/or damaging to the environment. • While new reactors may produce less waste, the U.S still doesn't have a plan for permanent disposal. • Assuming the U.S. starts producing its own renewable components, like solar panels and wind turbines, this pathway offers the least job growth opportunity of all the alternatives. • The biggest problem with nuclear is that, even with optimistic assumptions, it takes too long to build. We don't have time to wait for new technologies.
In addition to renewables and nuclear, the U.S. should allow for some **continued use of fossil fuels past 2050, coupled with carbon capture**.	• This pathway to Net Zero will result in a more manageable doubling of electricity demand by 2050, only about half of that for the renewables-only option. • Compared to the renewables-only pathway, this pathway requires only about 1/4 of the land, and about $2 trillion less in transition costs. • Carbon capture would make it possible to continue using limited quantities of fossil fuel because their emissions, or a portion of them, could be removed from the atmosphere.	• We should not be using carbon capture technologies as an excuse to avoid getting rid of the energy sources that have created our global warming problem. While we may need carbon capture for a small percent of emissions, it should be considered a last resort and not a primary strategy. • This pathway will reduce use of oil and gas only by 56% by 2050, a lot less than a renewables-only pathway. • Renewables are cheaper than fossil fuel energy with carbon capture technologies, which are still emerging.
In addition to renewables, nuclear, and some fossil fuels, the U.S. should require allocating **some agricultural lands from food to energy** to significantly increase production of biofuels.	• As with the previous pathway, this pathway will result in a more manageable doubling in electricity demand by 2050. • This pathway requires about 30% less land and about $1 trillion less in transition costs than the "renewables-only" option. • The combination of biofuel, hydrogen and carbon capture results in a very "clean energy" option: The biomass sequesters carbon until it is burned, the carbon-capture prevents emissions from entering the atmosphere when it is burned, and the hydrogen itself emits no greenhouse gas.[110]	• This pathway will only reduce use of oil and gas by 62% by 2050, compared to 100% for a renewables-only pathway. • It will require about three times as much land and about $1 trillion more in transition costs than the mixed technology pathway that uses only nuclear, renewables, and some fossil fuels. • Hundreds of biomass conversion facilities would need to be built, and transporting biomass long distances to conversion facilities is costly.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
		• A study from the American Association for the Advancement of Science concludes that, "as farmers worldwide respond to higher prices by converting forest and food crops to fuel crops, greenhouse gases actually increase substantially."[111]
Rather than follow a single pathway, a comprehensive U.S. plan should **require that all states meet federally set goals but give states flexibility** to choose the pathway that best suits their needs and energy assets.	• Cost-effective energy sources vary significantly between states. The same is true of energy distribution assets. What works in California may not work in Virginia or Wyoming. • The values and beliefs held by residents of different states also vary significantly. Some states may find new-generation nuclear to be an acceptable alternative while others may not. • This approach would allow states to partner with each other to develop and implement Net Zero pathways that optimize use of energy sources and distribution assets.	• It will take too long for each state to figure out their pathway to Net Zero. It's best for the federal government to define a national pathway and require every state to adhere to it. • Our energy systems are interconnected across states and regions. We need a more coordinated effort.

SMALL GROUP 4
PRACTICAL CONSIDERATIONS IN CRAFTING AND IMPLEMENTING A U.S. PLAN TO REDUCE GHGS

A transition to net zero would require not only technological solutions, but also a political framework to guide and manage this transition over at least three decades, with full consideration of its economic and social impacts. Some argue this will require a comprehensive plan, designed to avoid unfair burdens throughout the country. Others might argue that such a national plan is not necessary, or even possible.

There are many potential benefits from transitioning to a Net Zero economy. Americans should expect to experience improved public health and less severe natural disasters over time than would otherwise occur. But it's not a given that everyone will benefit economically unless this is an explicit part of the transition plan. For example, it is often asserted that there will be more jobs for Americans, but that will not happen without a plan that defines what types of jobs should be prioritized and how American manufacturing and business will remain competitive during and after the transition. Currently, most U.S. clean energy technology is imported from other nations, primarily China. Hence, the U.S. will need a plan to ensure access to the raw materials required to produce domestic energy and/or find efficient recycling methods or alternative materials. Even if we solve these problems, who will bear the costs of the transition and what will be the roles of the private sector and of the local, state, federal governments?

California's experience already shows that there are likely to be higher energy costs during a transition. Many other communities and states currently derive a significant percentage of their tax revenues from the fossil fuel industry and they use those tax revenues to fund services for their residents. Are there ways to manage the transition and cushion those states and populations from some of those losses? During the transition, can we ensure affordable and reliable energy without the blackouts and brownouts that have been seen in Texas and California? How can we ensure that the cost of the transition is equitably shared? Should the transition plan include provisions to help communities that have been harmed by past environmental practices? Can all this be accomplished while retaining American economic competitiveness? If American products are produced with higher environmental standards in comparison to products from other countries, they may be at a competitive disadvantage, not only in the US market, but in the global economy. These are considerations the proposals are trying to balance.

As discussed earlier in this briefing book, greenhouse gas emissions are a global challenge. Because the U.S. generates only about 13% of global greenhouse gas emissions, even full success in attaining Net Zero in the U.S. will not prevent Americans from experiencing the more destructive effects of climate change if other nations aren't making similar changes. Some policy proposals address whether the U.S. should have plans to ensure that other countries are also seriously engaged in doing their part to achieve net zero.

Not everyone agrees that the U.S. needs a comprehensive transition plan. Some believe that the transition should be determined by the market, with as little intervention from government as possible. Others believe a transition plan is indispensable. Among the latter, there are two camps: Some believe climate change has reached a crisis stage, and the federal government should declare an emergency and issue mandates that apply throughout the nation. Others see this as contrary to America's federalist roots, and believe the federal government should limit itself to setting broad national goals and policy guidance but allow flexibility for local governments and the private sector to determine optimal pathways that best engage regional assets and values.

The proposed policies consider what role the government should play in regulations and/or incentives in encouraging innovations, promoting timely changes, and policies towards land use for agriculture, energy

production, and wildlife habitat. The arguments for and against in the table below share some of the tradeoffs that these policies should consider.

Defining a transition plan requires deciding who will do what. The National Academy of Sciences has recommended a White House-level Office of Equitable Energy Transition and a new independent National Transition Corporation that could be insulated to some extent from two- and four-year election cycles. This is one of many possible models, and you may have your own recommendation.

A 30-year transition plan is a long time. The budget for plan implementation would certainly need to be adjusted from time to time based on new information, technological developments, observed impacts, and so on. How might the US manage such a process over multiple decades, in a way that can accommodate the many changes that will occur during that period, and is that realistic? Finally, since priorities are also reflected in budgets, should the U.S. develop a long-term national budget to identify costs of the transition and a plan for who will pay for them? How much of such a budget should come from taxpayers? How much should come from investments made by the private sector?

Proposals and Arguments For and Against

CONSIDERING THE IMPACTS ON PEOPLE AND COMMUNITIES WHEN PURSUING REDUCED EMISSIONS IN A COMPREHENSIVE U.S. PLAN.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
Have the US reach Net Zero by 2050, and sooner if possible.	• Multiple independent studies have concluded that 2050 is an achievable goal for reaching Net Zero, so long as the U.S. and other countries show substantially accelerated progress by 2030. • The Paris Climate Agreement, which has been ratified by 191 (out of 195) nations, calls for a balance between emissions and removals (Net Zero) in the second half of this century. • If the U.S. (along with other major greenhouse gas emitters) does not seriously commit to achieve this goal, the world's nations risk passing a point of no return with regard to severe and irreversible increases in global temperatures, caused by greenhouse gas emissions.	• Even if it is just aspirational, we should shoot for a more aggressive goal than 2050, recognizing that there may be some slippage if scaled-up innovation does not materialize as hoped for. • We should commit to a specific timeline that is shared by other major greenhouse gas emitting nations. Failure to do so will create U.S. economic disadvantage and job losses for Americans. • Every decade there are people who swear the U.S., and the world, are on the brink of disaster due to rising temperatures globally, yet we are still here. This may be important, but no one knows for sure what the right date is or how much time we really have.
Specify how the costs of the transition will be **reduced for low-and-middle income Americans**.	• The only way to ensure that a future energy system avoids worsening economic insecurity among low and middle-income Americans is to clearly define how all Americans can transition to this new system without additional economic hardship.	• It will take too much time to figure this out in any kind of detailed way ahead of time; if we don't reduce greenhouse gas emissions fast enough everyone will be harmed and there will be no way to reverse course. We need to just agree this is a priority and work out the details as we go.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
	• Inadequate attention to social equity impacts, economic competitiveness and economic dislocation has been a barrier to building sustained American consensus for moving to Net Zero in the past. • Individuals need to know they will be able to afford a transition to clean-powered products such as electric vehicles, electric stoves, electric dryers, heat pumps, solar roofs, and more.	• This may increase income redistribution and represent an unnecessary expansion of government.
Specify how the transition will ensure a **reliable supply of energy** for all communities.	• If we take advantage of the full range of options for reducing greenhouse gas emissions in how we produce energy, it should be possible to meet our needs while ensuring a reliable, predictable energy supply for all communities in the U.S. • Brownouts or blackouts such as have recently been experienced in Texas and California, take a major toll on affected families, health care service and businesses, and should not be considered acceptable trade-offs in achieving a transition to net zero greenhouse gas.	• We must press on to achieve our sustainability goals, even if it occasionally inconveniences Americans. • We may need to change our expectations regarding energy access and availability. At some point Americans and others may need to figure out how to sustain a decent quality of life with less power, so that there is enough for everyone.
Specify how the transition will ensure **that energy is affordable** for low-and-middle-income Americans.	• If we take advantage of the full range of options for reducing greenhouse gas emissions in the production of energy, it should be possible to navigate the transition while ensuring affordability. • If people in the U.S. can't afford their energy bill as a result of Net Zero transition policies, we will have gone backward as a nation. This could not be called progress by any definition.	• People at all income levels will ultimately benefit from the transition to Net Zero, and all of us together will be harmed if we don't make it in time. Our top priority has to be making the transition, soon.
Minimize impacts on **U.S. economic competitiveness**, in particular **job impacts** for American workers during and after the transition.	• Many thousands of jobs in the U.S. and economies of numerous states are tied to fossil fuel-dependent industries, not just fossil fuel extraction and refining, but also pharmaceuticals, chemicals, plastics, building materials and many more. Failing to take serious steps to minimize the impact of a transition away from these energy and feedstock sources would have dire economic and social impacts on people and communities throughout the country. • Americans need to be convinced that assurances made by politicians that the transition will generate more jobs at comparable wages are real.	• A comprehensive plan should focus on getting to Net Zero at the earliest possible date. Examining and understanding the economic and social impacts and trying to offset them is important but should not be allowed to delay action.
Help remedy conditions in **communities that have been harmed by past environmental practices**.	• Many communities throughout the U.S. have been gravely harmed, in some cases over multiple generations, by irresponsible industrial and agricultural environmental practices. Inclusion of steps to remedy this past damage in a comprehensive transition plan to Net Zero would be both efficient and fair.	• These are extremely important issues, but this isn't the place to remedy them; there are other more appropriate programs and methods for addressing legacy environmental issues without adding this to the climate change agenda and budget.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
	• It is often lower-income communities that have been the most harmed, and they are most in need of remedies.	
Specify how states that currently depend on tax revenues from the fossil fuel industry can **transition to other sources of revenue**.	• Some states and communities rely heavily on tax revenues from the fossil fuel industry to provide services to their residents. Failing to develop plans for replacing that revenue with realistic and sustainable alternatives will create serious economic hardship in these areas and political impediments to accelerated progress.	• The economy changes over time with different industries rising and falling in importance and states and communities adapt eventually. Affected regions should be planning ahead rather than expecting bailouts. This isn't a surprise; this situation has been building in importance for decades.
The selection of locations to produce large-scale renewable energy should prioritize **lands that are low impact for wildlife and habitat**.	• Siting of renewable energy facilities should be done in a way that seeks to minimize environmental damage, facilitate sustainable water management, and protect important habitat and linkages for wildlife. These values of sustainability will protect all Americans' quality of life and well-being as we strive to adapt to changing climate conditions.	• Consideration of wider values such as water management, or protection of wildlife habitat will only add to the cost of developing renewable energy – which is already too high.
Locations for large-scale solar energy should prioritize development on **lands that do not impact prime agricultural land**.	• Prime farmland is essential to meeting current and future food demands. Large-scale solar projects should only be sited on marginal farmland. • The impact of solar installations on water management has also been a concern; analysis has shown that taking marginal farmland out of production can be done in a way that supports sustainable water management. • Research shows these goals are not mutually exclusive: The Nature Conservancy's Power of Place report concludes states should be able to meet solar energy targets without relying on prime farmland if states partner with each other to implement regional strategies.[112]	• Priority has to be given to renewable energy production if we are going to get to Net Zero. • Especially in the western U.S., we need to reconcile energy and water use to make both agricultural production and development of solar and other renewable energy sources more sustainable.
Create strong incentives for all **other nations to join the U.S.** in expediting the transition to a Net Zero global economy.	• The Paris Agreement produced broad goals but no binding agreements, and the results thus far fall substantially short of actually meeting the intended goals. • The U.S., Canada, the 27 Europe union countries and the U.K, which collectively generate less than 25% of global greenhouse gas emissions, can't solve this problem on their own. All major greenhouse gas emitting nations will need to cut their emissions. • If the November 2021 Glasgow global climate conference is to produce real progress, it must have a mechanism to encourage all nations to participate in the solution.	• Wealthier industrial countries have over many decades contributed disproportionately to the problem and should therefore make by far the greatest contribution to the solution.

HOW TO IMPLEMENT A PLAN / POLITICAL CONSIDERATIONS

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The U.S. government should **declare a national emergency** to enact a comprehensive national plan and **mandate that clear goals be met**.	• Failure to act earlier has created an emergency that the U.S. must now address with a high level of urgency. We have no assurance of reaching Net Zero unless the U.S. Government takes decisive action. • If we don't treat climate change as a national emergency now, the rising pace of climate-related disasters will devastate communities and our national economy in ways that lead to even greater expansion of government authority.	• The energy assets of different states and regions vary greatly. A top-down, "one-size-fits all' approach will not work. • The pace at which we attain Net Zero will be heavily influenced by innovation. In America, that innovation will come largely from the private sector. • Declaring an emergency would enable the federal government to assume powers that could threaten our freedoms.
The U.S. Government should require that states meet broad goals and measure progress but **allow states and the private sector maximum flexibility to achieve those goals**.	• States and regions have different energy assets and transmission infrastructure. What works in Pennsylvania may differ from what works in Wisconsin or Tennessee. So long as they meet national goals and timelines, every state should contribute through strategies that optimize the time and cost to attain Net Zero. • States and regions should be able to contribute based on the values of their residents. For example, residents of some states may find nuclear energy acceptable, while other states may not. • The federal government lacks the capacity to do in essence a full rewiring of each state's economy. Every other major environmental law has taken a decentralized approach, and we have seen substantial progress in cleaner air and water as a result. Where cooperation across states is needed, states have shown they can achieve this through state compacts and less binding voluntary associations.	• It will take longer to orchestrate the work of states and regions as well as the private sector than it would to provide clear federal mandates for action. The fastest path to Net Zero is through policy mandated by our elected leaders in Washington D.C. • There is less certainty that fifty state plans will produce the required results than will a single plan implemented at the federal level.
The U.S. Government should not play an active role in setting goals, timelines or monitoring progress, but rather let the **free market** make the needed changes.	• Our goals as a nation are best achieved when the private sector takes the lead and the government "gets out of the way". That doesn't mean getting rid of regulations, but it does suggest removing bureaucratic obstacles to enable progress at the rate that is required in this case.	• As a representative democracy, we elect our leaders to provide us with a comprehensive view of what communities need and clear mandates to address emergencies. Markets do not always work perfectly or fast enough—that is why we sometimes need government regulation. The climate situation is too urgent and the consequences of delay too catastrophic for human wellbeing to wait for the market to work and hope that it produces the right result.

PROPOSALS	ARGUMENTS FOR	ARGUMENTS AGAINST
The President should designate who is responsible for coordinating the development of a comprehensive public-private transition plan.	• Given that multiple levels of government and the private sector would need to be involved in developing such a plan, revising it based on real-time information, and implementing it over multiple decades, a coordinating function is vital. • The National Academy of Sciences and other independent institutions have concluded that federal level coordinating entities are needed to successfully address both the technical and socio-economic challenges of Net Zero attainment, and the President is the only office with the authority to determine this role. • This doesn't mean the federal government has to be heavily involved in decisions that would be better made at the state level, but only in the steps needed to ensure efficient progress. • Both the private sector and all sectors of government need policy predictability to invest at the level that will be required to achieve these goals; accomplishing this quickly will require federal coordination positioned to collaborate with the states.	• Private and public entrepreneurship should drive the transition; the U.S. doesn't need a coordinated plan. • This proposal gives too much power to the presidency. Congress needs to be much more involved.
The President and Congress should develop a **long-term budget** that shows how much the transition will cost, how the funding will be provided, and who will pay.	• We need to understand how we will fund all elements of the transition, including the cost of new infrastructure, maintenance of existing infrastructure until the transition is complete, incentives for technology development and scale-up, mitigation of transition costs for low- and middle-income Americans, support programs for dislocated workers and communities, and costs to help lift communities environmentally impacted by past practices. • Much of the needed funding will come from the private sector, but in order to attract investment, the federal government will sometimes have to fund catalytic action, reduce the risk of innovative projects, and provide policy and funding predictability. • Assurance that the future energy system will equitably benefit all Americans will not come without a plan that is backed up with funding commitments.	• It is too difficult to predict all the costs over a thirty-year time frame. This is an existential threat that we must be committed to solve irrespective of the costs. • This smacks of government planning, and the government already has too much power. • We need to start taking action now and adjust as needed.
States and Congress should **streamline regulations that slow or impede progress toward Net Zero**.	• If the U.S. does not address outmoded regulations and streamline siting decisions, technological innovation will be slowed, investments will take longer, costs will be higher, overall effects on workers and households will be more severe, and adjustment by the rest of the economy will be prolonged and more painful.	• Regulations exist for a reason. Eliminating them may put people and the environment at risk. It is important to keep protection of the public as our highest priority, even if it means that projects take more time to be approved.

ABOUT THE ORGANIZERS

Helena is a global problem-solving organization. Through Helena Projects, Helena seeks to implement solutions to critical societal problems. Since its founding in 2015, Helena Projects have included: America In One Room, which garnered the attention of President Barack Obama and The New York Times for one of the most significant political experiments in US history; Factory in the Sky, which supported the development and construction of the world's first carbon capture factory; Shield, which worked to protect the electrical grid from foreign and domestic threats; and most recently The Covid Project, which supplied tens of millions units of medical supplies and personal protective equipment to frontline responders during the COVID-19 pandemic. To learn more about Helena, visit helena.org.

The Center for Deliberative Democracy at Stanford University is housed in the Department of Communication. The CDD is devoted to research about democracy and public opinion obtained through Deliberative Polling®. The method of Deliberative Polling has been used in over 30 countries and jurisdictions around the world through over 110 projects, at varying levels of government and society. To learn more about the CDD, visit: cdd.stanford.edu.

NORC at the University of Chicago is an objective, non-partisan research institution that delivers reliable data and rigorous analysis to guide critical programmatic, business, and policy decisions. Since 1941, NORC has conducted groundbreaking studies, created and applied innovative methods and tools, and advanced principles of scientific integrity and collaboration. Today, government, corporate, and nonprofit clients around the world partner with NORC to transform increasingly complex information into useful knowledge.

The Greater Houston Partnership is the largest chamber of commerce in the Houston area. The Partnership is an economic development organization for the Greater Houston area, including the counties of Austin, Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, San Jacinto, Waller, Walker and Wharton. The Greater Houston Partnership champions Houston's growth and success by bringing together business and civic-minded leaders to address the region's unique challenges. The Partnership's mission is to make Houston one of the best places to live, work and build a business.

California Forward leads a statewide movement, bringing people together across communities, regions and interests to improve government and create inclusive, sustainable growth for everyone. A 501(c)(3) organization, CA FWD drives collective action to identify solutions that can be taken to scale to meet the challenges the state is facing. The organization is driven by the belief that this collective action will help ensure the economic, environmental and social prosperity of all people.

In This Together is a collective of Republicans, Democrats and Independents working to bridge the partisan divide by prioritizing environmental protection and energy innovation policies among elected officials, partner organizations and voters. The mission of In This Together is to identify and bring together millions of "problem solver" voters to renew democracy and protect the planet. Supported by the Donor Roundtable and dozens of strategic NGO partners, In This Together is leading with programs such as Climate of Unity, Defund Hate, and an Orange County pilot program, all while working closely with data partners to establish a 5 million problem solver voter database.

Center for Houston's Future works to address matters of highest importance to the long-term future of the greater Houston region, by engaging diverse leaders, providing impactful research, and defining actionable strategies. CHF brings business and community together to innovate for the future of the greater Houston region. CHF is an organization devoted exclusively to thinking and acting strategically for the long-term future of the Houston nine-county region.

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*Participation and counsel is personal and not on behalf of the organization

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GLOSSARY

(in alphabetical order)

Afforestation. The process of planting trees and plants in areas where they did not exist before.

Biofuels. Fuels made from plants and crops.

Border carbon adjustment. A tariff that foreign producers would have to pay at the U.S. border if they do not pay a carbon fee in their own country equivalent to what the U.S. charges its own producers.

Cap-and-trade system. A system that places a cap on the amount of carbon emissions companies may produce (called "allowances") but permits them to buy rights to produce additional emissions from other companies that do not use all of their own allowances.

Carbon capture, utilization and sequestration (CCUS). A process that captures carbon dioxide emissions from industrial processes and either reuses or stores (sequesters) it deep underground in geologically stable areas where it can remain for thousands of years.

Carbon dividend. A system where the money collected from the carbon fee is returned directly to the American population.

Carbon fee/carbon tax. A fee that businesses pay to the government (essentially a tax) based on how much greenhouse gas they emit.

Carbon pricing. Different methods of incentivizing businesses to reduce their greenhouse gas emissions and encouraging private sector investment in cleaner options.

Centralized power grid. A power grid generating large-scale electricity at centralized facilities.

Clean Energy Standards. Standards that provide utilities with incentives for adding more clean power and impose penalties for failing to do so.

Combustion. The process of burning.

Deforestation. The action of clearing a wide area of trees.

Direct Air Capture. A technology to pull CO2 out of the atmosphere and either store it underground or use it in production.

Distributed power grid. A power grid generating electricity where consumers can generate their own electricity (for example with solar), store it, and sell the excess back to the grid or each other, will make energy supplies in the U.S. more reliable and secure.

Electrolysis. The process of using electricity to split water into hydrogen and oxygen.

Emission abatement. Any measure taken to reduce emissions or their impact on the environment.

Energy-dense. An energy source that delivers enormous energy per unit of volume.

Enteric fermentation. Fermentation that takes place in the digestive systems of animals, producing methane.

Feedstock. Raw material or fuel required for an industrial process.

Fission. A process where the nucleus of an atom breaks into two parts, which can cause a chain reaction and produce massive amounts of energy.

Fracking. A procedure that splits open rock with a high-pressure stream of water, and then props it open with tiny grains of sand, glass, or silica, allowing trapped gas to flow more freely out of the well.

Geothermal energy. Energy derived from heat within the earth.

Greenhouse gases (GHG). Gases like carbon dioxide and methane that trap heat in the atmosphere.

Horizontal drilling. A method of drilling at a nonvertical angle allowing previously unproductive rocks to supply shale gas among other types of natural gas and oil.

Hydroelectric power. Energy derived from harnessing the power of water in motion, generally with dams.

Hydrofluorocarbons (HFCs). Any organic compound composed of hydrogen, fluorine, and carbon, used in refrigeration, air conditioning, and other common appliances.

Load shifting. A technique that moves energy demand from peak periods to off-peak periods of the day.

Marginal farmland. Farmland that has low agricultural value.

Modular reactors. Nuclear reactors designed for serial construction and to collectively comprise a larger nuclear power plant.

Net Zero. The total of all greenhouse gases released into the earth's atmosphere each year equals the amount removed by nature or by human engineering.

Paris Agreement. An international agreement adopted in 2015 calling for all nations to limit the rise in average temperature to under 2º centigrade above pre-industrial levels. The U.S. announced it would withdraw from the treaty in 2017, but rejoined in 2021.

Particulate matter. A mixture of tiny solids and liquids found in the air.

Photovoltaic solar panels. Solar panels that directly convert sunlight into electricity.

Pork barrel spending. When taxpayer funds and government spending are used for localized projects and special interest groups.

Reforestation. The process of planting trees to recover forests that have previously been diverted to other purposes.

Self-generation. The use of energy developed on-site by the energy consumer, reducing the amount of energy taken from the grid

Social cost of carbon (SCC). The projected cost of the harm to society of releasing one ton of carbon into the atmosphere.

Thorium. An element more abundant in nature than uranium, which is not fissile on its own (meaning reactions can be stopped) and produces less radioactive waste.

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