ADVANCING TECHNOLOGIES, MARKETS, AND POLICIES TO ACHIEVE A NET-ZERO ECONOMY

A Report from
2022 Aspen Institute Winter Energy Forum

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EXECUTIVE SUMMARY

Achieving a net-zero economy will require innovations and advancements in technologies, markets, and policies.

Every topic related to clean energy and a net-zero economy is affected by policy, and Congress has produced some notable bipartisan clean energy and climate wins the past couple of years. There has been record support for major energy technology innovation programs, including in the 2021 bipartisan infrastructure law, which also appropriated billions of dollars for other climate-related needs. Despite the magnitude of spending in the law, it has been overlooked a bit, seen by climate advocates as secondary to the stalled Build Back Better bill. There will be more opportunities to advance climate priorities in this Congress and future Congresses, including additional opportunities for bipartisan climate policy action. The Biden Administration, meanwhile, has been pursuing a multitude of domestic and international climate initiatives across the entire federal government to fulfill the President's campaign focus on re-establishing U.S. climate leadership and building a clean energy economy. The United States made progress globally in 2021 by riding on the excitement of a new Administration and a strengthened national climate commitment, but the country has to start delivering on its commitments and passing ambitious domestic policies.

Achieving a net-zero economy will require innovations and advancements in technologies, markets, and policies.

Given the need for rapid decarbonization, some question whether the Federal Power Act (FPA) and the Federal Energy Regulatory Commission (FERC) are still fit for purpose. FERC prefers to leave environmental issues to environmental regulators, but FERC has some tools relevant to the energy transition, such as enabling innovative new technologies to compete in wholesale markets. It is not clear if FERC could impose a price on carbon, but it could approve a regional transmission organization (RTO) taking steps to incorporate a state's carbon price. Decarbonization will also require building a lot more transmission infrastructure, but the FPA's split of jurisdiction between the states and the federal government (unlike for gas pipelines) means there are constant fights and lengthy delays in getting transmission lines built. In the bipartisan infrastructure law, FERC got backstop authority for siting transmission (though FERC may not exercise it), but some transmission advocates argue that states have to be taken out of the interstate transmission business. At the moment, though, there are not the votes in Congress to open up the FPA. While some are pushing for more central planning on transmission, many are at the same time pushing for more competitive wholesale markets for generation. There are questions about whether FERC should require all states to participate in something that looks like an RTO, whether market design and data should be standardized, and whether FERC should also have jurisdiction over the distribution system. In addition, markets need to better recognize that power is not a single-attribute commodity, but rather has multiple dimensions, including time, place, environmental quality, flexibility, and reliability.

Deep decarbonization efforts have long been hindered by trade and competitiveness concerns, but that script might be starting to flip. Some countries are considering implementing carbon border adjustments — or, collectively, a carbon club — to avoid economic harms and carbon leakage, factor in embedded carbon, and recognize the carbon intensity of production in different countries. The United States and the European Union both like the idea of setting up a carbon club but do not agree on the core framework, such as the requirements for entry into the club and the adjustment at the club's borders. The nuts and bolts of policy design really matter, with implications for the club's ability to secure country participation, withstand World Trade Organization (WTO) challenges, protect the least developed countries, and measure embodied carbon. There is bipartisan interest in monetizing the relative carbon efficiency of the U.S. economy, and a

carbon club could be a chance to redo the foundations of global trade for the 21st century and to disrupt the domestic and international politics of climate change.

The role of private-sector actors in voluntarily driving decarbonization remains more critical than ever, but the quasi-regulatory rules and standards that guide decisions about electricity procurement and carbon credits may not be keeping up. With respect to electricity, the current rules have driven significant levels of wind and solar procurement but are not designed for, and do not have the effect of, optimizing emission reduction impact. Some companies are shifting focus to procuring carbon-free energy with grid decarbonization impact. The standards have to change with the times, which will require metrics such as locational marginal emissions to better account for the emissions displaced by clean energy on the grid at a specific place and time. The next version of the standards could be made more rigorous, but a balance has to be struck between rigor and maintaining a big tent to bring in as many actors as possible. With respect to the voluntary market for verified carbon credits, credits now are mostly for emissions avoidance and reductions, but the market will likely shift to focusing more on carbon removals over time. Achieving scale in the voluntary carbon market requires a foundation of integrity in terms of supply, demand, and accountability, including to address critiques regarding offsets and credits. As with electricity procurement, though, making the aperture too narrow regarding credits could make it harder to have a big tent.

Divesting shares of a publicly traded company just means the original investor no longer has a say in how that company allocates capital.

Capital markets and investors focused on environmental, social, and governance (ESG) issues are among the biggest drivers of company action. The recent progress on ESG has been incredible in pace and momentum. Many trillions of dollars' worth of assets under management are now committed to a net-zero timetable, and decisions about which companies are included in ESG indexes — and which ones to lend to — will become even more intense as financial actors figure out how to meet their net-zero commitments. It is important to figure out how to harness the power of ESG to be more climate-optimized. Exclusion is probably the oldest and bluntest approach to avoiding risks, though some negative screens cover things that may be climate solutions (e.g., nuclear power), and divesting shares of a publicly traded company just means the original investor no longer has a say in how that company allocates capital. Some criticize ESG funds for focusing primarily on avoiding sectors with climate risk, as opposed to finding companies within sectors that are leaders and recognizing the potential for alpha in companies proactively creating positive climate impact. Once ESG funds and ratings are based less on disclosure and more on actual performance, there will be clearer differentiation in costs of capital for ESG leaders within a sector, though it is not yet clear how companies whose emissions are insignificant but whose products can be part of the solution can show up in portfolios. Private-sector net-zero ambitions have to be paired with supportive policies (in addition to regulation). Governments have to send a signal to drive markets towards carbon impact.

One sector that is starting to grapple with its climate impact is maritime shipping — a "hard to decarbonize" industry that is the lifeblood of the global economy. There are debates about which fuels and technologies are the right ones to decarbonize shipping, and the fuel mix landscape will likely be complex. Electrification seems to be an option only for some types of ships. Industry members are starting to invest in different technologies they believe in, including green methanol, ammonia, and nuclear, all of which have pros and cons. Given that ships last for decades, the ships that matter most for decarbonization are already on the water, which means efficiency improvements (e.g., slow shipping, wind sails) and retrofits to use zero-carbon fuels (where feasible) will be vital. Customer demand signals, domestic and international policy and regulatory support, and maritime financing can all be important levers for accelerating maritime decarbonization solutions. At the same time, ships and shipyards can leverage other decarbonization opportunities.

There is a lot of money, interest, and innovation going into hydrogen as a climate solution as well. Most of the hydrogen produced today is carbon-intensive "gray" hydrogen made from fossil fuels, but many options exist or are being explored

to produce zero-carbon hydrogen, including "green" hydrogen (zero-carbon electricity and electrolyzers), "turquoise" hydrogen (high-temperature pyrolysis of methane), and "blue" hydrogen (fossil fuels with carbon capture). These are all more expensive right now, but costs are coming down, and all the different colors may have roles to play. A clear starting market for zero-carbon hydrogen could be the sectors of the economy that already consume significant volumes of gray hydrogen. From there, potential uses may lie in heavy-duty transportation, steel and cement production, electricity production, and more. There is still a lot of work to be done to create the demand and to find the off-takers for zero-carbon hydrogen. There are also key challenges to address, including methane leakage (for blue hydrogen), how electrolyzer facilities interact with the grid (for green hydrogen), hydrogen storage and transport, and hydrogen leakage (and its potential climate impact from slowing the degradation of methane).

STATUS OF FEDERAL POLICY

Policy is critical. Every topic related to clean energy and decarbonization of the economy is affected by policy, whether as an accelerant or an impediment.

CONGRESS

It has been a remarkable couple of years for bipartisan clean energy and climate policymaking in Washington. The focus is often on all the partisan discord and disagreement about climate policy in the United States, which is real, but there is too little appreciation of the areas of bipartisan agreement and the strong record of bipartisan progress over the past couple of Congresses.

Given the short timeframes to address climate change, there are three types of projects that need to be advanced: technology-driven projects pursuing clear technology and cost goals; capital availability projects focused on unleashing the markets to fund needed infrastructure (e.g., by de-risking projects); and sandbox projects to get incumbents, insurgents, and innovators to work together. The focus of the bipartisan push has been primarily on the first of these — innovation in technologies needed to get the global economy to net-zero on any meaningful timeframe. The recent bipartisan progress started with the Energy Act of 2020 (adopted in the December 2020 bipartisan omnibus bill), which was a huge coming-together of several years of policy development. In authorizing huge expansions of funding for several major energy innovation programs, the law represented the largest commitment of funding in the low-carbon energy space ever. The Energy Act of 2020 also included authority for the Environmental Protection Agency (EPA) to phase down hydrofluorocarbons (HFCs), as well as many other provisions.

It has been a remarkable couple of years for bipartisan clean energy and climate policymaking in Washington.

In 2021, Congress enacted the bipartisan infrastructure law (the Infrastructure Investment and Jobs Act), which fully appropriated funds for all the major innovation programs authorized in the Energy Act, including demonstrations for advanced nuclear, long-duration storage, carbon capture, and geothermal. The bipartisan infrastructure law also included billions of dollars for weatherization, state and local energy programs, distribution and transmission upgrades, electric vehicle (EV) charging, existing nuclear plants in competitive markets, direct air capture (DAC), batteries, recycling, manufacturing, industrial hubs for clean hydrogen, cleaning up orphaned oil and gas wells, and more. The law reflected a tech-inclusive, global approach.

The demonstration programs authorized in 2020 and funded in 2021 are akin to a new Manhattan Project in scale. The bipartisan infrastructure law increased Department of Energy (DOE) funding for energy demonstrations by a factor of six. Given the magnitude of spending in the bipartisan infrastructure bill, it is notable that it is not being talked about more. The infrastructure bill has been overlooked a bit, as it was always seen as secondary to the more partisan Build Back Better bill for climate advocates.

Build Back Better included billions of dollars of investment in climate, including long-term extensions of tax credits and investment in clean energy manufacturing. Many climate and clean energy provisions were stripped from the bill

during negotiations, and there are limitations and frustrations associated with the budget reconciliation process, but it would still be a game-changer if passed. Though the bill stalled, there remains significant agreement on the climate and clean energy provisions of Build Back Better; it was mostly the non-climate provisions that proved to be sticking points. Hope remains that something can still get done.

There is some bipartisan recognition that clean energy is a way to grow the economy.

Climate will never be solved by a single bill or rulemaking. Regardless of the outcome on Build Back Better, additional steps will be needed to ensure the country achieves net-zero by 2050. There will be more opportunities to advance climate priorities, including in the farm bill, the defense bill, and the annual appropriations bills. Congress is also deliberating on competition bills, and the House version has a fair amount of climate-related funding. Democrats, particularly in the House, have been trying to include climate prioritization in any bill, on any issue, wherever possible.

There could be additional opportunities for bipartisan climate policy action too. The Energy Sector Innovation Credit, for example, is bicameral and bipartisan and could be the next bipartisan measure to move. In addition, there may be bipartisan willingness to explore permitting and siting reform to enable cleaner infrastructure to be built faster, and there could be bipartisan policy opportunities with respect to the climate-trade nexus, natural climate solutions, and clean energy tax credits (including a production tax credit for nuclear power).

There is some bipartisan recognition that clean energy is a way to grow the economy, provide jobs, and produce better outcomes for public health and the environment, and the impacts of climate change and pressure from the public are increasingly influencing members of both parties in both houses of Congress. In the House, for instance, Republicans are taking seriously the need to have a climate framework if they take control after the midterm elections. The issue is no longer about polar bears but about backyard issues that people have witnessed and experienced, such as storms and wildfires. The American public speaking out more on climate will inspire more bipartisan response.

BIDEN ADMINISTRATION

The Administration has been working to fulfill President Biden's campaign focus on re-establishing U.S. climate leadership and building a clean energy economy that supports good-paying jobs and makes life better, healthier, safer, and more secure for the American people. The Administration acted quickly upon taking office, including issuing executive orders, rejoining the Paris Agreement, making a commitment to cut emissions by more than half by 2030, setting a goal of achieving net-zero by 2050, creating a multi-agency climate taskforce, and planning a wide range of climate-related actions and initiatives across the entire federal government.

Domestically, the Administration has been fast-tracking solar arrays on public lands, trying to address permitting challenges, releasing apps to cut through red tape for rooftop solar, approving the first large offshore wind projects, promoting EV manufacturing and deployment, and launching a building performance standards coalition with state and local partners. It also launched the Justice40 initiative to deliver at least 40% of the overall benefits from investments in climate and clean energy to disadvantaged communities, and there are several important standards and regulations that the Administration is looking at updating to help make sure it reaches its climate goals. In addition, the Administration has been focusing on getting resources to communities already hit by the energy transition to help them transition to good jobs in those same communities that help deliver the clean energy future.

Moving forward, a big focus of the Administration will be implementing the bipartisan infrastructure law across the federal government — turning dollars into impact. That is not a simple task, particularly with several agencies still somewhat hollowed out due to the previous Administration. DOE has not mobilized funding on this scale in ages, so there is a particular need to focus on implementation there. Much of the funding for energy innovation will flow through a new DOE Office of Clean Energy Demonstrations. DOE put out a call for a new 1000-person Clean Energy

Corps to get the human infrastructure in place to make sure the historic increase in resources is spent wisely, well, and with the desired impacts; getting really good people with the right experience into these positions soon is a big priority.

Internationally, the Administration had three basic climate goals when it came into office. The first was to take the necessary actions domestically to get the U.S. house in order, including rejoining Paris, submitting a new Nationally Determined Contribution (NDC), and getting the HFC phaseout rules in place. The second involved reasserting or exercising U.S. leadership on climate, which included appointing John Kerry as the first presidential special envoy for climate, holding a leader-level summit on climate change within the first 100 days (which was used to revive the Major Economies Forum), and sending a large, high-level delegation to the 26th Conference of the Parties (COP) in Glasgow. The third goal was to raise international climate ambition, focusing on the major economies, which involved lots of multilateral and bilateral meetings, negotiations of joint statements, and work to ensure a successful COP26. The Administration's goals for Glasgow included trying to keep a 1.5°C goal within reach, which meant working with countries to increase their targets, generating support for a new Global Methane Pledge, and joining other initiatives on decarbonization. In addition, the rulebook to make the Paris Agreement operational had to be finished, and the Administration completed the U.S.-China joint declaration. The Administration also wanted a signal coming out of the COP that this was the start of a decisive decade in which countries would need to accelerate emission reductions.

Internationally, the Administration had three basic climate goals when it came into office.

In 2022, the Administration's international focus will be on boosting countries' existing commitments and goals, helping to mobilize sufficient climate finance for developing countries, and trying to move the world from goals to implementation, including through a range of international venues. The United States made progress in 2021 by riding on the excitement of a new Administration and a strengthened NDC, but if the United States does not start delivering on its commitments, passing ambitious domestic policies, and implementing actions in 2022, it will be very detrimental to efforts to get other countries to do more.

CLIMATE, THE FEDERAL ENERGY REGULATORY COMMISSION, & THE FEDERAL POWER ACT

The Federal Power Act (FPA) is almost a century old, and the modern Federal Energy Regulatory Commission (FERC) was established in 1977. There are questions about whether they are still fit for purpose given the urgent need for rapid decarbonization.

FERC'S AUTHORITY ON ELECTRIC POWER DECARBONIZATION

FERC's role with respect to decarbonization of electric power is limited. The FPA explicitly states that FERC is not in charge of electricity generation facilities; regulating electricity generation facilities is a role more actively played by the EPA, the Nuclear Regulatory Commission, and other federal and state regulators. FERC's main role in the electricity sector involves wholesale rates and transmission. On environmental issues, FERC prefers to let environmental regulators do their thing, and then FERC can be responsible for transmission policies and wholesale market policies that make implementation of environmental policies as cost-effective and reliable as possible. That is what happened with the acid rain trading program, and FERC would likewise prefer to have EPA or Congress decide on the rules for climate and carbon.

That said, there are tools that FERC has under its existing authority to deal with some of the questions raised by the energy transition and decarbonization. For instance, FERC has a couple of jurisdictional areas that affect generation, including licensing hydro facilities and a role under the Natural Gas Act regarding pipelines and infrastructure. (FERC is reviewing how it reviews project applications under the Natural Gas Act, including with respect to whether and how to account for greenhouse gas emissions.) FERC has also issued orders removing barriers to entry for battery storage technologies and aggregated distributed energy resources (DERs), enabling innovative new technologies to be compensated for all their attributes. There are new issues arising with the deployment of offshore wind, and FERC can try to streamline policies regarding generation interconnection and interconnection queues. FERC has conditioning authority that it has used for other purposes that could plausibly be used to condition merger approvals or rate authorizations on things that would be good for driving clean energy. In addition, under the Public Utility Regulatory Policies Act (PURPA), FERC has some authority over how renewable electricity generators participate in markets.

It is not clear if FERC could impose a price on carbon. FERC held a technical conference on the subject of carbon pricing, and there was considerable disagreement among legal experts about whether FERC had authority, as part of setting just and reasonable wholesale rates, to require consideration of a carbon price. Imposing a carbon price could be the type of overstep that might not be legally durable, with the Supreme Court having to decide whether that is what Congress intended by "just and reasonable". Especially with the current makeup of the Supreme Court, FERC has to be careful about pushing the boundaries of existing authorities (particularly to address climate change) in ways that are not consistent with how the Court might read the statutes. In contrast, if a regional transmission organization (RTO) or an independent system operator (ISO) took steps to incorporate a carbon price that had been implemented in a state in its region, FERC approval of that incorporation should be on sounder legal footing. New York and New England are exploring this approach.

TRANSMISSION & THE FPA

Transmission will also be essential to the transition. FERC has tools related to setting return-on-equity methodology, providing incentives for the right kind of transmission, and looking at reforms around planning, siting, and cost allocation that will be critical to getting lines built to get clean energy to market. The FPA, though, may not be fit for purpose at a time when decarbonization requires building significantly more transmission infrastructure.

A big problem is that it takes years to build a single transmission line. The Natural Gas Act specifically gives FERC the authority to site pipelines, but there is no equivalent for transmission. Instead, the FPA splits jurisdiction between the states and the federal government, and there are continual fights over who makes what decisions, who pays for what, and how to address environmental complexities. If states try to decide who pays for transmission lines, they will never agree. Some will have to pay more than others, but no states will agree to pay more than others. There is not even agreement on what is transmission and what is distribution in the United States; there is a multi-factor test, and there are constant fights about who has control.

A big problem is that it takes years to build a single transmission line.

Perennial state-based fights about siting and who pays for transmission may be unworkable, suggesting the need for some central planner to make hard calls. FERC got explicit backstop siting authority in the bipartisan infrastructure law, but it is not clear that FERC will exercise it. It is trying to collaborate with its state counterparts, and the Chairman has in the past been adamant about supporting states. DOE's new program to facilitate transmission could also help solve some problems of splitting the check by distributing free money. There is never enough free money, though, which leads to the moral hazard of people waiting to act until they get the free money (which has happened on other things in the past).

While states have been influential in moving climate policy forward, some transmission advocates argue that states have to be taken out of the transmission business. FERC may need to be given the same authority for transmission that it has under the Natural Gas Act — to site the infrastructure (not just backstop authority) and make cost allocation decisions. Half measures were taken in the early 2000s instead of a firm federal solution, which led to 20 years of a muddle in the middle. The U.S. interstate highway system might never have been built if every state needed to agree first. Transmission is similar interstate infrastructure that serves as connective tissue. In the United States, property law is generally left to the states, but under the Constitution, the wires crossing state lines are clearly an interstate commerce issue under federal control, like the highways.

It was not possible in the bipartisan infrastructure bill to go farther than backstop siting. The political economy is tough. Some states would love to be taken out of the transmission business, given the massive headache that siting issues present, but most would never admit that publicly. State commissioners are adamantly opposed to going further than backstop authority, and utilities currently need the state commissioners' votes to get stuff built. To get the Natural Gas Act provisions mirrored for transmission will require getting enough people on Capitol Hill to agree there is a problem on transmission that needs fixing. Some wonder whether the influx of funding from the bipartisan infrastructure law to build lots of clean energy systems, demonstrations, and hubs could be a forcing function to change the political calculus, to avoid that new infrastructure from being stranded. At the moment, though, there are not the votes in Congress to open up the FPA, which means blowing up the FPA is unlikely to happen.

Even if it was possible to mirror the Natural Gas Act pipeline provisions in the FPA for transmission, it is worth being cognizant of the fact that those provisions face their own challenges and litigation. Proponents of building out transmission for clean energy have sometimes been the opponents of building out pipeline infrastructure. The challenges with siting pipelines will be similar for transmission, bringing in environmental issues (e.g., water, species), community issues (e.g., NIMBY), and land use (e.g., impacts on farming). The playbook to frustrate pipeline infrastructure will be applied to transmission as well, which could lead to interesting political dynamics.

It is probable that the ultimate destination for transmission siting challenges is the Supreme Court. If that is the case, it might be advisable to force the interstate commerce clause questions to the Supreme Court faster. Creative imagination is needed about who the plaintiffs should be and how best to accelerate an interstate commerce clause versus states' rights case. Whatever the outcome of the case is, it might force Congress to act, as it did in telecom. On the other hand, the Congress on the Telecom Act is not the Congress now, and it may not be true that Congress would act to fill the void if the current U.S. electricity regulation system is deemed unconstitutional.

It is probable that the ultimate destination for transmission siting challenges is the Supreme Court.

All of the battles over transmission make it all the more important to recognize that there is not only one way to do transmission. It does not have to involve taxing people, fighting about who pays, and sticking lines over people's property. Transmission can be merchant, paid for only by the people using and benefitting from it. Transmission can also use existing rights of way; for instance, there are groups working with state departments of transportation to underground lines in highway corridors. Especially if greenfield interregional transmission development seems to be nearly impossible, brownfield developments — existing rights of way — seem important to explore. There are also hundreds of retiring coal plant sites in the United States, all of which already have transmission and interconnection, that could be repurposed with new generation. In addition, the fact that transmission is a rate limiter for the transition might suggest a need to drive toward pursuing a different solution space, such as more distributed power. There is already lots of interest in behind-the-meter power systems from customers who cannot get connection to the grid.

QUESTIONS ABOUT MARKET DESIGN & EXPANSION

While some are pushing for more central planning on transmission, many are at the same time pushing for more competitive wholesale markets for generation. Markets have delivered tremendous benefits for consumers, the economy, and the environment. On the other hand, the fact that wholesale power markets have been driving toward cleaner power may be coincidental, not causal. If shale gas had been more carbon intensive than coal, nothing in market design would have stopped its growth or factored in carbon intensity, and emissions would have gone up.

Still, regions that currently lack markets are seeing increased interest in them. Some argue that all states should be required to participate in something that looks like an RTO, but that seems unlikely to happen. FERC nominees have to go through the Senate Energy and Natural Resources Committee, and most senators on it happen to be from non-market states. It would be tough to go before that committee and tell them their states will be required to participate. In addition, there is a lot of value in market measures (e.g., energy imbalance market, day ahead market) that are well short of an RTO, and it is not any faster to build transmission in an RTO than outside of one.

Standardizing market design among RTOs also seems unlikely to happen, since it is seen as being more hassle than it is worth. Even if standard market design is not achievable, standardization of data (both acquisition and process standards) would be helpful. The United States is far behind Europe in the ability to acquire and move data efficiently, and each RTO has and provides data in different ways. FERC and the Energy Information Administration (EIA) have some data collection authorities that could be directed to tackling this problem, though FERC is not a statistical agency. In the bipartisan infrastructure law, there were several provisions about EIA, including expanding the reporting of real-time electricity data and connecting to emissions data. There are also troves of data in state integrated resource plans, company-reported data (e.g., in financial markets), and elsewhere. There is an excess of data, but there is a shortage of organizing, indexing, and applying data. The energy sector and federal government are both lagging companies that prosper from data management.

If DERs are able to participate in wholesale markets, there are also questions about whether it is time to regulate the distribution system as well. Some are skeptical that FERC should have jurisdiction over the distribution system; FERC

just needs sufficient jurisdiction to make sure DERs can get power to the grid. Others argue that FERC keeps creeping into the distribution system and may need more control over it; if DERs are to fully participate in wholesale markets, there is a need to invest in the distribution system, and states are hard pressed to make those decisions. Indeed, looking to the telecom example and hoping to get out of the current "muddle in the middle", some argue that all of these issues should be decided in favor of centralized FERC control — i.e., that the distribution system should be regulated, there should be standard market design, and everyone should be in an RTO — even if some of these changes would be hard or unlikely.

Markets need to recognize that power is not a single-attribute commodity, but rather has multiple dimensions, including time, place, environmental quality, flexibility, and degree of certainty (i.e., reliability).

Markets could also face other challenges in decarbonizing the grid. For example, if markets are based on ranking supplies by fuel costs, a zero-carbon portfolio in which a huge portion of market participants have no fuel costs could present significant challenges. In addition, the energy market is not currently appreciating some key aspects of energy sources, such as whether they are firm and dispatchable or not. Markets need to recognize that power is not a single-attribute commodity, but rather has multiple dimensions, including time, place, environmental quality, flexibility, and degree of certainty (i.e., reliability). Pricing has been set on some, but not all, of those. It is possible to create new ancillary benefits markets, valuing the reliability that resources might bring and not expecting them to get compensated only from the energy market. Some states are also exploring how to create a product like renewable energy credits (RECs) for a market that covers demand response, long-duration storage, hydrogen, and other clean and dispatchable options.

TRADE & CLIMATE

Concerns about national competitiveness have long been a critical obstacle to deep decarbonization. That script might be starting to flip, as there has been growing convergence of the trade and climate policy communities.

CROSS-BORDER CARBON COMPETITIVENESS CONSIDERATIONS

There are two related concerns that have been frequently discussed regarding countries acting on their own to address climate change. One worry has been that leaders on climate change might bear costs that competitor countries do not, setting back economic opportunity in those places. From a climate perspective, the concern is that high-standard countries will just suffer carbon leakage, with activities moving to countries that do not penalize emissions.

A more interesting challenge may be the carbon emissions embedded in global trade in the form of emissions in one jurisdiction for the benefit of consumption in another.

While carbon leakage has often been the threat that politicians and manufacturers worry about (and that academics say does not exist), a more interesting challenge may be the carbon emissions embedded in global trade in the form of emissions in one jurisdiction for the benefit of consumption in another. All domestic climate goals are artificial unless this carbon loophole is addressed. Another key lens is to consider the carbon intensity of production in different locations. The carbon intensity of production is relatively low in the United States; it is a cleaner economy than much of the world. (The focus should be on greenhouse gas efficiency, though, not just carbon dioxide.)

CREATING A CARBON CLUB

To factor in these considerations, avoid economic harms and leakage, and achieve competitive advantage, some countries are starting to consider implementing carbon border adjustments. Most notably, the EU is moving forward with a carbon border adjustment mechanism (CBAM). The United States is looking at something similar. Acting alone, measures such as a CBAM represent narrow, protectionist thinking, but countries could also use their economic leverage in cooperation, expanding beyond their borders to form a broader carbon club. A carbon club would involve countries with similar commitments to high levels of action on climate getting together, with those within the club not paying extra tariffs. Those lagging would face border penalties of some kind; a lack of environmental compliance or rigor would be framed as a government subsidy that could be countervailed through duties.

The United States and the EU both like the idea of setting up a carbon club but do not agree on the core framework, such as the requirements for entry into the club and the adjustment at the club's borders. The EU wants the club to be based on having explicit, nominal carbon prices, which would not work for the United States. Most of the United States does not have an explicit carbon price, but the mix of incentives and mandates at different levels of government does represent an effective or implicit price on carbon (albeit one that is wildly disaggregated, distorted, and unharmonized). Some argue that the United States needs an explicit domestic carbon price if it wants to apply one to imports, but others suggest a carbon club could be based on emissions performance (i.e., how much embodied carbon is in a given good). A

performance-based approach also has the benefit of focusing on the metric that actually matters. On the other hand, an explicit domestic carbon price may be more defensible against World Trade Organization (WTO) challenges; a carbon border adjustment based on how goods are produced (i.e., process-focused) runs headlong into years of WTO problems.

The next steps are to develop consensus around a policy design that would be pragmatic in the United States and EU. The nuts and bolts of policy design really matter. The narrower the definition of what counts, the harder it will be to get others to participate. (A club is great if a country owns the club, sets the rules, and guarantees it will win a lot, but that may not be an easy sell for others to join, and it may lack legitimacy and credibility.) It will also be important to design a system that does not move the world more toward isolationism, as more trade will be needed to meet global decarbonization goals.

There are numerous design issues to sort out, beyond just the question of whether an explicit carbon price is needed versus some kind of minimum performance standard. For instance, there is a question about whether to start with a few sectors or all. It may make sense to start with sectors, particularly the energy-intensive trade-exposed sectors. Sectoral approaches can be powerful in themselves and can help illuminate how greater climate ambition equals greater economic opportunity.

There are also critical issues about the treatment of least developed countries (LDCs) under such a system. A tiny portion of energy-intensive trade-exposed goods comes from LDCs; they are a very small part of the problem, but the trade opportunities are of enormous importance for them. It is vital not to create a U.S.-Europe energy poverty engine that will be detrimental to developing countries that are heavily reliant on emitting energy sources. Trade restrictions cannot be allowed to trap people in energy poverty. There are potential solutions. A preferences program could give developing countries a cut on a carbon border adjustment in exchange for agreeing to purchase a certain amount of environmental and other associated technologies and services from countries in the club, though there may be WTO challenges to such an idea. Finance mechanisms could be another key to fairness; what worked with the Montreal Protocol was a fund aimed at developing countries that signed up and conformed. Developing countries mostly want to be able to have the benefit of their comparative advantage in agricultural trade and to not be burdened with developed countries' protectionist trade measures on their imports. The simplest solution may be that LDCs would be exempted from the carbon border measures, as a matter of justice.

How to count the carbon is how to make the carbon count.

A fundamental design question is how to actually implement a carbon club, including whether it operates inside or outside of the WTO. There is an existing regime of excise taxes at the border. The global trade system aims not for harmonization but for interoperability, to facilitate international commerce between national economic systems. It is built on the backbone of a harmonized tariff system. Every customs official in the world knows the codes and how to price and tax things. There is a clear need for an analogue for embedded carbon, so it can be scheduled between nations, with established rules of origin explaining how to charge for things made in lots of places. Under the Montreal Protocol, which could be a model in many respects, parties agreed that the Protocol's rules on ozone-depleting substances could be enforced with excise taxes at the border, and that mostly worked, with a process to deal with small disputes.

Pulling off a carbon club will require agreeing on how to measure embodied carbon. How to count the carbon is how to make the carbon count. Accounting systems have to be able to schedule things in a way that is verifiable and enforceable, identifies the full value chain, protects the right to regulate, and protects proprietary information. There need to be gate-to-gate methodologies to assess carbon in products, which will be hard, but doable; there are existing input and output methodologies on air pollution control that could provide a springboard. The data foundation to address carbon embedded in trade is also starting to emerge. Companies now are voluntarily using environmental product disclosures (EPDs), which could provide some of the data needed to quantify embodied carbon. A lot of data is needed to implement carbon border adjustments, but the calculation does not need to be perfect. It is already possible to differentiate by country today, using proxies such as EPDs, the relative intensity of electricity production, and other data.

Some are skeptical about border fees and tariffs, arguing that countries and markets will get around them. The right policy design, though, might create a dynamic that results in a race to the top. Countries would always want to be at the point where no one else is better — or at least at the point of being better than their chief competitors. Everyone would be chasing best performance. A carbon club also may be the only viable path to achieve a de facto global price on carbon with allies — a goal that has eluded the world for decades. An international price on carbon would accelerate investment from the private sector and state-owned enterprises in low-carbon technologies around the world. A critical mass of economies could have enough leverage to create a de facto global price. The G7 bloc alone could have a major impact on China and developing country decision-making.

Competition with China looms large in the push for a carbon club. Looking a few years down the road, however, could have implications for the balance of power in and motivations behind the creation of such a club. China has committed to peak emissions by 2030, may have reduced carbon intensity more than almost anyone over the past couple of decades (though the data may be untrustworthy), and has launched an ambitious emissions trading scheme. Some, however, are not concerned about the U.S. carbon advantage eroding any time soon.

China is also a key factor for those who argue that the WTO system may have been created with serious errors in design, especially around countries that are not serious about reciprocity. A carbon club could be a chance to redo the foundations of trade on a basis that addresses those mistakes. The policy design details have to be considered carefully, as the future of the U.S. and global economies may be on the line. There is also the possibility of more broadly remaking the global trade system for a sustainable future, focusing not just on climate action but on all of the Sustainable Development Goals. Redoing the trade regime for the 21st century — a Bretton Woods 2.0 — could be so politically powerful it could create bipartisan support.

BIPARTISAN SUPPORT

Looking at the carbon math a different way — as a lever for more competitiveness — can creatively disrupt the domestic and international politics of climate change. The politics of U.S. trade and climate policy represent an opportunity for bipartisanship. By aligning Democrat and Republican priorities, it may be possible to develop a national consensus to address climate change through trade. It could be a merger of Trump's America First and Biden's Made in America platforms, blending climate policy and economic nationalism.

By aligning Democrat and Republican priorities, it may be possible to develop a national consensus to address climate change through trade.

Within the Republican caucus, there is growing understanding of the relative U.S. carbon efficiency across the economy and interest in monetizing the U.S. carbon advantage. It is not about climate change but about geopolitics and commerce, and Republicans who are interested in the trade aspect would lose interest if it was linked to a domestic carbon price. Congressional Republicans asked the Trump Administration to lobby to recognize America's carbon advantage, and Senate Republicans wrote a letter last year to push the Europeans on CBAM to do a common climate and trade approach with allies. Republican Senators and others have publicly called for a carbon club with the EU, with a common fee at the border, in part as a check on Russian energy dominance in Europe (i.e., due to the greenhouse gas benefits of using U.S. liquefied natural gas versus Russian gas). An effective trade mechanism would bolster U.S. manufacturing and reinforce supply chain security. Since the vast majority of U.S. imports are from more emissions-intensive economies, a carbon-trade mechanism could help the United States recapture elements of the supply chain. A robust regime based on world-class disclosure rules would put non-market economies at a competitive disadvantage, enabling U.S. producers to capture global market share from China and other competitors with higher-carbon production processes.

What to do with the revenues from a carbon border adjustment raises interesting policy and political questions. In terms of equity, revenue distribution may be necessary to address any negative effects of such a policy domestically. A point of policy design to be debated is whether to invest the revenues in R&D to sustain the carbon advantage of the United States. However, once the existing narrative gets flipped on its head, such that pursuing climate policy is a boon for the U.S. economy, it opens up the conversation for a range of investment options and other domestic climate policy actions.

Bringing a carbon club into existence may or may not require action in Congress. A carbon club could be created under existing authority via a 232 tariff, which is a tariff based on national security. The Trump Administration used that for the auto sector, and there could be a 232 justification that climate change is a national security crisis (which the Department of Defense has already stated). If done on that basis, a WTO challenge is guaranteed, but it has a better chance of winning than the auto sector tariff did. Still, some feel it would be a mistake to use 232. If the club comes into being via a trade agreement between the United States and partners, that is not considered a treaty and also would not need action in Congress to implement. Alternatively, if a new tax is being created, that would have to come from Congress.

VOLUNTARY MARKETS

The role of private markets, the private sector, and buyers in voluntarily driving decarbonization remains more critical than ever. The system of quasi-regulatory rules and standards that guide those decisions may not be keeping up with the dynamism of the marketplace and the increasingly steep trajectory of needed emissions reductions.

CARBON-FREE ENERGY PROCUREMENT

The Greenhouse Gas (GHG) Protocol was a breakthrough when it launched in the early 2000s. It has been the most widely used and referenced accounting standard to guide private sector entities in calculating and reporting their GHG footprints. The Protocol classified emissions as either Scope 1 (direct), Scope 2 (indirect / procured energy), or Scope 3 (full value chain). It was revolutionary and simple, forming a shared language and a credible system.

The current procurement guidelines, expectations, and accounting rules, however, are not designed for, nor have the effect of, optimizing emission reduction impact.

The rules have driven significant levels of new wind and solar electricity procurement by voluntary private sector buyers. Companies that buy RECs or that have power purchase agreements (PPAs) for renewable energy equivalent to their electricity usage can credibly claim and report zero electricity (Scope 2) emissions under the GHG Protocol. The Protocol considers the U.S. market as a single entity. A U.S. company need only purchase a large enough volume of RECs, no matter when or where in the country they were generated, to claim zero electricity emissions. The current procurement guidelines, expectations, and accounting rules, however, are not designed for, nor have the effect of, optimizing emission reduction impact. The system is decoupled from actual operations in a local grid and removes the incentive for companies to have a policy and procurement agenda to drive clean energy options where they actually operate.

Some companies and other entities are now setting 24x7 carbon-free energy goals, aiming to be carbon-free every hour of the day in all locations — thereby matching the electricity they are actually consuming with the clean energy they are buying. Such goals shift the focus from procuring easy and cheap renewables to procuring carbon-free energy with "emissionality", or grid decarbonization impact. Between these companies and the huge numbers of companies that have now set net-zero targets (which will require Scope 2 decarbonization), there could be billions or trillions of dollars of private sector investment in play for electricity system decarbonization.

To facilitate such goals, the underlying system driving purchasing behavior needs fixing. Standards really drive corporate purchasing behavior and how capital is deployed, and the standards have to change with the times to drive carbon-free energy where and when the grid needs it most to maximize the emission reduction benefits.

Standards that measure impact on transforming the electricity system will require better GHG measurement in the power industry. Traditional methods track the grid aggregated over very large areas, blurring the distinctions of major variables that impact the carbon dioxide (CO_2) reduction outcome from a clean megawatt-hour on the system. Buyers have no ability to meaningfully compare two systems, even if located close to each other, on a CO_2 basis. The power

system is a bunch of little systems that are connected, and location and time differences can really matter in terms of carbon impact. *Locational marginal emissions* — the emissions displaced by clean energy on the grid at a specific place and time — are one potential tool to allow customers to significantly differentiate among projects. The concept requires data to inform it, whether from RTOs or utilities, and, as noted earlier, the bipartisan infrastructure law asked EIA to start collecting and connecting electricity market data and emissions data. There is a need for transparency in both the data and the algorithms that process the data. The measurement should be kept simple but as right as possible. In the interim, steps could be taken that expand on tools people understand, such as a time-based attribute or a carbon-free-energy stamped attribute with a carbon weight on it.

The Protocol's accounting systems can evolve, as they have in the past. When the GHG Protocol started, no one was reporting on Scope 2 and 3, and there was skepticism that entities would. Now they are common practice, though there are still some problems. The initial phases of the Protocol had to encourage adoption and growth; now that has been achieved. The next version of the standards could be made more rigorous.

The challenge is that if standards are made too rigorous or difficult, there is a risk of driving people out of the voluntary standard.

The challenge is that if standards are made too rigorous or difficult, there is a risk of driving people out of the voluntary standard — of creating a smaller tent rather than a bigger one — when the goal is to bring in as many actors as possible to reduce emissions. A big tent is not an easy task; it is always a balance between defining leadership and expectations and providing support to bring everyone else along. As the standard moves to a more impactful but more complex approach, not every company will have the expertise and resources to execute it. Lots of companies want to engage and do not know how; pathways are needed for them to engage any way they can. Processes need to be established to guide companies on a journey from unbundled RECs to virtual PPAs to grid impact. It is important to implement the changes in a way that is accessible. It will also be important to find a soft landing for companies whose Scope 2 emissions will go up if standards change to account more for grid decarbonization impact.

Companies are not the only entities involved in this. The Biden Administration adopted an aggressive goal on clean electricity procurement for the federal government, and a lot of other governments have adopted 100% clean grid goals as well. It is essential that there is communication among the public and private sector entities with such goals, otherwise conflicts could arise regarding siting, permitting, land use, and transmission buildouts needed. Electricity suppliers will have to figure out how to help governments achieve their goals; once they do, there is no reason they could not offer the same product to others who want it. Governments can be vanguard customers in figuring out what the offering should be.

CARBON CREDITS

Private sector capital is already being deployed in voluntary markets that are focused squarely on the climate challenge. The voluntary carbon market is a market for verified carbon credits that depend on voluntary purchases (i.e., outside of required markets such as the EU Emissions Trading Scheme). A carbon credit represents a verified reduction, avoidance, or removal of one ton of CO_2 or the equivalent. In 2019-2020, the size of the market was around 100 million tons. It is plausible to think it could scale to 1 gigaton of high-quality credits by 2025 and a couple of gigatons by 2030, representing tens of billions of dollars annually.

In the near term, the purchases will mostly be credits for avoidance and reduction, such as clean energy projects in least developed countries, with some smaller percentage involving removal. Over time, the market will likely shift to focusing more and more on removals, whether "nature-based" (e.g., soils) or engineered (e.g., direct air capture). The market today is already demonstrating differentiation in prices, with removals costing more than avoided emissions, and some companies in the market are willing to pay for those removals.

The voluntary market enables companies to support innovative — and currently more expensive — forms of offsets, such as removals. Having a simple and transparent accounting mechanism that supports fungible credits is important, but so is having a regime that leaves room for innovation. Early dollars that support market creation for longer-term technologies that are currently pricy but will have substantial impact are important. (It would also be a mark of success if a way was found to use the voluntary market to create a price signal for innovative technologies in hard-to-abate sectors.)

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In addition to market infrastructure (e.g., contracts) that can scale, achieving scale in the voluntary carbon market requires a foundation of integrity. On the supply side, that means a need for real, well-established standards of quality regarding what a good carbon credit looks like, and there are efforts underway to develop such a standard. On the demand side, integrity involves what it means to use credits to get to net-zero, and there are initiatives underway looking at that as well. In addition, there is a need for integrity in accountability on both sides.

With respect to supply-side integrity, there is still a lot of uncertainty and inadequate transparency on some types of credits, such as in the agricultural space. There is a role for government involvement in driving greater understanding of the science, establishing guardrails, and enhancing certainty about credits. There is cause for caution, however, in having governments be too involved in voluntary markets.

Demand integrity is a difficult issue, particularly in light of the views of norm-creating NGOs regarding the responsibilities of companies. There is significant skepticism and opposition, primarily from the left, regarding offsets, credits, and voluntary carbon markets. The theory is that offsets are essentially a form of cheating or greenwashing, allowing entities to spend money to buy someone else's reductions, which may or may not be real and may or may not be additional to what would have happened anyway ("additionality"). The Science-Based Targets initiative (SBTi) does not recognize offsets for targets, and SBTi has become almost a requirement for corporations with net-zero commitments. There were fights in the Glasgow Financial Alliance for Net Zero (GFANZ) about whether offsets should be recognized.

The critiques of offsets are fair, to an extent, but tackling climate change requires every ton everywhere possible. Avoided and reduced emissions are also quite different from removals, which science says are critical to achieving climate targets. Carbon removals represent the "net" in "net-zero".

As with voluntary carbon-free electricity procurement, making the aperture too narrow with regard to credits could make it harder to have a big tent. Stringent integrity is necessary for climate purposes, but it is a voluntary market, which means there has to be a balance with having entities still want to participate. A great deal of effort is premised on the assumption that complex rules are needed to thwart companies that want to greenwash, but robust efforts to prevent the tiny percentage that might want to greenwash or game the system can make it much harder for companies that actually want to take action. Most companies really want to do good, not just because of pressure from stockholders and customers, but also to attract and retain talent. Companies worried about being called out for greenwashing may not participate in the market at all. Perfection may be hindering progress.

ROLE OF CAPITAL MARKETS AND ESG

Capital markets and investors focused on environmental, social, and governance (ESG) issues are among the biggest drivers of company action.

MEANINGS & TRENDS

ESG as a single concept — grouping E, S, and G together — is somewhat meaningless and incoherent. ESG is not just about climate, but climate has become the most important part of it. The shift to a climate focus took a lot of the energy away from other important E aspects such as water and waste, and the S and the G are also of huge importance. Really, ESG is about two pillars of information — environmental factors and social factors — that investors and corporates need to consider with respect to risks and opportunities; governance is the foundation for everything. The three concepts are distinct but also interrelated. Areas that are at high risk from the physical impacts of climate change are mostly lower-income, vulnerable communities; at the same time, entities putting money into conventional energy systems are couching their defense of those investments under the S. The push to get new directors elected at ExxonMobil succeeded because of the G.

The recent progress on ESG has been incredible in pace and momentum.

The recent progress on ESG has been incredible in pace and momentum. The sustainable finance market is growing rapidly, with various bonds, bank loans, and other products bearing sustainability labels. ESG fund flows have reached record highs, across asset classes. ESG is not only accelerating, but also becoming mainstream. Sustainability and climate goals have become table stakes and a regular part of doing business. ESG has become more of a value opportunity instead of just a values play, though many efforts are still focused mostly on greenhouse gas emissions and the impacts of climate change, not dollars per se. There are regular ESG dialogues at the C-suite and board levels; ESG investors have succeeded in getting CEOs' attention. Every board meeting now touches on ESG issues, and it is top of mind for shareholders and investment teams. ESG is now part of the license to operate, and all key stakeholders are generally aligned. There have been similar cycles over the past few decades. In the 1990s, for example, there was a movement to push companies to go "beyond compliance". The ESG focus is the latest manifestation.

ROLE IN MEETING NET-ZERO COMMITMENTS

A positive aspect of the ESG movement is that it allows companies to attract longer-term investors, which in turn gives them space to plan, innovate, and implement climate strategies that might take several years. Coming out of the Glasgow COP, many trillions of dollars' worth of assets under management are committed to a net-zero timetable. Many of these net-zero commitments are simply aspirational. Aspirational 2050 commitments are not enough, and the CEOs that make them will not be in place when they are fulfilled. This is the critical decade for climate action. Implementation is what matters.

Committing to align financial portfolios with a net-zero by 2050 pathway is a very confusing space. Each bank's business is very different from other banks, for example. For investors, there are multiple net-zero frameworks available, but they are not necessarily easy to operationalize in a way that will lead to emission reductions. There is a lot of work being

done to figure out what operationalizing a net-zero commitment means for financial actors and how to do comparable frameworks across financial actors.

Asset owners, asset managers, and banks are all looking to the companies they finance; a bank's or investor's challenges in addressing Scope 3 emissions are companies' challenges in addressing Scope 1 and Scope 2 emissions. The central questions for companies are about both the impacts on the business from physical and transition climate risks and how to align the business with global net-zero climate goals. Financial actors need the companies they finance to disclose answers to those kinds of questions. Disclosure is complicated and costly and is not a substitute for actual carbon avoidance and carbon reduction, but market forces can be brought to bear by various market actors once they have better information. For example, in a different context, a New York City law required all large buildings to post a letter grade for energy efficiency in the lobby, and now a low grade devalues a building, dissuades renters, lowers resale values, can affect insurance, and more. The market will respond to information, and value will be created and destroyed.

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Decisions being made today about which companies are included in ESG indexes — and which ones to lend money to — will become even more intense over the next couple of years as financial actors with net-zero commitments try to really nail down the framework they will use, figure out how to apply it, and have engaged discussions with clients. For all the momentum, though, ESG still has a lot of growing up to do. A significant amount of the capital that has gone into passive ESG funds and indexes is based on third-party scoring. The ratings, prepared for indexes and portfolio manager analyses, are really important, but they need more transparency and to be better aligned with decarbonization. It is clear that at the level of capital markets and public corporations, there is psychological readiness to take on the ESG concept. Companies want to get graded, and they want to get better grades. A lot of ESG ratings are still reliant on the level of disclosure, though, not on actual sustainability performance. ESG ratings systems are also based on different methodologies and do not align in their results, unlike credit ratings. ESG ratings decisions affect trillions of dollars, but there is no process akin to the federal Administrative Procedure Act to try to balance effectiveness, fairness, and engagement by those who feel affected.

While many competitive issues that companies face may be more impactful than climate, it is important to figure out how to harness the ESG power that is affecting corporate behavior in order to be more climate-optimized. If companies are managing against those metrics, it is better if the metrics are right. Increasing volumes of comparable, high-quality raw data on key climate performance indicators will drive impact. Investors will be able to disaggregate ESG scores and reconstruct the data in various ways to support a certain investment thesis around climate, whether for a portfolio, an index, or something else.

APPROACHES & STRATEGIES

ESG can sometimes be used to encompass two different strategies: one focused on integrating ESG issues and risks to assess financial materiality, and the other on driving towards a particular carbon impact and achieving it at a market rate of return. An oversimplified framework could think of companies as falling into three categories: (1) heavily extractive, emissions-intensive sectors and companies; (2) the vast majority of companies in the middle, offering a range of products and services; and (3) a smaller group of companies trying to claim very positive climate impact (e.g., producing climate-solution technologies). Given the range of company types and the issue of risks versus carbon impact, what it actually means for a financial institution to incorporate ESG as a path to net-zero is unclear.

Exclusion — including negative screens and divestment — is probably the oldest and bluntest approach to avoiding risks. Some big ESG funds still use negative screens. These screens may cover heavily extractive, emissions-intensive sectors and companies, but they also may cover things that some experts feel could be a vital part of the climate solution set, such as

nuclear power. The reality is that many asset owners do not have a lot of sophistication on these issues and are responding to the NGOs and activist shareholders who have been working on these issues for 20-25 years and have views on what is or is not desirable and needed. The negative screens often reflect this rich history of engagement and activism. Changing those will require new dialogues and forums that create new principles. Screens that are nuanced, sectoral, and based on a rational carbon metric can still be subject to political attack, though. For example, parts of the financial sector have agreed on what they will or will not finance with respect to coal or other fossil fuels, and as a result, some fossil-fuel-producing U.S. states are adopting positions forbidding any state business with those financial institutions.

Likewise, there has been a heavy push on the financial services sector to divest in order to quickly reduce its Scope 3 financed emissions. It is hard for financial institutions to get to absolute greenhouse gas reductions in their portfolios unless they start selling off holdings. Divestments usually just result in shifting money around, though, with other investors (including private equity) buying up the investments at low prices and making a killing. Divesting shares of a publicly traded company just means the original investor no longer has a say in how that company allocates capital. (Private equity has the potential to be a powerful tool for decarbonization, though, whether they have set a net-zero commitment or not; private equity firms often control their companies, partner with them, and own them for many years.)

Divestments usually just result in shifting money around, though, with other investors (including private equity) buying up the investments at low prices and making a killing.

While it is relatively easy to differentiate between sectors that are carbon-intensive and ones that are not, it is more challenging to distinguish between companies within a sector based on strategies, risk exposures, and other measures. There are some standard frameworks to help companies report emissions and reductions, which can be used to pick leaders within sectors. For companies, there is starting to be more internal allocation of capital and budget to go along with corporate climate goals, but it is still an open question whether that is being appreciated by boards and investors and whether it is impacting share price and credit rating. There is a need for climate to show up in the underwriting and the pricing (i.e., getting a lower rate on equity and debt because of ESG); until, for example, the decisions of credit officers at banks start being influenced by climate considerations, it will be hard to make real change. That mostly is not happening yet, but once ESG funds and ratings are based more on actual performance, there will be clearer differentiation in costs of capital for ESG leaders. The evolution of ESG should include whether companies are putting their balance sheets to work to solve the climate problem.

Indeed, some criticize ESG funds for focusing primarily on avoiding companies with climate risk, as opposed to recognizing the potential for alpha in companies proactively creating positive climate impact. A broader solution set and more nuanced understanding of what the transition will require are needed, and the discussion is starting to move from risk mitigation (which is still important) to value creation and opportunity. It is not yet clear how innovation companies — companies whose emissions are insignificant but whose products can be part of the solution — can show up in portfolios, nor how companies that partner with or hire such solution innovators get benefits for it in ways that can pull those solution providers along. Companies trying to claim very positive climate impact are where the data is least standardized in terms of enabling portfolios to steer capital towards climate solutions. If ESG can direct money to the right places, though, it could be the answer to the conundrum of how to mobilize trillions of dollars for the transition.

POLICY

The boom in ESG investing has brought out more scrutiny from regulators. That is good, as it means commitments will be tested and be stronger. There is a lot of regulation in Europe, and the Securities and Exchange Commission (SEC) is starting to focus on these issues in the United States. The SEC will soon be proposing a rule to move to mandatory climate risk disclosure. Getting to consistent, comparable raw performance data in disclosures is crucial, but it is im-

portant to be careful about compliance costs and to avoid codifying some of the fundamental flaws in voluntary disclosure. In addition to the SEC's focus on disclosure, the Federal Reserve has been focusing on climate risks. There are also efforts to harmonize efforts internationally, including the International Sustainability Standards Board (for corporate disclosure) and the Network for Greening the Financial System (which includes the Fed and other central bankers).

Some financial actors are concerned that they are being pushed into a position of becoming de facto policy makers, given the increasing expectations for financial institutions to achieve objectives that policymakers have been unable to coalesce around. The financial sector may not have the ability in the near and medium terms to achieve those objectives. Private-sector net-zero ambition has to be paired with supportive policies. Money is fungible, and if emitting assets and industries are not disadvantaged in the market on return and value, there will continue to be plenty of interest in reaping the huge returns still to be made from investments in high-emitting projects, companies, and industries. Governments have to send a signal to drive markets towards carbon impact, though Congress acts best when there is a base of well-informed support under it. If banks and others can get together and structure a workable framework, Congress can build on that and provide cover and support. If there are policy goals in place, the financial sector can act as an accelerant. For example, in Canada, where there is a carbon price and a 2030 mandate to get out of coal, ESG pressure has led to decisions to move from coal facilities to natural gas facilities within a year or two, rather than waiting for 2030.

MARITIME SHIPPING

Maritime shipping — an industry that is the lifeblood of the global economy — is considered to be one of the "hard to decarbonize" sectors, but expectations are rising for the sector to address its climate impacts.

TECHNOLOGICAL OPTIONS FOR NEW SHIPS

A relatively small percentage of ships — the biggest ones — emit most of the sector's emissions and are the hardest to move off of diesel engine power. There are debates about which fuels and technologies are the right ones to decarbonize maritime shipping. The optionality available is great but also scary. At some point, decisions will have to be made about which technologies to push forward harder — picking a few and funneling significant investment into them if they are ready or close to ready for deployment. Solutions should be proven (or have credible potential), take account of all greenhouse gases across the full lifecycle, offer significant reductions in air pollution, be vastly scalable, and have safe and ethical sourcing. Consideration should be given to the impacts on people and the planet, including the health and safety of crew members and the oceans.

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A full package of technologies has to be available to decarbonize the sector, and the fuel mix landscape will likely be complex. Electrification (i.e., batteries) seems to be an option only for some types of ships and not for others. (Electrification is also an option for ports, which have pretty sizable carbon footprints.) Industry members are starting to step up with deep-pocket investments in different technologies they believe in.

Some are starting to deploy ships that can burn green methanol — a zero-carbon (but not zero-emission) synthetic fuel. The engines already exist and are proven (burning regular methanol), and the fuel is a simple liquid alcohol that is easy to handle and bunker, has a low flash point but no other safety issues, and will evaporate with little harm if spilled. The challenge is that methanol contains carbon, which means being a green fuel requires the carbon to be extracted from the atmosphere and put into the fuel before it is combusted and returned to the atmosphere. Pulling CO2 from the atmosphere can be done either via direct air capture or by using biogenic point sources; there is adequate biogenic source material for this decade, but scaling green methanol beyond that will require DAC to achieve much greater scale at much lower costs. For action this decade, though, methanol is one of the few options available immediately, assuming volumes of fuel production scale up significantly. The fuel is expensive at the moment, but costs will come down over time, and what will happen to the price of oil (the competitor) is always unclear.

Others in the industry are gravitating toward hydrogen-derived fuels, particularly ammonia. Ammonia is a less mature technology than methanol, which means it is not available immediately as a solution (though it will be by the 2030s). As a gas, it is harder to handle. It is also a highly toxic gas for humans and the marine environment, and pumping it at massive scale in ports around the world is not a trivial challenge. In addition, green hydrogen and ammonia are both currently very energy intensive to produce, and they have low energy content and low specific gravity (meaning vessels need more fuel and more storage space). They can work for small ships on short voyages. Green ammonia and hydrogen are more expensive now, but not prohibitively so, and their costs are coming down and will achieve parity at some point. Cogeneration and cheap feedstocks could also be used to produce ammonia and hydrogen very cheaply.

The perfect new green fuel would be a liquid fuel that does not contain carbon, but that does not exist, which leads to tradeoffs between having a liquid fuel that does contain carbon (i.e., methanol) and a gas fuel that does not (e.g., ammonia). Using biomethane as a fuel has both negatives — it is a gas that contains carbon. Biomethane raises risks of methane leakage as well. Like other biogenic-based fuel options, there are also questions about the feasibility of guaranteeing the sustainability and scalability of biogenic inputs. It is hard to see any biofuel as the main solution if the goal is to achieve vast scale. Aviation is also looking at biofuels, and shipping may not want to get into competition with aviation for those fuels.

Nuclear is an option worth pursuing as well. Nuclear can be very suitable for large ships, enabling them to go faster, longer, without emissions. Nuclear has high energy density, takes little space, provides reliable electric power, and can provide power at berth as well (helping to decarbonize ports). American, British, and other navies have been using the technology for decades without accident or injury; while naval reactors are not suited to commercial shipping, some of the systems for training, safety, and so forth could be adapted. Nuclear for commercial shipping should involve reactors that are fueled for the life of a ship (20-30 years) without refueling, which eliminates the need to handle spent fuel in ports around the world and thus avoids lots of proliferation risk. Advanced nuclear reactors under development can be small, affordable, and mass-produced, with passive safety systems, and they may be available by the end of the decade. Rules have to be modernized to enable this, however, including insurance frameworks, international rules (by the International Maritime Organization (IMO) and the International Atomic Energy Agency), and more.

Nuclear can be very suitable for large ships, enabling them to go faster, longer, without emissions.

Coordination will be important as any of these fuel options are deployed. For example, if big increases in power demand are coming to an industrial facility to create fuels (via electrolysis) or to electrify ships or ports, conversations have to include local power utilities, so they can plan for it. In addition, given the competition for low-carbon fuels, regional collaborations between ports and airports, such as in industrial clusters or hubs, could be advisable.

THE EXISTING FLEET

Ships last 20-30 years or more, depending on the type of vessel. The advantage of having a slow fleet turnover is that it provides time to plan and to sort out some of the technological challenges, so that solutions are ready, replicable, and scalable when it is time for a new ship. On the other hand, a slow fleet turnover also heightens the importance of figuring out what can be done with ships on the ocean now. The ships that matter most for decarbonization are already on the water.

The sector is very efficient, but there is room for more efficiency improvements from operational and technological measures. Operationally, slow steaming / slow shipping could help a lot now. Slow steaming may mean more ships are needed to do the same work, but it may also mean getting smarter instead of slower (e.g., not racing across the ocean only to sit in line waiting for berth). There is also work on electric tugboats to take large container ships further out of ports, and electrification of ships in berth is starting to happen. Wind sails are making a comeback too, representing an anachronistic but serious and exciting way to increase efficiency.

Retrofits of existing ships are also a possibility as viable technological solutions are identified, though some fuels are easier to retrofit for than others. Existing ships can be retrofitted for methanol; ammonia is very expensive to do a retrofit for. Right now, a lot of older ships cannot feasibly be retrofitted. For a just transition, it will be important to learn from the results of similar retrofit efforts, such as regulations to reduce air pollution from trucks at one port that had the effect of cutting by more than half the number of independent truckers, due to the costs of the needed retrofits or new trucks.

LEVERAGE POINTS

There are at least three key levers to accelerate maritime decarbonization solutions: customers, policy, and money. First, there is a need to get customers into the game, aggregate their demand, and get zero-emission projects and offerings into the water. There is a bit of a chicken-and-egg problem now; the fuels are not being made at scale because there is no demand, but there is no demand in part because there are no fuels available. There is a need for some leaders to put a demand signal into the market. Customers can lead the way, paying a little extra for zero-emission shipping. (Such added costs are mostly immaterial for end customers; even doubling the fuel bill on a container ship would only change the price of end-use goods for the consumer by a matter of cents.) First-mover champions will shoulder the premium, to kickstart the transition and get the first offerings in the water, but that can only last for so long and achieve so much scale. Ideally, customers could work together in pre-competitive partnerships to move everyone along in meeting their climate goals.

The fuels are not being made at scale because there is no demand, but there is no demand in part because there are no fuels available.

The vast majority of businesses will wait and follow the leaders, so policy and regulatory support is needed to bring the price of green shipping fuels to parity with fossil fuels as quickly as possible. Maritime shipping is a global industry that needs global regulation, and the IMO, which is notoriously slow, needs to rise to the occasion to adapt and modernize rules. While a global strategy would be more efficient and less of a patchwork, there is lots of potential for action at a domestic level too. Governments need to be enabling technology demonstrations so it can be determined what actually works and investment can flow quickly. The United States is still the largest importer of goods globally and could be doing more in domestic policy and at the port level to establish requirements for green fuels or zero-carbon vessels as ships come into American waters. Indeed, the ports play a huge role in this. That is where ships spend their time and where bunkering operations take place; the infrastructure, fuels, systems, and crews need to be there. There could also be incentives provided, such as giving zero-carbon vessels priority for berth.

Money can be a powerful lever as well. The Poseidon Principles involve some major maritime lenders that have committed to have their portfolios be on a Paris-aligned trajectory, which means ship financing can provide an important and additive driver for transition.

While there are several ways to leverage action in shipping, it is important to recognize that ships and shipyards can also leverage other decarbonization. Ships are a wildly underappreciated resource for global decarbonization. For example, in addition to decarbonizing the ships themselves, ships powered by zero-carbon energy (e.g., nuclear) could also be used as platforms for clean fuels production or as a source for on-shore power needs. Shipyards are unique and powerful resources too; nothing on the planet is built like ships are built. Shipyards exist on a global scale and can build things at the complexity of a nuclear reactor in a matter of months at a fraction of the cost and in a cycle allowing for continuous improvement. As the world transitions from global fossil fuel infrastructure, and the need for global transport of fossil fuels declines, applying the capacity and knowledge for complex construction to clean energy solutions could provide a transition for shipyard workers and locations.

HYDROGEN 2.0

There is a lot of money from different sources being put into hydrogen, a lot of support for innovation, and a lot of players involved. Hydrogen has gone through a hype cycle before, in the early 2000s. Progress during hydrogen 1.0 was slow, with a handful of small-scale demonstrations focused only on the transportation fuels market. Toward the end of the decade, the security and scarcity conversation changed at the federal level, the impetus for the demonstrations waned, and the work basically stopped. This time, the problem people are trying to solve is different. Hydrogen 2.0 is less about security than about energy systems and climate change.

Hydrogen 2.0 is less about security than about energy systems and climate change.

RAINBOW OF HYDROGEN OPTIONS

Most of the hydrogen produced in the United States and the world at the moment is "gray" hydrogen, produced through steam methane reforming of natural gas or coal. Gray hydrogen is very carbon-intensive, but a range of options exist or are being explored to produce zero-carbon hydrogen.

"Green" hydrogen, produced with electrolyzers and zero-carbon electricity, receives a lot of attention. Electrolyzers running on the regular grid would have significant carbon intensity, especially if upstream methane leaks in the gas system are considered. To be truly zero-carbon, electrolyzers need either a decarbonized grid (which has not yet been achieved) or a dedicated source of zero-carbon electricity. The low costs of renewables have sparked significant interest in green hydrogen, and the cost of electrolyzers is also coming down in a steep curve, which is a relatively new development. The materials science advancements around electrolyzers have also been really important. Producing hydrogen with renewable energy via electrolysis is currently rather expensive, but that could change in the future, as the cost of renewables comes down.

Broadening the palette of zero-carbon hydrogen options beyond "green" may be advisable. "Turquoise" hydrogen, for instance, involves high-temperature pyrolysis of methane, resulting in hydrogen and solid carbon black; this opens the possibility of turning methane into a non-GHG product, with hydrogen as a side effect. Some assert that hydrogen production with the lowest carbon intensity and lowest cost can be accomplished via steam methane reforming of natural gas with carbon capture and storage (CCS) added into the process, known as "blue" hydrogen. The cost of CCS is also coming down, and managing CO2 as just another process stream from the hydrogen production process can lead to some very practical solutions.

All the different colors may have roles to play depending on the industry involved, cost input tolerance, geographic location, and the resources available. Especially given the uncertainty around what approach is best, it is important for supportive policies to be tech-inclusive. There has been an exponential rise in interest in hydrogen from both parties in both houses of Congress, including a big push for R&D to lower the costs. Build Back Better included a proposal for a tech-neutral hydrogen tax credit that focused not on how the hydrogen is made but on how much lower it is in emissions. There is another bill in Congress that uses contracts for differences to incentivize all types of lower-emitting hydrogen.

POTENTIAL USES

A clear starting market for zero-carbon hydrogen could be the many sectors of the economy that already consume significant volumes of "gray" hydrogen. Zero-carbon hydrogen can meet that demand where it already is (e.g., ammonia refining and production) and abate the associated emissions. The existing sectors can provide a stable base of near-term low-hanging fruit from which to diversify into other markets.

For transportation, refueling a vehicle with hydrogen is significantly faster than recharging a battery in an EV. Hydrogen is also very energy dense in terms of mass, which means vehicles would not have to carry much additional fuel weight to have lots of range. While the transportation debate has matured since hydrogen 1.0 — mostly away from hydrogen and toward lithium-ion batteries for lightweight vehicles — hydrogen is still on the table for heavy-duty vehicles where weight matters a lot, such as airplanes, shipping, and large trucks.

Hydrogen has the potential to play a key role in decarbonization throughout the value chain.

Hydrogen has the potential to play a key role in decarbonization throughout the value chain. At the local level, hydrogen could provide support to 100% renewables microgrids in communities, boosting security and resilience. Hydrogen's biggest emissions impact could be up the supply chain, replacing coal for steel and cement production. Replacing natural gas for electricity production would have a lower emissions impact, but some gas plants are looking at hydrogen blending to achieve some level of reductions. Reliance on the potential of hydrogen is not without controversy, though. For example, utilities or companies that build new natural gas plants or infrastructure but say they will switch to hydrogen someday receive serious pushback for continuing emissions in the present based on a hypothetical conversion plan that may not come to pass.

Costs and tensions between supply and demand may dictate where hydrogen does or does not get used early on. Zero-carbon hydrogen's impact will be greater if both supply and demand scale up, but scaling supply and demand at the same time is not easy. Early projects need to get their costs down, but investments are harder to come by because the costs are not down yet. For example, there are pilots to pair electrolyzers with nuclear plants, but the costs for the clean hydrogen produced are too high for cost-sensitive, high-emission off-takers such as steel plants. There is a lot of work to be done to create the demand and to find the off-takers for zero-carbon hydrogen. Price sensitivity is a real concern because hydrogen has to compete to have a role; for every aspect of potential demand, hydrogen is only one of several ways to achieve a lower carbon future.

ADDRESSING CHALLENGES

It is easy to get caught up in the hydrogen hype, but it is important to remember that everything has tradeoffs. Hydrogen comes with some cautions.

For example, leaks of methane (a potent greenhouse gas) are a big concern with blue hydrogen. There is work suggesting blue hydrogen is worse for the climate than burning diesel on a 20-year timeframe because of methane leakage. (While fugitive methane emissions are a problem, lifecycle analyses have to be done across all forms of hydrogen production, not just for blue.) Given the challenges of methane leakage during transport of natural gas, co-locating gas production with hydrogen conversion facilities can reduce the climate impact of hydrogen made from natural gas, compared to transporting methane to a conversion site.

Transporting and storing hydrogen are also challenging, in multiple ways. From a regulatory perspective, there is no current federal jurisdiction for siting new pure hydrogen pipelines across state lines, which means no eminent domain is available. If such infrastructure is going to be built, Congress will have to act (e.g., under the Natural Gas Act) to allow for some sort of regulatory oversight that would enable eminent domain to move those molecules across state lines. It

is also not clear what level of blending hydrogen into a natural gas pipeline would prompt a change in jurisdiction away from natural gas oversight.

Transporting and storing hydrogen are also challenging, in multiple ways.

From a physical perspective, a great disadvantage of hydrogen is that it requires high levels of compression to be stored at room temperature. Hydrogen also reacts differently with metals than natural gas does, such as causing pipeline embrittlement, and those types of reactions have to be considered throughout the energy infrastructure system. There has been innovation there, from organic hydrogen carriers (e.g., converting hydrogen to ammonia for transport) to novel ways to do compression. A near-term opportunity is to inventory the materials in existing natural gas pipeline infrastructure to determine the maximum amount of hydrogen that can be blended in. (Even small percentages of hydrogen blends can be significant volumes.) Pipe pigs can also be run through existing pipes to put in liners that are not permeable to hydrogen, reducing the need for new pipes. In addition, some are looking at shipping around containers with pressurized hydrogen inside as if dry freight, instead of using pipelines.

Hydrogen gas is also slippery and leaks a lot. Unlike other gases that sink, lightweight hydrogen tends to float up and disperse, so indoor applications are not dangerous unless there is a sealed roof. Hydrogen in the atmosphere, though, is an indirect greenhouse gas, as it interacts with radicals that otherwise would be a methane sink. Hydrogen slows the degradation of methane, which has a non-zero GHG impact. Since hydrogen readily seeps out of infrastructure, it is important to really understand the impacts of that and to be cautious about applications where hydrogen is likely to leak. If a good energy-carrying molecule turns out not to exist, though, it will be much harder to achieve decarbonization.

As with methane leaks, concerns about hydrogen leakage may call for starting with hydrogen applications where production and use can be fairly near each other. Hydrogen hubs aim to create an industrial ecosystem in which the demand centers are close to the production centers, systems are co-located to see how they work together, and economies of scale are achieved to drive the costs of hydrogen down. The bipartisan infrastructure bill put significant cost-share into hydrogen hubs that address a diversity of sources of clean hydrogen.

For green hydrogen, how a facility interacts with the grid is a key question. If a hydrogen electrolyzer facility is expecting to run at a 99% capacity factor, that could be a problematic load for the grid. Electrolyzers can be flexible (e.g., throttling down when power demand elsewhere is high), but they have to be part of a larger system that is designed to take advantage of the flexibility. In periods of oversupply of wind and solar, electrolyzers can be good grid citizens when they run in load-following mode, flexibly producing renewable hydrogen (or ammonia).

APPENDICES: PARTICIPANT LIST

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APPENDICES: AGENDA

SUNDAY, JANUARY 30, 2022

6:30 – 7:30 PM MST **Opening Reception**
Davis Commons, Aspen Meadows Resort

7:30 – 9:30 PM MST **Opening Dinner**
Albright Pavilion, Aspen Meadows Resort

MONDAY, JANUARY 31, 2022

7:15 – 8:30 AM MST **Breakfast**
Davis Commons, Aspen Meadows Resort

8:30 – 9:00 AM MST **Welcome:**
Greg Gershuny, The Aspen Institute

Introduction:
Jim Connaughton, Nautilus Data Technologies
Roger Ballentine, Green Strategies Inc.

9:00 – 10:15 AM MST **SESSION ONE: Briefing Room – Federal Policy Levelset**

The first year of the Biden Administration and a Democrat-controlled Congress provided a rush of policy changes, proposals, and diplomatic efforts impacting the energy sector and the prospects for a low carbon transition. The briefing room will offer an update and summary of relevant developments.

Moderators: Jim Connaughton and **Roger Ballentine**

Discussants:
Congressman Paul Tonko, United States House of Representatives
Sonia Aggarwal, The White House
Sue Biniaz, Office of the Special Presidential Envoy for Climate
Rich Powell, ClearPath

10:15 – 10:30 AM MST **Break**

10:30AM – 12:00PM MST **SESSION TWO: Climate, the FERC, and The Federal Power Act: Empowerment and Constraint**

What society is asking of the electricity sector to address climate change – to decarbonize itself and provide decarbonization solutions to other sectors – was not contemplated when the Federal Power Act (FPA) was enacted nearly a century ago nor when the modern Federal Energy Regulatory Commission (FERC) was established in 1977. What *was* contemplated was that the electric grid would fulfill the social compact of universal, affordable, and reliable power. By most reasonable measures, those foundational goals have been achieved (and must be maintained). But the cli-

mate challenge suggests that a new pillar of the electricity sector's social compact must include rapid decarbonization. Though not contemplated at the time of passage, what authorities do the Federal Power Act and successor laws grant the FERC and other market regulators that today could support market driven action to address climate change? And if the FPA constrains actions that the FERC might take in the modern era, is it time to reopen the FPA? Likewise, is it time to restructure the federal and state role in the electricity sector? If not, why not?

Moderators: Jim Connaughton and **Roger Ballentine**

Discussants:
Doug Smith, Van Ness Feldman LLP
Neil Chatterjee, Hogan Lovells
Emily Fisher, Edison Electric Institute

12:00 PM – 1:30 PM MST **Lunch – Davis Commons**, Aspen Meadows Resort

1:30 – 3:00 PM MST **SESSION THREE: Trade and Climate Change**

Environmental and climate change concerns have been increasingly in-focus for the international trade community in recent years. The European Union has undertaken the development of a "Carbon Border Adjustment Mechanism" while certain multilateral trading regimes have likewise sought to identify trade levers to address climate change. Can countries continue to pursue trade liberalization while leveling the carbon playing field through the imposition of border carbon adjustments? How will (or can) the WTO play a role in fighting climate change? Will "carbon clubs" emerge?

Moderator: Jim Connaughton

Discussants:
Dan Esty, Yale University
George David Banks, Bipartisan Policy Center
Maureen Hinman, Silverado Policy Accelerator
Catrina Rorke, Climate Leadership Council

6:30 – 9:30 PM MST **Forum Reception and Dinner | Presented by Wells Fargo**
Pine Creek Cookhouse, 11399 Castle Creek Rd, Aspen, CO 81611

TUESDAY, FEBRUARY 1, 2022

7:30 – 9:00 AM MST **Breakfast**
Davis Commons, Aspen Meadows Resort

9:00 – 10:30am MST **SESSION FOUR: Voluntary Markets, Environmental Attributes, Offsets, and the Evolving Concepts of Leadership**

As progress on climate policy continues in fits and starts, private sector actions not driven by regulatory requirements may be more important than ever in trying to meet our decarbonization timelines. Over the past two decades, more and more companies have committed to reducing their direct and indirect carbon footprints, such as by investing in energy efficiency, procuring clean electricity, and/or investing in projects that sequester or avoid emissions. Op-

erating without a clear legal construct, these voluntary markets have been guided and enabled through stakeholder developed rules and practices. Environmental attributes and carbon offsets have been commoditized, and companies follow a common voluntary framework for reporting their carbon footprints and demonstrating their efforts at reducing impact. As more companies seek to participate in these markets, as investor and stakeholder expectations rise, and as the need for the private sector to play a greater role in decarbonization becomes more clear, do the practices and rules of the road in voluntary markets need to be updated?

Moderators: Roger Ballentine and **Jim Connaughton**

Discussants:
Brian Marrs, Microsoft
Sarah Penndorf, Google
Nat Keohane, Center for Climate and Energy Solutions
Pankaj Bhatia, World Resources Institute

10:30 – 10:45 AM MST **Break**

10:45 – 12:00 PM MST **SESSION FIVE: "Tough to Decarbonize" Sectors: Maritime Shipping**

Maritime shipping causes about 3% of global greenhouse gas emissions and almost all ships run on fossil fuels. And without changes, as other sectors decarbonize, the shipping industry is poised to rise to 10% of global emissions by 2050. Many low-carbon alternatives to petroleum fuels have been proposed – from hydrogen/ammonia, hydrogen fuel cells, biofuels, wind-assistance, nuclear, and others. Are the primary challenges to decarbonization technology, cost, or lack of demand? Does the inherently global footprint of the industry create unique challenges? What role can national policies play or does the "regulatory" role rest with international organizations or industry associations?

Moderators: Jim Connaughton and **Roger Ballentine**

Discussants:
Ingrid Irigoyen, The Aspen Institute
Morten Bo Christiansen, Maersk
Sonal Dalal, Target Corporation
Mikal Bøe, Core Power Energy

12:00 – 1:30 PM MST **Lunch – Davis Commons,** Aspen Meadows Resort

1:00 – 2:30 pm ET **SESSION SIX: Hydrogen 2.0 – Do We Really Mean it this Time?**

Hydrogen has been billed as the "jack of all trades" for the energy future, deployable across a wide array of sectors. For what problems is hydrogen the right solution? How will markets develop? Will the significant new federal resources and incentives make a meaningful impact? Is conventional hydrogen production too carbon intensive to offer much of a climate solution? What "flavors" of hydrogen should be incentivized and deployed? If supply exists alongside the infrastructure, will there also be demand?

Moderators: Roger Ballentine and **Jim Connaughton**

Discussants:
Damian Beauchamp, 8 Rivers Capital, LLC

Barbara Burger, Chevron
Gill Pratt, Toyota Motor Corporation
Jay Bartlett, Resources for the Future

3:00 – 3:15 PM MST **Break**

3:15 – 4:45 PM MST **SESSION SEVEN: What can ESG do for the Climate?**

However imprecisely defined, most would agree that the environmental, social, and governance (ESG) issues have significantly altered capital markets as managed assets migrate to vehicles and investment processes seeking to incorporate ESG considerations. There is less of a consensus, however, on the actual real-world impact of this shift. If climate change is the long pole in the "E" tent of ESG, how has the growth in ESG investing impacted emissions and decarbonization progress on both the demand and supply sides of the capital markets? Are investors asking the right questions and seeking the best investments from a climate (and return) perspective? Do companies know what ESG investors are looking for and is it aligned with their own sustainability and climate objectives? Do companies, investors, and stakeholders have access to the right information?

Moderators: Roger Ballentine and **Jim Connaughton**

Discussants:
Susan Gray, S&P Global
Elizabeth Lewis, Blackstone
Kara Mangone, Goldman Sachs

No formal dinner is planned for this evening to allow participants to gather in small groups and explore Aspen – restaurant suggestions and reviews are available at www.eataspen.com or the Aspen Meadows Reception Center.

WEDNESDAY, FEBRUARY 2, 2022

7:30 – 9:00 AM MST **Breakfast – Davis Commons**, Aspen Meadows Resort

9:00 – 10:30 AM MST **Wrap Up - Putting it all together**

Moderators: Jim Connaughton and **Roger Ballentine**

11:00 AM MST **Forum Adjourns**

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