Clean Energy Innovation Roundtable Series

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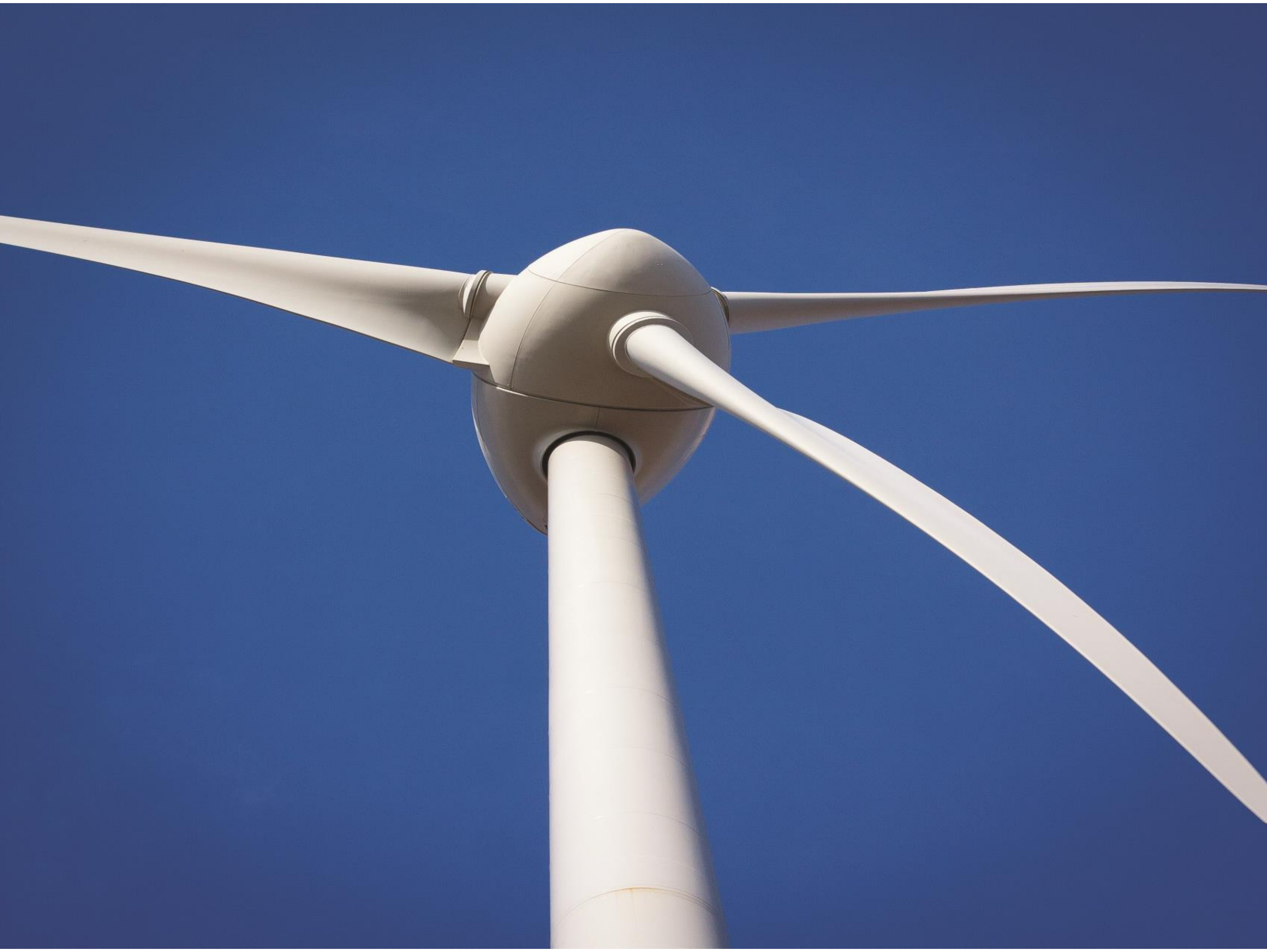

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Session I: Challenges and Opportunities in U.S. Energy Policy

On March 4, 2021, the Aspen Institute Energy & Environment Program virtually convened a roundtable of experts to discuss the context for climate and energy policy in Congress, the potential for bipartisanship, the need for ambition, and what is required to produce durable policy. This summary captures some of the key topics of discussion.

Policy Context & Scope

Climate change is a problem of utmost urgency, requiring strong, gigaton-scale solutions. Policy is an immensely important element of advancing those solutions. Political, capital, and social cycles are in a relatively rare moment of alignment for achieving climate and energy policy. It is important to take advantage of this culminating moment.

There is momentum to build on. Congress enacted a large, bipartisan energy package at the end of 2020 – the first major update to national energy policy in more than a decade. The Energy Act of 2020 had many elements, but its focus was primarily on research, development, and demonstration. The policy conversation now needs to shift from a focus mostly on innovation to a focus that also includes scalable implementation and investment.

Some maintain that policy must encourage energy and climate solutions that encompass all fuels. Deployment of existing technologies at scale is essential, but so is continued funding for discovery science and new technologies. Climate policy should also enable the United States to deploy technologies domestically and globally.

It is important to be cognizant of the fact that the climate challenge is much broader than the power sector. The power sector plays a central role and has already made substantial progress in reducing emissions – largely because policies, technologies, economics, and public support are all aligned in that direction – but policies and action are needed in transportation, buildings, and industry as well. Indeed, those sectors will be relying to an extent on the grid to reduce their emissions. The power sector can lead, but it will be more economic to look at the entire, economy-wide supply curve of carbon abatement options.

Bipartisanship

The divisions in this relatively evenly divided Congress appear to be particularly wide, deep, and personal. Most would agree that a bipartisan pathway on climate policy is preferred, but it may be unattainable in a media and political ecosystem with echo chambers that vilify people in the middle and that make everything into an ideological battle, whether it is a non-rigged election, wearing a mask, or climate change. Still, there may be some potential for bipartisanship – if for no other reason than the fact that key actors in Congress, particularly a few from coal states, are putting an emphasis on finding bipartisan paths forward on climate and energy.

The fact that a large bipartisan energy package was just adopted at the end of 2020 suggests it may be possible to accomplish again. Getting that legislation enacted involved leaders from both parties spending years working through long lists of ideas and proposals from numerous members of Congress; enough people had a stake in the legislation and wanted it to pass. One potential area of bipartisanship in the current Congress could be funding the programs authorized in that law. While the Energy Act of 2020 is now on the books and authorizes lots of new investments, authorizations are like checks in a checkbook that still need to be written – appropriations are needed to actually deploy funds to the programs.

Investing in a broad range of technologies can get broader political support. To achieve bipartisanship on climate policy in this Congress, fossil fuels will have to be part of the mix, which means carbon capture, utilization, and storage (CCUS) is vital. Again looking to the Energy Act of 2020, carbon capture was the technology that made out the best both in terms of innovation investments and incentives. The United States could play a key role in bringing down the costs of CCUS for the world.

The power of corporate voices and dollars to move policy through on a bipartisan basis also should not be underestimated. Getting CEOs speaking up will be critical, and more large corporate energy buyers are starting to get engaged in federal energy policy issues. These companies bring jobs, infrastructure, economic benefit, and growth to states, and they are not engaged in policy arenas to promote their own products, so policymakers are keen to hear from them. Business-supported climate policies that are designed to be market-enhancing (not market-squelching) could open the potential for conversations with members of Congress who tend to be more market-oriented in their preferred solutions.

In addition, there is more potential for bipartisan movement on narrower issues – such as modernization of grids, cyber security, forest policy, or wetlands management – than on a sweeping, comprehensive climate package. These could be areas to find common ground to reduce emissions, promote innovation, and create jobs. For example, decarbonization, environmental justice, infrastructure, resilience, labor, and many other issues and interests all intersect in improving the grid. It is unclear, though, if such bills would drain the will to pursue more ambitious policy or empower bipartisan actors to build from a narrow start. Achieving the necessary levels of climate ambition does not allow for a narrow policy approach if that is where the policy action stops.

Ambition

Addressing the climate crisis requires ambitious policy. There may be a relatively small political window open now in which to get robust climate policies adopted, so there should be a sense of urgency to actually do so. Ambitious U.S. action is a key factor not only in advancing decarbonization domestically, but also in driving ambition and action globally.

There are numerous climate-related proposals in Congress. The perfect should not be the enemy of the good, but some argue that the good has to be big enough to address the problem. Just in the power sector, there are proposals ranging from an 80% reduction by 2050 to a 100% reduction by 2035. There is a multi-gigaton difference between those two goals for the power sector, and a ton reduced earlier is more valuable than one reduced decades later. Accelerating reductions in the power sector is critical, as that is where the reducible tons will primarily be found over the next decade. In addition, if the power sector is key to decarbonizing other sectors, and if decarbonization of the economy by 2050 is the goal, then the power sector has to be decarbonized earlier.

Some maintain that adopting policies to address climate change should not involve negotiating on ambition. The necessary emission reduction curve now is very steep, and the ambition cannot be where compromise happens. Ambitious climate policy, though, must involve listening carefully to concerns about achieving that ambition. The combination of high ambition and my-way-or-the-highway will not work. Instead, there must be clear listening and approaches that build in flexibility, optionality, and other policy designs to bring people to the level of ambition needed. A broader set of people can be brought into the tent by having processes that include them and policy design and implementation that address their concerns.

Durability

There are many views on what creates durable policy – and on what durable policy even is. Durability can mean many things. It can mean a policy that can survive court challenges. It can mean a policy that can be reliably implemented, including with adequate agency staffing and spending. It can mean a policy that gets passed and does not get altered or repealed. Congress, however, revisits legislation frequently, whether for technical fixes or big amendments (e.g., the Clean Air Act amendments of 1990). If a climate bill hopes to set targets out through 2050, it is unlikely that Congress will not revisit the legislation again for 30 years.

Ideally, durable policy would be inclusive, encompassing parties, regions, technologies, communities burdened by pollution, and communities fearful of and hurting from the energy transition. This is because durable policy requires broad support. In Congress, that would mean bipartisan support, but some argue that ambition cannot be sacrificed for bipartisanship and that partisan climate policy could still be durable.

It is not clear that bipartisanship, even if desirable, is necessary for durable policy. Something that is neither bipartisan nor has public support will not be durable, but something that is not bipartisan but does have public support could be. The Affordable Care Act is one example. It passed on partisan votes, has been subject to constant attempts to repeal and undermine it, and yet in 2020 saw its highest level of public support since its enactment. Key provisions of it, such as protections for pre-existing conditions, are broadly popular regardless of party affiliation. While bipartisanship increases the potential for durability, the most durable policies see strengthened support over time because the benefits accrue broadly, opposition fades, and new allies emerge. Sometimes, those policies have to be initially passed with just enough support, even if all or mostly from one party, with public support over time pulling along the bipartisan support that was not there in the beginning. There is now broad public support for climate action as well.

On the other hand, when policies are rammed through Congress in a partisan manner, such as through budget reconciliation, politicians take positions that are hard to move, setting up a weversus-them dynamic that poisons future efforts and alienates people. Some argue that pursuing a party-line budget reconciliation approach wastes time that could be spent building support from 60 senators. From a business perspective, it also erodes predictability; if a policy is consistently attacked and political winds change, businesses do not have confidence in the policy's durability.

Regardless of the role of bipartisanship, broad support from a range of constituencies is key to policy durability. Policies should consider how to address the transition to the desired outcome, to avoid mobilization of constituencies that are affected negatively and to build support by providing benefits broadly. For climate policy, it is critical to direct investment to a fair transition for communities and workers being left behind by the transition and feeling the pain of a changing economy and energy mix. Attention to equity and justice for pollution-burdened communities also has to be a central part of the policy package. In addition, it is essential to ensure the energy transition maintains affordable, reliable energy and enhances resilient infrastructure. Well-designed policy can do those things and build a broader consensus.

Durability is not just about the policy design but also about policy implementation. The follow-through matters. Implementation of a policy in a way that ensures a broad set of citizens experience the value and importance of it engenders greater support and durability.

In addition, though, policies that can create concentrated benefits in some actors can also be more durable. The acid rain program under the Clean Air Act, for example, let companies bank allowances under the cap-and-trade program, giving emitters a capital stake in the long-term continuation of the policy. Likewise, when policies incentivize innovation, early adopters have a vested interest in the durability of the policy.

Appropriations by Congress and spending by an Administration can be another form of durable policy. Procurement and deployment of technologies at scale has extremely durable ramifications, as the 2009 stimulus package's investments in deployment of renewables made clear. The 2009 package, though, also missed opportunities for durability in its low-income energy efficiency investments. The Obama Administration directed billions of dollars in low-income energy efficiency grants through the nonprofit community action programs that run weatherization programs; this missed a chance for a public-private partnership with labor unions that wanted to coinvest their assets on top of the grants. Those private assets could not be tapped, and the program wound down a couple of years later. Partnerships matter in durability.

Ownership is also key. For example, Franklin Delano Roosevelt's rural electrification initiative has been hugely popular and durable because it enabled community-based ownership of electric utilities across the country. Rather than just allocating grants to constituencies, policies that can build and embed community ownership (e.g., loan-loss reserves, using public dollars to leverage private-sector capital) can be more durable.

Durability can also come with clarity – i.e., an ambitious target that is achievable. For example, even though Congress defunded the light bulb efficiency standard (which means no appropriations to support it), the mandate has achieved widespread compliance ahead of schedule. If Congress could at least agree on legislating the climate goal – how far and how fast – that could prove to be durable.

Session II: Transmission & Reliability

On March 25, the Aspen Institute Energy & Environment Program virtually convened the second in its 2021 series of Clean Energy Innovation Roundtables. This convening brought together experts to discuss electricity system reliability and resilience, as well as the need for inter-regional transmission. This summary captures some of the key topics of discussion.

Reliability & Resilience

Reliability and resilience are terms that are often used interchangeably, but, while related, they are somewhat different. Reliability can be thought of as keeping the lights on all the time, whereas resilience is more about the ability to withstand major events (e.g., extreme weather events) and to recover from those events when they occur. Reliability therefore involves balancing supply and demand in real time, whereas resilience involves efforts such as hardening infrastructure and putting more intelligence and flexibility into the system. Some think of reliability as being more of a short-term focus and resilience as being more long-term. Either way, they are very complementary; more resilience means more reliability.

System reliability and resilience have been in the news, with the freeze in Texas, wildfires in California, and other extreme events. In a world of progressing global warming and climate change, the underlying climatic conditions that impact the grid are not going to get any better. Planning in the power sector still focuses too much on looking in the rearview mirror on weather extremes, but the past is nearly irrelevant in terms of projecting an appropriate risk profile. The bookends of "normal" are getting wider, and there is a need for a new paradigm of risk profiling throughout the country. It is not clear who should be responsible for the risk profiling, though; these are very complex economic and system-level issues, and resilience is a multi-scale challenge, requiring action and coordination by entities at the federal, regional, state, and local levels, as well as by both public and private actors.

Risk profiles vary widely by region. While further advancements are needed to enable higher fidelity regional projections, there are tools available now to enable regional risk profiling in a modern way. The need for improved risk profiling is particularly important if the system will have much greater levels of wind and solar – weather-dependent sources in a time of rapidly changing weather. Texas, for instance, is planning to add substantial amounts of solar power and to continue building on its huge base of wind power over the next 15 years. (The low carbon future may well be written in Texas faster than in California simply because the resource base is so good – though it is still too soon to know if the recent freeze and blackouts and the very partisan reactions to them will hinder or accelerate the transition to a cleaner grid.) Risk profiling and resilience planning need to take a system view that accommodates variations in the availability of renewables. Studies in states such as Texas and California, for example, have shown that there can be multi-day periods with no wind. To ensure reliability and resilience, high penetrations of renewables not only need to be complemented with firm, dispatchable sources, but also need to be supported by a much more robust storage system that goes beyond batteries to cover generation lulls on the order of days, weeks, or seasons.

More broadly, the system cannot be planned around yesterday's or even current technologies. The infrastructure is not just being built for today, but for the capabilities and needs decades from now. The power system has to move from a structure designed to serve current loads to new, significant infrastructure built for much bigger purposes (including to power transportation). These are not just incremental upgrades, though incremental upgrades are certainly needed too; this is a new machine being built. That may look like overbuilding today, but it is real infrastructure investment for the future.

A resilient and reliable grid has to be planned, designed, and built for an unknown future, so regulatory regimes, policies, analyses, processes, and tools have to be adapted. For example, regulatory regimes focused on whether investments are used and useful for current customers may no longer work when planning future needs; at the same time, the costs cannot all be put onto current ratepayers, as doing so not only is unpopular but also creates intergenerational equity issues. Similarly, concepts such as critical infrastructure and transmission may need to be thought of differently if a hydrogen economy will be developed, and interdependency across types of infrastructure – such as electricity, gas, and water systems – will have to be a major factor in resilience planning. Adding lots of renewables to the grid will require models and other decision and analytic tools to address new problems that arise on the grid as different resources interact with each other. Power system modeling tools for connections should also be made available to large customers or developers so they can design systems to meet grid needs; the system operators now are a congestion point because they are the only ones with all the data. Decisions will necessarily be made under conditions of uncertainty, which means optionality and flexibility should be built into the decision process. The rest of the energy industry may be able to learn from the probabilistic risk assessments undertaken by the nuclear sector, though there are other kinds of tools in decision science that can be used too.

There are also still enormous unharvested opportunities to boost reliability, resilience, and emission reductions by fully integrating information technology into key systems. This includes sensors on high-voltage and distribution systems, artificial intelligence, machine learning, and more technologies that allow faster situational awareness and response, as well as improved demand management, efficiencies, and energy services for consumers. Integrating all the digital technologies into a system full of diverse, non-emitting sources to meet a lot more demand as other sectors electrify will require significant building and overbuilding (i.e., redundancy), but affordability then starts to become a key issue.

Indeed, affordability, resilience/reliability, and sustainability are now the key social objectives for the electricity grid. Markets do not operate in isolation, but rather are conditioned by policies, which set the guardrails and the social objectives. Markets work when they have proper definitions as defined by social imperatives. Some view part of the shortcoming in Texas as stemming from not having sufficient guardrails, requirements, authorities, communications, and planning. Texas regulators were very focused on affordability, and to a degree on sustainability (e.g., with the Competitive Renewable Energy Zones), but they took their eye off the ball on reliability. It is important to balance market rules, robust infrastructure, and vigilant oversight, and Texas probably dropped the ball on all three of those. Reforms of some kind will be needed to the guardrails in Texas, though the tools and mechanisms will likely look very different from what PJM and other system operators utilize.

Still, the fact that the operators in Texas stopped the system from going down entirely is heroic, and they did not get the recognition they deserved. These also are not new stories or issues. These types of things happen again and again (e.g., California in 2000); they are repeating stories with different wrinkles. Everything old is new again, though it is a new new, as the challenges and technologies are substantially different than in the past.

Inter-Regional Transmission

The situation in Texas has also raised the salience of inter-regional grid connections. Texas may not decide to interconnect to the rest of the country, even if it would boost reliability and resilience, though it is possible the federal government could promise Texas that it would not use interconnection as a backdoor for federal authority over the Texas grid.

While increasing the volume of inter-regional transmission can enhance reliability and resilience, people have different end visions for such a buildout. Some envision a continental scale macro-grid as a long-term goal, to the extent it can be planned and actually built. Others envision interconnections between regional infrastructures, preferring to strengthen the ties between regions (e.g., requiring minimum bulk power transfer capacity between regions as a system reliability and resilience measure) rather than build an expensive new system. There have been federal studies that demonstrate the high value and reliability benefits of a macro/interconnected grid, particularly as the grid decarbonizes.

Under either vision, there is a need for an effective inter-regional transmission planning process in the United States to identify projects in the best interests of interconnections and the nation. The lack of inter-regional lines is a national problem; some other countries (e.g., Australia) use integrated system planning on a national basis, with the government supporting funding for a transmission buildout as infrastructure, and the United States needs a federal solution as well. The planning process needs to incorporate a future vision – 20-30 years out – and work backwards to ensure the infrastructure is located where it will be needed. (If there is a large buildout of transmission to places where it is not used much yet, though, it is important to think through who pays for it while it sits unused.) The planning process has to recognize the potential doubling of demand due to electrification, the potential quadrupling of capacity due to the variability of some renewable resources, and the need for grid stability as penetrations of variable renewables increase.

This process could involve a range of elements and approaches. For example, the Department of Energy (DOE) and the Federal Energy Regulatory Commission (FERC) could use their national interest electric transmission corridor authorities. FERC could mandate inter-regional planning that uses scenarios, identifies plausible futures a couple of decades out, and incorporates assumptions about binding carbon goals, approved utility goals, technology trends, and weather events. FERC could also empower new regional planning boards under the Federal Power Act, led by representatives of states, to identify and plan inter-regional transmission; projects that come out of an inter-regional planning board with state representatives might see more state support, though some worry that regional power boards might end up as just another layer of bureaucracy. DOE also has power marketing administrations whose territories are already inter-regional and could be used for planning. FERC and DOE can do a lot right now to accelerate transmission, but they need the courage to do it and to act fast.

Once the planning processes are complete, there is a need to make sure the plans are binding when handed off to system operators or other authorities – and that the needed transmission actually gets built relatively quickly, given the urgency of addressing climate change.

Permitting and getting land rights for inter-regional transmission lines can often be very challenging. The split between the states and the federal government on permitting has been dysfunctional for decades – a vestige of the fact that electricity was more localized than interstate natural gas pipelines were. Even permitting reform, though, would only go so far in the face of public opposition. When it comes to developing transmission projects, regions tend to look inward, engaging local stakeholders to address local concerns about perceived winners and losers. Eminent domain, in particular, is never easy and is always unpopular, which means states are unlikely to support its use in local processes related to transmission lines. Traditional inter-regional lines also require multiple states to agree on who pays for them, which is often contentious. If the country is serious about moving to high levels of clean energy, though, substantial investments in transmission are needed, and exercise of federal jurisdiction over interstate commerce, as well as the use of eminent domain, may be necessary.

One option that could avoid some of these challenges is privately financed merchant transmission located in existing railroad and highway corridors. Merchant transmission lines cost ratepayers nothing, as those who use them pay for them. Co-locating transmission lines with existing railroad and highway rights-of-way can also avoid eminent domain fights and virtually eliminate landowner opposition. (Expanding broadband access could be accomplished in a similar fashion.) Some doubt that co-location will be sufficient in itself, while others think it could be. Existing railroad and highway corridors already go everywhere and can expedite permitting, development, and deployment, as the path the transmission will follow is known from the start. Transmission usually takes years to approve and build, but taking a decade to get built is a failure from a climate perspective. Co-location, the right financial incentives, and the deployment of private capital could expedite deployment.

Financial incentives to help developers build more inter-regional lines could take a variety of forms. For example, the idea of a tax credit for transmission lines has been gaining traction; while they can be a huge pain to deal with, and some fear that tax credits could slow projects down given the complexity and cost of tax equity, tax credits do bring down costs, and a tax credit with a direct pay option might be a preferable approach. Congress renewing the 48C advanced manufacturing tax credits to include underground HVDC cables would also help. The cables are currently built in Europe and Asia, and manufacturers need market certainty to invest in U.S. plants. The combination of tax credits could provide the needed signals to invest in U.S. manufacturing capacity – and the plants could be located in places where energy jobs have been displaced, which could be politically resilient policy. The modest federal investment represented by the tax credits could get several inter-regional projects built around the country, bring the grid into the digital age with advanced grid technologies, get more renewables built in remote regions, help achieve decarbonization goals, and put union labor to work in a vital technology sector.

Another mechanism to reduce risks for transmission developers could be tweaks to DOE's loan guarantees to get the government to effectively underwrite the risk of filling up lines. (In a country where utilities are small by global standards, the big HVDC lines are hard to fill by one entity; more utility consolidation could actually therefore be of help to transmission development by concentrating load and resources.) Similarly, there are discussions about the federal government underwriting capacity purchases on certain critical lines.

A national clean energy grid, however, cannot be built quickly enough without fixing policies, rules, and regulations that are not currently set up to enable speedy deployment of transmission. PJM, for instance, has an antiquated grid connection process that needs to be updated. Modern HVDC technologies can make the grid more resilient, with undergrounded lines that are bi-directional and dispatchable, but modern HVDC projects are currently languishing in PJM's generation queue. FERC can provide leadership and direct grid operators to update their interconnection rules to have such projects studied as transmission. Like batteries, modern bi-directional HVDC transmission lines also should also be compensated for the range of benefits they bring, including boosting resilience. In addition, state regulatory structures will be big hurdles to transmission development if the question of how utilities can recover fixed expenses is not addressed.

In general, resilience and reliability may be an effective framing to actually get inter-regional transmission built. When inter-regional projects get developed, cheap and clean megawatts can flow around the grid, and everyone benefits – including in terms of reliability and resilience.

Session III: Revolutionizing Clean Energy Project Finance

On April 15, the Aspen Institute Energy & Environment Program virtually convened the third in its 2021 series of Clean Energy Innovation Roundtables. This convening brought together experts to discuss the U.S. Department of Energy's Loan Programs Office, tax incentives, market reforms, and other issues related to clean energy project finance. This summary captures some of the key topics of discussion.

Loan Programs Office

Industry and government need to work more closely together to unlock American clean energy innovation. The U.S. Department of Energy's Loan Programs Office (LPO) can play a key role in that. LPO operates within the Department of Energy which exists within an Administration that has a clear objective and agenda on climate change. The market, society, and politics are all currently more supportive of deploying clean technologies, and LPO aims to operate synergistically within that, wherever it can help move the ball faster and farther. LPO has far more potential than it has achieved to date, but there are signs that it is looking to extend and maximize that potential.

There are hundreds of billions of dollars of climate-related investment opportunities that are being turned down because the senior debt markets are not comfortable with them, and equity investors will pass on them if not paired up with the senior debt. LPO can help save those projects by providing the debt. LPO has roughly $46 billion of capacity, split up among the Title 17 Innovative Energy Loan Guarantee Program, the Advanced Technology Vehicle Manufacturing (ATVM) Direct Loan Program, and the Tribal Energy Loan Guarantee Program. Title 17 is basically a project finance structure for advanced fossil energy projects (about $8.5 billion), advanced nuclear energy projects (about $10.9 billion), and renewable energy and energy efficiency projects (about $4.5 billion). ATVM (about $17.7 billion) is largely focused on improving the fuel economy of vehicles, which can involve vehicles, materials, critical minerals needed for components, and other supply chain elements. The Tribal Energy funding (about $2 billion) can be used for any tribal energy development, as long as more than half of the project is tribally owned.

There is not a lack of money for LPO. Its score in deficit spending is incredibly small, as it is only scored on the money it loses; the rest of it cycles back to Treasury. The reason LPO does not have more money now is because Congress does not believe LPO can get the money out the door; historically, LPO has had a hard time pushing money out. If it proves it can do so, LPO should be able to get more funding.

LPO's recent history – at least politically – has been dominated by the failed Solyndra loan. That loan is embarrassing not because it failed but because due diligence was not done; there are protections in place now to ensure that will never be repeated. There are risks inherent in getting LPO money out the door, and some projects will not pan out. In battery manufacturing, for example, there are lots of companies claiming to be the future, and while many will be funded, it is impossible to know which ones will actually win. The risks of supporting companies that make it through the due diligence process are worth taking. Due diligence is important, but it also should not take forever to get money out to good projects. The average time to evaluate a deal now, though, is only around four months.

LPO is a bridge to the private sector. When the risks LPO takes work out, the private sector can eventually take over. As a bridge to bankability, LPO can take on deals that are outside the comfort level of existing financial players and help get commercial banks comfortable with them. At some point, banks could use LPO as a guarantor, bringing deals to LPO that could go forward only with an LPO guarantee; that would enable LPO to outsource some of the due diligence to the commercial banks. Commercial banks can also invest in projects alongside LPO; LPO does not have to be the sole debt financing in every deal, as long as LPO remains senior in the capital stack.

LPO is a public policy bank, but it is still a bank and needs a reasonable prospect of repayment. The potential projects at LPO span technologies, including carbon capture and storage, green hydrogen, advanced nuclear, and others that have bipartisan support. LPO will support projects that not only have great loan applications but also have real environmental value in terms of greenhouse gas reductions. There are many clean energy projects that could use LPO's capacity, and they are being encouraged to apply. The Energy Act of 2020 included reforms that got rid of a lot of the fees involved in applying for LPO financing, which had been a big barrier. Applying to LPO had not been a riskless, no-regrets undertaking, but now it is. LPO absorbs all broken deal costs, so LPO is now getting more applications.

There are further legislative reforms, though, that could make LPO more effective. In ATVM, for instance, LPO is currently limited only to passenger vehicles, but the biggest opportunities are likely in medium- and heavy-duty vehicles. In Title 17, there is not much credit subsidy left, which limits LPO's ability to help small borrowers. In Tribal Energy, LPO cannot use the Federal Financing Bank (as it can in Title 17 and ATVM), which leaves LPO at the mercy of banks to underwrite particular loans for tribes.

LPO is the only entity in government that does what it does – fundamental due diligence and reports on every project – and there are other parts of the government that want to tap into that expertise. LPO coordinates with other federal entities to enhance efficiency. One particular entity, the Office of Management and Budget (OMB), has micromanaged LPO in the past, but that may be less the case under the Biden Administration, giving LPO more freedom to operate. There may still be conflicts to sort out with OMB, though. For instance, OMB requires LPO to use S&P and Moody's in assessing credit risk, but they focus on FICO score models tied to credit card debt and healthcare, whereas default has been far lower in the experiences of electric utilities and appliance financing companies. All actors in the clean energy finance space will need to weigh in on the various frictions between LPO and OMB.

Tax Incentives, Opportunity Zones, & Clean Energy Project Finance

Financial markets crave certainty and predictability. The ability to scale the clean energy market is about being boring, like the municipal bond market. Clean energy project developers are therefore in the business of manufacturing long-duration, low-risk cash flows in order to mobilize private investment into power sector modernization. This means making the complex into simple, sustainable solutions that can get financed with bond-like returns. It is also important to create predictability and certainty for the capital needs of given projects, including aligning capital with the lifespans of the underlying technologies.

To align incentives, increase competition, and accelerate deployment, federal actions are needed, including making the investment and production tax credits longer (e.g., 10 years), steady (e.g., at 30%), and applicable to more technologies. No tax credits at all might be preferable to tax credits that are short and episodic, as at least the former provides certainty. Tax credits also are not the answer to everything. For instance, there are differences in thinking about financing projects at the distributed versus the utility scale; accelerating the deployment of distributed technologies into communities – particularly hard-hit communities – could involve structures under which cash can flow directly into projects, not indirectly via tax credits. The types of financing and structures are also not the same for mature clean energy technologies and for newer clean energy technologies. There is no one-size-fits-all approach for technologies or for regions.

That said, tax incentives can be powerful. Tax incentives tied to opportunity zones, for example, could be an innovative and disruptive tool to bring capital for clean energy to low- and moderate-income (LMI) communities. Opportunity zones, which are based on geography, were part of the 2017 tax law, but drafting regulations took two years, at which point COVID hit and caused further delays – so their potential is only just starting to be understood and acted upon. The final rules now give clear guidance for investors, funds, and projects, each with their own sets of requirements and timing. Any capital that goes into building things in those LMI census tracts that stay in place for the requisite number of years gets the tax break, across asset classes.

Opportunity zone investments to date have focused on real estate, since all the guidance at first was about real estate, but with the final rules now in place and the economy starting to emerge from the COVID hit, animated discussions are under way about projects beyond real estate, including clean energy. (Real estate is also easier and more pro forma than some other investments; the turnkey model does not exist yet for big clean energy infrastructure projects.) It is possible there could be $1 trillion of equity coming off the sidelines and into opportunity zones for new-builds over the next few years. Banks are looking at opportunity zones for Community Reinvestment Act credit. ESG investors will want to invest. Innovation companies and venture capitalists are looking to put deals in opportunity zones. Opportunity zones open up the potential for infrastructure buildouts related to offshore wind and port communities. The Biden Administration wants 40% of clean energy investment going to frontline communities, and opportunity zones could be a great vehicle for that (as could community solar), though care must be taken that opportunity zone projects are sensitive to environmental justice concerns and are siting things in the communities that they actually want, that bring great jobs, and that are not exacerbating the impacts that communities are already feeling. The equity unleashed by opportunity zones could be a source of long-term predictable capital, and long-term equity brings in the rest of the capital stack.

The opportunity zones designated thus far have been focused on areas where there are lots of people, not the less populated areas nearby that might be a better fit for some clean energy infrastructure. An opportunity coming up in the push for infrastructure legislation is a new round of opportunity zone designations to supplement the previous ones – tied to the same communities, but opening up the land next door for brownfield redevelopment.

Market Reforms & Other Measures to Advance Clean Energy Projects

Market reforms are part of making clean energy projects into long-duration, low-risk cash flows. In addition to more transparent and competitive pricing for power, ways must be found to finance storage, demand response, transmission, and firm, dispatchable resources that will be needed to integrate high levels of variable renewable energy and create an affordable, reliable, zero-emission grid.

States have made significant progress in getting variable renewable energy sources deployed and financed, but they face challenges in creating durable revenue streams for zero-emission resources that can integrate more of those variable renewable sources on the grid. A challenge with financing some projects involving firm, dispatchable, low-carbon resources is that most utilities and public service commissions do not have compensation mechanisms in place for them yet. For pumped hydro, geothermal, nuclear, low-impact hydro, or other projects that will cost a bit more but will provide significant value in a portfolio, it is unclear who will pay for the ancillary benefits and other elements of value. Debates about the Minimum Offer Price Rule and capacity markets have been taking up lots of oxygen, but reforms are also needed in ancillary service and energy markets to help incentivize needed resources. Once public service commissions approve the revenue streams for these kinds of resources, financing – whether from LPO or others – will be easier and more cost-effective.

More mature ancillary services markets that can value integration of renewables onto the grid can also help states focus on reforming energy efficiency programs to incentivize demand response and other resources. Capacity markets are not sending the price signals that would promote deployment of demand response programs to avoid construction of peaker plants, though there is hope that Order 2222 from the Federal Energy Regulatory Commission can lead to capacity market structure reforms that can better identify value and unlock demand response at scale. Performance-based regulation could also make a big difference in rewarding utilities for investments in smart meters, bidirectional capabilities, and other measures to advance demand response and load optimization. In vertically integrated states, there is a need for demand-side management and energy efficiency programs to evolve toward carbon reduction and not energy savings as their primary goal. There also need to be tools to find and mobilize scalable opportunities for demand reduction that are as powerful and accessible as the tools that have benefited solar deployment (e.g., net metering programs, roof mapping).

In addition, it is important to speed up processes for interconnection; capacity markets are keeping low-utilization fossil resources on the system that are taking up interconnection. The capacity market structure is built around the needs of fossil plants, but there has to be a hard look taken at what capacity and reliability benefits those incumbent generators are actually providing, what resource adequacy actually means, and which resources are truly providing value and should be retained – and which should be retired to unlock more interconnection resources for clean energy to plug into. More broadly, states are increasingly coming to appreciate the critical investments needed in transmission infrastructure. There is a need to build a 21st century transmission grid and to be more forward-looking in planning for transmission. The grid is operating at 50% of capacity utilization, but adoption of newer technologies could bring it up to 80%; the need is not just for new wires, but also for better-functioning wires. The sooner policies and laws change to align incentives for interconnection, the sooner clean energy projects will be able to scale up and the sooner there will be a better, integrated grid with high utilization levels.

States can couple such reforms with revisions to renewable portfolio and clean energy standards to procure around inter-day greenhouse gas reduction opportunities instead of around average annual load. Expansion of the scope and ambition of these standards can drive innovation and accelerate deployment of clean energy projects, particularly leveraging the expected influx of federal funding.

States have to focus on removing other barriers to project deployment as well, such as siting and permitting. Some states, for example, are working on public species datasets, so developers can pre-clear or avoid sites and do not have to wait weeks for answers from agency staff. Given the importance of natural sinks and working lands, states could also do a better job of directing clean energy projects to preferred locations and away from greenfield sites. Likewise, cleaning up more contaminated sites, clearing the title, and so forth can make more sites ready to be repurposed for clean energy development.

Session IV: Clean Electricity Standard

On April 29, the Aspen Institute Energy & Environment Program virtually convened the fourth in its 2021 series of Clean Energy Innovation Roundtables. This convening brought together experts to discuss the design and political realities of a clean electricity standard (CES), as well as other complementary climate policy needs. This summary captures some of the key topics of discussion.

Design of a Clean Electricity Standard

The Biden Administration has been promoting the concept of a Clean Electricity Standard, but it has provided few details. Likewise, Democrats in Congress have proposed various CES ideas that differ in numerous respects. The design details of a CES matter.

A CES has to be designed to be effective, and the relevant goals and timetables have shifted over the years. A few years ago, the conversation was about 80% clean by 2050, which became 100% by 2050, and now 100% by 2035 (which has recently been coupled with 80% by 2030). The ambition and timetable have moved steadily forward. Aspiration and ambition are good, but the goals also have to be possible. Early modeling suggests there may be challenges with the more ambitious targets, as systems' costs may reach the thresholds for alternative compliance payments before reaching the targets.

It is also important that a CES be tech-inclusive. There are debates about which technologies should be included in a CES, but the conversation has largely moved in the direction of inclusivity. Most major proposals include renewables, existing hydro, existing and new nuclear, carbon capture and storage, and direct air capture. The inclusion of nuclear within a CES will improve nuclear power's prospects, as it currently is not valued for the 24/7/365 carbon-free generation it provides. The role of natural gas in a CES is a topic of contention. Some want gas excluded, while others want it to receive partial credits; modeling suggests that partial credits for gas achieve more reductions, faster, at lower cost.

There is some contention as well around including direct air capture and other forms of carbon dioxide removal. Net-zero emissions is an economy-wide goal, but it may not be the goal for the power sector, where existing technologies can achieve deep reductions in the near term and where there are plausible newer technologies to get the sector to actual zero in the long term. The removals that will be necessary to achieve economy-wide net-zero may be better reserved for harder-to-abate emissions outside the power sector, though the door can be left open to using them in the power sector if it turns out that advances in other sectors make emission reductions there more feasible and/or the last emissions in the power sector prove to be very costly to eliminate. Rural electric co-ops may also benefit from having access to removals to offset their emissions, though rural communities may not actually be that hard to decarbonize (especially with targeted infrastructure investments). In addition, there may be no technological pathway to achieve an actual-zero target by 2035 (versus 2050), so removals will be needed to achieve that more aggressive target.

A historic concern about technology inclusiveness has involved crediting existing resources, which can create wealth transfers between regions that are leading on clean energy and ones that are further behind. However, different baselines can be established for different regions. Differentiated baselines allow a CES to work for both heavily clean and heavily emitting states, as it allows entities to make progress from where they are, not relative to other parts of the country. The best CES proposals, by using regionally differentiated baselines, are also careful about how they credit sources to encourage ones that actually yield decarbonization benefits as opposed to add to saturated parts of the grid. A CES should focus on transforming grids where more clean energy is needed, not on overcrowding parts of the country's grid already well-stocked with clean energy; clean energy resources and jobs should be located everywhere and close to local loads.

Technology inclusiveness can expand the political base of support and improve the political economy for a CES. For example, unions do not see themselves having lots of jobs building wind and solar, but they do see jobs in nuclear, hydrogen, and other technologies. At least three different types of small modular reactors could be built by the end of this decade and could be sited to replace coal plants, and there is a high degree of job transferability between the two. Indeed, the new tech that is coming will matter a lot in changing the political economy of action.

To decarbonize the grid on aggressive timeframes, there is a need to not just promote an inclusive set of clean resources but also to drive unabated emitting assets off the system. There is no shortage of capital in the market that wants to invest in clean energy; the market failure is in getting the legacy emitting assets off the system early. A CES can do that, by creating positive incentives for the generation of clean power and by requiring anyone selling power that is not 100% clean to purchase credits, which is basically equivalent to a fee for emitting. There are regulatory challenges involved in pushing emitting assets off the system, and public utilities commissions and ratepayers are very sensitive to stranded assets and the costs they have to carry for retiring them early, but those challenges need to be worked through to create a glide path for the exit of old emitting assets.

Beyond the key criteria of a CES being effective and ambitious in reducing emissions, being tech-inclusive, being geographically fair, and addressing air quality in local disadvantaged communities, there can be lots of flexibility, creativity, and optionality in how to design a CES. A CES also should not undercut the work that big energy buyers have done to help drive clean energy on the grid; it is important to figure out how to have a CES that does not shut down voluntary markets.

In addition, it may not be feasible to expect a nationwide CES to work while having well-functioning markets for clean energy only in some parts of the country; expanding wholesale markets across the country should be part of the conversation from the start. This could help keep costs down, ensure access to clean energy in a broader geographic range, and promote innovation, competition, and meeting of customer needs. On the other hand, expanding wholesale markets can create risks if the Federal Energy Regulatory Commission (FERC) under some future administration once again pursues more aggressive preemption of state policies; federalizing some aspects of energy policy could prove to be a devil's bargain that is later regretted. Beyond market expansion, market reforms are also needed, but conversations about market reforms (and transmission) at FERC and about a CES in Congress are not currently connected at all.

Politics of a Clean Electricity Standard

Along with the other essential criteria for a CES that have already been mentioned, a key one inherent in getting a CES passed through Congress is political viability. In 2009-10, following the failed Waxman-Markey cap-and-trade proposal, there was a slimmed down CES proposal that still hit a political brick wall (even with Democratic control of the Senate). Legislative cycles tend to be about 8-10 years, but the current conversation around a CES in the United States suggests there are still significant political viability constraints.

There are two paths being discussed for a CES (or a CES-like policy) in Congress: regular order (which will require bipartisan support) and budget reconciliation (which will require only majority support). Regular order is preferable for many reasons. Tackling climate change will require decades of sustained effort, and environmental policy has only ever been durable through regular order – though there are examples in other areas (e.g., Obamacare) of partisan policies that have so far proven to be durable. Regular order also allows more flexibility in finding alignment and addressing concerns. While there are benefits to a CES being bipartisan and moving through regular order, that is not where the conversation is heading at the moment. A lot of the conversation now is about adopting something through budget reconciliation; while that may not look like a traditional CES, it may be the only road forward, though it is not clear that there are 50 votes for a reconciliation approach either.

Pursuing an entirely partisan approach may be fraught in the long term. If the Republicans retake the House in 2022, it is hard to overstate the degree of anger they will have if an entirely partisan CES-type measure is pushed through, and government shutdowns and significant partisan efforts to dismantle the policy become possibilities. On the other hand, the potential outcome of the 2022 elections cuts the other way as well; the sense in the Democratic caucus is that now is the opportunity to act, and there seems to be little prospect of securing support from 10 Senate Republicans for a CES within the next year or so.

Getting to "yes" on a regular-order CES will involve difficult, long-term conversations to build as broad a base of support as possible – and would have to start with Sen. Manchin (D-WV) and Sen. Barrasso (R-WY), the Chairman and Ranking Member (respectively) of the Energy Committee. A CES that is satisfactory to both of them – assuming one exists and that it is also satisfactory to the rest of the Democratic caucus – could pass with more than 80 votes in the Senate. Such a CES – in addition to being sufficiently ambitious – would have to address some of the concerns fossil fuel states have about an energy transition. For example, fossil-dependent states rely on the money from fossil fuel production to fund schools and other government programs; an answer has to be found for these states of how else to fund schools and fill budget holes – or some role must be kept for the fossil fleet and fossil production. There seems to be close to no direct engagement occurring between high-level Democrats and Republicans on the Hill on this topic, though, and a bipartisan approach cannot be found without that.

If the reconciliation route is pursued, the policy has to involve federal budget outlays and revenue flows, which is antithetical to the original notions of a CES. There are many design possibilities (e.g., feebates) to fit something into reconciliation, but whatever it is will look starkly different from a CES that goes through regular order. Feebates or other mechanisms that might make it through reconciliation should not be called a CES unless there are enforceable limits on pollution; calling a reconciliation approach a CES might ruin the chances of getting a real CES (and probably will not help with the parliamentarian either). Still, a CES-like policy adopted through reconciliation can be designed to effectively reduce emissions and, whether through a fee, alternative compliance payment, or other approach, to push dirty power off the grid.

Complementary Policies

A CES is not the end-all. It is one policy in a portfolio of climate-related measures at all levels of government. For example, the Biden Administration has increased the social cost of carbon – which can be a benchmark for informing policy – back to where it was under the Obama Administration (which had updated the Bush Administration number), and there is a process underway to update it by early 2022. Permitting modernization that is smart, safe, and speedy is also needed to be able to move at the pace the climate crisis demands; a simplified, accelerated permitting regime to get stuff built faster could have bipartisan support. Carbon border adjustments are being discussed as well, particularly in the European Union, because countries want to take action on their own without having their emissions leak elsewhere and losing their competitive advantage. It is not clear that the United States can implement carbon border adjustments without having a carbon price in place.

Complementary measures also include tax credits, which played a large role in the transformation of the wind and solar industries. Tax credits provide an additional positive incentive for clean energy deployment (though they need to pair with a clean energy performance standard or some other policy that penalizes emitting assets to achieve the quickest emissions reductions). Sen. Wyden (D-OR) has introduced a proposal that would simplify clean energy tax credits, make them tech-inclusive, and expand the market participants that can utilize them. The Wyden bill would essentially convert a CES from an unfunded mandate to a funded one (though perhaps not from a budget scoring perspective).

In addition, while the country should be able to reach 80% clean energy relatively quickly, the last 20% will be harder, requiring additional policies to support new clean dispatchable technologies and to invest in the transmission system. Funding for research and development (R&D), for example, is a critical down payment for needed future technologies and should be increased. Both deployment of existing technologies and R&D for new technologies are needed, but a focus on new technologies cannot just be a political excuse to avoid taking significant actions in the present.

Session V: Hydrogen Renaissance?

On May 20, the Aspen Institute Energy & Environment Program virtually convened the fifth in its 2021 series of Clean Energy Innovation Roundtables. This convening brought together experts to discuss the categories of decarbonized hydrogen, uses for it, and the opportunities for and barriers to its deployment. This summary captures some of the key topics of discussion.

The Hydrogen Color Wheel

Hydrogen is currently produced primarily by gasification of coal or reformation of natural gas. Producing this hydrogen, sometimes referred to as gray hydrogen, is a carbon-intensive process. Existing hydrogen production accounts for a small but significant portion of global carbon emissions.

There are various methods by which hydrogen production can be decarbonized. One, generally referred to as blue hydrogen, involves adding carbon capture, utilization, and storage (CCUS) to the coal gasification or natural gas reformation process. Another, generally referred to as green hydrogen, involves producing hydrogen via electrolysis of water, using zero-carbon electricity. Some consider green hydrogen to include only hydrogen produced using renewable electricity; others include hydrogen produced with electricity from nuclear power, which is sometimes also referred to as pink hydrogen. It is unclear if the green hydrogen label applies only to hydrogen produced directly from clean electricity or if it also encompasses electrolytic hydrogen that is “clean” by virtue of acquiring renewable energy credits; the current fiction of Scope 2 reporting suggests that latter route is plausible. Gasifying or reforming biomass or biofuels and applying CCUS to the processes could result in a net-carbon-negative production process; this carbon negative hydrogen does not yet have a color designation, though some suggest gold hydrogen.

The color wheel of labels could create confusion in the marketplace, impeding progress and transactions. A color-blind approach is needed to drive the decarbonization of hydrogen, regardless of the particular production pathway. The various “colors” or brands of decarbonized hydrogen matter less than the lifecycle analysis of each type, factoring in all feedstocks and production pathways. It is the carbon that matters. It would be simpler to have labels that just make clear whether the hydrogen production is carbon-negative, carbon neutral, or carbon-emitting. Some kind of carbon accounting is needed, with both accuracy and flexibility to provide simplicity. That said, some do not want to call all decarbonized hydrogen “clean” or “zero-carbon” because they do not want those labels applied to hydrogen produced with nuclear or CCUS; they oppose those as potential climate solutions. This is what leads to the rainbow of hydrogen labels, as well as other terms such as “renewable hydrogen”. There is value in holding discussions and gathering consensus on how to characterize the different types of hydrogen and, if possible, how to merge them into labels focused on greenhouse gas characteristics.

Uses for Decarbonized Hydrogen

Hydrogen can be a decarbonization solution for a range of sectors and uses. Most directly, decarbonized hydrogen could replace existing hydrogen feedstocks, particularly for ammonia production and oil refineries; there really is no other decarbonization solution for existing hydrogen feedstocks. While there may be other potential solutions for hard-to-abate industry sectors, hydrogen is widely seen as being among the most viable. Decarbonized hydrogen is being targeted for use in the iron and steel industry, as well as for use in producing high temperature heat for industrial processes involving cement, glass, aluminum, and other materials. Hydrogen could also be an input into ammonia for the agricultural sector (and other sectors), as well as part of the petrochemical supply chain.

In the power sector, decarbonized hydrogen could provide either dispatchable zero-carbon electricity or long-term energy storage. Excess local renewable energy can be used to produce green hydrogen, while high-temperature solid oxide electrolyzers can complement nuclear power, enabling existing nuclear plants that are struggling economically to produce electricity when electricity prices are high and to produce hydrogen when electricity prices are low.

In the transportation sector, decarbonized hydrogen could be utilized as a zero-carbon fuel; one exciting thing about hydrogen is that it opens a path from electricity – which is cheap compared to existing liquid fuels – to fuels. In the early 2000s, the transportation sector was the main focus of hydrogen hype, with efforts such as FreedomCAR. Hydrogen appears to have mostly lost out on the light-duty vehicle space, but the situation remains more unresolved with medium- and heavy-duty vehicles. Beyond road vehicles, hydrogen can also be an input for low-carbon hydrocarbons to support aviation. In maritime, hydrogen or ammonia could advance decarbonization, complemented by efficiency efforts and wind propulsion. (Liquefied natural gas is also in the debate mix for maritime fuels, and small thorium reactors could work in cargo vessels.) In addition to hydrogen fuel cell technologies, ammonia engines should be coming out within a couple of years. Ammonia is seen as potentially preferable in shipping because hydrogen must be stored at super-cold temperatures, which is hugely expensive to do on a ship. Ammonia, which is a hydrogen carrier, has much more reasonable storage requirements. Ammonia is also familiar; it is already widely transported by ship around the world. Shipping is global, and there are countries excited about the potential to produce, use, and export hydrogen and ammonia.

Hydrogen can be transported over land or water in liquified form and could, to an extent, leverage existing natural gas networks to be used anywhere gas is currently used. For example, with equipment and infrastructure modifications, hydrogen could be used in the buildings sector to provide heat. Utilizing and repurposing existing infrastructure – whether gas pipelines, maritime engines, or others – can facilitate the use of hydrogen across sectors. While hydrogen's potential uses span sectors, there is an argument to be made that, whether through policy or market pressure, the aim should be to accelerate hydrogen for use in the areas where few other decarbonization solutions are available.

Opportunities for and Barriers to Decarbonized Hydrogen Deployment

Hydrogen has perpetually been “10 years away”, but its potential is now on the precipice of being unlocked. Technological advancements, policy shifts, and increased penetration of ever cheaper renewable energy have all contributed to the present moment. For instance, electrolyzer technologies have improved in efficiency and costs, thanks in part to the success of fuel cells; electrolyzers are basically fuel cells run in reverse. While technologies have improved, decarbonized hydrogen production is still in the early stages and is not yet fully bankable. Technological readiness is just table stakes for deployment; new products also need process integration, capital market support, and policy support, and those are just starting to come together.

At the moment, costs – including not only production costs, but also infrastructure costs for storage and pipeline transport – are something of a barrier to greater deployment of decarbonized hydrogen. Hydrogen has to be cost-competitive with the fuels it is replacing. Some estimate the tipping point for decarbonized hydrogen to be around $2/kg, but that is something like $14-$15/MMBtu, which is far more expensive than $3/MMBtu for natural gas if one is thinking about heating. In contrast, hydrogen as a transportation fuel displaces gasoline or diesel, which are very expensive fuels. A carbon price, of course, would make competitor fuels account for their carbon emissions, which would change the competitive comparison. Beyond emitting competitors, the costs of decarbonized hydrogen also need to come down to be competitive with other technologies and pathways for significantly reducing emissions, including CCUS and electrification. In addition, there will be cost competition among the types of decarbonized hydrogen. Hydrogen produced via fossil CCUS, biomass CCUS, or nuclear could be produced 24/7, which means high asset utilization, unlike hydrogen produced via electrolysis from cheap but variable renewables. Electrolyzer costs are expected to come down substantially over the next decade, though, which means they may not need to run all the time to be economical. Many things are made in factories that do not run 24/7.

While costs may be a hurdle for some, price thus far has not been much of an obstacle for the customers that want hydrogen. Some customers are demanding hydrogen that is generated by co-located renewables. Others want green hydrogen, not caring whether it is direct or through a power purchase agreement and credits (which means renewables are not the actual source of electrons). Others just want hydrogen, not caring whether it is low-carbon or not. Price has rarely been part of the conversation; people decide they want hydrogen, and then within that they want lower costs. At least in some early markets, hydrogen demand does not seem particularly price sensitive, and those early markets will drive down costs for other uses.

Inadequate public policy support has been another hurdle for decarbonized hydrogen. For example, policy is needed to drive change in maritime shipping, but none is evident yet. The International Maritime Organization has a target to reduce shipping emissions by half by 2050, but the United States recently said the goal should be zero by 2050; it remains to be seen what the United States proposes in terms of policies to get there. While maritime shipping is not hard to decarbonize in terms of technology, it seems to be in terms of political will.

The policy picture for hydrogen is starting to change, though, as policy efforts on decarbonization have never been stronger. The EU is leading the way. The European Green Deal is coming in July, with a big focus on hydrogen, and the EU will be putting shipping into its Emissions Trading Scheme. Europe is showing that with the right policies, investments, and implementation, there is significant potential for decarbonized hydrogen. (Japan, too, has always thought of itself as a leader on hydrogen and will be featuring it at the Olympics this year – if they take place.) Public policy in the United States concerning hydrogen is not nearly as mature as it is in Europe, but there are several new legislative proposals addressing almost every component of the burgeoning hydrogen economy, and there is great interest on Capitol Hill, in the Administration, in industry, and among civil society groups.

To get industry moving quickly to bring costs down and boost deployment, beneficial policy tools could include: support for research, development, and demonstration; expansion of the Loan Programs Office's mandate to include all forms of decarbonized hydrogen; technical assistance; codes and standards (e.g., on pipelines and blending); and tax incentives, such as a production tax credit (PTC). A PTC for all the potential "colors" of decarbonized hydrogen could help make their production costs competitive with gray hydrogen. At a minimum, policy should label and incentivize the production of decarbonized hydrogen accurately so the market can react accordingly. This has to be done carefully. For instance, life cycle analysis requirements that set a carbon intensity threshold at super-low levels from the outset could hinder the development of the market for hydrogen and of many forms of decarbonized hydrogen, preventing achievement of scale. Carbon intensity factors should perhaps start with a more achievable threshold (e.g., an 80% reduction of carbon dioxide emissions compared to natural gas reformation) and grow more stringent over time.

The net carbon benefits of hydrogen, though, depend on how it is used and what it displaces. Because hydrogen can be used across sectors and in numerous ways (e.g., for electricity, as a fuel), dealing with it from a policy standpoint can be very complicated; those with compliance obligations are operating under existing sector-specific frameworks. If policies are adopted or reformed to be tech-inclusive – including a new Clean Energy Standard, a modified Renewable Fuel Standard, and a reformed Corporate Average Fuel Economy standard – the policy accounting of hydrogen could take care of itself. Still, there may be a need in the policy realm to separate production from use – to promote hydrogen production on a zero-carbon basis and then provide some separate incentive based on how it is used and what it displaces – with accounting to prevent double-counting. Yet another mechanism may be needed for when hydrogen operates as energy storage. This suite of incentives would allow for a fuller accounting of hydrogen's benefits, though it would be much more difficult and complex than something like the wind PTC or 45Q for CCUS.

Opportunities for hydrogen deployment also lie in the private sector and in public-private partnerships. For example, corporations could move beyond buying renewable energy credits and invest more in other technologies, such as hydrogen, that could have meaningful decarbonization impact. Public-private regional hydrogen demonstrations are also key because manufacturing centers both are centers of job creation and will be impacted by the energy transition. The regional cluster approach to hydrogen development is being implemented successfully in Europe, where there are tangible examples – including in the United Kingdom, Germany, and the Netherlands – of clusters and other industrial projects advancing decarbonized hydrogen. There was also a recent announcement about plans for a hydrogen industrial cluster in the Southern California region. Overall, the market is getting excited about hydrogen. There has been a 20-fold increase in hydrogen projects over the last 18 months, and there are companies pursuing innovations and approaches that will burst the doors open.

Session VI: Putting the "Net" into "Net Zero"

On June 3, the Aspen Institute Energy & Environment Program virtually convened the sixth and final session in its 2021 series of Clean Energy Innovation Roundtables. This convening brought together experts to discuss the meaning of "net zero", types of negative-emissions approaches, and ways that markets are supporting carbon removal. This summary captures some of the key topics of discussion.

"Net Zero"

"Net zero" has become a ubiquitous term as various actors set their climate ambitions; it is the topic of the moment on target-setting. "Net zero" is a scientific term describing a state where the level of emissions is simultaneously and equally matched by the level of removals – a state that must be achieved within a reasonable timeframe in order to stabilize global temperatures at a compatible and adaptable level.

The term becomes murkier when applied to an individual entity's goal. For example, as more companies achieve the goal of 100% renewable electricity procured on an annualized basis, either through power purchase agreements or renewable energy credits (RECs), and adopt or consider net-zero targets, many are trying to figure out what net-zero actually means in their electricity portfolios – i.e., whether reductions in energy emissions everywhere at all times is required or whether an electricity number that is itself a net number is part of the broader net-zero goal.

Still, the increased focus on "net zero" may be a very helpful development. Unlike targets focused on global temperature change, which no one has a lever to control, "net zero" brings a more practical lens for viewing long-term climate goals, as entities do have control over emissions. In addition, the concept has enabled companies in harder-to-decarbonize sectors (e.g., airlines) to make climate pledges that they would not otherwise have been able to make.

The "net zero" concept opens up a set of options – carbon dioxide (CO_2) removals – that would not otherwise be on the table. Achieving direct emission reductions is still the main priority for meeting climate targets – as well as for addressing the disproportionate impacts that frontline communities experience – but even after steep declines in emissions from electricity and fuels, some emissions will likely remain from harder-to-decarbonize sectors (e.g., aviation), as well as significant levels of non-CO_2 emissions. All net-zero scenarios combine large reductions in emissions with negative-emissions strategies; removal is not a substitute for reductions but a complement. Removal solutions need to scale up separately from emission reductions, and there may need to be different accounting systems for the two. To meet climate goals, several gigatons of carbon dioxide will have to be removed annually by 2050. There is a need for an inclusive set of strategies to achieve climate objectives, given the magnitude and urgency of the climate challenge.

Indeed, governments and companies should be more ambitious in their thinking about the role of carbon removal. Beyond net-zero goals, governments and companies should set net-negative goals – committing to remove their historic emissions – to be in line with the climate math, though the role that carbon removals should play in a company's portfolio of climate efforts is probably different for every sort of emitter in the economy.

Negative Emissions

Negative-emissions approaches have a critical role to play. Negative emissions can involve sequestration of carbon in the biosphere, geologic sequestration, or sequestration in products.

Sequestration in the biosphere generally involves nature-based solutions, including reforestation, improved forest management, mangrove restoration, improved soil health, improved grassland management, and other approaches in different ecosystem types that can enhance carbon sequestration. Natural climate solutions have the potential to contribute significantly to the carbon mitigation needed over the next decade. They face numerous challenges, however, some of which have been around for decades, such as issues about additionality, permanence, and leakage, although there has been significant progress over the past couple of decades in thinking about and trying to address these issues. Challenges also persist with respect to conditions that hinder nature-based climate solutions from achieving scale globally, including absence of clear land title, fractionated ownership, adverse trade and land policies, and upfront costs for preparing lands to generate carbon credits.

In the United States, land-based negative emissions are expected to decline – perhaps by as much as half by 2050. Most of the U.S. carbon sink is on the East Coast, but as those forests mature, their rate of carbon uptake will decline. In the West, modeling suggests that forests in northern states may have some carbon uptake through 2050, but forests in the more arid states in the Southwest (including California) may be a net source of carbon, releasing more than they take up (e.g., due to wildfires). Scenarios that successfully achieve net-zero involve either holding the U.S. land sink constant (i.e., acting to balance out the decline) or enhancing it. The majority of U.S. forested lands are privately owned, so it is vital to develop programs to catalyze opportunities for private forest landowners to get involved. Restoring the health of forests in the West, perhaps combined with bioenergy with carbon capture and storage (BECCS), could be an opportunity to achieve significant climate benefits while also improving the ecology of the West, though biomass energy is not universally recognized as a good thing.

The scale of annual removals needed to meet climate targets is unlikely to be met by nature-based solutions alone, especially as they are vulnerable to reversal. While nature-based solutions should absolutely be deployed today, it is also essential to develop and deploy technological carbon removal options, such as ones that use chemical processes to mimic photosynthesis and then bury the captured CO_2 underground. Direct air capture (DAC) technologies filter ambient air through chemical solutions that bind with CO_2, resulting in a pure stream of CO_2 for geologic sequestration (or for use in products). The technology works, but DAC is really high in cost today, with prices around $500/ton, though there is line of sight to $50-100/ton. There are about a dozen pilot- or commercial-scale DAC projects around the globe, but most DAC plants today are on the order of 1,000 to 10,000 tons removed per year, not billions; there is one new plant planned in Texas that would get to 1 million tons, but solutions have mostly been deployed on small and niche scales. There are few scalable business models. Even if costs come down, a key constraint on the total amount of negative emissions possible is annual injection rates in different basins across the United States.

There are also technological removal approaches that are a sort of mix of biological and geological sequestration. For example, enhanced mineralization involves speeding up the natural weathering of rocks by increasing the surface area; the pulverized rock is spread on land and binds with CO_2. Enhanced weathering involves high energy use but results in fairly permanent sequestration. Another blended negative emissions technology is BECCS, in which the biomass removes CO_2 from the atmosphere as it grows and then the emissions from its combustion are captured and geologically sequestered. BECCS faces a number of challenges around sustainability, lifecycle accounting, direct and indirect land use changes, water use, competition with food production, indigenous sovereignty, and forest protection.

Captured CO_2, such as from DAC or BECCS plants, can also be used as a feedstock in a range of materials (e.g., plastics), rather than being sequestered underground. Near-term markets for such products represent spaces that entrepreneurs can move into. Climate change is a waste management problem where no one is paying for the cleanup, so these markets represent payers. The near-term markets will not result in meaningful tons removed in the scale of the climate challenge, but they are a way to give technologies a foothold and drive down their cost.

The technological carbon removal approaches can result in permanent and verifiable sequestration for thousands of years, in addition to providing economic and job benefits. Like renewable energy technologies before them, carbon removal technologies need to come down the tech and cost learning curves over the next decade in order to realize their potential.

Markets & Private-Sector Investments

As countries and companies step up their ambitions, there is growing private-sector interest in incorporating carbon dioxide removal into climate goals. There are at least three ways the private sector is investing in negative emissions. First, there are compliance markets. Globally, roughly 20% of emissions are covered by carbon pricing systems, several of which allow some level of offsets with nature-based solutions. Second, policy vacuums have led to the current balkanized system, with states, cities, corporations, and other actors each pursuing net-zero targets separately, leading to both substantial inefficiencies and robust interest in voluntary carbon markets. Voluntary carbon markets have thus seen rapid growth and are leading the way on negative emissions, though the scale is still relatively small. Third, there are companies with innovation funds and other market development efforts that are investing in first-of-a-kind projects; they are paying high prices but are creating a market to drive down costs and accelerate deployment of negative-emissions options.

Voluntary markets involve offsets, which are controversial. Voluntary offset markets have lacked strong enforcement of quality, and some see them as a race to the bottom. The availability of high-quality carbon removal opportunities is extremely limited at the moment. The issues related to permanence, additionality, verifiability, leakage, and double-counting are a big concern, and it is unrealistic to think that most companies and countries can do an extremely high level of diligence and review in a sustainable way. Currently, there is a wide spectrum of quality in terms of offset protocols, especially for land-based solutions, and there is no good way at the moment to ensure quality standardization. Many companies buy offsets because they are low-cost and easy; they are not aiming for quality, and the low levels of public awareness and education mean there is little external pressure on these companies to do so. Interestingly, while a company buying an offset is on controversial ground, a company buying a REC is applauded, even if that REC has little carbon value (e.g., if it is from a renewable resource on a grid saturated with renewables and thus is not displacing any carbon). Not all offsets are created equal, but the same could be said about RECs. Current attitudes toward best corporate practices are not carbon- or climate-optimized, which could affect the growth of the negative-emissions sector.

Nature-based offsets are using ever-improving methodologies and standards, developed through open processes, for monitoring, reporting, and verification, but criticisms persist, and there is room for more improvement. There is a need for better accounting, standards, and oversight. Accounting and transparency systems must be able to ensure reductions are real, verified, permanent, and not double-counted. Some of the issues faced by nature-based solutions can be addressed in their selection and design. For instance, projects can be avoided in places that are highly dynamic and prone to disruption. Nature-based offsets can also recognize the risks from fires and other landscape changes, such as through a buffer pool that spans projects; like an insurance mechanism, the projects can still deliver credits if such a circumstance arises. (While buffer pools are important, some recent research and evidence suggests there has been an underestimation of the scale of buffer pools necessary to account for land-based reversals.) Nature-based solutions can vary in their durability, but they generally are not permanent solutions. The perfect cannot be the enemy of the good, but it is important to know the drawbacks of solutions and try to address them.

In the short term, nature-based offsets have to be a huge part of the carbon removal market. Longer-term, it might be worth considering ways to think of the value of nature-based solutions as encompassing more than just carbon removals. Investments in nature can also reduce climate impacts and bring numerous other benefits; there could be a market for investing in nature where carbon removals are part of the solution but may not need to be held to a level of accounting rigor that may be unrealistic.

Removal offsets are not just nature-based. Companies purchasing tons from DAC or other removal technologies and applying those tons to their net-zero or other climate goals are treating those removals as offsets. These offsets have more permanence and fewer accounting challenges than nature-based solutions.

While offsets remain controversial, CO_2 removals can compensate in the near term for emissions further out of companies' control (e.g., Scope 3 emissions) and in the long term can remove historic emissions. Using offsets outside of one's sector in addition to pursuing in-sector reductions may also be better (or more justifiable) than using them inside one's sector.

There are a few companies that are procuring removal tons and not applying them to their ledgers. These companies are really focusing on a market creation and innovation play. While revolutionary, that is probably not scalable. By investing in removal technologies, private-sector actors can support the creation of a market for them, so that eventually the supply will be greater, of high quality, and available at a reasonable price point for others to support at scale. It is important to lay the foundations for removals to be done and done well. Early investments can drive the space forward, particularly in the absence of other incentives for the private sector to deploy these solutions. Near-term markets, whether in the form of offsets or innovation investments, can start driving volume, improving the economics and scalability.

Scaling up removal solutions – both nature-based and technology-based – will be a significant challenge, but there is cause for optimism. There are proven tools that have been used to scale other carbon solutions, such as renewables. Government actions, such as regulations and investments in R&D and infrastructure, could help drive removal solutions forward. The value of R&D in technologies such as DAC and CCS is equal to tens or hundreds of billions of dollars in terms of reducing the costs of achieving net-zero and avoiding catastrophic climate change. Early technologies are expensive, with external values that cannot be fully internalized. Government subsidies are one way to overcome that (as is voluntary private-sector demand). There has been a huge amount of bipartisan, bicameral interest (as well as in the Biden Administration) in carbon removal. It is top of mind for policymakers, but there is a need to drastically ramp up to get to scale by 2050.

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