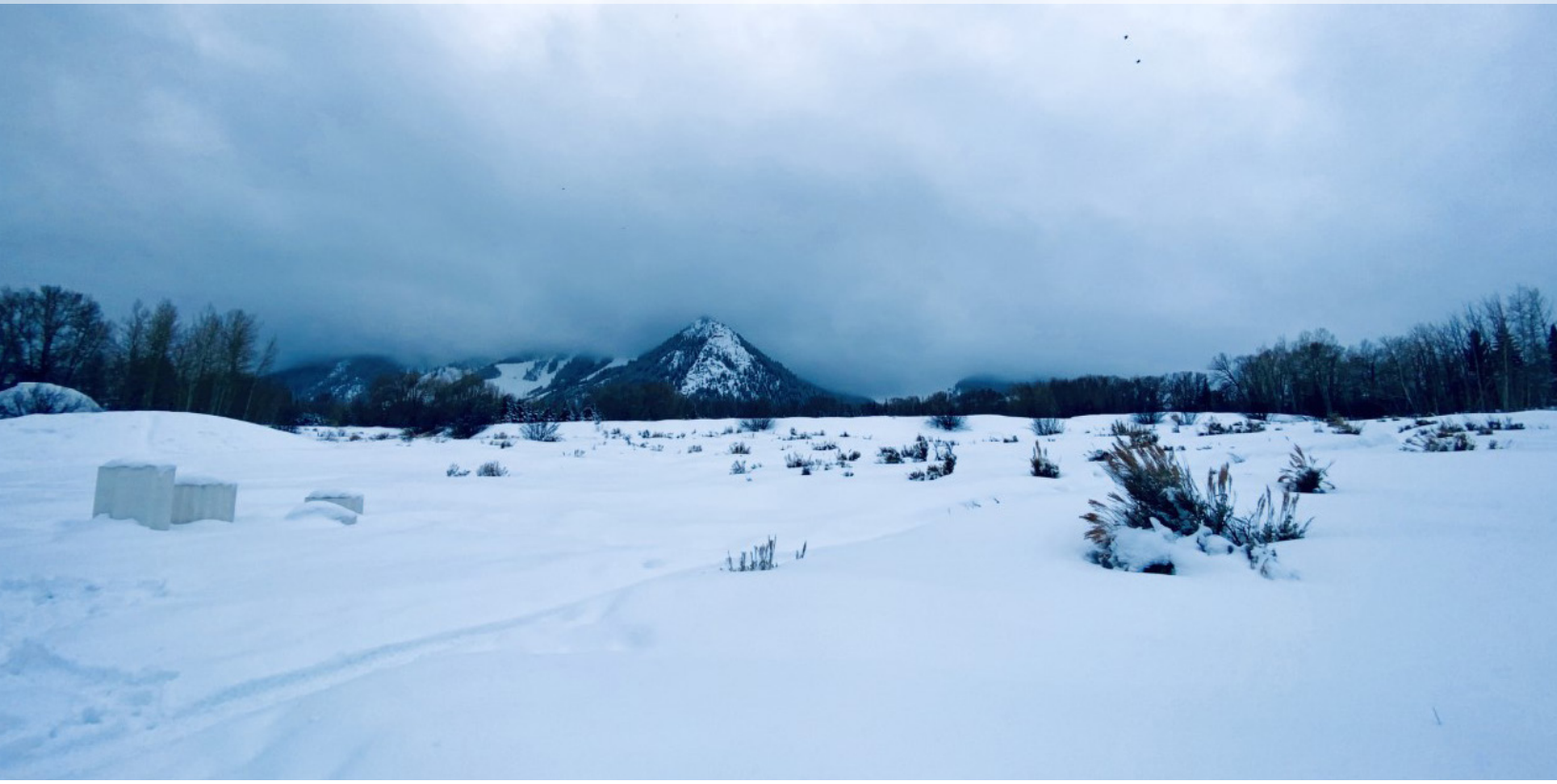

UNLOCKING MID-CENTURY DEEP DECARBONIZATION

A REPORT FROM THE 2020 ASPEN INSTITUTE WINTER ENERGY ROUNDTABLE

Roger Ballentine & Jim Connaughton, Co-Chairs

Dave Grossman, Rapporteur

THE ASPEN INSTITUTE ENERGY & ENVIRONMENT PROGRAM
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For all inquiries, please contact:

Energy & Environment Program
The Aspen Institute
2300 N Street, NW | Suite 700
Washington, DC 20037
Phone: 202.736.2933
Fax: 202.467.0790

The Aspen Institute
2300 N Street, NW | Suite 700
Washington, DC 20037

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CO-CHAIRS' FOREWORD

Given how the months since our gathering in Aspen have played out, we look back with particular appreciation for the privilege we had to share several days of thoughtful and informative personal interaction with a remarkable collection of people. We were able to convene a broad cross-section of leaders from industry, academia, government, the financial sector, and the non-profit community to dive deep into issues in a spirit of both sharing views and learning from each other. We thank all of our participants.

As Co-Chairs, our job is to solicit the full range of views and experiences among our group and to stimulate discussion, dialogue, and even disagreements. If we fall short of finding all of the answers, we endeavor to raise all the tough questions. Admittedly, we do not come to this task without bias: we embrace the science that tells us that to stabilize global temperatures at a sustainable level, global greenhouse gas emissions need to reach net zero by 2050. It is through this lens that we explored issues of technology development and deployment, clean energy policy options, infrastructure investment, the role of energy consumers, wholesale electricity market reform, and the changing role of capital providers and markets. Building a low-carbon and prosperous future will not be achieved without the collective and interdependent contributions of all these actors and stakeholders.

We explored questions around technology development, including: What is the true state of technology development and investment? Are governmental and private R&D investments properly segmented and aligned? Are we developing the right technologies across a sufficiently broad range of applications that are directed to solving our most pressing needs? With current and former congressional leaders, we probed whether there is truly growing bipartisan support for addressing the climate challenge and how and whether both incremental and transformational policy goals might be achieved and when. Irrespective of either the development of new technologies or a need for new governmental policies, we asked what major energy buyers could do in the near term to further accelerate grid decarbonization even beyond the significant contribution they have already made to scaling up renewable energy. And we pressed federal regulators, major users, and major utilities on whether it is time to fundamentally rethink the underlying legal framework of the U.S. power sector in order to better align the power of markets with the value of decarbonization.

We took a new approach this year to how we involve the financial sector in our forum. In addition to the need for capital in scaling up climate-friendly technologies, businesses, and infrastructure (as well as the need for capital investment in adaptation), climate is becoming a key factor in the decisions of nearly all mainstream investors and debt providers. To that end, we invited major asset managers, ratings firms, banks, and leading sector thinkers to explore how climate change – and climate risk in particular – is becoming the centerpiece of the growing move toward consideration of environmental, social, and governance (ESG) factors in financial sector decision making. We wanted to understand how this increasing focus is translating into changes in perceptions of value and driving capital toward climate-friendly projects and enterprises – and how the power of the capital markets can work most synergistically with social and political drivers toward a decarbonized future.

We continue to find our time in Aspen to be informative, stimulating, and impactful. To a person, our attendees report that they leave Aspen more informed than when they came and more energized to contribute to building a better and more sustainable world.

Roger Ballentine

Jim Connaughton

EXECUTIVE SUMMARY

To stabilize global temperatures at a sustainable level, global greenhouse gas emissions need to reach net zero by 2050. This reality must guide how we support technology development, craft governmental policy, and invest capital. Mid-century deep decarbonization is most achievable with a technology-inclusive climate strategy and will likely require maintaining the zero-carbon resources that are already in operation, accelerating deployment of existing zero-carbon technologies, and boosting innovation for new technologies such as zero-carbon hydrogen and direct air capture of carbon dioxide.

While a great challenge, the electricity sector will likely be easier to decarbonize than the industrial and transportation sectors. Decarbonizing electricity is particularly critical since a key strategy for decarbonizing other sectors is to electrify them. A number of major utilities have adopted strong voluntary carbon reduction targets, and these utilities' access to low-cost capital suggests that they can play a leading role by investing in zero-carbon generation and other assets to further grid decarbonization. Even with strong voluntary commitments, appropriately supportive regulatory structures are needed. Performance-based ratemaking can provide stronger incentives for utilities to bring more clean energy to market, pursue beneficial electrification of other sectors, and invest in grid infrastructure needed for decarbonization. Since meeting decarbonization timelines may require early retirement of some fossil generating assets, innovative policy approaches (such as accelerated depreciation and securitization mechanisms) are needed that can overcome economic disincentives and spur investment in communities negatively impacted by such retirements. On the other side, we must avoid the premature retirement of existing zero emission generation sources and will need creative and equitable policy and regulatory approaches to accomplish that.

Large corporate buyers have been key drivers of the growth in renewables deployment as well. This is a great success story, and more buyers seeking to procure renewables will add to that, but grid decarbonization is most likely to occur with deployment of a range of zero-carbon options. Some large consumers of power are starting to shift their focus from meeting 100% renewables purchasing goals to meeting more (and ultimately all) of their load with time-matched consumption of zero-carbon energy. How that can be accomplished raises a number of key issues, including how buyers feel about procurement of existing nuclear power, the readiness of new zero-carbon technologies, and how buyers can maximize their carbon-reducing impact.

The role that nuclear power can play in deep decarbonization goes beyond the procurement decisions of large buyers, of course. While existing nuclear plants are the largest current source of zero-emission energy, new nuclear, at least in the United States, may depend on advanced technologies, such as small modular and other advanced reactors. Innovations, demonstrations, and policy support are needed to make them technologically and economically viable.

Beyond new supply and new demand for zero-carbon generation, other technologies will be needed to decarbonize the grid. Energy storage, for instance, will have a key role to play, and innovations and supportive approaches are needed at the wholesale and retail market levels. Deep decarbonization will also likely require new approaches to building transmission infrastructure to connect clean energy generation to load. Traditional transmission planning processes have proven challenging. Policy makers, capital providers, buyers, and other stakeholders will need to align to meet the promise of a more robust and interconnected transmission system.

Whether transmission lines, new fossil energy with carbon capture, carbon dioxide pipelines, or new advanced nuclear plants, the task of building projects is slowed or blocked by a range of hurdles, including public opposition, the interconnection process, financial markets' desire for full contracted revenues, and inflexible capacity planning and grid planning processes. There is a need for new commitments to address these hurdles. The urgency of investing as a nation in infrastructure needs to match the urgency of decarbonization.

Climate change is an increasingly relevant issue across the financial sector. In addition to the need for capital to scale up climate-friendly technologies, businesses, and infrastructure – and the increasing need for large capital investments in adaptation – climate is becoming a key factor in the decisions of asset managers and debt providers. While more traditional "socially responsible" investors might focus on excluding high-emitting sectors (like fossil energy) from their portfolios, and investors seeking "impact" might look to invest in solutions-based companies, investors and debt providers across the board are looking at climate risk as relevant to diligence and decision-making. Climate risks – both from the transition to a low-carbon economy and from the physical risks of climate change itself –impact the value of portfolio holdings.

Climate risks, however, can be challenging to characterize, assess, and price. Different investors take different views on the breadth of risks and types of technologies to incorporate into decisions about particular companies or portfolios. Emerging systems and standards of disclosure and reporting on climate-related risks are being used more broadly by mainstream financial sector players, but these systems and standards are far from perfect. Metrics are not fully standardized, and reporting varies widely. Third-party sustainability analysts often do not tell investors the assumptions underlying their assessments, and different providers disagree with each other in their assessments of corporate sustainability. If a critical mass of investors, debt providers, analysts, and financial system regulators could get alignment on the key climate metrics, calculation methodologies, and common disclosure practices – as some, particularly in Europe, are trying to do – the result could be not just greater risk-adjusted returns for capital providers, but also a migration of capital to more climate-friendly sectors and companies.

While capital markets will play an indispensable role in decarbonization, by what means and how quickly the climate crisis is addressed will also be determined at least in part by policy. There is more happening on the federal policy scene than many would expect (but less than many would like), including the largest-ever investment in clean energy research and development in the FY20 spending bill, prospects for a significant energy bill out of the Senate, and a new, bipartisan, tech-neutral innovation incentive concept in the House of Representatives. There are clear signs that climate change is becoming more bipartisan – at least at the level of acknowledging a need for policy responses – though strong disagreements remain on policy design and levels of ambition.

Irrespective of federal action or inaction, many states have been taking actions to direct their own energy futures. Several states are building on existing renewable portfolio standards and supporting a broader set of zero-carbon resources via clean energy standards. While many welcome these state-level efforts, they are causing tensions regarding the boundary between federal and state jurisdictions. Recent Federal Energy Regulatory Commission rulings, which have been highly controversial, seek to counter the perceived effects of these state policies on organized wholesale markets. The United States remains far short of having a true national climate change strategy.

DECARBONIZATION OVERVIEW

Decarbonization of the global economy no later than mid-century has to be one of the main guideposts for technology, finance, and policy efforts going forward.

GOALPOSTS & PRIORITIES

To meet the goal of keeping warming well below 2°C, or the tougher goal of limiting warming to 1.5°C, this is the decade for action. Even in meeting a 1.5°C goal, we will still face a world with significant impacts on our ecosystems, food systems, and weather patterns. To avoid any of this, atmospheric concentrations would need to return to 1980's levels – an increasingly difficult task.

To achieve goals in line with the Paris Agreement, global carbon dioxide (CO2) emissions have to reach net zero by 2050, which means some economies need to get to net zero earlier. There will be a need to revolutionize how energy is produced, delivered, and used across sectors, as well as to remove CO2 from the atmosphere through both natural and engineered approaches. Getting to net zero by mid-century will require repairing, replacing, retrofitting, or offsetting $3-6 billion or more of carbon-emitting equipment – every day, for decades. Current commitments from countries need to be strengthened significantly. By 2050, at least 50 gigatons of CO2e (carbon dioxide equivalent) emissions will have to be avoided.

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Getting to 1.5°C will be harder and probably more costly than getting to 2°C, but 1.5°C scenarios that take the demand side seriously can save a lot of costs. Indeed, a comprehensive approach to deep decarbonization that takes the demand side seriously and lets it compete against the supply side may or may not result in rising needs for electricity and capital; it is worth exploring that and finding out. Either way, there is a need to at least double efficiency (energy use per dollar of GDP) in the United States; while more than doubling is possible, doubling would at least get the United States to the Swiss level and would substantially cut CO2 emissions.

More broadly, deep decarbonization is a challenge that requires thinking in terms of "and" – renewables *and* efficiency *and* other zero-carbon resources *and* policy action *and* private sector action *and* deployment of existing technologies *and* innovation for new technologies *and and and*… To make real headway on collective action, people need to stop being against everything they are not specifically for – and may need to start being for that which they were once specifically against. If they are focused on mid-century deep decarbonization, they should be for allowing everything available to compete to achieve the common goal.

In addition, while many prior clean energy approaches did relatively well, the emerging decarbonization ecosystem has to be stronger and better, with a greater focus on decarbonization impact. A focus on impact – and the scale of the decarbonization challenge – means that work on solutions has to focus on achieving or enabling gigatons-scale reductions. Solutions also need to have a framework of inspiration, financing, tech transfer, or international relations leverage in order to have global, not just U.S., impact.

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KEY DECARBONIZATION TECHNOLOGIES

Mid-century deep decarbonization will require technology solutions (in addition to policy, finance, and other solutions). Looking at the 1.5°C pathways in the scientific literature, it seems clear that achieving that target cannot be done with a limited set of alternatives. A technology-inclusive climate strategy is attractive for several reasons. For one thing, technologies are needed across sectors of the economy, which have different needs. In addition, the more options there are on the table, the more cost-effective the suite of options to deploy will generally be. A broad strategy is also more resilient against uncertainty; no one knows if 10-20 years down the road there will be massive innovation in certain technologies. Portfolio theory supports trying a lot of things and keeping them in the mix until there is eventually a sifting out. Given the speed and scale of reductions needed, every zero-carbon technology needs to be on the table. Such a strategy can better leverage existing capabilities too. The vast majority of the world's energy system is based on coal, oil, gas, nuclear, and hydro, not wind and solar, so it may be beneficial to bring more technological capabilities into the game versus excluding them. There is a political feasibility argument as well, as different constituencies, stakeholders, and regions may have different preferences for solutions.

As a start, achieving deep decarbonization will require deploying much more quickly the technological solutions that already exist. Completely proven technologies are woefully under-deployed, but it is easier to raise a $100 million venture fund for new technologies than for deployment of existing ones. Cumulative emissions matter, though, so near-term reductions are essential, which means keeping the zero-carbon resources that exist and building out the zero-carbon resources that are economic now.

While deployment of existing technologies such as wind, solar PV, and electric vehicles is vital, innovation is also needed, including in those technologies. For instance, making onshore wind turbines comparable in size to ones offshore could make wind generation much more powerful and much cheaper, though a range of innovations are needed to transport such huge blades to wind farm locations. In general, there is a need to pull new future technologies forward as quickly as possible. Large-scale technological and infrastructure evolution can take decades to innovate, develop, and deploy widely. To achieve 2050 decarbonization targets, there is therefore a 30-year window to imagine and implement what is needed to achieve massive emission reductions. 2050 is not that far away, and planning and action now are required to be on track. Given that technologies need to be at scale by 2050, they need to be commercially demonstrated with initial market entry by 2030, which means ambitious, serious innovation and commercialization efforts need to be happening now.

Technological solution gaps are particularly notable in "harder-to-decarbonize" sectors such as long-haul transport, industry, and load-following electricity. In long-haul transport, lots of time has been spent trying to find a really good biofuel, with limited success. Biofuels look like they will be very expensive. Rather than biomass pulling the CO2 out of the air, though, it is possible to envision direct air capture (DAC) plants doing it, and then making synthetic fuels. DAC technologies and systems are making progress, and there is real line of sight based on existing technology platforms to get DAC down below $100/ton. Hydrogen also has high potential to be a long-haul

transport solution. Zero-carbon hydrogen could potentially become very inexpensive (under $2/kilogram), given cheap renewable electricity with which to convert water into hydrogen. There is a credible world where these two important technologies – DAC and zero-carbon hydrogen – happen within the next five years, which is a plausibility that did not exist even a couple of years ago.

Deep decarbonization requires being able to achieve zero emissions while still making things like cement and fertilizer. In industry, carbon capture and storage (CCS) is a very credible solution in geographies where it will work, but it faces public acceptance challenges. People and industries pushing for CCS should be pushing for strong monitoring, reporting, and verification of the sequestered carbon as well; if there is not appropriate transparency, there will be no trust. As with long-haul transport, zero-carbon hydrogen could also be a decarbonization solution for industry; if hydrogen gets cheap enough, it could be dropped in to satisfy some industrial heat needs (e.g., for steel). Technologies that can retrofit existing facilities will be vital. Industrial buildout is already happening on the Gulf Coast (and elsewhere), and by the time solutions such as hydrogen are ready, lots of emitting infrastructure will already have been built.

Given that technologies need to be at scale by 2050, they need to be commercially demonstrated with initial market entry by 2030, which means ambitious, serious innovation and commercialization efforts need to be happening now.

There are deep decarbonization challenges in the power sector as well. Lots of studies show that cheap renewables can get to a certain percentage of penetration on the grid but that some zero-carbon, dispatchable solution is needed for the final 20% or so. Available solutions such as nuclear power and CCS face regulatory and public acceptance challenges. There are efforts to scale geothermal or get seasonal batteries, but these are 10- to 15-year high-risk efforts. With hydrogen, in contrast, the technology has been around for 40 years, but now there is a lot of cheap zero-carbon electricity, creating an opportunity to quickly scale a long-duration seasonal storage solution. Hydrogen really does have the potential to help achieve decarbonization in many different sectors.

There are non-technology opportunities for abatement in harder-to-decarbonize sectors too, such as substitution and demand destruction. The demand side matters a lot. Energy efficiency potential, for instance, is large and profitable on ships, trucks, and airplanes. Efficient use can also reduce demand for industrially produced materials; designing buildings differently, for instance, can reduce the amount of concrete needed.

Getting to net zero by mid-century will be much easier with solutions that are low-cost and fast to deploy; if policy might not be a sufficient driver, then clean has to be cheaper than dirty. For instance, technologies that allow for co-generation of electrons with other products (e.g., streams of carbon dioxide, argon, and nitrogen) can improve the economics by using the same equipment for multiple income streams. Likewise, using existing equipment and existing value chains enables cheaper and faster solutions. Redrawing system boundaries can open up solutions as well, allowing the waste of one process to be a feedstock for another; power plants and cement plants, for instance, could help solve each other's decarbonization challenges. (There are investment, market, engineering, and regulatory silos, however, that make co-location and boundary re-drawing challenging and that may have to be broken to scale up solutions.) Tapping into the cash and capabilities of large oil and gas companies could also accelerate deployment; if they can be transitioned into hydrogen exporters and electron exporters, they could help create an electro-molecular economy.

ROLE OF THE ELECTRICITY SECTOR IN DECARBONIZATION

Electricity is among the easier sectors to decarbonize, and deep decarbonization economy-wide will require electrification of other sectors. (This may increase overall load, depending on the degree of energy efficiency and demand reduction that also occurs.) The target date for decarbonizing the grid therefore has to be well ahead of the economy-wide date.

UTILITIES

Dozens of major utilities have publicly stated voluntary carbon reduction targets, including several that are targeting carbon-free or net-zero portfolios. Drivers for utilities' carbon-free commitments have included customers and communities, reductions in the cost of technology, evolving climate science, and large shareholders calling utility executives regularly to pressure them on climate change. Utility commitments are meaningful, though, not just when they set a target but when they say what they will do in the near term, set interim targets, and provide in-depth analysis of how they plan to achieve long-term pledges.

Society can benefit from decarbonization, investors can benefit from rate-based growth, and consumers can benefit from the transition to lower-cost resources.

Across the utility industry, there has been a significant reduction in CO2 emissions over the past 15 years and a huge ramp-up in deployment of renewables. On the other hand, some argue against the assertion that natural gas has reduced emissions by displacing coal, as cheap gas also displaced carbon-free resources sometimes, the gas system has significant methane emissions, and the displaced coal often got exported and burned elsewhere.

Still, utilities have tools at their disposal to advance deep decarbonization. In particular, utilities have unparalleled access to capital on attractive terms because capital is priced on risk, and regulated utilities present a low-risk business model. Highly uncertain earnings, for instance, are part of what lead to the high risk premium on merchant companies. Regulated utilities, in contrast, have a very low cost of capital because of the predictability and longevity of earnings. (Relatedly, their credit ratings are also strong because they default at a rate far lower than corporates.) Utilities earn a return on capital spent, and for resources such as wind, solar, and storage, the biggest cost is the price of capital, as the fuel is free. In addition, in the utility space, every dollar in cost reductions in operations and maintenance yields several dollars of investment capability without affecting rates for customers, so savings in the former can create more headroom for investments in the transition. Society can benefit from decarbonization, investors can benefit from rate-based growth, and consumers can benefit from the transition to lower-cost resources (though greener is not cheaper everywhere, particularly absent a carbon price).

Beyond the investor-owned utility model, munis and co-ops can access lower-cost finance too, whether through municipal bonds or the U.S. Department of Agriculture's Rural Utilities Service (RUS). It could be beneficial to more

regularly apply screens or other measures to municipal bonds, debt offered by the Cooperative Finance Corporation (which is where co-ops get their money), and RUS funding to guide muni and co-op capital toward the clean energy transition. Utilities – whether investor-owned, munis, or co-ops – are poised to be problem solvers, working with customers, communities, regulators, governors, and others to help achieve environmental, social, and customer goals in a way that maintains a reliable and affordable electricity system.

There is a moral hazard in rewarding the spending of capital, though, as it creates the risk of wasting lots of capital, which can drive capital costs and rates up. Some see the concept of rewarding utilities for how much capital they invest as outdated. The United States is unique in clinging to that model; much of the rest of the world is moving away from it, either to a performance-based ratemaking (PBR) system or to a system that at least does not allow the entity achieving the return on capital to be the entity determining how much capital to deploy. Throughout Europe, for instance, if a utility wants to propose a major new project, other utilities will provide a joint perspective on how valuable the project really is.

Breakthroughs are needed on the U.S. regulatory front. Common hurdles across states prevent regulators from being able to provide the structure and earnings predictability that utilities and their investors desire. These include: the steep learning curve for regulators regarding new technologies and operating practices; difficulties in managing risk and uncertainty and in measuring benefits and costs; difficulties in managing the increased rate of change (i.e., regulations cannot keep up); and the increasing complexity of objectives, as the system has evolved from having regulators focus mostly on economics (i.e., least-cost options) to having regulators trying to balance a suite of competing objectives. To address such challenges, regulators in different states have been trialing various approaches, including comprehensive stakeholder processes, PBR, and updated frameworks for benefit-cost analysis.

States may still be a couple of years away from really understanding how to rebalance utility revenues to incent the right behaviors while still providing a foundational level of revenue and ensuring that the system remains reliable, resilient, secure, affordable, and equitable.

There is a need for better alignment of economic rewards and penalties to drive U.S. utilities toward the desired outcomes. Some utilities and regulators are starting to look at changing the utility business model to create incentives for utilities and third parties to engage in transactions that will bring value and more clean energy to market. If PBR is done right, it can address the moral hazard of a regulatory monopoly that is otherwise incentivized to put steel in the ground. At the distribution level, PBR can make utilities indifferent between owning assets and accessing assets owned by third parties – whichever is the most economical way to achieve an objective. PBR can also incentivize investments in grid infrastructure needed for decarbonization, as opposed to just growing the rate base. If beneficial electrification is a key climate strategy, then a PBR system could reward utilities for growing load (from other sectors) while still investing in energy efficiency and demand-side strategies. The key is that the incentive structure would be based not on capital but on results.

Some regulatory commissions have trepidation about PBR and are fearful of providing incentives for behavior that they think utilities would have taken anyway. In addition, it is not always clear what PBRs should be seeking to optimize; for some, climate change is the north star, but there are other possible north stars, such as social equity or public health.

Some utilities are asking commissions to start small with PBR, with small incentives on things like reliability. They are also asking commissions to limit performance incentive mechanisms (PIMs) to things that are actionable and within their control; some commissions, for instance, have been pushing PIMs for things like the amount of solar on the system, but utilities cannot control customer decisions. Some large customers, meanwhile, want more granularity in how PBR deals with the grid. Grid-wide performance measures can be pretty meaningless if a customer is sitting on an awful circuit, so PIMs should enable addressing specific circuit-level problems and opportunities.

States may still be a couple of years away from really understanding how to rebalance utility revenues to incent the right behaviors while still providing a foundational level of revenue and ensuring that the system remains reliable, resilient, secure, affordable, and equitable. Using PBR to decouple utility revenues from asset investments raises a host of questions that could take years to work through at the distribution level, yielding different solutions in different places. For instance, distribution planning processes have to become more collaborative and transparent to come to agreement and provide clarity on issues such as how utilities operate, plan, and share liability and operational risk with third parties (e.g., how to build in contingencies if third parties do not perform as expected).

A future decarbonized electricity system will be much more complex than today's system, with two-way traffic, more assets on the edge of the grid, more assets to integrate into the distribution system, and evolving relationships between utilities, customers, and third-party providers.

In addition, the changing technologies and roles are in some ways hindering utilities' ability to move forward, as it is unclear which entities are responsible for what (e.g., who has accountability for what occurs behind the meter). Physical and legal entities have to work together to accelerate the transition, but both are under stress. There is stress in the system on the physical level, with changes in technologies and customer behavior. There is just as much stress on the legal one, with discussions of disaggregating utilities from customers and debates around who gets to offer services. A future decarbonized electricity system will be much more complex than today's system, with two-way traffic, more assets on the edge of the grid, more assets to integrate into the distribution system, and evolving relationships between utilities, customers, and third-party providers. To minimize costs, some kind of central planning process to make sure all the pieces are working together and integrate across the grid would be advisable. Again, that will require a robust, transparent process to come up with long-term plans that provide certainty to utilities and other stakeholders about investments and returns. Regulatory structure determines where risks and responsibilities lie.

There are additional challenges to utilities' evolution as well. For instance, utility growth is not assured. Long-run electrification will raise sales, but it is not clear that increase will be greater than the amount energy efficiency could reduce them. Energy efficiency is also an unregulated product that anyone can offer in utilities' territories. Energy efficiency in most states (those that have not decoupled) also cuts into utility revenues, as could increasing deployments of solar with behind-the-meter storage. Furthermore, analyses suggest that, over a wide range of industries, shares of incumbents crater when a fast-growing challenger reaches around 2-3% market share, at which point the challenger takes all the growth in the market. Investors want growth, and the electricity sector may be at the point where renewables take all the growth in the market. That means there may be some sizable shifts in investor sentiment, and as investors try to get out of the incumbents, they will reallocate capital to the fast-growers in the sector. Integrative design, which makes the energy efficiency resource much larger and cheaper, could make capital flight from incumbents happen sooner. While investors tend to jump to the safe haven of the utility sector when financial markets get disrupted, utilities and their investors face long-term stress. There are many things converging on existing utility revenue, and more are coming (e.g., new batteries, blockchain). Together, these are creating a different competitive landscape – potentially faster than utility cultures can adapt.

STRANDED ASSETS & EARLY RETIREMENT

There will be a transition period to achieve decarbonization, during which costs may well go up, trillions will need to be invested in the grid, and billions of dollars' worth of assets will become stranded. While the utility sector has lots of stranded asset risk, it does not have a lot of exposure. The vast majority of value will likely get recovered given the current regulatory construct (unless something changes in the future). Still, at this point, it is not clear why regulated utilities would invest in building generation. It is a much higher-risk investment, and the returns are no better, than investing in the distribution network.

In addition, if utilities' portfolios are already full of assets, there is no room to build or fund big new things, particularly if there is no demand growth. In a world of flat or declining demand, it is harder to displace things that are currently operating. Headroom needs to be created somehow. If entities with emitting assets cannot write them off and retire them, the ability of developers of cheaper zero-carbon technologies to sell to those entities will be inhibited. Removing the burden of those assets would accelerate new technologies, potentially even more than tax credits would.

Policymakers and regulators have options to address stranded assets and accelerate retirements of emitting assets. To avoid having utilities write off tons of remaining value or raise rates without customer benefit, regulators can enable utilization of approaches such as depreciation and securitization, though securitization is only possible in those states that have adopted enabling legislation. Alternatively, if political leaders in a state decide early retirement is the direction to go, some would advocate having everyone in the state share in bearing the costs, such as through a charge that appears on everyone's bills or by having the state float a bond to take on the costs. Another possible option could be a policy mandating forced retirement of emitting fossil assets. This would be pushing emitting plants off the books in a scheduled way, not just through gradual economic dispatch competition. This could be done at the federal or state level, though the notion of such state-level action may have taken a hit with the recent minimum-offer price rule actions taken by the Federal Energy Regulatory Commission (FERC).

If utilities' portfolios are already full of assets, there is no room to build or fund big new things, particularly if there is no demand growth. In a world of flat or declining demand, it is harder to displace things that are currently operating.

It is important to remember, though, that assets get stranded all the time, and protection is not always warranted. In the Telecom Act of 1996, for instance, there were explicit efforts to protect the copper network from becoming a stranded asset, but it turned out that was only important for a few years. Likewise, worker displacement always has been and will be part of the economy. That is part of progress and technological development. It has happened in the United States in mining, agriculture, and other sectors. As a result, there are many communities that have been stranded by past transitions (e.g., old silver mine towns). Resource-focused places have experienced dislocation and busts in the past.

Still, it is undeniable that stranded and prematurely retired assets impose costs not only on utilities but also on surrounding communities and the people in them. While some will benefit from the clean energy transition and others will hold their own, some will sink to even more desperate levels. The transition has to be accomplished while trying to preserve economic stability along the way. (This is true globally as well. There are many fossil fuel producers who may end up with stranded sovereign assets, and many countries rely on those assets for their revenues. If technology and capital are not shared around the world, transition issues will be much larger than some U.S. coal communities.)

There is a question as to whether society has an obligation to its citizens or its communities, but in communities in some states, there is not a clear separation between the two. All or most employment is tied to mines or plants, and the only assets people have is their homes, which lose all value because no one wants to move to an area with no hope. So people either have to leave communities they have sometimes been in for multiple generations or go on government assistance. Also, when jobs move out, drugs and addiction move in. There may therefore be an obligation to both citizens and communities.

Achieving a just transition can be an investment opportunity for green growth. A lot of jobs will not come back, and people will have to be able to move. That is what underlies one of the ideas in the Green New Deal – enabling people to be more mobile in the economy by letting their health care move with them. This can be a green trampoline – not just a safety net – that helps people transition.

It is also incumbent on community leaders to try to find other ways to bring hope for economic prosperity, whether in the new energy economy or elsewhere. It is imperative that communities be realistic about their prospects and di-

rection, but no community wants outsiders to tell them what to do. Worker retraining programs that have just been a checking-the-box exercise have spurred significant resentment in some communities, but communities need to try to be adaptive. States and corporations have big roles to play too in envisioning the future of work and deploying resources to take advantage of opportunities in smaller towns and rural America. Large electricity buyers, for example, could try to focus clean energy procurement in regions that need the economic support and jobs. Large buyers that provide economic lifelines for communities can spur those communities, even in the heart of coal country, to support the buyers' clean energy goals. If it is possible to get people comfortable with a future where their work is not linked to emitting fossil fuels, it will be much easier to move forward on decarbonization.

Achieving a just transition can be an investment opportunity for green growth.

LARGE BUYERS

The earliest wave of U.S. renewables deployment was driven by tax credits and mandates, but large buyers then took renewables to the next level. Some large buyers acted because their key leaders pushed it, but some were also afraid of being named and shamed by the environmental community.

Most corporate renewables deals have been signed in competitive markets; in deregulated states, customers have direct access to competitive generation in wholesale power markets, and thus cheaper costs. Many companies have signed on to pledges such as the RE100, but a much smaller subset has actually procured renewables, and an even smaller set has procured at any scale. It is critical to figure out how to scale up action from a few dozen to hundreds of companies and beyond, but the virtual power purchase agreements (PPAs) that the dozens have done are not replicable and scalable to hundreds. To get from dozens to hundreds, there will be a need for different contract mechanisms, as well as help for those who have large renewable energy opportunities behind the meter.

The corporate clean energy space is a dynamic one, and what was best practice in corporate leadership a decade ago now may not be sufficiently aligned with achieving deep decarbonization. There is increasing fervor around climate commitments – from the public and from corporate employees – but companies have been vague in their language around their energy commitments and actions. Many say they are powered 100% by renewable energy when they are not, as 100% renewable energy purchasing goals, while laudable, are offsets. Renewable energy credits (RECs) were a great tool in the early years to help corporations and buyers have a footprint in clean energy without having to be too much of an expert, but the limit of what RECs can do for buyers may have been reached.

One of the biggest trends occurring among large consumers of power is the transition away from goals focused on 100% renewables procurement. Procurement practices generally set a target for 100% renewables (or 100% clean) on an annual basis, but time of use and location matter. Resources are not there exactly when and where buyers need them. Supply and demand do not align. There are different types of demand profiles and resource availabilities, but in general, analyses suggest that combinations of wind and solar – even when linked to huge batteries – leave substantial gaps in load, up to 25% of annual load in the worst cases. Other resources are needed as well; failure to diversify could lead to a very expensive system once renewables hit, say, 80% of the system. Others have analyzed the role that grid flexibility strategies can play and have determined that it is possible to do 100% renewables with no bulk storage but with various kinds of distributed storage – achieving very attractive economics by optimizing the system. Either way, the levels of renewables needed are still far, far away from where renewables are now.

Companies are starting to look at the attributes of their megawatt-hours in various locations and are trying to figure out how to truly decarbonize every hour of electricity used – to achieve zero-carbon power 24/7/365. This represents a shift in focus from energy production to actual energy consumption. Put differently, it is a shift from a focus on 100% renewables to being a citizen in local grids. Companies do not know how to get there yet, but there is space now to have conversations about it. Not many companies, though, have the capacity to think about load matching on an hourly basis.

Moving to truly decarbonized grids opens up interesting questions about diversifying the generation mix and focusing on carbon impact. Investing for carbon impact is more complicated than simply buying renewables. Corporate renewables purchases have traditionally been focused on additionality (i.e., bringing new resources online), but if the effect of a corporate purchase is, for instance, to extend the life of an existing nuclear plant, it is unclear if that would be seen as being as worthy (or receive the same level of stakeholder endorsement). Corporate buyers could also try to broaden their scope of investment to include new advanced nuclear. Such actions by large buyers would put their institutional credibility and thought leadership behind the idea that nuclear is part of the climate solution set. Corporate moves on nuclear, however, involve reputational risks. Unlike renewables, there is not consensus around nuclear, and companies are loath to stick their necks out. Companies are unlikely to move into nuclear procurement until it is seen as easy and safe to move into the space. Beyond nuclear, buyers could compile a portfolio of different technologies, which would diversify the risks, but very few buyers look at their procurement from the perspective of hedging.

Moving large buyers' efforts beyond procurement of 100% renewables becomes more of an imperative when the scale involved increases. Some governments, for instance, are starting to look at corporations' success in achieving 100% renewables and considering modeling a similar approach, but while 100% renewable energy goals may be the right moves for some companies, they may not necessarily be the right thing for grids. Likewise, when the number of buyers reaches hundreds or thousands of companies, bilateral procurements may not be the best thing for the overall system, and such procurement efforts may not actually be instigating any change. Large buyers know that a full 24/7/365 zero-carbon grid for the entire country will not be achieved one corporate PPA at a time.

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Buyers are trying to figure out how they can go beyond decarbonizing only their own loads. The grid is what balances various buyers' load needs, and individual buyers will never have the impact that changing a MISO or a PJM would, so there are questions about how buyers can put effort into changing the levers or drivers that regional transmission organizations (RTOs) can affect. For example, RTOs have jurisdiction to aggregate state clean or renewable energy standards into a kind of forward clean energy capacity market, which corporate or municipal procurers could add to, creating a more reconciled market that could drive down the cost of procuring zero-carbon resources. A dynamic forward clean energy market is also a way to address the issue of where to build zero-carbon resources and whether a new resource offsets an existing carbon resource or is taking value away from another zero-carbon resource. It could be a powerful tool to add to a power market.

It is hard to figure out what the next right thing is for large buyers to do. The next steps may not be focused on procurement at all, but rather on how large buyers can effectuate bigger changes in policy, technologies, and investments. Corporate buyers might be able to help set the vision for faster system decarbonization and support the policies to make it a reality. For instance, they could push for carbon pricing. Even if a buyer has carbon heat maps of its various facilities that enable it to see pretty clearly where it needs to focus on securing additional zero-carbon power, that will be harder to do in some locations than others – particularly absent a carbon price signal. Buyers could also participate in state grid modernization proceedings to help advance the transition, figure out how utilities can bring long-lived assets onto the system, and find common ground on the short-term costs that some initiatives might bring. In return, buyers might want to remove from proposed grid modernization packages those investments that are not necessary or justified for the transmission and distribution system buildout needed for deep decarbonization.

NUCLEAR

Opportunities for nuclear power to play a key role in deep decarbonization go beyond the procurement decisions of large buyers. As noted earlier, even with massively increasing energy efficiency and renewables, there will likely be a need for other zero-carbon resources. High penetrations of renewables are expected to be expensive, and that is not tenable in many parts of the world and the country. Ignoring the last 20% or so of electricity needed in the mix means the renewables buildout could be a bridge to nowhere. In addition, there are geopolitical factors to consider. Nuclear energy agreements between countries compel an enduring level of technological dependence, and Russia holds nearly half of such agreements globally, while the United States holds about 10%. Russia and China are moving forward on nuclear and will grow their global market shares if the United States does not.

It was not that long ago that lots of large, gigawatt-scale lightwater reactors were seen as being the likely future. After the 2008 recession, however, there were fewer places where they made sense, at least in the United States. (They are still being built elsewhere.) New technologies have been developed, including small modular reactors (SMRs), which are lightwater reactors that produce hundreds of megawatts instead of thousands – and which are coming to market in the next few years. SMRs rely more on off-site fabrication, which can reduce costs. SMRs, however, are also decades behind in catching up with small modular renewables, which scale down much better than nuclear does.

There is an immediate but perishable opportunity to make these nuclear innovations into realities by demonstrating the next generations of the technology.

There are also advanced reactors under development with new fuels, new coolants, and new business models. Advanced nuclear is safer, cleaner, and has fewer waste issues. The new generation of reactors could have applications beyond electricity, including providing industrial process heat.

There is an immediate but perishable opportunity to make these nuclear innovations into realities by demonstrating the next generations of the technology. It has been impossible to build nuclear plants in the United States on time or on budget, and, like large buyers, no utility will take on a first-of-a-kind nuclear demonstration, but Congress has provided millions of dollars in funding recently toward advanced reactor demonstration programs. The plan is for federal demonstrations of at least two advanced nuclear technologies by 2025 – on budget, on time, and working as expected. Micro reactors for remote and secure facilities may lead the way in showing there is a next generation of nuclear technologies that is not too far away, too expensive, or uncompetitive. Locating advanced nuclear demonstrations behind the fenceline at Department of Defense (DOD) facilities could be a good avenue for proving the technologies and accelerating deployment, as the nation already trusts DOD to handle nuclear material, and permitting can happen more quickly in the DOD context.

Deployment of clean technologies globally has to occur at a massive scale, so potential speed of deployment matters a lot. Laying the groundwork for advanced nuclear demonstrations therefore has to start now. There is a need for first-of-a-kind demonstrations by the middle of this decade, and adoption by fast followers after that, to create the scale of construction and supply chains necessary to meet decarbonization deployment needs. If nuclear is to play a big role in decarbonization, though, then licensing could be a problem. The first SMR licensing has taken several years, and that is using largely the same technology as existing reactors. It will be even harder and longer with different fuels and coolants.

Cost could be another hurdle. Some argue that nuclear is out of the money under the best of circumstances, so pouring money into it means getting less carbon saving per dollar than if the money was invested in other carbon-saving opportunities. Just as coal plants get built by counting cost but not carbon, nuclear is often defended by counting carbon and not cost. Displacing the most carbon with finite money should involve counting both; there is a climate opportunity cost to be considered.

ACCELERATING OTHER TECHNOLOGIES THAT ENABLE ZERO-CARBON GENERATION

Achieving deep decarbonization in the electricity sector will require more than just generation. Storage, for instance, could be a game-changer at the distribution level, but it faces a range of hurdles. Some regulators have struggled to understand how batteries function; some want to classify batteries as generation, when they are more accurately considered distributed energy resources (DERs) or load. (A number of states need to re-look more broadly at what is deemed generation, a wholesale asset, a distribution asset, and so forth.) In addition, it can be hard to make storage pencil economically. There will have to be approaches taken to tap multiple value streams, including figuring out how utilities can share storage assets with customers. The market is not quite mature enough yet, but in some states' grid modernization proceedings, there has been an explicit focus on testing markets and business models for storage to see what works in terms of sharing the resource at the distribution level (e.g., owned and operated by utilities versus third parties). There may be a similar willingness to test models at the transmission level. Lots of maturation is needed in terms of the economics of the storage market and people's understanding of the resource.

Without transmission, there will be backlogs of clean energy projects that will not be able to come online because they cannot get their power to market.

New transmission infrastructure will also likely be needed for deep decarbonization. Without transmission, there will be backlogs of clean energy projects that will not be able to come online because they cannot get their power to market. Transmission planning processes need to change to incorporate more renewables and to take into account longer-term objectives. In addition, there are technologies that can be deployed in less than a year that can boost the efficiency of the transmission grid and create significant amounts of additional capacity at relatively low cost. The challenge is that utilities would have to spend little capital on them, so they would make little return. Performance-based incentives in a regulatory regime that rewarded intelligence instead of steel would help accelerate such solutions.

GETTING THINGS BUILT

Achieving any ambitious emissions reduction target by mid-century will require building a lot of stuff – potentially including transmission lines, zero-carbon generation facilities, CO2 pipelines, and more – but it is hard to get infrastructure built in the United States. Thousands of projects are not getting financed and deployed due to regulatory and other obstacles, including sometimes NIMBY (not in my backyard) and BANANA (build absolutely nothing anywhere near anyone) opposition. It will be essential to figure out how to remove the barriers to deployment of infrastructure needed for decarbonization.

The hurdles that slow down projects and hinder deployment of carbon-free technologies are numerous. The interconnection process is one such hurdle. Before building renewable energy projects, developers want an off-taker for the energy, and off-takers want to minimize execution risk, the biggest of which is interconnection – connecting to the grid in a certain place at a certain cost in a certain timeframe. Developers go to the local transmission grid operator, put in an interconnection request, and then wait in a queue. Today, in a lot of U.S. markets, that queue is overcrowded, and it can take years to go through. That means customers looking for carbon-free energy find years-long waits to build things in some markets. The queue takes a long time in part because developers do not have any data, so it is hard for them to know where to interconnect and at what cost. It is like playing darts; they pick a few locations, put them in the queue, and see what comes back to them on cost. If everyone is throwing several darts, the queue gets overcrowded quickly, and it is impossible to distinguish requests for information from real projects. It can be even harder in some geographies, which require developers to pick one spot at a time; developers ask if one spot works, wait more than a year for a response, and if the answer is no, pick another place and try again. The intercon-

nection hurdle could be alleviated with more data and transparency to help developers pick the right spots. There is a need for a process that is more flexible and transparent and that includes tools to fast-track real projects.

Revenues and financeability are additional hurdles. To finance a clean energy project, developers need contracted revenues from off-takers, such as through power purchase agreements. Customers are increasingly unwilling to sign long-term PPAs (e.g., 20 years), given the price volatility in the market; they want shorter contracts to limit risk. Developers, however, still have assets with 20-25 year lifespans. They can try to bridge the gap with merchant revenues in the marketplace, but it can be hard to get financing based on that. The financial marketplace needs to shift models away from a requirement for full contracted revenues if things are going to get built.

There are many pathways to decarbonization, and it will not be possible to pick one now that will still be right for the next 30 years.

Capacity planning and grid planning present hurdles as well. Current planning processes that try to make decisions about the next 20-30 years are impractical. The system will change in unforeseen ways over that time, including with regard to technologies and load. There is a need to create flexibility in the processes and in the system so entities can try and iterate on more things. There are many pathways to decarbonization, and it will not be possible to pick one now that will still be right for the next 30 years. Processes have to allow for risk and iteration. Asking people not to make mistakes means people will be afraid to fail.

There have been and continue to be numerous efforts to address at least the regulatory hurdles to getting things built. There has to be a better way, consistent with environmental and other laws, to get to yes or no on projects; a fast no can be just as valuable as a fast yes. Every presidential administration, it seems, tries to accelerate infrastructure projects, but very little structural change actually occurs. There is currently a proposed National Environmental Policy Act rule that is attracting lots of attention – both support and opposition. At the state level, New York State has proposed an accelerated permitting process for development of in-state renewables to try to bypass local, county, and state obstacles. Texas is already organized to get to fast decisions, and some jurisdictions have gone through zoning processes to pre-site locations and clear the decks of issues.

In addition, some people and companies are working to do end-runs around the system. For example, some are working to develop HVDC transmission along rail lines, where the railroad already has the interstate right-of-way corridor. (This basically duplicates the fiber-optic co-location model.) Undergrounding the lines makes the permitting easier, as does the fact that the transmission lines are on private, brownfield land.

ROLE OF FINANCE

Capital markets – which only care about cash flow, growth, and risk – are starting to look more at climate change, and climate issues are becoming of interest in the mainstream of the finance sector. Investors have been radically, incrementally transformational; while they have not gone outside of their core competency of investing tools, they have tried to apply those tools in a systematic way to climate change.

BACKGROUND

To achieve mid-century deep decarbonization, estimates are that hundreds of billions of dollars more in investment will be needed for the energy transition. Estimates of the capital needed to achieve deep decarbonization, though, are sensitive to how much energy efficiency one assumes. Energy savings, mostly from technical efficiency, accounted for the substantial majority of the world's decarbonization between 2010 and 2016, and energy savings combined with decarbonized supply growth from 2016-18 spurred even more. Models that robustly account for efficiency suggest that global reduction goals can be achieved with trillions less in investment needed in the supply side. Many models, however, incorporate modest or weak energy efficiency assumptions. The assumptions built into models may make climate solutions look harder and costlier than they should be based on current market prices and technology adoption levels.

Models that robustly account for efficiency suggest that global reduction goals can be achieved with trillions less in investment needed in the supply side.

Regardless of the precise estimate, capital has a central role to play, and action has been revving back up in the capital markets again. There was an era of optimism in clean-tech capital from 2006-08, which did not work out so well, leading to carnage in 2009-10. As a result, little clean-tech investing occurred through 2015 or so. Around 2016-17, a new era of urgent optimism began to take hold, leading to the creation of new funds and billions of dollars of investment in hundreds of companies. Money is flowing back into what is now seen as climate-tech. Venture capital is a big part of this, but it is far from the only player. Some innovations are inappropriate for venture funds (or some other types of finance) and so require partnerships with large, well-financed private companies (e.g., oil and gas companies looking for ways to move more into the clean energy space). Others in the finance sector are pushing to put more mutualized funds on the table. Many are trying to figure out how best to apply environmental, social, and governance (ESG) criteria to their investment portfolios to direct capital toward actors that can lead the way to or thrive in a decarbonized economy.

ESG

As an initial matter, it can be helpful to distinguish some of the confusing terms utilized in the space. *Socially responsible investing* (SRI) focuses on what companies make or do (e.g., screening out tobacco or firearms companies), while ESG investing is more focused on how companies make or do it. ESG investments can encompass many issues beyond climate change, including air pollution, water issues, community impacts, board composition, and much more. SRI and ESG represent trillions of dollars in investing. Impact investing, which currently represents billions of dollars in investing, is an alternative to charitable giving that seeks to put capital to work in ways that can make a difference (e.g., investing in water companies in drought-stricken places). Impact investing is aiming for additionality and intentionality in trying to do good in the world. Activist investing seeks to change companies, shift management, get seats on boards, and so forth to get companies to act in a certain way. If SRI investors find a company they do not like, they just divest from it. ESG investors could divest from it or engage with it. Activist investors would try to force it to change.

As ESG becomes mainstream for institutional asset owners and managers, engagement with companies is becoming a vital investor tool. Institutional investors have a huge amount of their assets devoted to passive funds (active managers have failed to outperform the passive benchmark), and passive index funds that include companies across the economy cannot screen out companies or change the shares they own. All they can do is engage with companies to try to address their problems. Large institutional investors now have teams of people dedicated to engaging with companies on any issue that affects their ability to generate long-term value, including governance and the range of risks associated with climate change. European institutional investors have generally been much more interested in incorporating ESG into their investment programs than American investors have, with the exception of a few large U.S. state pension funds.

As ESG becomes mainstream for institutional asset owners and managers, engagement with companies is becoming a vital investor tool.

In the United States, all that is taught in business school and most of what equity investors have focused on in the past has been short-term valuation. If all that investors are considering is what will affect company value over the next three months, that affects corporate behavior. Things are starting to change, though. Companies going to the market for debt instead of equity are encountering ESG concerns in those conversations. ESG will also become a more central part of the conversation for investments in infrastructure, which is long-lived. At some point, ESG investing will just be investing. ESG will become business-as-usual, with pretty much every investor asking management about these issues.

ESG is part of a phenomenon of broader changes occurring in the value drivers of companies, where more value is being driven by intangibles. Companies broadly want to be seen as being on the right side of the sustainability imperative, which is one of the core societal trends of this century. The change in core values that appears to be underway suggests that the age of externalities being acceptable business practices may be coming to an end. The change could be similar to the societal change over the past few decades with regard to smoking. Any company with a business model based on externalizing costs on society may have to rethink that model.

Profit motive will also push ESG into Wall Street. As assets pass to younger generations that have much greater interest in ESG issues, big companies will be forcing ESG products into their networks to try to keep people and their assets. At the moment, though, the ESG push from retail audiences has mostly been in Europe; there is nothing similar happening yet at any kind of scale in the United States.

In addition, U.S. financial advisors seem to be confused by the differing approaches and objectives, particularly with regard to climate change. SRI funds focused on climate change, for instance, will not own fossil fuel producers, but

other investors will, so advisors are unclear what society accomplishes with that; screening companies out does not necessarily impact carbon emissions. Other investors talk about ceasing to invest in companies, sectors, or areas that are vulnerable to climate impacts, but that means taking capital from victims of climate change. Financial advisors are not clear on what they are supposed to be trying to accomplish.

Serious leaders in the global financial sector have been pressing the message that climate change presents systemic risks to financial stability, which advances climate-related ESG work because it focuses less on values and more on valuation – on the impacts that climate risks can have on the value of portfolio holdings. There are two major types of climate risks: transition risks (e.g., to the energy industry from decarbonization) and physical risks (i.e., from the impacts of climate change). Transition risks include things such as regulation, policy, and societal changes that could decrease the value of higher-emitting sources. Transition risk can be driven by climate action (actual and anticipated) by regulators and policymakers, changing customer preferences (both individuals and major buyers), changing investor preferences, and more. Physical risks include things such as the impacts of rising sea levels, extreme weather, heatwaves, wildfires, ocean acidification, and other effects of climate change. These effects can damage infrastructure, affect real estate values, and exacerbate wildfire liability risks for electric utilities.

ESG is part of a phenomenon of broader changes occurring in the value drivers of companies, where more value is being driven by intangibles.

Climate risks, however, can be challenging to characterize and assess. Looking just at physical risks, for instance, there are many factors that affect risks to a company's physical infrastructure, and climate adds new ones. While there are some NGOs and private firms that have quantified physical risks, the science is far less certain when it comes to local and regional effects, so it is really hard to do anything other than describe possibilities. Of course, that is the textbook definition of risk – more things can happen than will happen – which makes climate impacts part of a general risk management challenge. The insurance and reinsurance businesses have been at the forefront in trying to model the physical risks of climate change, but some advocates of climate action who have engaged with other major corporate CEOs have come away noting a lack of a sense of urgency on their part. Most corporates do not fully understand the vulnerability of current physical systems to climate risks, whether from droughts, changing wind patterns, or other impacts. When corporates see utilities putting grid resilience into their infrastructure buildouts, they see it as unrelated to getting to zero-carbon, but it is a core part of preparing to address climate risks.

Climate risks can also be hard to price. Transition risk can sometimes be addressed by incorporating a carbon price into decision-making, but there are all sorts of carbon prices set at very different levels. Physical risks can be somewhat captured using the social cost of carbon, best estimates of which are currently somewhere between $50 and $100 per ton, but it is hard to calculate.

Different investors take different views on the breadth of risks and types of technologies to incorporate into decisions about particular companies or portfolios. In evaluating what companies are doing and what should be included in portfolios, it is not always clear what is good or bad. Early SRI funds, for example, screened nuclear power out of their portfolios, and there are still lively debates, even in Europe, about what constitutes a climate-resilient portfolio. It can also be hard to figure out what matters. For instance, it is unclear if ESG investors would be interested in a solar company that does not recycle its panels, has a factory powered by coal, and so forth. Conversely, huge companies that make machines for mining, pipelines, and the like but also have the biggest and most effective recycling programs for their machines might end up on some sustainability indexes because of their work on circularity. For impact investors seeking "intentionality", companies that are not actively doing anything to reduce climate risks but stand to make money from them (e.g., construction companies delivering infrastructure solutions) probably would not be included in an impact fund.

Scenarios are very important for investors trying to assess risks looking forward. Scenarios can include ones of how different sectors will perform in a decarbonized world, how specific low-carbon technologies will perform, how climate change's impacts are expected to proceed, and more. There are lots of bits of information and analysis being developed, but they have yet to be brought together in a consistent way.

	SRI (Socially Responsible Investing)	ESG (Environmental, Social, Governance)	Impact	Activist
Critical Company Attributes	What the company makes (product)	How the company makes it (process)	Having a positive social impact	Company is not doing what I want
Clients	High Net Worth	High Net Worth, Foundations, Pensions	High Net Worth	Hedge Funds, Non-Profits
Motivation	Moral	Ethical, Risk Avoidance	Moral	Moral, Short-Term Profit
Stock Selection	Negative Screening	Negative Screening	Positive Screening for Additionality and Intentionality	SOTP; Behavior + or -
Fund Manager Action	Divest	Divest	Buy, Hold, Engage	Buy, Force Changes, Sell
Fund Manager Engagement	None	Limited	Having a "seat at the table"	Force changes internally

ESG DATA & METRICS

To make finance flow toward climate solutions, transparency is critical. Companies are an important point of leverage in the pursuit of decarbonization, and disclosure and reporting on how companies are addressing climate-related risks and opportunities can help investors who are trying to understand non-financial risks that could become material and affect the value of a company. From an ESG investor perspective, the more they can understand about how well a company is run and how attuned to key issues it is, the better they can assess how sustainable an investment it will be over the long term.

Investors are starting to inspect companies' ESG attributes more and to create ways to measure them. A big ESG headwind, however, is the complete data disarray. The current data ecosystem is a mess. A cottage industry of data providers and analysts has arisen, but leading data providers – who are now big businesses – do not tell investors the assumptions underlying their assessments. Exacerbating the murkiness, different providers disagree with each other in their assessments of corporate sustainability.

Despite being around for quite a while, it is still early days in the ESG world in terms of data and metrics. Some of the data just comes from scraping companies' ESG reports to find out whether they are referencing key words or not. Companies' answers to investors' surveys also provide a lot of data, which is used to inform not only sustainabil-

ity scores but also things such as credit ratings. A lot of the data, though, focuses on snapshots instead of trends, is narrow instead of broad, is backward-looking instead of forward-looking, does not capture a range of value drivers, and is anecdotal in some cases. The data does not help investors differentiate real sustainability from those engaged in greenwashing or smoke-blowing.

Investors need granular, high-resolution pictures of which companies are leading the way to sustainable futures, which companies will thrive in those futures, and which management teams are ready to lead. For instance, the market needs greater insight into transition risks of utilities and assets. Carbon footprinting alone is not enough to understand which assets in the system could be shut down and what the exposures of different companies and assets are to market and policy risks. Similarly, ESG services that grade and rank companies make no distinction between a company that buys a bunch of Texas wind RECs and a company that procures energy in places and ways that have bigger carbon impacts, as the services look only at megawatts of capacity bought. In terms of risk in the electricity sector, metrics focus on providing zero-carbon power when the enterprise risk may be just as much (or more) about resilience. Having the wrong metrics can lead to missing important nuances and areas of risk.

Companies are an important point of leverage in the pursuit of decarbonization, and disclosure and reporting on how companies are addressing climate-related risks and opportunities can help investors who are trying to understand non-financial risks that could become material and affect the value of a company.

Metrics are currently immature and incomplete, with non-elected authorities creating conflicting standards. The huge range of metrics, frameworks, and reporting initiatives is becoming exasperating and resource-intensive for the business community. There is a ton of mandatory reporting of environmental data that already occurs to meet government requirements, though much of it is irrelevant and never read by anyone. In addition to the massive amounts of compliance data, there are even more metrics that corporate leaders set, some of which are probably relevant to climate change. In the electricity sector, utilities already have lots of metrics around delivering electricity to customers safely, affordably, and reliably; the challenge is how to add in sustainability and have it be seen as co-equal. Investors are pushing for yet more data that is not yet required by governments; there is a gap between what governments say companies should report as a matter of compliance and what investors and other stakeholders want them to report. The data burden is particularly heavy for smaller entities that do not have a full-time person (much less a team of people) to devote solely to sustainability reporting.

Things would be much simpler – and utilities and other companies could better focus on outcomes – if there was agreement on the metrics to focus on. If a critical mass of portfolio managers and analysts could get alignment on the key climate metrics they want, the methodology companies should use to calculate them, and how companies should disclose them, then it will be easier to shift capital to scale the decarbonization process. The investor community needs to figure out what data is available now that provides a basis for iteration and improvement. They do not have the luxury of decades to figure it out; they have to start with the frameworks that already exist and that have substantial investor support and build on them. There is a need for incrementally radical transformation.

There are lots of well-intentioned actors in various initiatives and alliances seeking to address the disarray around metrics, impacts, and valuation. There could be an opportunity to have some coalescing and standardization. The recommendations of the Taskforce on Climate-Related Financial Disclosure (TCFD) may be a first step in addressing the disarray. TCFD, which has many investors behind it, sets up a framework that asks companies to disclose metrics, strategy, scenarios, how climate change impacts them over time, how they are reacting to it, and the governance they have in place to handle it. TCFD has lots of potential to let investors decide what metrics and methodologies they want and how they want them reported. TCFD is highly imperfect, and there is little TCFD reporting in the

United States, but TCFD will generally help drive more transparency. It is a necessary incremental step, but it is not an endpoint. There is still a lack of comparability across companies that would enable benchmarking and assessment of which companies are really acting. A way has to be developed to distinguish socially and environmentally responsible actors in the energy sector (and other sectors as well).

Policy frameworks can help establish some of that comparability by creating a structured set of required sustainability metrics (and methodologies). A model could be the Financial Accounting Standards Board (FASB), on which every company's accounting is based. Until sustainability metrics are standardized and audited in the same way that financial performance metrics are, there will always be imperfection in the system. There is a need to drive higher quality information and deeper knowledge further into enterprises so that someone without an ESG background can make decisions based on the information with the rapidity the science demands as the economy decarbonizes. There has to be investment-quality ESG data just like there is currently investment-quality financial data. There have been attempts at this, but they have variously been too narrow in focus, asked people to report too much, or failed to establish a base for comparability.

Until sustainability metrics are standardized and audited in the same way that financial performance metrics are, there will always be imperfection in the system.

It is not clear what group needs to come together to create a more unified, coherent set of metrics. It is possible these metrics could be driven by a future U.S. Securities and Exchange Commission in redefining materiality, in collaboration with stock markets around the world. It also might be beneficial for investors to dialogue with companies to start getting rid of the noisier, less relevant, and more opaque data sources and hone in on the ones that have meaning. Engagement with other stakeholders could be valuable too, including industry associations, NGOs, and consumer advocates. Investors should also be engaging with policymakers and regulators, who have their own constraints, needs, and desired changes.

Investors in this space who do not think of themselves as advocates in policy arenas should transition their thinking. Europe is becoming the global standard-setting superpower on climate finance issues. European policymakers are making it quite clear what they want reported, how they want it reported, the hierarchy of technologies they will recognize, and more. Climate risk reporting is also now mandatory in France. The United States needs to come up with its own set of solutions and its own tools addressing the whole profile of risk – or what is happening in Europe will bleed into the United States.

POLICY & POLITICS

How and how quickly the climate crisis is addressed will be determined at least in part by policy. Because policy drives action at scale, it is a vital part of the solution. However, because the rates of innovation in technologies, ideas, and business models do not align with the rate of policy and regulatory innovation, policy is also part of the problem.

FEDERAL POLICY

To be successful, federal climate policy has to be geared at solving the global emissions problem, legislatively realistic (e.g., with champions on relevant committees), and politically sustainable. A climate policy will be more politically sustainable if consensus for it has been built up among more than "the elites" in the country. Most people in the country are fuel-agnostic; they do not care where their power comes from or what moves their car, just that their energy is cheap, reliable, redundant, and – increasingly – clean. Climate policy discussions are frequently driven by climate concerns, but they have to integrate with the cheap, reliable, and redundant needs as well. If climate and energy policies are not designed to work for people, there is risk of public backlash. On the other hand, there is no scientific field other than climate where the American public's opinion particularly matters. Some fear that democracy has become an excuse for inaction.

Climate policy discussions are frequently driven by climate concerns, but they have to integrate with the cheap, reliable, and redundant needs as well.

Still, there is more happening on the policy scene in Washington, DC, than many realize. Last year, in the FY20 spending bill, Congress made the largest-ever investment in clean energy research and development (R&D). In FY17, the Applied Energy Office at the Department of Energy (DOE) received about $4.3 billion, spread across various areas, with a little less than two-thirds going into innovation and R&D. While the Administration's proposed budgets have tried to decrease that amount, Congress has gone in the other direction. It added $500 million in FY18, with more than two-thirds going to innovation programs. In FY19, it added another $200 million. In FY20, Congress put another $800 million into applied programs, driven in part by a big investment in the advanced nuclear space. These increases – more than 33% over 3 years – are not enough to tackle the climate challenge, but they put the United States on track for achieving the Mission Innovation challenge of doubling R&D investment. This is not a bad track record, especially for divided government. In terms of spending the appropriated money, DOE is doing well in some offices (e.g., Nuclear, Fossil) and not so well in others (e.g., Energy Efficiency and Renewable Energy).

In 2020, there are prospects for a significant energy bill out of the Senate that includes measures on nuclear innovation, fossil innovation, DAC, long-duration battery storage, and enhanced geothermal demonstrations. The bill is composed of other bills that have already gone through the Senate Energy Committee, and many have matching bills in the House. If the bill is enacted, it will spur many demonstrations of new technologies throughout the 2020s, with lots of federal resources available to advance innovative technologies (with cost-shares).

A new, bipartisan innovation incentive concept has been introduced in the House this year as well. Supported by multiple members of the House Ways and Means Committee from both parties, as well as others, the bill would create a permanent tax incentive for new clean energy technologies. Any new technology would start with high levels of incentives that would ramp down as the technology's deployment ramps up. High-performing technologies that are low-cost, flexible, dispatchable, and able to be sited could get billions of dollars in incentives. This is like a tech-neutral, revenue-based, structural production tax credit, paid out not as dollars per megawatt-hour-generated but rather as a percentage of how much technologies make in wholesale power markets. The tech-neutral nature of the incentive means a new credit would not have to move through Congress every time a new technology emerges. The concept is gaining support.

More is needed on the federal policy front, however, to advance a range of solutions needed for deep decarbonization. For one thing, co-generation of products could be a much bigger aspect of a decarbonized future than some expect. Co-generation of electrons and heat, electrons and chemicals, electrons and hydrogen, ammonia and fertilizers and hydrogen, and other combinations could allow for sectors to join forces to provide decarbonization to other sectors. It will be a challenge for policy, which is often siloed, to try to pull those different sectors together. Adaptation and resilience also have to be core elements of climate policy.

Co-generation of electrons and heat, electrons and chemicals, electrons and hydrogen, ammonia and fertilizers and hydrogen, and other combinations could allow for sectors to join forces to provide decarbonization to other sectors.

In addition, some kind of persistent, robust policy signal is needed. Long-term visions, plans, and efforts will not work if companies have to change their priorities every time there is an election. There are a handful of policy ideas that can provide a durable signal over decades, including carbon pricing and a permanent 45Q tax credit for CCS. A policy to create a nationally capitalized climate bank could provide an additional powerful long-term driver for decarbonization. Such a bank – which is essentially a development bank concept – could make low-cost, long-term capital available to a wider range of actors to demonstrate new technologies, accelerate and aggregate small projects, and potentially acquire facilities to retire.

More broadly, what might move the needle is a bipartisan resolution in Congress recognizing the climate crisis as a priority to address. The United States has achieved emission reductions from the power sector without a federal mandate – through innovation, accident, and some tax code measures in end-of-year bills. It is a good thing such reductions were achieved, but that outcome was by no means guaranteed – and it still is not ambitious enough. Some politicians would be content to let the innovation approach continue to play out for another decade or two, with corporate buyers exercising their choices in the market, but the market needs a mandate in terms of the desired outcome. (If there was a 100% zero-carbon mandate, the issue of corporate procurements would matter much less.) The United States needs consensus on a clear, overarching moonshot climate goal, which will be a tough ask, as the country could not even find consensus on the relatively anemic first step represented by the Paris Agreement. In the absence of clear direction, it is far from a given that other mechanisms will achieve the needed reductions in the United States (much less globally).

CONGRESSIONAL POLITICS

The Republican evolution on climate policy has been notable, and some Republicans have started to identify climate change as a significant challenge to take on in their own climate policy package, following a very different approach than the Democrats. The first leg of the package included permanent extension of the 45Q tax credit for CCS, as well as provisions on DAC, carbon utilization, and natural climate solutions (i.e., tree planting). A second leg is expected on clean energy R&D, as well as a third on conservation measures (e.g., decreasing plastic waste). Some of the Republicans working on and supporting this package are not the usual suspects in terms of climate change messengers.

Part of the reason Republicans have started coming to the table on climate policy is because the majority of Americans have come around to believing climate change is an existential problem and that the United States needs to lead. Some Republicans seem to understand they are behind on this issue and have to catch up if they want to be a viable party going forward, particularly with younger voters who have created urgency around the issue.

The reasons why Republicans have evolved on the issue, however, may be irrelevant. The fact is that the political terrain on climate is clearly shifting, and the change creates a negotiating space to try to achieve better outcomes for policy. For instance, with some Republicans starting to rally around the idea of massive R&D investments, some think that may open a space to talk about how to fund such investments, such as with a modest carbon pricing policy.

There can be a bipartisan sweet spot in public policy, as long as people are willing to make bargains. Capitulating on some provisions and picking the right fights can open up the space for deals to move things forward.

There can be a bipartisan sweet spot in public policy, as long as people are willing to make bargains. Capitulating on some provisions and picking the right fights can open up the space for deals to move things forward. Too many politicians want to be ideologically pure. However, what is necessary on climate policy now likely exceeds what is seen as politically possible, and winning slowly on climate change is the same as losing. It is important to figure out how to close that gap. Some would argue that good policy does not necessarily have to be bipartisan. It can be, but the climate does not care who voted for what. Advocates could wait to get big Democratic majorities in the Senate and the House, and a Democrat in the White House, to move climate policy. On the other hand, doing it in a bipartisan way will be more durable, and the ingredients are starting to come together for bipartisan solutions.

STATES & FERC

Absent leadership from Congress, several states have been taking actions to direct their own energy futures. Not all of these are in the direction of carbon mitigation; some are aimed at propping up coal-fired generation. Most, however, have climate change in mind. Many states have renewable portfolio standards (RPSs), which were well designed and effective in some places, though not in others. There has been a recent trend of states building on their existing RPSs to create broader renewables-plus pathways via a clean energy standard (CES). Many of the states that adopted a long-term vision (e.g., through 2050) that includes all zero-carbon resources in a CES also moved to boost their RPSs in the near term (e.g., through 2030), as wind and solar are the most cost-effective options in that timeframe for achieving significant emission reductions. People can mean different things, though, when discussing the idea of CESs. Sometimes they mean allowing all carbon-free resources (including the demand side) to compete fairly against each other, without carve-outs or subsidies, but sometimes they mean support for particular technologies that are left out of RPSs, such as nuclear power.

State mandates have influence, but states' rights can come into conflict when state policy decisions impact cross-state markets. The complicated intersection of state policy decisions and competitive wholesale markets is leading to disputes before FERC, which does not necessarily have adequate tools to respond. Recent FERC rulings requiring minimum offer prices for some resources bidding into capacity markets in order to counter-balance state subsidies have been very contentious. The subsidies FERC seems to be paying attention to are the ones that are easy to see, but what is subsidized and what is not is not as black and white as some make it seem. Energy markets are not actually fair, open, and competitive. Fossil fuels receive substantial subsidies of various forms that distort prices but that are not accounted for. There are also indirect "subsidies" that could be considered; nuclear power, for instance, pays for its downstream costs, but coal gets them paid out of Medicaid. Some states are concerned that recent FERC rulings tread on their ability to make energy decisions, and it could be that FERC's efforts to make markets fairer might

result in some states pulling out of regional capacity markets entirely. Some would argue, though, that pulling out of capacity markets would be worse for consumers and the environment and that the costs for renewables have come down so much that they can compete without mandates or subsidies.

The biggest distortion in the market may be the absence of a price on carbon, and renewable and zero-carbon energy subsidies are at least partly attempts by states to correct for that. A price on carbon in organized wholesale markets might be the easiest way to handle these tensions. There are carbon prices in the United States – tons of them in lots of different forms and places – and one-off efforts to reconcile them before the courts, public service commissions, or FERC create a randomness and incoherence in the system that lead to price and risk premiums. Simplification would be preferable, and congressional leadership is needed.

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Where it has identified market failures, FERC has adopted some policies that could accelerate the clean energy transition. For instance, it had a rulemaking removing barriers to entry for battery storage technologies and allowing storage to be compensated for a range of attributes. Another rule on generation interconnections could facilitate new generation coming online. FERC is also looking at removing barriers to entry for aggregated DERs and is exploring whether it has the right kinds of incentives policy and return-on-equity policy in place for transmission infrastructure.

Some decades-old policy frameworks are limiting, while the issues and systems are growing ever more complex. Maximizing decarbonization within those frameworks can be challenging. For instance, FERC has proposed to change how it implements the Public Utility Regulatory Policies Act (PURPA), a 1978 law that says FERC must encourage cogeneration and relatively small power plant production. PURPA gives medium-sized plant owners the ability to sell power to utilities at the local avoided cost, creating a market for such facilities. Some feel FERC's proposal will eviscerate PURPA, radically change capital markets, and make it impossible to build medium-sized power plants. Others feel that PURPA has been abused in requiring forced purchases by utilities, allowing developers to occupy the market that should instead be driven by markets and state resource planning. Even older than PURPA is the Federal Power Act of 1935, but it could be challenging to open it up to create the Federal Power Act of 2020.

APPENDICES: AGENDA

MONDAY, FEBRUARY 24

Opening Session

Introduction — **Greg Gershuny**, Energy & Environment Program, The Aspen Institute

Welcome — **Roger Ballentine**, Green Strategies Inc.
Jim Connaughton, Nautilus Data Technologies

SESSION ONE: **Data Room**

Data-driven conversation to open the dialogue and set the scene for the remainder of the convening. Includes data on technology updates (storage, H2, industrial decarb tech, vehicles, transmission, advanced nuclear, CCUS/DAC, etc.), policy and emissions data, and finance considerations.

Moderator: Jim Connaughton

Discussants:

Surabi Menon, ClimateWorks Foundation
Dave Danielson, Breakthrough Energy Ventures
Rich Powell, ClearPath

Fireside Chat: A Q&A with current and former policymakers on policies that most effectively unlock mid-century deep decarbonization.

Sean Casten, U.S. Congressman, (D-IL-06)
Carlos Curbelo, Former U.S. Congressman, (R-FL-26)
Heidi Heitkamp, Former U.S. Senator, North Dakota (D)

SESSION TWO: **Getting to 100% Clean Electricity – Are We on the Right Path?**

A prerequisite to achieving net-zero emissions economy-wide by mid-century is a 100% zero carbon (ZC) grid prior to 2050. The challenge and need for a ZC grid are heightened by the anticipation that electrification of other sectors (such as transportation and heat) needed to achieve economy-wide decarbonization will mean significant new generation capacity must be added. The choices we make now about the pathways to decarbonizing generation could determine whether we are successful in the time frame needed. In the policy world, there is a growing movement away from renewables only portfolio approaches to broader zero carbon incentives and requirements. On the demand side, the prevailing "best practice" among many sustainability-minded buyers remains a "RE100" approach. Which is the better pathway for achieving decarbonization goals? Do 100% renewable purchase goals maximize the decarbonization impact that buyers can have? What would alternative goals based on all ZC resources look like and what are the options and obstacles in the marketplace for such an alternative approach?

Moderator: Roger Ballentine

Discussants:

Melissa Lott, Columbia University, Center on Global Energy Policy
Peter Freed, Facebook
Lisa Barton, AEP
Ashley Finan, Idaho National Laboratory

SESSION THREE: **Some Ask Why, Others Ask Why Not? – Reimagining the Underpinnings of the Electricity Sector**

The task of modernizing, dynamically operating, safeguarding, and decarbonizing the electricity sector faces many political, social, economic, and technology challenges. But the fundamental legal and regulatory structure of the electricity sector is still based on legal constructs from the 1930's. While there have been some additions to the federal legislative framework, the Federal Power Act of 1935 remains the primary governing law of the land. Do we need to reinforce or reconsider the FPA? How could we better harness market forces to drive and accelerate innovation, transformation, air pollution reduction and decarbonization, while meeting the legacy objectives of electricity sector policy?

Moderator: Jim Connaughton

Discussants:

Neil Chatterjee, FERC
Steve Chriss, Walmart Inc.
Susan Mora-Schrader, Exelon Utilities

TUESDAY, FEBRUARY 25

SESSION FOUR: **The Changing Role of Investors and Financiers in Driving Decarbonization**

Changing views of both risk and value creation opportunities in a warming and more carbon-conscious world, as well as the more overt role some investors are taking in driving environmental outcomes through their holdings, may mean that the capital markets are the next big player in driving decarbonization.

A. **Capital Markets and Climate Change:** Meeting in the Mainstream – Including so-called ESG (environmental, social and governance) criteria in investment decisions is no longer the province of just "socially responsible"/alternative investors. Mainstream asset managers, shareholders, and debt providers – as well as the ratings agencies, analysts, and other influencers that affect capital market decision-making – are either seeking more information from companies on climate risk or evaluating how companies are positioned to compete in a carbon-constrained world. What impact do new investing and risk evaluation criteria have on the allocation and cost of private capital and what effect might it have on corporate decision-making? What data and reporting systems are needed? What tools available to investors and shareholders will prove most impactful in driving change (negative screens, positive screens, divestment, etc.)? The panel will address how their investors are changing how they allocate or recommend how capital is allocated and how they assess energy/climate/ESG risk.

Moderator: Roger Ballentine

Discussants:

Patricia Hudson, State Street Corporation
Jim Murchie, Energy Income Partners, LLC
Susan Gray, S&P Global
Richard Newell, Resources for the Future

B. **The Case of Regulated Energy Sector Companies** – Other than cooperatives and municipal utilities, the majority of energy sector companies are public companies with responsibilities to shareholders, and other capital providers. In a sector as beholden to regulators as to shareholders, how can impact-driven capital drive the most change? Are legacy business models and regulatory constructs barriers to the change investors/financiers may seek? What needs to change?

Moderator: Jim Connaughton

Discussants:

Sam Brothwell, Energy Income Partners, LLC
Julia Hamm, Smart Electric Power Alliance
Paul Chodak, AEP
Jim Hempstead, Moody's Investors Service
Bryan Hannegan, Holy Cross Energy

C. **Pulling it All Together: How Does the "Pull" of the Capital Markets Fit with Policy, Political, and Equity-Based Efforts to Address Climate Change?** If money is "talking" and perhaps driving change, how can that be accelerated? How does policy interplay and what does the changing role of investors mean for the politics of climate change? Can these market forces address the questions of equity posed by a shift to a low carbon economy?

Moderator: Roger Ballentine

Discussants:

Dan Esty, Yale
Diana Glassman, Hermes EOS
Doug Sims, NRDC

WEDNESDAY, FEBRUARY 26

SESSION FIVE: **Getting it Built**

New green projects require changes to infrastructure, permitting, transmission, and potentially a new wave of policy and regulation. How can these projects be accelerated to advance mid-century decarbonization goals?

Moderator: Jim Connaughton

Discussants:

Bill Brown, NET Power, LLC; 8 Rivers Capital, LLC
Matt Crozat, Nuclear Energy Institute
Maud Texier, Google

PARTICIPANTS

Roger Ballentine, President, Green Strategies Inc. (*Co-Chair*)
Jim Connaughton, President & CEO, Nautilus Data Technologies (*Co-Chair*)
Doug Arent, Deputy Associate Laboratory Director, National Renewable Energy Laboratory
Bryn Baker, Director, Policy Innovation, Renewable Energy Buyers Alliance
Miranda Ballentine, CEO, Renewable Energy Buyers Alliance
Lisa Barton, Executive Vice President, Utilities, American Electric Power
Paul Bauman, Senior Advisor, Rodel Foundation
Steve Beuning, Vice President, Power Supply & Programs, Holy Cross Energy
Sam Brothwell, Director of Research, Energy Income Partners, LLC
Bill Brown, CEO, NET Power, LLC; 8 Rivers Capital, LLC
Sean Casten, U.S. Congressman, (D-IL-06)
Neil Chatterjee, Chairman, Federal Energy Regulatory Commission
Paul Chodak, Executive Vice President, Generation, American Electric Power
Steve Chriss, Director, Energy Services, Walmart Inc.
Steve Clemmer, Director, Energy Research & Analysis, Union of Concerned Scientists
Jon Creyts, Managing Director, Rocky Mountain Institute
Matt Crozat, Senior Director, Strategy & Policy Development, Nuclear Energy Institute
Carlos Curbelo, Former U.S. Congressman, (R-FL-26)
Dave Danielson, Managing Director, Breakthrough Energy Ventures
Ankit Desai, Senior Advisor to the CEO, Tellurian Inc.
Dan Esty, Hillhouse Professor, Yale School of Forestry & Environmental Studies; Yale Law School
Shelley Fidler, Principal, Governmental Affairs, Energy & Environmental Policy, Van Ness Feldman LLP
Ashley Finan, Director, National Reactor Innovation Center, Idaho National Laboratory
Peter Freed, Head of Energy Strategy, Facebook
Denise Galambos, Vice President, Utility Oversight, Exelon Utilities
Greg Gershuny, Executive Director, Energy & Environment Program, The Aspen Institute
Megan Gilman, Chair, Board of Directors, Holy Cross Energy
Diana Glassman, Director, Engagement, Hermes EOS

Albert Gore, Policy & Business Development, Tesla

Susan Gray, Global Head, Sustainable Finance & Innovation, S&P Global

Dave Grossman, Principal, Green Light Consulting (*Rapporteur*)

Julia Hamm, President & CEO, Smart Electric Power Alliance

Bryan Hannegan, President & CEO, Holy Cross Energy

Heidi Heitkamp, Former U.S. Senator, North Dakota (D)

Jim Hempstead, Managing Director, Moody's Investors Service

Christopher Herbst, Vice President, Government Programs, Eaton

Patricia Hudson, Head of Executive Communications & Thought Leadership, State Street Corporation

Ramsay Huntley, Sustainable Finance Strategist, Wells Fargo

Melissa Lott, Senior Research Scholar, Columbia University, Center on Global Energy Policy

Amory Lovins, Co-Founder & Chairman Emeritus, Rocky Mountain Institute

Mark Lundstrom, Founder & CEO, Radia, Inc.

Rachael Marsh, Legal Advisor, Federal Energy Regulatory Commission

Surabi Menon, Vice President, Global Intelligence, ClimateWorks Foundation

Susan Mora-Schrader, Director, Utility Initiatives, Exelon Utilities

Jim Murchie, CEO, Energy Income Partners, LLC

Drew Nelson, Clean Energy Program Officer, Cynthia & George Mitchell Foundation

Richard Newell, President & CEO, Resources for the Future

Rich Powell, Executive Director, ClearPath

Frank Prager, Senior Vice President, Strategy, Planning & External Affairs, Xcel Energy Inc.

Kathy Robertson, Sr. Manager, Environmental Policy & Wholesale Market Development, Exelon Corp.

Gregg Rotenberg, CEO, Smart Wires Inc.

Doug Sims, Director, Green Finance Center, Natural Resources Defense Council

Devon Swezey, Global Energy Markets Lead, Google

Martha Symko-Davies, Senior Laboratory Program Manager, National Renewable Energy Laboratory

Michael Terrell, Director, Operations & Head of Energy Market Strategy, Google

Maud Texier, 24x7 Carbon Free Energy Lead, Google

Doug Vine, Senior Energy Fellow, C2ES

Trey Ward, CEO, Direct Connect Development Company, LLC

Jeff Weiss, Executive Chairman, Distributed Sun

ASPEN INSTITUTE STAFF:

Maggie Carroll, Assistant Director for Energy, Energy & Environment Program, The Aspen Institute

Kate Harrison, Senior Program Coordinator, Energy & Environment Program, The Aspen Institute

Mykelle Richburg, Program Coordinator, Energy & Environment Program, The Aspen Institute

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