2018 ASPEN INSTITUTE CLEAN ENERGY INNOVATION
WINTER ROUNDTABLE

CLEAN ENERGY INNOVATION & DEEP DECARBONIZATION IN A TIME OF POLITICAL & TECHNOLOGICAL CHANGE

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THE ASPEN INSTITUTE
ENERGY & ENVIRONMENT
PROGRAM

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The Aspen Institute Energy and Environment Program challenges thought leaders to test and shape energy and environmental policies, governance systems, and institutions that support the wellbeing of both nature and society. The Program's forums and dialogues are designed to cultivate trust and leadership, and develop collective solutions based on the ideal that both humankind and the natural world have intrinsic value. Like the Aspen Institute as a whole, EEP seeks to inspire and explore new ideas that provoke action in the world.

CO-CHAIRS' FOREWORD

At the dawn of the internet, no one saw Facebook coming, and certainly no one submitted a resource development and deployment plan that pledged "Facebook by 2010". With relatively few regulatory constraints and with no incumbent economic or physical legacy systems to overcome, innovation occurred in a non-linear fashion. While we certainly recognize the limits of this analogy, The Aspen Institute Clean Energy Innovation Forum continues to be the place where the tough questions are asked about how we can more fully empower innovation to modernize our energy system. Our mantra in exploring the potential for an energy system that is cleaner, smarter, and better is to eschew the mindset of "no, because" in favor of "yes, if".

Innovation in the face of the constraints posed by our legacy energy system is our ongoing theme. We don't come up with all the answers, but we seek to ask all the tough questions. And again in 2018, we convened some of the brightest minds and most influential players to engage in the discussion.

Questions we explored included: Can we really do "long-term planning" in the electricity sector in an age of rapid innovation and low to zero marginal cost electricity? What are the regulatory and business model impediments to innovation? Is the road to "deep decarbonization" just a long trip on the same road that leads first to "shallow" decarbonization — or do we need to make hard choices now? Are utilities really an obstacle or do we just need to rethink how to better allow them to innovate? What functions really should be assigned to monopolies? Is it realistic to expect utilities to replace their capital investments with third party services? Is there necessarily a conflict between core obligations under the social compact and innovation? Should the traditional permission-based regulatory model of FERC/utility commissions be replaced (or joined with) more of a Federal Trade Commission-type regulatory model whereby consumer protections/climate protections are the sideboards within which industry innovates and competes? By what metrics do we plan the electricity system in the age of innovation? Do we "plan" for — or even mandate — low carbon outcomes and let energy transitions, innovation and financing develop in service of that end? Do important concerns about reliability, resiliency and cybersecurity cut against some otherwise attractive innovation pathways? And so forth.

As can be seen in this report of our 2018 Forum, we dove deep into these issues. We sought to look around the corner to identify change already baked into the system and to contemplate changes that can be made today to get to a better future.

Few discussions on virtually any aspect of the economy today avoid Blockchain; we were no different. Some have gone as far to say that Blockchain could pose an existential threat to the regulated utility model. We came to no conclusion, but transactive energy markets at the end-user level do seem to have the potential for efficiencies and great optionality for customers and almost certainly could benefit clean energy access.

We thank all those who provided the great input we received and look forward to continuing the discussion.

Roger Ballentine

Jim Connaughton

EXECUTIVE SUMMARY

Despite significant uncertainty about the direction of policy and regulation, the trends for clean energy are remarkably clear. Since 2008, renewable power generation in the United States (including hydropower) has doubled, from 9% to 18%, nuclear has maintained its share of U.S. power generation at 20%, and coal's share has shrunk from 48% to 30%. Over the past decade, energy efficiency improvements have led to the effective decoupling of U.S. economic growth from primary energy consumption, with GDP rising and energy consumption falling. In addition, lithium-ion battery prices have plummeted and are expected to keep declining, which is leading to increased deployment of battery storage and plans in several countries to ramp up deployment of electric vehicles. In terms of greenhouse gas emissions, U.S. power sector emissions have decreased, bringing down overall U.S. emissions, though the country is still far from its Paris Agreement commitment trajectory – and far from being on track to achieve a 2°C trajectory.

Political and policy changes will continue to affect the deployment of energy technologies and the achievement of climate objectives. At the federal level, the Trump Administration has worked to repeal the Clean Power Plan, leave the Paris Agreement, and roll back a sweeping range of regulations, in addition to imposing trade tariffs that threaten to reduce growth in U.S. solar deployment. The Department of Energy also proposed that the Federal Energy Regulatory Commission (FERC) issue a ruling to support coal and nuclear plants – a proposal that FERC rejected, although it opened a new debate about grid reliability.

In Congress, the new tax reform legislation has clouded the future of financing for clean technologies, particularly those reliant on tax equity, but has also put hundreds of billions of dollars of equity back on corporate balance sheets that could theoretically be deployed to replace outdated infrastructure and install more efficient technologies. Furthermore, the February 2018 budget deal increased the caps for discretionary domestic spending, which led to more federal money going into clean energy R&D. This budget deal also extended and expanded a range of important tax credits, including the 45J tax credit for nuclear and the 45Q tax credit for carbon capture and storage (CCS). In particular, the expanded 45Q credit should be large enough to get CCS projects going, help make the technology ubiquitous and cheaper, move significant capital into the space, and create a gigatons-scale sequestration opportunity over the next couple of decades.

At the state level, governors and legislators of both parties are increasingly exploring how to build out clean energy economies and attract growth markets, startups, and capital to their states. Several renewable portfolio standards will be coming up for renewal over the next couple of years in a mix of red and blue states, and there will be battles over increasing their ambition and/or expanding the scope of included technologies. States are also pursuing a range of interesting carbon policy efforts, particularly on the West Coast. Beyond government, the private sector has been a driving force on these issues, both in terms of renewables procurement and making operational changes to account for climate risks.

Changing policies and behind-the-meter technologies have led to significant debates about appropriate business models, regulatory structures, and jurisdictional boundaries in retail electricity markets. Regulators can either lead or respond to market developments, and innovation can favor either incumbents or insurgents – and the future is in many ways about how the power of incumbency and the desire for innovation intersect with each other and with regulations. As clean energy continues to grow on the distribution side, questions are surfacing about what stays a utility function and what gets carved away. It is less clear today where the monopoly should stop and competition should start. Utilities need to continue providing reliable service for low-income consumers and serve as a backstop for those generating their own power, while at the same time embracing and enabling the future by making the distribution system more flexible and rethinking their business models. One of the major drivers of activity and disruption at the grid edge could be blockchain, which could eventually enable a peer-to-peer, transactive energy market platform and let grids balance from the bottom up – which, in turn, would require a very different model of regulation and role for regulators.

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In wholesale electricity markets, meanwhile, prices have been declining in real terms, and some wholesale market operators have been struggling to address tensions created by state policies that favor clean energy sources in the generation resource mix. While things seemed to operate relatively smoothly with state policies to support renewables, new state policies to support nuclear power have highlighted the issue of whether providing out-of-market revenues to resources is distorting the market or just paying for a preferred attribute as expressed by a state policy. These state policies generally affect capacity markets, even though many clean generation sources get most of their revenues from energy markets – which has led some to argue for shifting the conversation away from capacity and toward energy markets. As a range of energy debates swirl, FERC has come down repeatedly on the side of markets – trying to help markets handle the different attributes that the growing deployments of renewables provide, trying to figure out how best to promote grid reliability and resilience, and trying to enable planning to address the growing incorporation of distributed energy resources (DERs) on the grid. As in the retail markets, blockchain, transactive DERs, and other innovations could disrupt wholesale markets as well by creating the potential to dispatch load, storage, and generation all from the customer upward into the grid. Figuring out how to meld the conventional wholesale markets reliant on big generators with highly distributed behind-the-meter generation in a way that works will require robust planning and supportive political action.

At FERC and beyond, discussions around reliability, resiliency, and security are getting a lot of attention and bipartisan interest. Some would argue that a modernized grid with robust deployment of DERs that are interconnected but can also be islanded would be more reliable and more resilient – a mesh network instead of a radial/linear system. In addition to enhancing resilience by designing a smarter and more distributed grid, there is also a great deal of focus in the industry on hardening the grid against potential disruptions, though there is a need for a balance between hardening and smartening. Utility planning and investments also need to better factor in both the acute and chronic impacts of climate change, as these assets will last decades. Furthermore, security is becoming another aspect of resilience, with cybersecurity of both critical infrastructure and the smart devices on the edge of the grid growing in importance. While there have been pockets of progress, and many actors have important roles to play, jurisdictional questions about who is and who ought to be in charge of cybersecurity are slowing action. There is also risk that grid vulnerabilities could steer the adoption of innovations in ways that favor incumbents and attempt to maintain the status quo.

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The proliferation of clean energy technologies has contributed to shallow decarbonization, but achieving deep decarbonization is much more difficult. The climate math is daunting, and the world is far, far off-track for limiting warming to 2°C. Most deep decarbonization studies suggest the need to optimize energy efficiency, decarbonize the electricity supply, electrify as many end-uses as possible, use zero-carbon fuels for the rest, and capture and sequester the residual carbon. There has been progress in energy efficiency, and tremendous potential remains, especially from integrative design options generally left out of decarbonization studies and forecasts because they are not new technologies. At the same time, zero-carbon generation's share of electricity is growing as renewable energy's costs continue to plummet. If electricity providers can decarbonize their electricity, then electrifying residential and industrial heating, transportation, refining, manufacturing, and other adjacent markets both decarbonizes and creates increased demand for clean electricity. Decarbonized electricity could likewise spur the manufacturing of zero-carbon fuels. Given that it is very hard to scrub carbon out of some sectors, most deep decarbonization models show a need for both CCS and carbon removal as well. Large scale carbon management will require carbon removal through engineered approaches (e.g., direct air capture), turning carbon into products of value (e.g., cement, chemicals, fuels, carbon fibers), commercial CCS deployment (e.g., for industrial processes), and natural carbon uptake (e.g., by forests and soils). Policies and procurement at the federal and state levels can help create markets and improve the economics for these carbon management technologies. More broadly, government policies need to treat climate change with the urgency it requires, keep as many options as possible on the table in light of the uncertainties about what the energy future will be, and support R&D and innovation in this space.

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