



Princeton Energy Dialogues

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Executive Summary

Prepared by:

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INTRODUCTION

The Andlinger Center for Energy and the Environment at Princeton University and Energy Dialogues LLC convened the Princeton City Series conference on February 18, 2020. The conference covered regional and global topics in the changing energy landscape: transitioning New Jersey and the broader PJM grid to a carbon-neutral electricity supply; achieving large scale carbon sequestration in the U.S. and internationally; and messaging in environmental communications including corporate environmental, social and governance (ESG) reporting.

The conference welcomed nearly 60 participants, led by Princeton faculty, senior research staff and visiting fellows who moderated panels and roundtable discussions. On hand were state government officials, energy investors, NGO representatives, and a diverse set of energy industry practitioners. The event included two panel discussions, one moderated by Professor Michael Celia, Director of the Princeton Environmental Institute, and one moderated by Professor Jesse Jenkins of the Andlinger Center. Professor Elke Weber, Associate Director of the Andlinger Center, gave a midday presentation, and three roundtable discussions engaged all attendees on the conference's key topics.

This report summarizes key points made throughout the day and gives voice to the rich diversity of perspectives shared in each of the conference's panels, presentations and roundtable discussions.

Panel discussion 1: Achieving a carbon-neutral electricity supply for NJ and PJM

The conference began with a panel discussion on the path toward a carbon-neutral electricity supply for New Jersey, as well as for the larger PJM Interconnection region. The panelists discussed four key topics:

- The need for both technology advances and supportive policies
- Changing requirements for transmission infrastructure
- Achieving balanced and efficient economic outcomes
- FERC's recent ruling on PJM's Minimum Offer Price Rule (MOPR) and its potential effects on the clean energy transition

As New Jersey works toward achieving its goal of fully decarbonizing its electricity supply by 2050, panelists noted that 80% of that goal can be met with well-understood approaches including replacing current gas generators with more efficient ones in the short term, and replacing gas units with renewables as their costs decline over the next two decades. Achieving the last 20% of electric sector decarbonization, however, will require technological advances.

Technology advances must be matched with appropriate government policy solutions to increase the renewable share in the PJM resource mix in a coordinated, cost-effective manner. Energy storage that can enhance both the economics and flexibility of intermittent wind and solar, for example, will require new and expanded policy support.

Increased outreach by PJM to state policy makers is needed to assure that PJM understands the magnitudes and time frames of state decarbonization goals, allowing PJM to provide advice and to develop tools needed to achieve those goals. PJM's transmission network currently has capacity to accommodate distributed resources and intermittent power production, but in a future where renewables make up more than half of the energy mix, significant redesign of operating procedures and resource planning will be needed.

New Jersey has recently set a goal of building 7.5 GW of offshore wind capacity, up from an earlier target of 3.5 GW. The new target would make the New Jersey coastal region a net exporter of electricity. As the resulting flow of electricity across the State begins to move from east to west, significant transmission upgrades will be required. New Jersey expects, however, that the economic development benefits of the new offshore wind industry, including manufacturing, transportation, installation and maintenance, will more than justify the costs of infrastructure.

Movement toward greater electrification of the overall energy system, which could double electricity demand by mid-century, will make the task of power sector decarbonization even more challenging. The uncertain pace of electrification, however, including the rate of electric vehicles adoption, led panelists to agree that flexible, sequential investments in transmission assets are advisable.

Balancing the pursuit of clean energy policies with the need to manage ratepayer impacts for consumers and businesses in New Jersey will be important to the transition, a task made especially challenging in New Jersey, which is viewed as a high tax state and a generally expensive business climate.

Panelists highlighted the importance of matching investors' needs with the risk-return profile of clean energy investments. Greater revenue certainty over two to four decades would spur investment, while less certainty will increase the cost of capital and result in higher costs to consumers.

Panelists supported a market-wide carbon price as a general incentive to advance the clean energy transition as well as a tool to point investments in the right direction.

The tradeoffs between lower electricity costs that can be obtained from large-scale renewable energy facilities versus the flexibility and grid-resilience benefits afforded by smaller, distributed sources were discussed. New Jersey has not established quantitative targets for the proportions of large-scale versus distributed solar energy production. It has, however, launched a community solar program to support projects up to 5 MW that are economical and enhance local grid resilience.

The Federal Energy Regulatory Commission's recent order, directing PJM to expand its minimum offer price rule (MOPR) to cover nearly all state-subsidized energy resources, was viewed as a potentially large setback for the transition to clean energy. It will cause subsidized, clean resources to have difficulty clearing the PJM capacity market, which is discouraging to potential investors. Despite the ruling, it is anticipated that states will continue to pursue their clean energy goals, and PJM is exploring ways in which it can continue to support them.

2 - Roundtable I: State action agendas to support the clean electricity transition

The first roundtable discussion covered energy technologies that need policy support from state governments to fully decarbonize the electricity supply. Four themes emerged:

- Creating policy incentives that target emerging needs in the clean energy transition
- Addressing concerns regarding reliability and resilience of a decarbonized electrical grid
- Aligning state policy goals within regional energy markets
- The resources that New Jersey can provide to facilitate the clean energy transition

New Jersey's efforts to increase the rate of adoption of rooftop solar panels and electric vehicles have been supported by state and federal subsidies, but additional efforts will be needed to scale the adoption of energy storage, vehicle charging stations and demand flexibility. To support storage deployment, for example, the PJM market currently provides only two-year contracts for storage capacity and does not accurately price the locational benefits of storage that relieves system congestion. In contrast, the New York Independent System Operator provides 5 to 10-year contracts and specifies preferred storage locations. Storage deployment can also be enhanced through time-of-use rates that provide financial benefits for shifting demand by a few hours. EVs will likely comprise a significant part of the light duty vehicle fleet within 10 years, requiring policy coordination between New Jersey and surrounding states to build EV charging stations and to use EVs as distributed energy resources.

Maintaining reliability and resilience in an energy system that is more broadly electrified and that integrates increasing variable renewable sources presents additional policy challenges. These challenges are especially pronounced in New Jersey, given the state's current reliance on nuclear energy for 40 percent of its electricity. Over the next 30 years, these plants will either need to operate beyond their original design lifetimes, be replaced by new nuclear facilities (which has proven costly in the United States over the past 40 years), be decommissioned, or be replaced by other zero-carbon sources. Additionally, electrifying transportation and indoor climate control may increase the state's vulnerability to threats to grid infrastructure ranging from natural disasters to cyberterrorism. Finally, policies that allow for demand flexibility will also be important to supporting electrification and increasing renewable energy generation.

Coordination of state-level clean energy goals with regional energy markets and federal regulations also presents challenges. The Federal Energy Regulatory Commission's Minimum Offer Price Rule (MOPR) order for PJM is an example. In its effort to level the playing field between fossil fueled and renewable generation sources in capacity market auctions, FERC diminished the effects of state incentives to support low-carbon generation. In reaction to the order, some states are considering leaving PJM in order to have more independence over energy policy, although the consensus view of participants is that this would be a costly strategy. Additional areas in which coordination would be valuable include developing a mechanism to invest in transmission and related infrastructure needed to integrate renewables and coordinating supply chains to support rapid growth of an off-shore wind industry along the U.S. East Coast.

New Jersey could support decarbonization efforts by detailing the state's low-carbon energy resource potential. This mapping could include geospatial data on the State's solar and wind potential, network congestion hotspots that could be alleviated by storage, waste resources that could be converted to biogas, and potential offshore locations for carbon sequestration. These data could be made public for the benefit of system planners and project developers.

3 - Presentation: Messaging and messengers for environmental issues

This presentation explored aspects of the global climate crisis that present challenges to making environmentally conscious decisions at the individual level. Communication strategies were outlined that aim to overcome these challenges, focusing on the realities of human behavior and decision making. The following ideas were emphasized:

- Human decision-making behavior is shaped by habit, social learning, norms and cognitive biases that influence judgments and rational chains of reasoning
- Both the content and delivery of climate action information matter
- Climate action needs to be seen as an economic growth opportunity as well as a risk-management effort

With respect to decision making, many people perceive the risks associated with climate change to be abstract and far in the future, while the cost of action - monetary or otherwise - is tangible, certain, and upfront. There is also a general preference for the status quo relative to change because it is viewed as the safer and more conservative than change. Climate change, however, demands immediate and decisive action, which runs counter to both of these tendencies.

Consumer decision-making is largely driven by feelings rather than rational assessments of costs and benefits. There is also a tendency to take the "path of least resistance", so proposed changes in behavior have to be made simple. These present further challenges to climate decision-making.

Regarding public policy development, people must feel genuinely influential in the policy-making process in order to cooperate with those policies.

With respect to communications, research has found that effective communication on issues of sustainability requires three dimensions beyond supplying relevant data. First, the messenger matters. A commitment to a sustainable future coming from the business sector has been measured to be more effective than the same message coming from an NGO. Second, trust matters. Messengers must demonstrate commitment to solving the problem through their personal behavior. Finally, perceived norms matter. People's tendencies to copy what others do or to compare their own actions to those of others are important levels when trying to influence large groups of people.

Metrics and labels associated with policies are also important. For example, a carbon tax is met with much more resistance than a carbon offset policy. Positive messaging is needed to transform the narrative around climate change so that it is not just perceived as a problem of risk management, but also as a growth opportunity.

4 - Roundtable II: Investor and public expectations for Environmental, Social and Governance (ESG) reporting

The second roundtable focused on relationships between companies, investors and the general public with respect to the environmental aspect of corporate Environmental, Social and Governance (ESG) reporting. Two key themes were discussed:

- The financial impacts of environmental decisions, and steps a company can take to gather both investor and broader public support
- Public misperceptions of environmental issues

With regard to financial impacts, discussions identified the reluctance of corporations to invest in environmental initiatives that do not have tangible financial benefits. There was consensus that while investors and corporations are beginning to feel pressure from the general public regarding environmental impacts – in a February 12th speech, BP CEO, Bernard Looney cited growing social pressure as a significant factor when announcing the company's target to become net carbon neutral by 2050 – financial performance will not be sacrificed for environmental credentials. Environment-driven initiatives need to be supported with either direct or indirect links to financial benefits, such as lower operating costs or positive publicity. There was recognition, however, that philanthropy with a clear goal can add value, exemplified by the pharmaceutical industry's development of malaria vaccinations in developing nations.

There was broad agreement among participants that garnering investor support is more successful when clear long-term plans are provided that outline how benefits and cost savings from initial investments will be used to offset the cost of future initiatives. Specialized firms can aid in the production of these plans, and small, low-risk initial investments can lead to comfort with larger, riskier future projects.

The cost burdens of reducing a company's carbon footprint can also fall on consumers in terms of higher prices. There was agreement that it is crucial to quantify costs passed onto the consumer in a manner that is transparent, educational and appealing, but participants had difficulty concluding on the best methods for doing so. One example discussed was pricing carbon offset credits for products and services. Blanket increases in prices or an opt-out model would provide predictable revenue streams to companies and allow firms to be more ambitious with the scope of their environmental initiatives. Such practices, however, may attract consumer backlash and place an unfair burden of cost on some consumers. The Good Traveler website that calculates CO₂ emissions for given flights and encourages visitors to purchase carbon offsets equivalent to these emissions, serves as a good model for transparency.

Another communications challenge is the disconnect between the public's superficial views on environmental issues and the complexity of the underlying reality. Positive environmental attributes are often associated with EVs, organic food, and sustainably-sourced clothing. Few consumers, however, will research the carbon footprint of the energy source for their EV or the definition of what constitutes organic produce. Participants pointed to the importance of impartial third-parties in providing education and information, whether state or national regulatory bodies or non-profit organizations. For energy markets, transparency with respect to the energy source characteristics, ideally provided by a

public body, would be pivotal in gaining consumer trust and encouraging environmentally-conscious decisions.

5 - Panel discussion II: Achieving large-scale carbon sequestration in the U.S. and internationally

Carbon Capture and Storage (CCS) technology has been available for two decades, but no large-scale industry has developed. Panelists endorsed the idea that CCS could, however, play a large part in moving the global economy towards carbon-neutrality. The following four themes emerged:

- The cost of capture must be lowered, and subsurface understanding improved to boost CCS implementation
- Implementation differences exist between developed and developing countries
- There is a first mover disadvantage in large-scale commercialization of CCS
- The U.S. government can support CCS by realigning incentives

Reflecting on the current status of CCS and the associated technology, the panelists noted several challenges and barriers that must be overcome. First, the cost of capture must be reduced. Amine stripping is an available and proven method of capture, but it is very expensive, calling for alternative strategies. Second, confidence in long-term CO₂ storage security in the subsurface must be established. Third, extensive subsurface characterization is needed in developing economies.

In the U.S. sources of captured CO₂ are likely to be natural gas power plants and the cement and steel manufacturing industries, while coal will be less important as its use declines in the power sector. For developing economies, including China and India, coal would be a larger source. Panelists noted that 70% of CO₂ emissions associated with coal, cement and steel come from the developing world, where little is known about the subsurface.

Uncertainties about the future of the U.S. CCS industry create first mover disadvantages. Oil and gas companies are well suited to take the lead in CCS, given that the required field technologies are almost identical to gas and oil exploration and production. The fact that the number of companies engaged in CO₂-enhanced oil recovery has dropped in the last 20 years, however, raises concern that it might be difficult for many companies to maintain capabilities in this area. A further impediment to commercial development is the lack of legal precedent regarding the liabilities involved with monitoring long-term storage security. Too few large-scale projects have gone through full life cycles to set those precedents.

Panelists highlighted the crucial importance of supportive government policy to large-scale CCS implementation, policy made challenging by the dynamics of state politics. It is a necessary, but not sufficient, condition that there are material financial incentives to store CO₂ rather than release it. The 45Q CO₂ tax credits must be extended and expanded, and clean energy standards should incorporate CCS. Governments can also assist CCS development by providing the required pipeline infrastructure. Being able to tie into an existing pipeline infrastructure may mitigate some of the first mover disadvantages.

6 - Roundtable III: Near-term action steps to advance CCS

The third roundtable session extended discussion on the challenges to increasing CCS' contribution to decarbonization. Participants focused on challenges associated with siting and permitting of storage and transport activities, and the more general question of what can be done by different industry sectors to advance the adoption of CCS. Three major points emerged:

- A stable investment environment is needed to instill confidence in CCS investors
- Most people are less familiar with CCS than with other decarbonization technologies
- Regional differences are important considerations in CCS

The need for a stable investment environment was noted throughout the discussions. CCS investors need confidence that there will be a sufficient price on CO₂ emissions sustained over the long term, even in the face of future price competition from new renewables. The design of financial incentives must not bias the market to favor CCS for specific CO₂-emitting sectors. Investors also need confidence in mechanisms for allocating liabilities for the long-term security of underground storage across multiple parties and over time. Potential shifts in the composition of the energy sector (e.g. competition that may develop from hydrogen as a fuel) is another source of investment uncertainty to be considered.

Outside the relatively small number of research and industry experts, far less is known about CCS than about alternative decarbonization technologies. It will be important to build comprehensive awareness on the parts of CO₂ emitters, other stakeholders in the CCS development process, regulators in states with less experience in subsurface oil and gas activities, and the general public. Developing a more cross-sectoral distribution of demonstration projects would help build confidence in CCS outside the oil and gas industry.

Echoing discussions by the panel members, participants identified that it is crucial to invest adequately in upfront geological modelling and site selection, especially since subsurface storage capacity varies substantially across the U.S. and globally. In the U.S. carbon storage opportunities may exist in the north-eastern US, but that region has not been adequately characterized. In contrast, Texas has better understood storage opportunities along with an amenable regulatory environment. Globally, questions remain about the likelihood that CCS will be adopted at scale in India and China. Well informed decisions in the early stages of the CCS industry will lower subsequent investment risk and reduce the challenges of long-term monitoring of the underground environment. Governments could play an important role, by sponsoring site characterization assessments.

Princeton Energy Dialogues Speakers and Panelists

1st Panel Discussion

Achieving a Carbon-Neutral Electric Supply for New Jersey and PJM

Moderator:

- Jesse Jenkins, Assistant Professor of Mechanical Engineering and Andlinger Center for Energy and the Environment, Princeton University

Panelists:

- Robert Gordon, Commissioner, New Jersey Board of Public Utilities
- Scott Jennings, Senior Vice President – Corporate Planning, Strategy and Utility Finance, PSEG
- Suzanne Glatz, Director, Infrastructure Planning, PJM Interconnection

Presentation

Messaging and Messengers for Environmental Issues

Speaker:

- Elke Weber, Associate Director for Education, Andlinger Center for Energy and the Environment; Gerhard R. Andlinger Professor in Energy and the Environment; Professor of Psychology and Public Affairs, Woodrow Wilson School of Public and International Affairs, Princeton University

2nd Panel Discussion

Achieving Large Scale Carbon Sequestration in the U.S. and Internationally

Moderator:

- Michael Celia, Director, Princeton Environmental Institute and Professor of Environmental Studies, Theodora Shelton Pitney Professor of Environmental Studies, Professor of Civil and Environmental Engineering

Panelists:

- Ryan Edwards, Low Carbon Policy Advisor, Oxy
- Gary Teletzke, Senior Reservoir Engineering Advisor, ExxonMobil
- Rebecca Fitz, Senior Director, Center for Energy Impact, Boston Consulting Group
- Chris Greig, Gerhard R. Andlinger Visiting Fellow in Energy and the Environment, Andlinger Center for Energy and the Environment, Princeton University

- 8:30am – 9:00am** **Coffee and Registration**
- 9:00am – 9:10am** **Welcome Remarks from Energy Dialogues LLC**
Monika Simoes, Founder & Managing Director, **Energy Dialogues LLC**
- 9:10am – 9:20am** **Princeton Welcome Remarks**
Barry Rand, Associate Director for External Partnerships, Andlinger Center for Energy and the Environment; Associate Professor of Electrical Engineering and the Andlinger Center for Energy and the Environment, **Princeton University**
- 9:20am – 10:00am** **1st Panel Discussion**
ACHIEVING A CARBON-NEUTRAL ELECTRIC SUPPLY FOR NEW JERSEY AND PJM
- What two or three things need to happen in next 5 years to put New Jersey on a path to achieve its 2050 carbon-neutral electricity supply objective? What additional / different things need to happen to put PJM as a whole on a similar path?
 - What one or two long-term developments will be essential to assuring that success, especially in light of increasing power demands from EVs and building electrification?
 - How will the near-term importance of natural gas in New Jersey’s and PJM’s power supply evolve into long-term carbon neutrality? What is the biggest challenge to moving along that path?
 - What regional processes or efforts can support state objectives?
- Moderator: **Jesse Jenkins**, Assistant Professor of Mechanical Engineering and Andlinger Center for Energy and the Environment, **Princeton University**
Panelists: **Robert Gordon**, Commissioner, **New Jersey Board of Public Utilities**
Scott Jennings, Senior Vice President – Corporate Planning, Strategy and Utility Finance, **PSEG**
Suzanne Glatz, Director, Infrastructure Planning, **PJM Interconnection**
- 10:00am – 11:00am** **1st Roundtable Working Session**
STATE ACTION AGENDAS TO SUPPORT THE CLEAN ELECTRICITY TRANSITION
- What technologies most need state government support to ramp up their contributions to a carbon-neutral electric supply? What are the most effective mechanisms for delivering that support?
 - How are EV penetration and building electrification likely to ramp up, and what strategies will help assure that the distribution, transmission and bulk power generation systems can accommodate the additional demand?
 - What approaches might states take to maintain support for clean electricity in reaction to the FERC PJM MOPR order, and what are the implications of those approaches?

11:00am – 11:20am Coffee Break

11:20am – 11:45am MESSAGING AND MESSENGERS FOR ENVIRONMENTAL ISSUES

Speaker: **Elke Weber**, Associate Director for Education, Andlinger Center for Energy and the Environment; Gerhard R. Andlinger Professor in Energy and the Environment; Professor of Psychology and Public Affairs, Woodrow Wilson School of Public and International Affairs, **Princeton University**

11:45am – 12:45pm 2nd Roundtable Working Session

INVESTOR AND PUBLIC EXPECTATIONS FOR ENVIRONMENTAL, SOCIAL AND GOVERNANCE EFFORTS

- What are investors looking for today from energy industry companies in the environmental dimension of ESG? What actions, messages and messengers are most effective in gaining investor as well as broader public support?
- Are investor requirements and public expectations changing, and how can energy companies respond?

12:45pm – 2:00pm Lunch Reception

2:00pm - 2:40pm 2nd Panel Discussion

ACHIEVING LARGE SCALE CARBON SEQUESTRATION IN THE U.S. AND INTERNATIONALLY

- What two or three things need to happen in the next 10 years to allow CCS to contribute significantly to U.S. decarbonization? What additional / different things need to happen in other parts of the world?
- What CO₂ sources will be the primary short-term and ong-term “users” of available carbon sequestration capacity (e.g. industrial sources, power generation, direct air capture, BECCS)?
- What can be learned from the history of CCS to date to help assure success in the future?

Moderator: **Michael Celia**, Director, Princeton Environmental Institute and Professor of Environmental Studies; Theodora Shelton Pitney Professor of Environmental Studies; Professor of Civil and Environmental Engineering, **Princeton University**

Panelists: **Ryan Edwards**, Low Carbon Policy Advisor, **Oxy**

Gary Teletzke, Senior Reservoir Engineering Advisor, **ExxonMobil**

Rebecca Fitz, Senior Director, Center for Energy Impact, **Boston Consulting Group**

Chris Greig, Gerhard R. Andlinger Visiting Fellow in Energy and the Environment, Andlinger Center for Energy and the Environment, **Princeton University**

- 2:40pm - 3:20pm** **3rd Roundtable Working Session**
NEAR-TERM ACTION STEPS TO ADVANCE CCUS
- What siting and permitting challenges will drilling injection wells and building CO₂ gathering pipelines present, and how can those be managed?
 - What steps can each industry sector take to advance progress on CCS / CCUS?
- 3:20pm - 4:00pm** **Roundtable Report Out**
WRAP-UP SESSION – ACTION ITEM REVIEW
- Considering the day’s discussions, what are the key action items for your sector?
 - Table report out
- 4:00pm - 5:00pm** **CLOSING RECEPTION**