

FACTS

French Ameri-Can Climate Talks



CONFRONTING CLIMATE CHANGE: POLICIES AND OPPORTUNITIES Conference Summary and Comment

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“Confronting Climate Change: Policies and Opportunities”

On October 22, 2015, the Center for Energy Studies (CES) at Rice University's Baker Institute for Public Policy and the Consulate General of France in Houston hosted the conference "Confronting Climate Change: Policies and Opportunities." The event was included as part of FACTS (French Ameri-Can Climate Talks), a series of public conferences in 12 cities across the United States and Canada involving academics, government officials, NGOs, political figures, journalists, and entrepreneurs. The timing and subject matter were designed to contribute to civic dialogue as the world prepared for the United Nations Climate Change Conference in Paris in December 2015.

This summary begins by sharing the perspectives of the conference panelists, which do not necessarily reflect the views of the researchers at the CES or representatives of the French Consulate. The purpose of this document is to capture the discourse at the conference. Afterwards, insights by CES researchers regarding the state of climate change policy are offered.

The conference began with introductory remarks by Regina M. Buono, Baker Botts Fellow in Energy and Environmental Regulatory Affairs at the Baker Institute's CES, and Sujiro Seam, Consul General of France in Houston. Buono and Seam stressed the importance of the topic and the need to facilitate dialogue and communication between experts and country leaders.

I. Climate Change, Regulation, and the Role of Government

Presentations

The first panel featured an array of current and former government officials with expertise in climate change policy, diplomatic negotiations, and related areas. Panelists were:

- Frédéric Bontems, director for development and global public goods at the Ministry of Foreign Affairs and International Development in France;
- Megan Ceronsky, senior policy advisor in the White House Office of Energy and Climate Change Policy; and
- Margo Oge, former director of the Office of Transportation and Air Quality at the U.S. Environmental Protection Agency (EPA).

Suzanne Beaudette Murray, a partner in the law firm of Haynes & Boone and former regional counsel for Region 6 of the EPA, moderated the panel.

Presentation: Frédéric Bontems

Frédéric Bontems began the session by providing an overview of preparations for the 2015 Paris Climate Conference (COP21) and discussing energy transition policy in France. Bontems articulated that the goal of the country participants at COP21 was the creation of an ambitious and legally binding agreement, applicable to all parties, to take measures to keep the average global increase in temperature below +2°C. He discussed four pillars to the negotiation process: the agreement, the national contributions, the financing, and the solution agenda.

Beginning with the first pillar, Bontems argued that the Paris meeting was the last opportunity for the international community to adopt a new agreement. He explained that the Kyoto Protocol in 1997 was very limited, as it addressed less than 20% of current global greenhouse gas (GHG) emissions, and he argued that it will be difficult to achieve significant results with such a narrow basis. The Copenhagen meeting (COP15) in 2009 also failed to include a wider range of participants. Bontems expressed confidence that, after four years of complex negotiations, the participants would reach an agreement at COP21.

Acting on the second pillar, the COP21 participating countries were asked to submit their contribution plans—the so-called Intended Nationally Determined Contributions (INDCs)—to address climate change through mitigation and adaptation measures. At the time of the conference at the Baker Institute, 149 countries had submitted their contributions, representing 87% of the planet's total CO₂ emissions. Bontems indicated that the total INDCs were expected to cover over 95% of global emissions and that assessment of each country's contribution was in progress. He stated that, according to a third party's preliminary studies, global temperatures could rise by around 3°C even if all the INDC were fully implemented. While this falls short of the target for COP21, it is a much better than the “business-as-usual” scenario, which is in the +5°C degree range. Bontems warned that Earth would still be at risk in a +3°C scenario, so future actions that build on the INDCs will be needed. Thus he argued that, as global warming becomes more visible in the future, a review mechanism in the agreements is needed to allow the parties to modify their contributions periodically to extend their commitments. To do so, it is necessary to reach a longer-term vision extending beyond 2050, perhaps even to 2100, and to adopt a “not-going-back” agreement in which countries may not lower their obligations.

The third and fourth pillars of financing and solution agenda were addressed next. Developed countries have agreed on the mobilization of \$100 billion to assist developing countries in addressing climate change. Bontems argued that such an investment is necessary to move towards a low-carbon economy in the private sector. It is also a critical aspect of the negotiations for both developed and developing countries, particularly as the former builds confidence with the latter to reach a global agreement. Bontems stated that the objective of the Paris conference is to register the commitments from all parties to contribute towards a global objective. More than 4,000 commitments had been registered at the date of the conference. Importantly, Bontems emphasized that COP21 would not be the end of the process; rather, it is a milestone at a decisive moment. A long diplomatic process is expected after COP21 to control CO₂ emissions progressively with appropriate tools under a global framework. Bontems believes that, eventually, the world can act sufficiently to keep global the temperature increase under 2°C.

Bontems concluded his remarks by discussing France's new energy transition policy, the “Energy Transition for Green Growth Act,” which passed in July 2015. He noted that goals include a 40% reduction in GHG emissions by 2030 relative to 1990, a 30% reduction in fossil fuel consumption by 2030 relative to 2012, and an increase in renewable energy generation so that it reaches 40% of electricity generation by 2030. Bontems described some of the policy initiatives in France, including regulations authorizing tax credits and

other incentives for the building sector to transition existing properties to low energy buildings by 2050. Another initiative seeks to turn all vehicles into low-emission vehicles, which was argued to boost GDP and create job opportunities.

Presentation: Megan Ceronsky

The second panelist to address the conference was Megan Ceronsky, senior policy advisor in the White House Office of Energy and Climate Change Policy. Ceronsky began by noting the Obama administration's determination to fight climate change and simultaneously provide affordable, reliable energy to facilitate a growing economy. The administration announced the Climate Action Plan, in which the U.S. will reduce GHG emissions through administrative actions. Ceronsky discussed the structure of the Clean Power Plan (CPP) and available options for state compliance suggested by the EPA as the core of the United States' plan.

The Clean Power Plan, which imposes new carbon pollution standards for existing power plants, is the centerpiece of President Obama's climate action plan. The plan is built under the Clean Air Act, which requires the EPA to address air pollution that has been deemed an endangerment. The power generation sector is the largest source of GHG emissions in the United States. Ceronsky noted that emission standards applicable to the power generation sector have been in place for some time—well before the CPP—but previously targeted pollutants other than GHGs.

Ceronsky also explained the process that EPA used to determine the most effective options to reduce GHG emissions from the power sector. The EPA examined the current situation with the intent of determining the most reasonable and viable emissions standards, or standards of performance, for GHG emissions from existing sources. She noted that within the U.S. there is a potential for a unified electric grid that interlinks generation resources and demands in the three existing large infrastructure regions: the Eastern interconnect, the Western interconnect, and Texas. A unified grid could balance supply and demand at any moment by, for instance, taking advantage of differences in time of peak load requirements and dispatch availability. EPA looked at the potential of the three grids to (1) shift generation from existing coal to existing natural gas, (2) shift generation from existing coal and gas to new renewable deployment, and (3) improve the efficiency of existing coal plants. Based on these three building blocks, EPA set a uniform emission rate for coal and gas plants and applied that rate across the country to determine the performance targets.

Ceronsky stated that the EPA is dedicated to maximizing the flexibility of states to meet the targets under the CPP. Along with an increase in the deployment of cleaner sources of generation, states can reduce supply from higher-emitting generation, and thus reduce overall carbon pollution levels while providing the same amount of electricity. States can also, through demand-side approaches, improve end-use energy efficiency and reach the same outcome altogether. Ceronsky argued that such policies have, to varying degrees, been implemented successfully by different states through either climate-related programs or development of greener economies, and noted in doing so that there are 50 states with demand-side energy efficiency programs and 37 states with renewable energy standards.

Ceronsky introduced four compliance options available for states under the CPP:

- (1) the standard rate plan,
- (2) the blended rate plan,
- (3) the mass-based and trading plan, and
- (4) the state-measures plan.

The first option, the standard rate plan, sets national standards for pounds of CO₂ per MWh for coal plants and natural gas plants, which are applied to each state. For the emission rate on the compliance side, states earn credits for renewable energy, a coal-to-gas shift, use of combined heat and power, demand-side energy efficiency, and other measures that reduce GHG emissions. States can thus meet the compliance rate with the actual emissions plus the compliance credits.

The second option, the blended rate, is calculated from each state's fleet of coal and gas plants as of 2015. Using this approach, Ceronsky explained, the same emission rate is applied to all coal and gas plants.

The third option converts the emission rate into tons of CO₂ and allows each state to comply based on a mass-based compliance structure. Mass-based emissions reduction through trading has historically been very successful, including cases such as NO_x and acid-rain trading programs. Trading gives flexibility to states regarding the physical location where the emissions are reduced and allows states and regulated sources to reach the targeted environmental results more cost effectively.

The fourth option is a traditional review-and-adjust (state measures) plan.

The states are required to specify each planned change regarding generation sources and expected emission reductions by 2030. States are looking at options and forming compliance plans, which must be submitted by September 2016. Ceronsky emphasized that EPA has set the structures in conjunction with a trading framework, which allows significant flexibility to engage with other states with the aim of allowing the environmental results to be achieved more coherently, rationally, and efficiently. The climate action plan and the CPP are the foundation of the administration's commitment to reduce GHG emissions as part of U.S. efforts on the international level.

Presentation: Margo T. Oge

Margo T. Oge, former director of the EPA's Office of Transportation and Air Quality, offered an example of a successful emissions reduction program regarding automobiles and described four trends that she believes will reduce carbon emissions in the transportation sector. Oge began with the history of addressing pollution in the U.S. In the 1960s, American cities were heavily polluted. Under the Nixon administration, the EPA and some "strong and smart" environmental laws, such as the Clean Air Act, were established. The first action taken under the Clean Air Act was to require new cars in the mid-1970s to reduce nitrogen oxide and hydrocarbon emissions by 95%. While manufacturers initially

doubted the viability of the target, the goal was achieved in 1975. Catalytic converters and electronic systems played an important role in terms of emissions control systems and prevented millions of premature deaths. Cars today are 99% cleaner than before the regulation. Oge used this example to argue that economic growth, innovation, and environmental benefits can all be achieved at the same time.

Oge argued that dialogues are necessary for EPA to craft smart policies. A number of regulatory programs regarding emissions in the transportation sector were accomplished through a collaborative effort under Oge's leadership. The first action of industry had always been refusal or arguing impossibility, yet history has shown that the regulations and standards are achievable with innovation. She noted that society has been hearing about climate change for decades but only now has the Obama administration begun to act. She identified two reasons for the delay in the actions on climate change: (1) doubts about the science, and (2) fear that taking action will compromise economic growth.

In 2009, the Obama administration was determined to improve fuel efficiency and at the same time reduce GHG emissions from cars, an objective supported by a 2007 U.S. Supreme Court decision that held that GHG emissions are pollutants and should be regulated under the Clean Air Act. A petition to the EPA in 1999 on regulating air pollutants other than NO_x (those identified as GHGs), was initially refused, but the petition eventually landed at the U.S. Supreme Court. In 2007, the Court ruled that the EPA has the responsibility to regulate GHG emissions as pollutants under the Clean Air Act, unless a determination is made that GHG emissions do not endanger public health and the environment. The Obama administration started acting. The state of California, the EPA, and the U.S. Department of Transportation worked together under Obama's order to develop a national program addressing both GHG emissions and fuel economy. Car companies supported the regulations with investment commitments. The expected results include a 54.5% increase in fuel economy by 2025, which was estimated to provide a \$1.7 trillion in economic benefit and increased consumer savings. It was also estimated that this would lead to an emissions reduction of about 2 billion metric tons of CO₂.

Oge argued that this program will play a vital role in the United States' commitment to COP21. Transportation accounts for 30% of GHG emissions in the U.S., second only to the power generation sector. Oge argued that the automotive industry is currently thriving and ahead of the game in terms of emission standards, but the measures are insufficient given what is needed. At the current rate of fuel efficiency improvement, a goal of zero-emitting vehicles with 180 mpg cannot be reached by 2050, so longer-term standards that look beyond 2025 are required.

Oge offered four trends that she believes will shape future mobility. First is the convergence of efforts to regulate the transportation sector in major markets worldwide. Vehicles today are manufactured under certain requirements for fuel economy and emissions standards, which are converging as incentives for cleaner vehicles are provided.

The second trend is the growth of megacities and the urban environment and the consequent growth in regulation in these areas. Seventy percent of GHG emissions are produced in these two areas, which account for only half the world's population and about 2% of land use. Growing cities have contributed greatly to poor air quality and traffic congestion in urban areas, thus negatively affecting productivity. Regulatory measures have been used to mitigate these problems. For example, the cost of obtaining a driving permit in Singapore will double the cost of purchasing a vehicle, which discourages additional vehicle purchases and, as a result, deters emissions from vehicles.

The third trend is “connected living and working.” Oge argued that the younger generation is delaying driving and prefers other ways to “connect and socialize working and living,” such as walking, biking, car-sharing, and working from home with the Internet. This in turn reduces both congestion in cities and GHG emissions. Oge also noted advancements in technology that are improving this space. For example, autonomous cars are becoming a reality, which will decrease accidents and reduce fuel consumption and GHG emissions.

The final trend is on-demand and shared transportation services. Oge presented a vision of the future in which electric, smart, and shared cars will result in great mobility and environmental improvement. She concluded her presentation by citing a Chinese proverb regarding danger and opportunity, which she believes describes the current situation of climate change. In particular, she expressed, we are faced with an incredible challenge that also presents an enormous opportunity for innovative thinking to address what lies before us.

Q&A

Following the panel, the audience asked a number of questions about the role of nuclear energy going forward, the future of the freight transportation business, and the role of the private sector in combating climate change.

Q&A: The Role of Nuclear Power

Addressing the future of nuclear energy, Bontems stated that nuclear generation still has a very important role to play in France as it accounts for 80% of power generation. However, France has decided to cap its nuclear generation at the current level of 62GW, meaning the share of nuclear in the future energy mix for power generation will decrease to 50% concomitant with an increase in generation from renewables to meet new demands. France will keep the nuclear capacity at current level by retiring existing units and adding new reactors with advanced technology (EPR).

Ceronsky noted that nuclear energy is a major source of electricity in the U.S., as well as the majority of zero-emitting generation. The current electricity market lacks the internalization for emissions costs. The CPP's requirement to reduce the emissions of both CO₂ and co-pollutants that are emitted by gas and coal plants will internalize these costs. Therefore, the relative economics and competitiveness of nuclear plants can be improved under the CPP. The five nuclear plants under construction in Tennessee, South Carolina, and Georgia are expected to serve an important role in those states' compliance plans.

Oge raised the issue that the inability to transport and dispose of nuclear waste from commercial use will increase the liability and uncertainty for nuclear power generation. As a result, nuclear still faces significant uncertainty.

Q&A: The Future of Freight Transportation

Regarding the future of the freight transportation business, Oge asserted that diesel—specifically “clean diesel”—will have an important role, as will LNG. She argued it will be more cost-effective for the industry to convert to LNG in marine freight transportation, particularly given the need to reduce the bunker fuel consumption. Moreover, land-based freight transport is also moving toward LNG, in long-haul trucking for instance, which will have bearing on CO₂ emissions in the transport sector. Finally, the electric powered train is another possibility for long distance freight transport.

Q&A: Private Sector Innovation

In response to a question about the contributions of private sector innovation to action on climate change, Bontems argued that his fourth pillar—the solution agenda—is intended to connect the private sector to the scientific community in order to design solutions for long-term energy consumption. He cited the “Global Compact,” where international companies have committed to developing new solutions to use higher efficiency to reduce energy consumption and emissions.

Ceronsky added that the market and innovation are our greatest hopes to mitigate GHG emissions. Funding core R&D and market-based signals for carbon reduction are necessary to incentivize efforts. She noted that the CPP recognizes demand-side energy efficiency and has an open compliance option to reduce carbon emissions.

II. Opportunities and Challenges for the Electric Energy Industry

Presentations

The second panel featured representatives of the electric energy industry addressing questions about how companies are positioning themselves regarding climate change.

Panelists were:

- Mark Anderson, senior vice president of public affairs for EDF (Électricité de France) Inc., a French energy company;
- Eric Bradley, senior vice president of strategy for ENGIE (previously known as GDF Suez) in North America; and
- John Caldwell, director of economics at the Edison Electric Institute.

Michael D. Maher, senior program advisor at the Baker Institute’s CES, moderated the panel.

Presentation: Mark Anderson

Mark Anderson provided an overview of EDF as a low-carbon independent power producer. He also described the company's efforts in preparation for COP21, and discussed key drivers for decarbonization. In particular, he argued that there are five critical drivers of decarbonization:

- (1) technological innovation,
- (2) customer demand,
- (3) market forces,
- (4) regulation and policy, and
- (5) the evolving role of the utility.

With regard to technological innovation, Anderson highlighted its impact on greater natural gas supply, as well as its facilitation of growth in distributed generation and behind-the-meter technologies. All have greatly impacted the electric power industry and challenged pre-existing paradigms. The abundance of natural gas in Texas, for example, has impacted the wholesale power price, given the state's economy a competitive advantage, and heavily impacted the generation mix as natural gas has steadily displaced coal. Growth in distributed generation options, such as solar and wind, have been driving the electric power industry away from a centralized utility model.

Customer demands have also been changing, as Anderson noted that two-thirds of customers are demonstrating interest in sustainability with an increasing desire for both energy services and a choice regarding the source of their electricity supply. He argued that as a utility business, EDF needs to respond to these new demands, as do all utilities.

It is also important to recognize and understand the market forces at play in driving us forward to a lower carbon future. Anderson identified low electricity demand growth and low natural gas prices as factors that are decreasing wholesale power prices. This presents both challenges and opportunities, as it puts certain baseload generation assets at risk as utilities face stiffer competition from cheaper electricity from natural gas plants and increasing renewable generation across the country.

A shifting landscape in policy and regulation are also driving decarbonization, particularly as state renewable portfolio standards and various federal tax and subsidy policies are encouraging deployment of renewables.

The evolving role of the utility, according to Anderson, is also vital to a lower carbon generation sector. Utilities are shifting from being a centralized generator on a power distribution network to being a system integrator that provides power when renewables may not be available. States such as California and New York are addressing the evolving role of their utility business models through regulatory proceedings.

Anderson also provided an overview of EDF and its vision, emphasizing that EDF is very forward-looking, as evidenced by its approach to executing long-term investment

decisions. He noted that EDF advocates heavily for the Clean Power Plan, hoping it will support and recognize the value of zero-carbon generation from the company's nuclear fleet. Twenty percent of U.S. power generation comes from nuclear power, displacing over 595 million metric tons of CO₂. A number of nuclear plants have announced retirement, and as those plants retire upwards of 90 GW of baseload generation capacity will need to be replaced with natural gas-fired power plants. This will present challenges for states striving to meet compliance under the CPP. As such, the EPA and other environmental authorities have made clear that it is critical in the near term that the U.S. maintains its nuclear fleet to reach the carbon reduction goals from the CPP.

Anderson also described the climate actions taken by EDF. First, EDF applauds U.S. INDC leadership in committing to 26-28% reduction in carbon emissions relative to 2005 levels by 2025, a goal that the company believes is "fair and ambitious." He observed that reductions in the power sector constitute 36% of the United States' INDC goals for COP21. EDF supports the Clean Power Plan, as it should accelerate the market's existing movements, including the move from coal to natural gas and the expansion of renewables. Anderson emphasized that EDF is an advocate for a price on carbon for three reasons: (1) it encourages correct long-term investment decisions; (2) it provides an immediate impact on operations; and (3) it allows humankind to address the climate emergency. Today, a carbon price of \$7 per ton is not sufficient to incentivize the proper wholesale power prices for investment decisions, whereas \$35 per ton is the social cost of carbon calculated for the CPP. Since most U.S. corporations already include a price on carbon in their long-term forecasting and planning, a carbon price would be a relatively simple way to regulate carbon emissions.

Anderson also argued that the power industry is on the right path to a lower carbon future as the sector has reduced CO₂ emission by 17% since 2005. He then introduced EDF's Cap 2030 goals, which are:

- (1) Move closer to customers to improve consumption efficiency;
- (2) Deliver reliable, affordable and sustainable power as an integrator of strong electric systems within the connected homes;
- (3) Increase renewable generation from 25 to 50 GW by 2030; and
- (4) Drive international presence and bring low carbon solutions to partners overseas.

Anderson observed that the private sector in the U.S. is engaging to act on climate change. In October 2015, 81 companies, including major players in the power sector, signed the American Business Act on Climate Pledge. This was part of COP21 and covers \$5 trillion of market capitalization plus 9 million employees. The climate pledges cover energy procurement and energy efficiency. Similarly, several agricultural companies have made pledges to act on climate change. Anderson added that nine large U.S. companies have pledged to transition to 100% renewable power, including a partnership of EDF RE and Proctor & Gamble.

Anderson concluded by noting that driving down costs of low carbon options through technological innovation is critical, and highlighted that achieving the goal of lower carbon emissions is impossible without the participation of the power sector.

Presentation: Eric Bradley

Eric Bradley, senior vice president of strategy for ENGIE in North America, provided an overview of his company, the energy transition, the drivers of the North American market, and ENGIE's strategy going forward.

ENGIE is the world's largest independent power producer with 115 GW of installed capacity. While ENGIE does not have nuclear capacity, its capacity is carbon light, with only 13% being coal-fired. Bradley claimed that ENGIE is well positioned for the energy transition in North America with its natural gas business, renewables capacity, and hydroelectric facilities. The company is confident it will be able to contribute to reaching the stated CPP targets.

Bradley identified three powerful forces shaping the market in North America:

- (1) shale gas,
- (2) energy policy, and
- (3) disruptive technology and digitalization.

Regarding shale gas, Bradley is bullish, arguing that shale development is driving the shift towards lower carbon generation. The decline in coal-based generation is primarily due to decreasing natural gas prices since 2008. In fact, carbon-dioxide emissions from the U.S. power sector hit a 27-year low in April 2015 as a result of the coal-to-gas shift in power generation that has transpired as a result of low natural gas price. However, as the U.S. reduced its coal consumption, its coal exports rose, with some being exported to Germany, which in turn saw its CO₂ emissions increase. Bradley compared the dispatch costs for a gas plant and a coal plant in Texas. If EPA's shadow price of \$30 per ton carbon is included, natural gas can easily compete with coal, particularly because a coal-fired power plant emits 2.5 times more CO₂ than a natural gas combined cycle power plant.

In terms of energy policy, Bradley believes that opportunity for renewables could be significant under the CPP. In ENGIE's analysis of the impact of the CPP on coal retirements and new renewables in each state without trading, renewables will replace 250 GW of the U.S. generation fleet. Coal retirements are projected to reach 104 GW by 2030, approximately one-third of total coal capacity in the country. However, if states implement the trading program, the number of coal retirements may be lower. Bradley stated that forecasts from various investment banks expect new renewable capacity to be in a range of 160 GW to 270 GW.

Bradley also elaborated on the role of disruptive technology and digitalization. In particular, he expects that significant and continuing advancements in technology will bring a surprise for the industry in the next five years and that digitalization will drive

changes ahead of regulations and industry actions. Bradley provided several examples of technology innovations. New machinery has allowed utility-scale solar to reach over 62% thermal efficiency. Moderately higher gas prices plus a reasonable cost for carbon should make solar a competitive source of energy for the periods it operates. Various forecasts project the utility-scale cost parity for solar without subsidies by 2030. Bradley argued that carbon pricing needs to be \$30 per ton by 2017 and decline to \$15/ton by 2020 to allow utility-scale solar to stay economically competitive without subsidies. ENGIE believes that utility scale solar is likely to be in play for the Southwest and Texas in next decade. Bradley emphasized that it is important that both CCGT and utility-scale solar compete with coal.

Bradley argued that new lighting and efficiency technology can have a significant impact on energy consumption. He noted that with federal lighting standards driving out incandescent bulbs, LED lighting is quickly gaining traction. Lighting represents approximately 20% of U.S. electricity use. Bradley reported that studies show that full LED lighting penetration can cut energy consumption for lighting by 50% through 2030.

Bradley stated that ENGIE is able to provide customers with packaged solutions of energy efficiency with distributed solar at low costs. He indicated that new business models incorporate non-intrusive load monitoring and analysis with innovative financing. Bradley pointed out that the deployment of simple steps—ranging from installing LED lighting, insulation, and HVAC to residential solar PV—can help customers reduce their load requirements from the grid and increase their cost savings.

Bradley described ENGIE's recent commitments on decarbonization, including a corporate-wide 10% reduction in CO₂ emissions relative to 2012 levels and a 50% increase in renewable installations relative to 2009 levels. The most important commitments are to cease all new coal-based power projects and to develop 100% of new projects with low-carbon or zero-carbon technologies going forward. Within North America's energy transition, ENGIE has a new focus on customer and retail services through provision of new technology solutions that help increase energy efficiency and reduce energy costs. Generation still plays an important role in ENGIE's strategy with an emphasis on combined heat and power (CHP). ENGIE's long-term strategy for natural gas is to develop a strong position in New England to provide LNG and CNG for transportation and heating as they become more competitive in those sectors.

Bradley presented ENGIE's new service offerings to optimize and reduce energy load requirements and provide "green" energy options for commercial and industrial customers. In addition to offerings that include services for measurement, management, and energy analytical tools, Bradley expects that online tools for energy benchmarking and management will lead to a decrease in energy consumption, energy costs, and carbon emissions.

Bradley also discussed ENGIE's redirection in power generation. ENGIE currently operates 1.4 GW of cogeneration facilities in North America, most of which are industrial. According to Bradley, the U.S. has over 80 GW of installed cogeneration capacity and over 40 GW of

economically attractive expansion opportunity. To ENGIE, natural gas is a bridge to a lower-carbon economy, and it currently operates a LNG business in New England that serves mostly commercial customers. Bradley argued that the current low oil price is challenging the LNG vehicle transportation business model in the near term, but long-term opportunities, particularly for LNG for marine transport and in remote off-grid applications, remain attractive. Natural gas has the potential to reduce carbon emissions by 10% in the transportation sector and 64% if it facilitates a transition from electric to gas furnaces.

Presentation: John Caldwell

John Caldwell, director of economics at the Edison Electric Institute (EEI), presented his views on the electricity industry's current situation and offered perspective on major companies' foci in terms of an energy transition. EEI is a trade association that represents investor-owned electric companies accounting for 70% of the power sector in the U.S. According to Caldwell, the electric energy industry is going through changes as radical as those that came with deregulation in the early 2000s. Deregulation was an interesting process as it only affected half of EEI members. This time, it remains to be seen whether the current transition will increase differentiation across the sector or bring the industry back to a common standard model. Caldwell expected profound changes in either case.

Caldwell commented that environmental regulations in 2015—the main driver of the changes that force the internalization of negative externalities—cover a wide range of issues ranging from air, climate, water, land, and natural resources to waste and chemical management. Caldwell agreed with prior speakers regarding the effectiveness of emissions trading programs, pointing to a successful record of industry acting to eliminate acid rain. These programs reduced sulfur dioxide emissions by 70-80%, even with a 35% increase in total power generation since 1990. Caldwell believes that a trading program for carbon could be similarly successful. Flexibility through emissions trading or a carbon tax would allow the industry to reach the policy-motivated carbon emissions reduction goals in the most economically efficient manner possible. Caldwell argued that an emissions trading program is a better approach than subsidization and reduction targets because a trading program introduces economic incentives that promote innovation and better resource allocation—benefits not offered by direct regulation.

Caldwell provided some context for the United States' movement away from coal. Coal resources have been greatly affected by regulations intended to keep generation resources clean and environmentally manageable. This movement has been greatly augmented by the radical decline of natural gas prices due to the increase in shale gas production, which has significantly lowered the operating cost for natural gas plants. As coal is being outcompeted by natural gas, the share of coal-fired generation has declined by 20%, all while total generation has increased. Nearly 20 GW of coal capacity were retired in the last three years, and Caldwell expects an additional 30 GW of coal retirements in the next three years. Fifty GW of retirement will account for one-sixth of the country's coal fleet. He observed that the CPP will cause more retirements in the longer term.

Caldwell suggested that the decline in solar PV costs has encouraged the electric energy industry to move towards decarbonization. The decline in costs has occurred for both residential and utility-scale solar PV. In fact, utility-scale solar is a more economical way to produce solar power than individual rooftops solar panels. EEI expects its members to pursue utility-scale solar aggressively to meet the stated objectives to reduce carbon emissions.

Natural gas-fired generation capacity has grown dramatically since 2000, driven primarily by lower natural gas prices and improvements in combined cycle generation technology. More recently, utilities have begun to build renewable capacity aggressively. According to EIA, renewable generation—including hydropower—is projected to reach 20% of total U.S. capacity by 2040, even without the Clean Power Plan. Some studies have shown that, with incentives under the Clean Power Plan, solar and wind alone will generate more than 20% of U.S. electricity by 2040. Caldwell argued that natural gas will continue to grow, ultimately surpassing coal to become the predominant fuel source in power generation. This will occur along with an expanding share of renewables.

Caldwell pointed out that while the growth rate in U.S. electricity sales was nearly 10% per year in the 1960s, it has since dropped to the point that it is now forecast at less than 1% per year—if not flat to negative—for the next 25 years. The decline in sales is the result of improved energy efficiency and the fact that a more mature economy needs fewer resources to support a given rate of economic activity, which lowers the growth rate of energy consumption. This trend presents a challenge for the electric power sector business model in that it cannot continue to be based on expanded sales; rather, it has to be based on efficiency and new means to provide electricity services.

Caldwell also offered three primary drivers that will propel grid modernization: aging infrastructure, the environment, and energy autonomy. The electric system in the U.S. was built decades ago and is in need of an overhaul. This requires developing new infrastructure to handle new sources of generation, many of which are “green” and must be connected. Thus, environmental aspirations will drive a need for grid enhancement. Caldwell continued that energy autonomy, which is the move to more distributed generation options that are inherently variable, will dictate that customer demands drive new ways of ensuring grid reliability.

The desire for energy autonomy is driving power decentralization, or distributed energy resources (DERs). DERs, which come in the form of generation options such as rooftop solar and combined heat and power, increase the need for back-up generation. Caldwell introduced the concept of the microgrid as means of reliable decentralization. Microgrids entail autonomous power driven by neighborhoods, the military, and communities that are in need of power resiliency regardless of cost. An increasing presence of microgrids will force the electric power industry to rethink how to generate, deliver, and manage electric power flows.

Caldwell also stated that extreme weather is causing more major power outages, thus tying climate and infrastructure together. So, grid resilience is vital going forward if the industry is to continue providing reliable power flow on a more autonomous grid. Of course, the industry has a track record of sufficient cost control, and it must meet the challenge of this historical record going forward during the energy transition. In making this point, Caldwell pointed out that consumers spent an average of 1.5 cents of every dollar on electricity in both 1959 and 2013.

Caldwell then presented the “utility of the future.” A number of third-party think tanks have been discussing the role of new utilities and how these entities will handle the new, clean, more decentralized energy portfolio coupled with flat electricity sales. In the past, Caldwell noted, utilities were the provider of electricity services with a one-way flow. Utilities are responsible for balancing load that fluctuates. With an increase in renewable generation, utilities will have to adjust to less control over delivered supply along with unpredictable demand, as increasing third-party generation, such as residential solar, will complicate the balancing act even more.

Caldwell argued that the structure and operation of electricity distribution systems will evolve towards an economic network as “smart” infrastructures and new distributed technologies are deployed. Caldwell expected that electricity will ultimately flow from many directions across distribution systems. As such, investing in a safe and reliable grid infrastructure is critical to the deployment of new technologies. Caldwell argued that the fundamental role of utilities will continue to be ensuring the reliable electricity flow. The new business model will be to integrate and manage distributed energy resources in conjunction with digitalization of a real-time monitoring system. Thus, Caldwell foresees three roles for utilities in the future: distributed system integrator, distribution system operator, and full energy services provider.

Caldwell concluded by arguing that electricity market evolution will happen in three phases at different rates in different states. The first phase is grid modernization, which involves moving towards a system where we can manage reliability and resiliency by upgrading the technical capability. The second is the integration of DERs that allow management of a multi-directional electricity flow balancing along with intermittent renewables and third-party resources. The final phase is distributed energy markets, with utilities as a broker of the market.

Q&A

Michael Maher, CES senior program advisor, moderated the Q&A session.

Q&A: The Future Role of the Utility

Dr. Maher began by inquiring whether there is still a long-term role for utilities, especially in ERCOT where both regulated and unregulated segments exist. Caldwell responded that there is debate over the role of utilities in the future, including over whether they will even exist, and he noted that questions have also been raised as to whether utilities should own or manage generation resources. The premise of the utility model in the past was the

regulatory compact. Caldwell argued that we needed the utilities to ensure adequate infrastructure and generation as well as safe distribution of electricity at a reasonable price. He believes the role of safeguard will be needed regardless of how the system evolves. Technology could create a future that marginalizes the utility, but in the near term utilities will still be the central player.

Anderson responded that many markets are currently—and will remain—regulated. The debate regarding utilities in merchant markets and whether they should return to being regulated will depend on how well the markets perform.

Bradley argued that utilities will exist in the future and that they will be important for providing physical connectivity between generators and customers. Additional transaction capability for utilities may emerge to ensure the communication between generators and consumers, which opens the door for innovation and new technology, such as customer control software, to play an important role as well.

Q&A: Regulation in the New Model

Maher then asked how regulations fit into the new utility model. Bradley answered that the wholesale market will need to evolve and recognize that the low carbon emitting generation assets will eventually have to account for payment for ancillary services, or back-up generation.

Caldwell responded that different states are moving along different trajectories at different rates. Currently there are a number of states in transition: New York's reforming energy vision model; Minnesota's e21 initiatives; submissions of distributed generation plans by companies in California; and grid modernization in Massachusetts, Hawaii, and Illinois. These states are leading the exploration of alternative regulatory models. He argued that 50 states with 50 regulatory commissions are like 50 laboratories, and EEI will observe the results from each.

Anderson added the example that in Illinois, the power company Exelon is persuading the legislature to format a low carbon portfolio standard to support the nuclear facilities that are at risk of early retirement.

Q&A: Distributed Generation and Pricing

A question was raised regarding the shift of electricity cost from those who install residential solar systems and sell power back to the grid to those who cannot afford a rooftop PV system.

Caldwell explained the problem as one in which customers are receiving the full retail rate for the power generated from their solar panel, which does not reflect the true market cost. The costs for the infrastructure included in the retail rate should be charged to the customers by utilities. However, utilities are paying the infrastructure cost to the solar panel owners by buying the power at the retail rate. This allows these residential customers with solar panels to receive a subsidy from the utility that is being paid by other customers.

Those who do not own residential solar are thus hurt by this system. Caldwell reiterated that he believes the correct way to achieve clean energy is through a carbon tax or an emissions trading program, not through subsidization. He argued that a correct market signal is needed to represent the true costs and benefits of this technology to create incentives towards more rational compensation mechanisms. Caldwell also argued that the power sector must be able to reach the level of reliability expected by customers and meet the level of clean energy required by the policies as safely, efficiently, and cost-effectively as possible, which is why the inequities of the existing paradigm must be addressed.

To help address the distortion in electricity pricing, Caldwell argued that advanced metering technology that displays a real-time electricity rate could play a role because it creates a real-time demand response as customers adjust their consumption when they observe higher prices. He also explained, however, that a large number of customers don't opt into the metering program because the value of electricity is such that they don't have to think about it. So, we have to be aware of those customers, and one option is through greater deployment of smart appliances, which respond automatically and can make the real-time rate program more feasible.

Q&A: Carbon Pricing

When asked about a price on carbon, Bradley responded that a price of \$20-\$25 per ton by 2020 is needed to encourage wider-scale development of renewables. He also argued that the costs of new technologies will gradually decrease, which should allow the price on carbon to follow.

III. Keynote Address

Steve Corneli, senior vice president for policy and strategy at NRG Energy, delivered the keynote address for the conference. He presented his perspective on competing thought processes in policymaking and gave some examples of current climate policies. Corneli's talk also included an overview of NRG and the company's actions to address climate change, and a discussion about how modes of thinking may engender mistakes on large policy issues.

Corneli introduced NRG as the largest independent power producer in the U.S., with 55 GW of installed capacity and a number of fossil-fuel burning generation assets. Given NRG is one of the top five carbon emitters in the U.S., Corneli indicated that the company is actively seeking to reduce its carbon footprint and help others do the same. NRG has set goals to reduce its carbon emissions by 50% by 2030 and by 90% by 2050, while at the same time growing the commercial value of the company. NRG's strategy for achieving those goals focuses on two areas:

- (1) existing assets that are sources of the carbon emissions, and
- (2) investment in new low- or zero-carbon technologies and value creation using new business models.

Corneli noted three “R” actions for the company’s existing assets to both reduce carbon emissions by 50% by 2030 and enhance firm value. These are:

- (1) repowering coal units with natural gas;
- (2) renewing coal units with carbon capture and sequestration (CCS) technology; and
- (3) retiring assets that outlive their commercial life so the company has the opportunity to augment the fleet through acquisition and development of new resources.

Corneli’s framed his remarks using Daniel Kahneman’s book, *Thinking Fast and Slow*, which describes two ways of thinking: an automatic-thought process (“thinking fast”) and a more laborious system with rules (“thinking slow”). Corneli noted that thinking fast is evolutionary and important, as humans need to react quickly in urgent circumstances. On the other hand, thinking slow is why humans are able to learn, as slow thinking can be channeled and used to solve complex and important problems. Corneli argued that when humans encounter a complex problem we do not understand, fast-thinking systematically substitutes a simple problem that we have seen before, allowing us to think we have solved the complex problem. This creates two issues. First, the substitution is usually incorrect. Second, it produces a dichotomous thinking in which the answer is either right or wrong, a phenomenon that can be observed in the political environment. Corneli argued that even though dichotomous thinking distracts people from creating value, people tend to reward this kind of thinking socially, as witnessed by a public that likes decisive figures who speak simply and assertively in debate.

Corneli presented three propositions that have been offered to address climate and noted that he believes they are to some degree the result of fast thinking: a price on carbon, renewable subsidies, and policymaking. A price on carbon is an answer from a simple economic approach that internalizes the negative externality of CO₂ emissions. Corneli argued that pricing carbon may be the wrong way to reduce CO₂ emissions effectively in the next decade. For example, the initial ERCOT analysis of the original Clean Power Plan proposal indicated one-third of the region’s coal fleet would need to be shut down to meet 2020 targets, but this would cause immediate reliability problems. The EPA subsequently changed the compliance date to 2030 in the final rule and gave states opportunities to comply aside from pricing carbon. Corneli nevertheless argued that a price on carbon is essential in the long run to motivate innovation and new generation types. However, shutting down too many plants quickly can lead to grid and market stresses that compromise reliable electricity services. Innovative technologies ranging from smart meters and demand response to batteries and nuclear waste disposal cannot be improved with an immediate price on carbon, whereas slowly phasing in a carbon price allows stakeholders the time to adjust investment plans and find workable solutions.

The second proposition Corneli identified as the result of fast thinking is the idea of addressing climate change by lowering the price of renewables through subsidies. He argued that such an approach may be the right answer to a simple economic analysis, but it is not necessarily a solution to climate change. He continued by noting that renewables involve high complexity, and generation from renewables can impinge on the minimum

hours that base load generation sources, such as coal with CCS or nuclear plants, need to operate to be economic. Once those plants become uneconomic, new investments in their capacity are discouraged. This problem cannot be solved by simply increasing renewable capacity, in particular because it is not a stable source of electricity flow. Instead, better understanding on how to integrate renewables with zero carbon base load sources, such as coal with CCS and nuclear, is necessary for long-term grid stability.

The third of the fast-thinking proposals to address climate change is policymaking, which Corneli argues is a particular pitfall for the fast-thinking approach. He indicated that there are three ways in which companies react to policy: (1) a company may support a policy that it believes will benefit both its core business and the public; (2) a company may oppose a policy that it believes it will impair its business and shift costs from the rich to the poor; or (3) a company may decide not to follow a policy and think about what it must do to make the system work. Corneli argued that it is essential to think about how a policy can help to create a system in which a business can make profits for shareholders and create value for its customers. In that sense, businesses can help drive solutions rather than fall into other dichotomous directions. To do that well, both fast and slow thinking are needed. Corneli suggested that the fundamental role that businesses can play is to take the third option and be a part of the effort to find solutions that help them to attract capital, create value for customers, and scale up. The COP21 INDCs are an opportunity for people to become aware of the need for solutions to climate change.

Regarding the CPP, Corneli argued that the state measure plan, rather than the mass or rate-based plans, provides the slow-thinking approach. The state measure plan allows states to come up with their own approach that is politically feasible, such as retiring certain affected units without other measures. However, a backstop program must be implemented when the emissions targets are not being met. The state measure plan gives more time to the actors in different states to integrate their plans into the system and ultimately lower costs. In the end, a price on carbon can be applied in 2030 or 2035. This is an option in the Clean Power Plan that is not discussed by many.

Q&A

In the Q&A session Corneli addressed NRG's path forward. He argued that the firm's challenge to developing cleaner technologies is the need to find a different source of capital. The purpose of founding a subsidiary company, "Greenco," is to match the capital with the right kind of business model. Addressing a question on investments for emissions control equipment for power plants, Corneli responded that it is a question of decision-making under uncertainty. In Texas, a company needs to look at the price of electricity in the wholesale market to recover the investment cost for upgrades and expansions. The return on investment is highly uncertain. He suggested environmental regulations that allow parties to estimate their expected return on investment and to have the option of light-handed regulations in return for either converting coal units to gas or simply pushing coal into retirement. This would allow the industry to rationalize its decisions on risky pollution control equipment.

When asked about carbon trading credits such as reforestation, Corneli introduced the Climate Action Reserve as one of the few organizations that certifies these particular kinds of intentional carbon reduction activities. Those activities are verifiable, measurable, and enforceable as they effectively reduce CO₂ emissions. In a carbon-trading regime, it is those kinds of credits that count toward compliance. However, Corneli pointed out that EPA has not made any provision of this sort, as the CPP regulates power plants but not trees. EPA does not want to go that far in terms of the legal risk for the moment.

III. Moving Forward: A Brief Reflection on the Conference Proceedings

Central to the mission of the CES at Rice University's Baker Institute is facilitating substantive discussion by experts and other stakeholders regarding important policy issues. A number of ideas and lessons regarding climate policy may be drawn directly from the presenters' comments. Moreover, reflection on the entirety of the presenters' comments allows for additional insights about the path forward as the world strives to shape a new energy future.

To begin, it is crucial that, as we transition the energy mix, policymakers take a long-term view in planning and coordinating the retirement of existing power generation sources in favor of lower carbon options. Emission reduction targets are important, but blunt policy to reach an abstract figure without careful consideration of the implications for supply, demand, and grid stability in the near- and long-term can cause significant problems.

Flexibility in policy mechanisms is also critical as increasingly binding regulations are implemented. Policymakers and regulators must allow time and space to adapt to new targets to avoid unintended negative consequences. Mechanisms must, however, be in place to ensure that reactive modifications in policy design do not undermine global efforts to curb CO₂ emissions. Accordingly, it is important that negotiators for global carbon emissions agreements keep these objectives in mind. They must also recognize differences in cultures, political systems, and economic standing, so as to avoid exacerbating tensions that could undermine desired outcomes.

Appropriate market signals and funding for research and development (R&D) are necessary parts of any solution. Innovation has always been critical in propelling human civilization to better living standards and prosperity. It has time and again rebuffed Malthusian predictions, and addressing CO₂ emissions is no different. Importantly, innovation comes from both private and public sector efforts. Market design that allows price to incentivize innovation in the private sector is very important in promoting the adoption of technologies that can help to begin the transformation of the energy system in a reasonable time frame. Moreover, while we must think about nudging the energy transition in the near term, it is also important in the longer term as new technologies and ideas progress from the drawing board to the marketplace.

Longer term considerations dictate that an appropriate level of funding for basic R&D be made available. In other words, the "drawing board" cannot be ignored; doing so is myopic

and dangerous. In fact, it is entirely possible that the next great energy technology of the future has yet to be conceived. As such, it is important to focus on both adoption of existing technologies and development of new ones. This is imperative for a sustainable energy future because the world is never in stasis, something policy should recognize. Therefore, governments must consider policies that incentivize adoption of existing technologies that have the desired goal of reducing CO₂ emissions while at the same time conceiving of ways to adequately fund basic R&D in the energy sector. Moreover, these funding mechanisms must remain unbiased because picking winners and losers could eliminate some ideas with transformative potential.

The speakers in the conference touched on the notion that command-and-control regulation, subsidies, and carbon pricing may not be sufficient to rapidly increase the number of carbon neutral or zero-carbon power generation resources. Many also noted that as technology evolves, advanced integration systems will be needed to properly integrate new technologies in order to balance volatile electricity supplies and demands. These points highlight a basic fact that must be recognized if we are to successfully address the issue at hand. Namely, the energy system is massive, and scale matters. Despite what some may say, introducing new energy technology and having it take significant market share is not as simple as the mobile phone displacing the land line. The process of “leap-frogging” is significantly more capital intensive when it comes to delivered energy services that support economic growth. In fact, a rapid energy transition would require an unprecedented amount of capital investment and entail significant stranded costs for displaced capital assets. These are realities that cannot be ignored. Accordingly, policymakers must design a path forward in order to propel a new energy vision that is both workable and affordable. Such a task is very likely doable, but it requires flexibility, creativity, and foresight. Energy assets are long-lived and transformations occur in decadal time scales because of their capital intensity. This extends beyond any single politician’s lifetime in office, meaning policy must be flexible enough to meet shifting social, economic, and political priorities and have the longer term squarely in focus.

Stakeholder participation and robust dialogue are crucial to designing and implementing sound public policy. The expanded participation in Paris relative to the meetings in Kyoto (1997) and Copenhagen (COP15, 2009) is an encouraging sign that a concerted effort to reduce CO₂ emissions is emerging and that the dialogue is indeed expanding. The level of engagement across individuals, organizations, and governments must continue to grow to ensure advancement of future negotiations and guarantee that agreements are implemented effectively.

The demonstrated commitment of the United States, as well as other global economic leaders, was crucial to the Paris negotiations, and it will be increasingly important if binding policy commitments are to emerge. Steadfast leadership will be a linchpin for successful implementation of various climate policies. Given that the existing commitments emerging from COP21 are non-binding and without explicit form, leadership will come in the form of actually demonstrating how a nation can successfully meet a stated emission reduction objective. Thus, as the U.S. forges ahead, it will create a

template for other countries to follow. Whether others actually follow will depend entirely on whether the U.S. is successful in meeting its goals in a cost-effective manner.

As noted by Margo Oge when she concluded her presentation, the word for “crisis” in Chinese is 危機, which contains the characters for “danger” (危) and “opportunity” (機). The world is at a point where it must address the challenges presented by the status quo, but addressing this challenge provides an opportunity to forge a more environmentally sustainable future. In wearing the leadership mantle on climate policy, the U.S. is presented with an opportunity to reshape the global energy landscape. Importantly, it must also recognize the path from here to there is not short. As a result, reshaping the global energy will require deployment of existing technologies as well as the development of transformative and new energy technologies, especially if the energy transition is to be cost-effective and sustainable.