

WASHINGTON D.C. USAEE/IAEE NORTH AMERICAN CONFERENCE

CONFERENCE OVERVIEW

The 36th USAEE/IAEE North American conference was held in Washington, D.C., a particularly apt location given the number of important movements in energy policy within the current administration. There were 361 attendees representing 28 distinct countries, 54 of whom were students, and 96 of whom were welcomed as new members to the organization. As with past conferences, the delegates came from varied backgrounds including academia, the U.S. federal government, oil and gas companies, utilities, and research and consulting groups. The theme of this year's conference was also quite apt, "Adapting to What's Next," suggesting not just change afoot throughout every portion of the energy sector but also substantial uncertainty. One of the great overriding themes throughout the conference was the rise of the United States once again as a major global producer of oil and gas, particularly at a time of instability in some parts of the world. Since this has both domestic and geopolitical implications, and since there have been definite changes in the way that the U.S. approaches relations with the rest of the world, the conference location in Washington, D.C. afforded excellent opportunities to discuss these issues.

Several successful elements from previous conferences were part of the Washington, D.C. conference this year. The PhD Day Session provided a number of students the opportunity to receive more detailed feedback on their papers as they prepared for the job market and practice presenting their job market talks. Student members were also able to compete for cash prizes in the Case, Poster, and Best Paper competitions with other conference delegates being able to watch the competition unfold and see the best of what USAEE and IAEE student members have to offer. Technical tours and workshops gave delegates the opportunity to visit a shale gas drilling rig, learn more about making effective presentations, and learning the elements of energy risk management. As ever, all delegates were given extensive opportunities to network with other members from a variety of backgrounds.

TECHNICAL TOUR – MARCELLUS SHALE DRILLING RIG

Twenty-three USAEE members participated in the Marcellus Shale Technical Tour. The overnight tour was coordinated with the help of Dr. Tim Carr at West Virginia University, and was hosted by Antero Resources.

After a thorough safety briefing and overview of Antero's Appalachian operations at Antero's headquarters in Bridgeport, WV, the group went to a production pad in Ritchie County, WV, where a rig was actively drilling the well. At that site Antero staff spoke about the process of selecting the site, preparing the pad, and conducting the drilling operations. The group had the opportunity to walk around the entire area, learning about the process and equipment on site, and directing numerous questions to the Antero staff.

Afterwards the tour went to Antero's Clearwater Facility in Doddridge County, WV, where the company has built a water treatment plant that processes flowback water from the oil and gas wells. After processing the flowback water, the plant returns 98% clean, surface discharge quality water, and 2% residual solids which includes salt and other contaminants.

The residual solids to to a landfill Antero built next to the water treatment facility. The treated water, which meets the standards to be discharged into local rivers or streams, is re-used in the fracking process. The plant has the capacity to produce up to 1.7 million gallons of treated water per day, which reduces Antero's need to draw water from local rivers and streams. In addition to seeing first hand the various sections of the plant, there was a presentation that thoroughly covered the need, history, and operations at the plant, as well as a long Q&A session.

The last site we visited was Markwest's Sherwood Natural Gas Processing Plant, also in Doddridge Count. Because of heavy rain the tour consisted of driving through the facility, while Markwest and Antero staff pointed out salient information and discussed the processes taking place. Although not being able to do a walking tour was somewhat disappointing, doing the bus tour gave the group a sense of the scale and rapid expansion that has taken place at the facility, which is currently able to process up to 1.6 Bcfd of production, separating liquids and other valuable petrochemicals from the natural gas stream.

Tour participants were happy and excited about this tour, as it was informative and even entertainment. In addition, the long drive to and from West Virginia allowed for ample time for the participants to network and learn about each other's areas of focus.





SUNDAY NOVEMBER 12TH

CASE COMPETITION

The 36th USAEE/IAEE conference in Washington, D.C. was the 7th year for the USAEE Case Competition started in 2012. The competition casts participating groups in the role of consultants with clients from government or industry who need them to do a quick, first-order analysis to inform a complex energy-related problem, usually with a technical, economic, and political component. This year's case asked students to develop a bold and aggressive renewable energy plan for the power grid of Western Australia that would provide affordable and reliable electricity with very low greenhouse gas emissions. Teams of 4-6 students were able to submit a report with the recommendation earlier this spring. Of these teams, three were selected to come and present their cases at the D.C. conference and compete for cash prizes.

Generous sponsorship for the competition came from the King Abdullah Petroleum Studies and Research Center (KAPSARC). The Case Competition was organized by Parth Vaishnav (Carnegie Mellon University)

This year, first prize was awarded to the team from Carnegie-Mellon, consisting of Jessica Lovering, Niles Guo, Turner Cotterman, Ana Lucia Caceres.

The USAEE Case Competition has been opened to students all over the world, not just in the United States. We look forward to this great event again at next year's conference in Denver!

MONDAY, SEPTEMBER 24TH

WELCOMING REMARKS

The 36th annual USAEE/IAEE North American Conference was kicked off by Guy Caruso (Center for Strategic and International Studies), the 2018 President of USAEE. In his opening remarks Caruso made note that the U.S. has not just become a major gas producer, but is rivalling Qatar as the world's biggest gas exporter, a position that was unthinkable even a decade ago. With the boom in oil production from shales and the lifting of the crude oil export ban in recent years, the U.S. is also poised to become one of the world's major crude oil exporters. Petrochemicals has been a major beneficiary of this, as has the electric power sector. Cheap natural gas has lowered power prices and also lowered the cost of integrating renewable energy into regional power grids.

David Knapp (Energy Intelligence, current IAEE president) and Mike Ratner (Congressional Research Service, current president of the National Capital Area Chapter of USAEE) were introduced and welcomed the delegates to the conference and to Washington, D.C. The diversity of the plenary sessions was highlighted – these interesting sessions focused not just on the boom in oil and gas production, but on batteries, geopolitics and technology leapfrogging.

Those who helped to make the conference successful were also thanked, particularly Andrew Slaughter (Deloitte Services LP), this year's USAEE VP for Conferences; Benjamin

Schlesinger (Benjamin Schlesinger and Associates LLC), the Plenary Session Coordinator; Pierre Pineau (HEC Montreal), the Concurrent Session Chair; John Holding (Independent Practitioner), the Poster Session Chair; Omar Cabrales (FERC), the Technical Tour Coordinator; Natalie Kempkey (EIA), the Sponsorship Committee Chair; and Nathalie Hinchey (Rice University), the Student Program Coordinator. Sponsors were also gratefully acknowledged.

KEYNOTE PRESENTATION

This year's keynote was given by Adam Sieminski of KAPSARC, who spoke on "Energy Economics in a Policy-Driven World." Sieminski wrestled with the particularly difficult question of how energy economics can provide the best information and advice in a world that is becoming highly politicized and where energy seems to be increasingly abundant rather than scarce. Sieminski pointed out that much of the politicization of energy arises because demand is highly inelastic in the short run, and therefore questions other than economics such as fairness, access and affordability often enter policy discussions. Sieminski suggested that energy economics needs to take these issues seriously and help policymakers understand the tradeoffs that they face. In this way, energy economics can play a valuable and independent role without get mired in political frays.

Given his role at KAPSARC, Sieminski also discussed the energy situation in Saudi Arabia. Oil is valuable in the global market, but Saudi Arabia is currently using a lot of it for electricity. There is great interest in moving to other fuels for electrification and also improving the efficiency of electricity use, particularly for air conditioning. Sieminski noted that Saudi Arabia has one of the world's most energy-efficient oil and gas production sectors. There are concerns about air emissions, but the focus on Saudi Arabia is not specifically on carbon but on reduction of emissions more broadly.

OPENING PLENARY SESSION: U.S. ENERGY RESURGENCE - IMPACT ON THE GLOBAL GEOPOLITICS OF ENERGY (Opening Plenary)

The Opening Plenary was an international panel chaired by Herman Franssen (Energy Intelligence) and consisted of Molly Williamson (Middle East Institute), Frank Verrastro (Center for Strategic and International Studies) and Jesus Reyes-Heroles (former Minister of Energy, Mexico). Franssen opened the panel appropriately with a focus on China, which wants to return to a position of global pre-eminence. Franssen mentioned that history for China is particularly powerful and is used as a motivation for its actions on the geopolitical stage. An important part of China's strategy is to weaken the world's use of the U.S. dollar.

Molly Williamson spoke on the geopolitical situation in the Middle East. She highlighted three important factors in the geopolitics of that region that she referred to as "ticking clocks." The first was demographics, which Williamson described as a "vast bulge of youth" in the region. Every year more than five million people in the region enter the labor force, so there is a major need for job creation. The second was a "regional contagion" of violence and social unrest. Williamson discussed how governments in the region are under tremendous social pressure to liberalize freedom of assembly. Young people in the region are using social media to protest in ways that have never been done before and are difficult to predict. Third, the region is not immune to global commitments to environmentally responsible industry and to overall global economic health. Despite sanctions affecting some countries, the region is

still very integrated with the global economy. Williamson mentioned that the clock of environmental quality is a difficult one to assess because we may not know that the clock has run out until it actually happens.

Frank Verrastro then spoke on the geopolitical angles of changing oil and gas markets. He opened by questioning whether “peak demand” is the new “peak supply” – just as large new oil and gas deposits are becoming economically viable, much of the world is getting more serious about energy efficiency and finding substitutes for fossil fuels. He noted in particular that energy intensity as a fraction of GDP in the US is down by 25% while oil production is up over 70%. While we are in a period of intense competition, much of this production is coming from a limited number of basins. Verrastro noted that the decline rate in unconventional plays is substantially higher than in conventional plays (50% - 60% decline after 18 months for unconventional plays versus 5% in conventional plays) and it’s unclear how production levels will be maintained – whether this means stimulating existing wells or drilling new wells. Infrastructure challenges continue – pipelines are being challenged on the grounds of lack of local benefits especially for exports. FERC will likely need to address this at some point. Verrastro finished with his “3 C’s” that he sees shaping energy markets in the near term: Competition, Consumers (shifts in demand), and Crises (trade wars and sanctions; cyber-attacks; and resilience to other disturbances).

The final speaker of the morning panel, Jesus Reyes-Heroles, focused on how political changes and events in Brazil, Venezuela and Mexico appear poised to affect energy markets. Of these, the least energy-central seems to be Brazil, although major candidates are opposed to privatization of Eletrobras. Venezuela is politically a mess and it is not clear how other countries will respond. Over the long term the decline in Venezuelan oil output is likely to continue and PDVSA is having cash flow problems with exports to the U.S. declining in particular. The prospect of populist control in Mexico would appear to stifle future energy sector reforms but perhaps could lead to an increase in production. Plans for new refineries in Mexico are not clear – existing refineries have low utilization rates and are basically in collapse, so it is not clear where new refineries would go or how they would make money.

KEYNOTE LUNCHEON

The lunchtime keynote on Monday was given by Edie Fraser, chairman and founder of STEMConnector and Million Women Mentors. Edie talked about the challenges that women have faced gaining top-level positions in corporations, and where the energy sector in particular has been more or less successful in promoting women. Like much of corporate America, the energy sector has struggled to maintain gender diversity in the workforce and to promote women to leadership positions. The best performing part of the energy sector overall has been utilities, which Fraser mentioned had an organized and concerted effort to place women in leadership positions. Fraser also mentioned some specific efforts by oil and gas companies are making efforts but the sector as a whole lags behind. In power generation, nuclear has the highest proportion of female workforce while the lowest is solar.

Just prior to her keynote talk, Edie sat down for a short interview with Seth Blumsack, VP of Communications for USAEE. Blumsack and Fraser talked in more depth about some of the challenges that the energy sector has faced in promoting women; some specific initiatives to improve this; and what steps energy firms could take in the short and long term. Look for this interview to be available via podcast on the USAEE web site!

U.S. ENERGY POLICY DEEP DIVE (Plenary Session)

DEMAND AND THE VEHICLE REVOLUTION (Plenary Session)

This panel was chaired by Sanya Carley (Indiana University) and featured presentations from Margaret Taylor (Berkeley Lab), Sharyn Lie (EPA) and Robert Wimmer (Toyota). The broad themes this plenary session addressed were consumer behavior, policy evolution, and technical advancements in the context of advanced and alternative fuel vehicles. There was a consensus belief among all the panel members that the transportation is at the cusp of three intersectional developments, namely shared mobility, automotive electrification and vehicle automation. In order to understand their cumulative impacts on the transportation sector demand, energy and environmental implications in the future, it is important to look at these 3 developments not in isolation but in an inter-dependent manner.

Margaret Yatlor focused on consumer behavior and plug-in electric vehicle (PEV) purchase decisions. The speed and scope of the evolving changes in the transportations sector introduces a wide spectrum of positive and negative effects on the vehicle miles travelled (VMT). A recent DOE study quantified that the impacts of vehicle automation and connectivity on energy and emissions ranges from +200% to -67%. Increase in energy consumption, emissions and subsequently VMT could be due to a combination of factors such as reduced travel costs, rebound effects due to increase in fuel efficiency and economy standards, enhanced features of advanced vehicles, and increase in share of trips and VMT made by low or zero occupancy vehicles. Whereas the decrease in energy and emissions could be from eco driving, platooning, optimal vehicle design and sizing, congestion mitigation, reduced incidents of congestion and traffic fatalities and the mainstream adoption of mobility as a service (MaaS). A key to shrinking the uncertainty intervals in energy and emissions estimation of shared mobility, automation and electrification starts with a better understanding of consumer vehicle purchase decision. Vehicle purchase decisions are influenced by internal long-term factors such as socio-demographic attributes and behavioral feedback from new product experience and brand loyalty, or due to internal short term factors such as impulse triggers. External factors are mainly due to consumer myopia in estimating future costs savings by shifting from ICEs to PEVs or fuel cell vehicles (FCVs) and their attitudes towards risk management and utility. With such variety in the factors that influences consumer vehicle purchase decision, one needs to evaluate and understand the heterogeneity in vehicle purchase decisions as not all consumers will approach the purchase decision in the same way. Taylor pointed out some of the key attributes people look for when purchase a vehicle, especially on the motivating factors and barriers in PEV purchase. Specific to PEV purchase decisions, range anxiety, lack of reliable, easy and convenient access to charging infrastructure, higher upfront capital costs were cited to be the most common barriers to PEV purchase. This talk concluded by pointed out the major behavioral challenges in PEV purchase decision process. Procrastination anticipating or reacting to change in PEV incentives or policies, higher financial risk in PEV purchase compared to ICE purchase, and how familiarity of the purchase process is influenced by the time and effort put my consumers in making the decision were mentioned as the major behavioral challenges facing PEV purchase decisions.

Sharyn Lie's talk reinforced that the bulk of uncertainties in the future transportation sector demand, energy and environment arises on the consumer side because they are the wild card. As innovative and new technologies disrupt the transportation sector, the past will cease to be

a good predictor of the future. Two major avenues for concern from the policy maker perspective was then presented. The first concern on the consumer side is the lack of awareness about PEV technologies, policies, available incentives and their lifecycle benefits and costs. Considering that the vehicle purchase is the second biggest purchase decision after a home, these knowledge and information gaps are quite important. The second major avenue of concern from a technology and innovation perspective is to how to ensure that a seamless integrated tool across many travel modes such as car, public transit, or TNCs/MaaS while providing the right price signals could be developed in the near future. Since consumers typically respond and react to price signals, it is imperative to understand the cumulative impacts of disruptive technologies in the transportation sector on the cost of travel. Due to the scale and level of transformative change that is expected to engulf the transportation sector, it is critical to not rely entirely on the past behavior and consumer decisions in estimating future demand.

In contrast to the first two speakers who focused on PEVs, Toyota's Bob Wimmer was bullish on fuel cell vehicles (FCVs) and PEVs. An interesting takeaway was the fact that in spite of having longer range, faster refueling, negligible changes to driving behavior compared to ICEs, and better performance in cold temperatures, FCVs have not reached similar market penetration levels when compared to the PEVs and a key reason being the lack of H2 refueling stations. The 3 main challenges that Toyota identifies in order to accelerate powertrain hybridization and electrification, and the adoption of zero tail pipe emission vehicles are: 1) cost competitiveness; 2) stable regulations and; 3) consumer pull. While the rate of cost reductions has significantly improved, the upfront capital cost in spite of the incentives continues to be a barrier and from an OEM perspective, in order for consistent long-term GHG reductions, it is imperative that the ZEV market be self-sustaining as the incentives eventually would have to go or scaled back. Toyota's vision is centered on the belief that in the near term the push for drive train electrification in the LDV and HDV sectors would have a cumulatively positive effect on increasing the diversity of low carbon/zero emission fuels in the long-run.

POSTER SESSION

The student poster session, organized and chaired by John Holding (Independent Practitioner), is an opportunity for students to present their work to a broad audience in an interactive manner. Students were judged by a field of experts from across the energy spectrum representing academia, industry and government.

This year's competition had ten posters representing a diverse set of projects primarily focused on electric power, transportation and natural gas. Topics covered by posters this year included renewable energy integration, energy efficiency choices, vehicle-to-grid services, climate policy, infrastructure investment and regulations on unconventional natural gas development. The winner of this year's poster competition was Liza Reed, doctoral student at Carnegie-Mellon whose poster was entitled "Under What Conditions is HVDC Conversion a Cost Effective Way to Increase Transmission Capacity in an Existing HVAC Corridor?"

TUESDAY, SEPTEMBER 25TH

GOVERNMENT TRACK

Once again, the USAEE North American conference featured a special track during the concurrent sessions focused on government issues. This year's Government Track session was chaired by Kim Coffman (Bureau of Ocean Energy Management) and featured interesting discussions from representatives of federal agencies that are involved in energy resource development. Sitting on the panel was Michael Ford (Bureau of Land Management), Martin Heinze (Bureau of Ocean Energy Management) and Aditi Mirani (Bureau of Ocean Energy Management). The three panelists each discussed some of the functions of their particular agency as it relates to energy development on public lands and in the oceans. Ford noted the importance of a federal role in energy development for security purposes, describing the SPR as a critical tool for keeping threats of oil embargo in check even if the SPR does not actually need to be used. Heinze reflected on the shifting role of federal agencies and public lands in energy development as opposed to private lands. The shift in development to Appalachia, where private landholdings dominate, is reducing the role of public lands for energy supplies, and this diminished role appears to be set to continue. Federal leasing revenues have been on the decline for around a decade. Also playing a role in this decline is the falling energy intensity of the U.S. economy. Finally, Aditi Mirani discussed the kinds of resource assessments conducted by the Bureau of Ocean Energy Management for offshore energy resources.

ELECTRICITY MARKET DESIGN AND OPERATIONS IN STRESS (Plenary Session)

This interesting panel focused on the transitions happening on the supply side of the electricity grid driven by the desire for greenhouse gas reductions, the emergence of cheap natural gas and competitive market forces. Presiding over the session was Barney Rush (Board, ISO New England). Delegates were treated to presentations by two CEOs at Regional Transmission Organizations (Andy Ott of PJM and Gordon van Weilie of ISO New England) as well as a supplier perspective from Thad Hill (CEO, Calpine).

While Ott and van Weile talked about their ambitious targets for increasing the portfolio of renewables, Hill explored the advantages and disadvantages of heavily regulated and free market driven RTO operation. All the panelists agreed that restructuring and deregulation has ultimately benefited the consumer and it is important to green the grid by shifting towards renewables and gradually moving away from fossil fueled plants. However, the panelists also alluded to the fact that increasing the targets for renewables introduce a new set of risks and reliability considerations which needs to be sorted via regulations, market forces or a hybrid approach. In the Northeast, colder winters drives up the demand for natural gas but the existing capacity of pipelines are not adequate enough to meet the demand in a timely and cost effective manner. Ott and van Weile agreed on the fact that the electricity grid is undergoing rapid physical changes in their fuel mix accompanied by the lack of regulatory certainty. Because of the sheer size of PJM's operations compared to ISO NE which has an elevated risk profile during the winter months due to demand for natural gas, PJM on the other hand wants to tackle not just fuel supply security concerns and mitigate the intermittency of renewables, but cope up with changing load profiles due to distributed generation and storage and cybersecurity. Both Ott and van Weilie believe that grid decarbonization poses a combination of physical, operational, fuel supply and market design challenges that should be addressed via market forces or regulations. This is particularly important in the context of reliability and capacity markets which introduces structural asymmetry in terms of the contract duration. A key takeaway from this session is the duality in electricity markets that is taking shape. On one end, competition and deregulation have

reduces the wholesale and end-user electricity prices but the introduction of renewables and extreme weather events introduces a newer risks. These newer risks have to be tackled via markets or through governmental interventions in the form of regulations and mandates. Towards the end of the session, the panel concluded by saying at some point or the other, the pendulum is going to swing towards either market driven forces or regulations as hybrid markets are not viable in the long-run.

ENERGY INNOVATION EXTENDS SUPPLY CURVE (Plenary Session)

The Energy Innovation Extends Supply Curve dual plenary session provided a thoughtful and insightful discussion on the innovation and future of technology in the energy industry.

Dr. Robert Kleinberg discussed various sources of innovation in the energy industry; primarily process and efficiencies improvement, technical improvements, major technological developments and industry changing innovations that profoundly affect the supply of energy. He suggested many of these improvements were independent of business cycles. For instance, average well drilling and completion costs peaked in 2014- at the same time energy prices plummeted. Dr. Kleinberg argued that the geological risk and front-load capital requirements required in the energy industry discourages untried innovations and future innovations are likely to stem from efficiency increases.

Mr. Godec then continued the discussion by highlighting the shale revolution and explaining how it was not truly an overnight success and was over 30 years in the making. He examined the potential of machine learning in the Marcellus Shale and the future of this technology. Mr. Godec emphasized the synergies between environmental and economic incentives in the energy industry and how environmental regulations helped improve efficiency and profitability in the industry. Mr. Godec then discussed the improvements in CO₂-EOR recovery methods and how innovation in this industry is dependent on both private and public support.

Mr. Scott Sanderson concluded the session by assessing how digital technology drives efficiency. He emphasized that there is risk in implementing these technologies overnight – the energy industry is still a very physical one. However, he points to the progress and continuity on perfecting horizontal drilling to suggest that technology has and can revolutionize the industry. Mr. Sanderson suggested it is still early days in uncovering new technologies but the potential is there.

AWARDS LUNCHEON

At lunch on Tuesday the USAEE Adelman Frankel Award was given to Richard Newell (Resources for the Future); USAEE Senior Fellow Awards were given to Thomas Drennen (Hobart and William Smith College) and John Holding (Independent Analyst); and the *Energy Journal* Best Paper award was presented to David Brown (University of Alberta) and David Sappington (University of Florida) for their paper on efficient compensation mechanisms for net metering.

Richard Newell's acceptance speech for the Adelman Frankel award touched on some of the same themes as Adam Sieminski's keynote – the role of energy economics in an increasingly

partisan world. Newell's take was that energy economics needs to identify the best possible policy options and communicate those, but also to realize that sometimes the "first best" option is not feasible in a political environment. In these cases, energy economics needs to help policymakers understand the costs and benefits of alternatives, and emphasize second-best or third-best solutions as opposed to those solutions that may be politically easiest but more costly.

ENERGY TRADING AND OPTIMIZATION - HOW THE BUSINESS IS CHANGING (Plenary Session)

This session, chaired by Tina Vital (Castle Placement LLC), brought together four experts on energy commodities trading: Margarita Brouwer-Boulankova (ABN-AMRO), Madeline Jowdy (S&P Platts), Michael Sell (GARP) and Ron Ripple (University of Tulsa). This panel was particularly notable for its representation across energy professionals, including not only practitioners and academics but also representatives from trade media and professional organizations. The panel's focus was on how geopolitical changes in crude oil and natural gas have affected the trading of energy commodities.

Margarita Brouwer-Boulankova's focus on crude oil contracts was a backdrop for her discussion of how traders themselves are changing – there are fewer physical traders who play on fundamentals and more financial short term traders looking for arbitrage opportunities. This has upended some traditional dynamics in the oil market. Brouwer-Boulankova presented some interesting information on how the oil market has shifted between contango and backwardation in response to the changing energy landscape (primarily U.S. shale oil production) and market events (hurricanes and pipeline interruptions).

Jowdy's focus was on LNG exports rather than crude oil, but much of the message was the same: because the U.S. is becoming a major producer and exporter, traditional market dynamics are changing rapidly. Jowdy mentioned that it is very possible that the U.S. could represent as much as 20% of global LNG exports in the coming years, rivaling both Australia and Qatar. Some integration in global natural gas prices is already happening, as seasonal LNG exports from the U.S. are making their way to Asian markets. Jowdy presented some evidence of this convergence in LNG prices for the U.S., Qatar and northern Asian markets. The final lesson from Jowdy's presentation was that not only are LNG markets being upended by the emergence of the U.S. as a major player, but also by the expiration of many long-term contracts and perhaps a new emergence of spot pricing.

Michael Sell provided some institutional information on the various roles in the risk management process, including those who make decisions on how much risk to assume and those who oversee risk acquisition decisions within a given trading operation. Sell also described how some emerging information and analytics technologies (like blockchain and machine learning) are likely to affect risk management operations, and raised the point that these tools and platforms could serve to reduce some kinds of risk exposure, but would not replace traditional risk allocation roles.

Ron Ripple took a deep dive into new crude oil contracts being offered through the International Energy Exchange (INE) in Shanghai, with comparisons to contracts currently offered through NYMEX and ICE. The existence of a potentially highly liquid crude oil contract based out of China and denominated in Chinese currency has implications for global

crude oil markets, whose contracts have been dollar denominated and linked to Brent and WTI in various ways. Volumes on the INE contracts to date appear to have been low compared with existing contracts through NYMEX and ICE, and there is limited evidence that the existence of the INE contract has affected trade or open interest volume. Ripple suggested a couple of possible reasons for the limited influence – first, much trading of the INE contract occurs overnight in order to coincide with trading hours in New York. Second, the INE contract specifies a medium sour crude oil while NYMEX and ICE contracts specify a light sweet crude oil. Ripple concluded that it is too early to tell whether the INE contract is a success or failure, but low volumes compared to other contracts are telling.

ENERGY DEMAND AND BEHAVIORAL CONSIDERATIONS (Plenary Session)

A panel discussion on energy consumption behavior was moderated by Jim Sweeney and featured Karen Palmer (Resources for the Future), Sebastien Houde (ETH Zurich) and Ken Gillingham (Yale University). Each panelist started off with some general observations about energy consumption decisions. Houde focused on purchase decisions for energy efficient appliances and the use of data analytics to get at customer behaviors. Palmer focused on policy choices to encourage energy efficiency consumption behaviors. Gillingham spoke about technology adoption, particularly in transportation choices. Sweeney posed a number of questions to the panel to stimulate discussion. The panel discussed changes in income, demand for electrification in particular, and structural changes to economies and transportation systems as key drivers of energy consumption. Houde in particular pointed out that income is the first-order driver of energy demand, so as countries become richer their citizens will demand more energy. There is also a feedback loop where access to energy and electricity are drivers for economic development. The panel session featured a lengthy discussion about the energy efficiency gap – why there are economically worthwhile energy efficiency investments that never get made. Palmer and Gillingham noted that this is one of the bigger puzzles in energy economics – we observe that an efficiency gap exists but we don't really know why it happens. Behavioral biases, lack of access to credit, inattention to future energy prices and discount rates that are hard to capture were all put forth as explanations. This has very important implications for markets, technology and policy. Houde also emphasized the importance for policy and particularly differences in the gap among income levels. The panel also discussed major changes in the demand for transportation (being pushed by ride-sharing services and autonomous vehicles) and electric power (air conditioning, the rise of IT as a large electricity consumer, and even cannabis operations in areas where that has been legalized). The panel discussed how energy innovations can increase or decrease the demand for energy and electric power. Sometimes the direction is difficult to determine. Gillingham brought up how ride-sharing services and autonomous vehicles may wind up increasing the demand for transportation fuels as consumers choose these services instead of mass transit. The panel discussion concluded with a set of questions about policy drivers – how actions in Washington and the decision of the U.S. to exit the Paris accords seem likely to affect energy consumption decisions. Palmer noted that in the absence of strong federal action on climate change some states and regions are moving in this space – particularly states like California and some of the Regional Transmission Organizations that manage the U.S. power grid. Gillingham noted that since many large energy firms are multi-national the policy decisions of one country may not have as substantial of an impact on industry decisions as might be expected. Houde noted that in terms of total global greenhouse gas emissions, aggressive action by Europe was probably not going to compensate for inaction at the federal level by the U.S.

WEDNESDAY, NOVEMBER 15TH

THE BATTERY REVOLUTION (Plenary Session)

The dual plenary session on battery energy technologies, chaired by Benjamin Schlesinger (Benjamin Schlesinger and Associates LLC) brought together an academic whose research has focused largely on integration of battery energy storage into the power grid (Eric Hittinger, Rochester Institute of Technology), a representative from the battery energy storage sector (Jason Burwen, Energy Storage Association) and a legislator from a state that has been trying to take a more aggressive approach to encouraging the adoption of energy storage technologies (Marc Korman, Maryland House of Delegates).

Eric Hittinger's talk began with a question that would seem to have a clear answer – does the grid need energy storage? Hittinger argued that the power grid needs balancing services, particularly as more wind and solar come online. But most of those services now can be provided effectively by natural gas. In one of the more memorable comparisons of the conference, Hittinger pointed out that the competition between natural gas and storage to provide this balancing service is a bit like a fight between “a bear and a shark – which one wins depends a lot on the conditions.” Storage tends to thrive when market prices for electricity are highly variable, while natural gas tends to thrive when the demand for balancing is more consistent. Both Hittinger and Jason Burwen mentioned the falling price of storage may change how it competes with natural gas. Costs are expected to continue to fall and within a decade may make storage an overall cheaper option than a flexible natural gas plant.

Both state and federal policy incentives are critical to energy storage at this stage, as discussed by Marc Korman and also by Eric Hittinger. Korman pointed out that states don't become leaders in storage policy overnight – it is a long process and states are just starting to learn from the leaders in this area. Korman's message that the structure of storage policy impacts investment decisions was also echoed by Hittinger, who noted that co-locating renewables with storage is not really necessary from the grid's perspective, and the growth in solar + storage projects in particular seems to be a function of state policy incentives. Jason Burwen also discussed that the regulatory environment for storage is fairly uneven across states – some have interconnection and rate policies that are favorable while others are quite restrictive.

CHANGING BALANCE OF GOVERNMENT ENERGY POLICY AND REGULATION (Plenary Session)

The changing federal approach to energy policy was a theme that came up time and again at various stages of the conference, so it was appropriate to have a plenary session devoted entirely to this theme. Peter Balash (NETL) presided over a panel of knowledgeable players in the Washington energy policy space, including Travis Fisher (FERC), Dean Foreman (API) and Joseph Balash (Land and Minerals Management). This changing federal policy

landscape, as the panellists pointed out, is inextricably linked to the position of the U.S. as a major global oil and gas exporter, with Dean Foreman noting that the U.S. effectively met the entirety of increased oil demand to date in 2018, and has also been serving an increasing share of rising global gas demand. Multiple speakers noted that in some ways, the role of states in the policy process is changing relative to the role of the federal government. As more oil and gas exploration happens on private lands, the federal government has less of an active role in ensuring domestic oil and gas supply. States have also become very active in the energy policy arena, particularly with respect to natural gas and electricity.

WORKSHOP: ENERGY RISK MANAGEMENT: UNDERSTANDING HEDGING, FUTURES AND OPTION MARKETS

Following the Closing Plenary delegates had the opportunity to attend a workshop on the fundamentals of energy risk management. The session was intended to give attendees insight into the basics of using futures and options contracts as hedging instruments. The session was put on by Alan Levine and Elaine Levin (both of Powerhouse).