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PRESIDENT'S MESSAGE

Energy in all its dimensions!

Oil, nuclear, electricity networks, residential and industrial consumers, energy and environmental policies, technologies, marketing... All these disciplines are fields of researches and studies for IAEE members, but they are also the professions that I have had the opportunity to practice throughout my career that I started in Dhahran, the city where Saudi Arabia's first oil well was drilled. My first contact with IAEE took place at a conference in Washington, DC more than thirty years ago. I never imagined then that I would be called upon to preside over it one day.

Dear members and friends, it is therefore an honor and an immense pleasure to ensure the leadership of this great international institution.

I thank the past presidents, and in particular the last one, David Knapp, as well as all IAEE officers such as our Executive Director David Williams and his team, the chief editors of our publications, for leading IAEE to this state of excellence and for making it a reference for energy economics.

In developing our institution's strategic action plan in 2018, I was able to identify high expectations from the community of energy experts, economists, policy makers, and more broadly from all stakeholders in the global energy system.

To date, our community includes 3900 members in 120 countries. Aware of the extent and diversity of expectations, I want 2019 to be a year of transformations in the services we will provide to the global economy.

- Because we are experiencing an awakening of global geopolitical tensions, new power relations are emerging that are affecting security of supply in the short and long term.
- Because we are aware of the two-way relationship between economic growth and access to affordable energy, all States on the planet must benefit from economic science applied to energy to build their public policies.
- Because new capital-intensive technologies, and in particular RES and perhaps CCUS, are needed in the energy mix, financing needs and market rules should be adapted.
- Because, as responsible energy economists, our duty requires us to look beyond the short term, we must together mobilize opinions and leaders on two priorities: the fight against climate change and the fight against fuel poverty.

Thus, for IAEE to strengthen its effectiveness in its competence areas, several projects will be launched or strengthened:

- Geographical extension: because *'one size does not fit all'*, we must adapt and fight against inequities, especially including Africa with appropriate academic research. After South Africa in 2018, we want to strengthen the community of economists elsewhere in Africa, in Central Asia, in India and in the Middle East,

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President's message (continued)

- The dissemination of our community's research work is necessary to support energy transition projects in different countries. We will strengthen the services provided by social networks that will value and enhance our conferences and publications,
- Close monitoring and enhanced exchanges with the world's leading research institutes will be set up to enhance the impact factor of our publications and our influence on public policies.
- One of our institution main strengths comes from the innovative visions brought to us by the many IAEE PhD students members. As they move to professional life, we want them to remain IAEE members and I will invite them to make it a priority.

Last year, I had the opportunity to meet many of you at our conferences in Pretoria, Athens, Groningen, Washington DC, Baku, Wuhan,...

This year, the IAEE agenda will be framed by several conferences, including:

- The 7th IAEE Latin American Conference in Buenos Aires (Argentina) from 10 to 13 March 2019
- The 16th IAEE European Conference in Ljubljana (Slovenia) from 25 to 28 August 2019
- The 1st IAEE / EVER Monaco Conference: local governance of electromobility in Monte Carlo (Monaco) on 8 May 2019
- The 4th Eurasian IAEE Conference in Astana (Kazakhstan) from 17 to 19 October 2019
- The 1st IAEE Energy Summit in Bangladesh on 21 October 2019
- The 37th IAEE North American Conference in Denver, November 3-6, 2019

IAEE's highlight will be the 42nd International Conference, held in Montreal from May 29 to June 1, on the theme "Local Energy, Global Markets".

All over the world, governance systems are changing and are getting closer to the end consumer. This is why I propose to our community an article based debate on the possible transformations of the energy system: **will the consumer become the master of the game?**

Centralized production and governance leave more room for local production and decision-making. Positive energy territories are being imagined all over the world. The deployment of renewable energies connected to local networks accelerates this decentralization process. What is the declared objective of this decentralization movement? To best meet the needs of each locality and, ultimately, each consumer.

Indeed, the consumer himself is gaining more and more weight in the energy system. It is impossible to think local without taking into consideration the individual, the consumer. Tomorrow's consumer will decide whether or not to install solar panels or acquire an electric vehicle, and manage his or her energy program. V2G" schemes could, for example, substantially modify the power distribution investment priorities. The paradigm shift is therefore great: the final consumer is no longer just a consumer; he produces, when he wants to. The energy board is thus on the verge of being overthrown: the pawn gradually becomes the master of the game.

This phenomenon is further exacerbated by severe environmental constraints. The latest IPCC report, published in October 2018, warns that in 15 years' time, not a single gram of CO2 can be emitted if the target of +1.5°C is to be achieved. These constraints imply not only the mobilization of States, but also of local authorities, companies and citizens. The maturation of CO2 capture and storage technologies, the massive deployment of renewable energy sources and/or the adoption of large-scale energy efficiency measures are also emerging as key technological solutions. Here, taking the consumer into consideration is again decisive. Environmental constraints will probably only increase the role of the consumer in the energy system.

At the same time, a centralized energy planning is probably still necessary. The legitimate aspirations of territories to contribute more to their own energy governance must be taken into account, without compromising solidarity and economic performance at the global level. A balance between the local and the centralized is not impossible.

IAEE MISSION STATEMENT

The International Association for Energy Economics is an independent, non-profit, global membership organisation for business, government, academic and other professionals concerned with energy and related issues in the international community. We advance the knowledge, understanding and application of economics across all aspects of energy and foster communication amongst energy concerned professionals.

WE FACILITATE:

- Worldwide information flow and exchange of ideas on energy issues
- High quality research
- Development and education of students and energy professionals

WE ACCOMPLISH THIS THROUGH:

- Providing leading edge publications and electronic media
- Organizing international and regional conferences
- Building networks of energy concerned professionals

NEWSLETTER DISCLAIMER

Moreover, traditional energy suppliers are gradually moving away from a vision in which supply creates demand. This movement may amplify. Utilities must always better understand the actual end-users' demand, without creating an artificial and non-existent demand. This begins with an evolution of the modelling tools they use, particularly demand foresight tools. These should be bottom-up... if the end-user consumer is put down.

If they are pushed to reform themselves, utilities will therefore retain a preponderant place in the energy system, thanks to their experience and expertise.

Dear members, I propose that you direct some of your research work on these issues so that we can draw up an assessment at the end of 2019!

Finally I could not conclude this first 2019 editorial without thanking the members who gave me their vote; I will try to return all the trust placed in me.

I also thank all Council members whose term in the Council ended last year for their commitment and in particular Gürkan Kumbaroğlu, past President.

The IAEE Council and I remain at your disposal to advance economic science applied to energy and make it useful to our societies.

Christophe Bonnery

Editor's Notes

In this issue we complete our coverage of renewables and begin a review of energy policy matters. Along the way we include a number of articles outside these areas. In this electronic version we carry a number of articles covering recent conferences including the North American, Asian, and Eurasian. Summaries of this issue's other articles follow below.

Sreekanth Venkataraman reports that since its inception in 2009 the Regional Greenhouse Gas Initiative (RGGI) has been very successful in reducing emissions at a faster pace and at a lower cost. However, reform measures are needed to make RGGI more effective in meeting the States' climate action goals.

Pallavi Roy and **Philip Walsh** discuss the potential for urban community energy systems as a solution to growing urban demand for electricity. Motivators for community involvement are identified and some examples of community energy projects highlight collaborative decision-making at various levels of active community participation.

Hisham Khatib outlines his vision of the Energy Future noting that in the future energy market, renewables are going to improve their contribution, mainly at the expense of nuclear, oil and coal. However, their future contribution will be slowed by the lack of foreseeable cheap and large storage facilities as well as the inertia of the existing energy system to slow change".

Jean-Michel Glachant and **Nicolò Rossetto** write that digitalisation revolutionized information and communications, then manufacturing, markets and trade of goods and services. It is now entering the energy world, its infrastructures, its markets structures and transaction rules. And more is to come with blockchains and Artificial Intelligence

Mamdouh Salameh argues that OPEC is an Important Energy Policy tool that helps keep the global oil market and prices stable. He also argues that OPEC is not a cartel and, therefore, the introduction of the bill called "No Oil Producing and Exporting Cartels Act," or NOPEC, is not justified.

Luciano de Castro states that for decades, renewables have been encouraged by government interventions: feed-in-tariffs, subsidies, regulation, taxes/cap-and-trade, etc. He argues that this route has achieved fading success, and now, efforts to promote renewables should increasingly focus on voluntary action, through platforms of collaboration and investment. This rarely pursued direction has yet many fruits to bear.

Emmanuel Falobi notes that Nigeria is well endowed with vast renewable energy resources that can augment the current dearth of energy (especially electricity) supply. He reviews the role of renewables in bridging the current energy demand gap in Nigeria in the face of economic growth demands.

Chen-Hao Tsai and eight other authors report on the Midcontinent Independent System Operator (MISO). MISO has developed a framework to examine renewable integration over a wide range of penetration levels, starting with the current physical infrastructure, operational practices, and regulations of the MISO bulk electric system. The maximum penetration of renewable energy is dependent on the types and distribution of renewable resources, the operational characteristics and locations of other existing assets, and the actions of neighboring regions.

Jonas Grafstrom provides an outline of how technological change in the renewable energy field can contribute to mitigate climate issues. Such knowledge enables policy makers (e.g., at the EU level) to make better and more informed decisions.

Hyun Jin Julie Yu writes that solar PV globalization has changed the nationwide PV innovation system. He provides the economic rationale of international energy transition mechanisms based on solar PV diffusion in new regions. The article demonstrates that a 'virtuous circle' in the PV sector can be produced on an international scale.

Tilak Doshi discusses the political economy since the U.S. exit from the Paris Acgreement and notes that making ends meet today is far more important to the average man on the street than speculative long-term scenarios of climate change which threaten a lower global GDP fifty or a hundred years from now.

Yabo Olanrele and **Pius Okeh** write that Nigeria has persistently remained at the bottom of the world's nations, with low electricity generation and consumption. Yet Nigeria is blessed with an array of renewable energy resources that when properly harnessed can be used to realize the country's power sector goals. To achieve this, major socio-cultural and technological changes are needed along with policies and regulations to ensure a sustained, efficient and effective use of renewable sources and technologies.

CONFERENCE THEME AND OBJECTIVES

Throughout the 150 years of modern energy history, change has been a pervasive driving force in our industry – from the development and deployment of new energy sources to the emergence of more and more diverse uses for energy as fuel and feedstock; the creation of new transport routes and delivery mechanisms to link energy sources to markets, shifting the geopolitical energy map of the world; and the accelerating impact of technological development both increasing our capacity to supply energy as well as to use it ever more efficiently. But in these early years of the 21st century, the pace of change seems to be accelerating as we move ahead into what many have termed the era of energy transitions. Meeting the challenge of providing affordable energy for growing populations while managing the carbon and environmental impact of energy supply and use is a central issue for the 21st century. Solutions informed by the sound application of energy economics will be vitally important in the coming years.

The 37th annual USAEE/IAEE Conference provides a forum for informed and collegial discussion of how these emerging realities will impact all stakeholders – from populations to companies to governments—in North America and around the world.

In 2019, we are taking our conference to the Denver, Colorado area, where oil and natural gas production have been a vital contributor to US energy supply for decades. The state has also strongly promoted energy diversification, particularly into wind and solar power; has worked at collaborative frameworks for energy development embracing the needs of multiple stakeholder interests; and is the home to a strong intellectual and academic tradition of thinking about energy supply, energy technologies and energy markets.

The conference will highlight contemporary energy themes at the intersection of economics, technology and public policy, including those affecting energy infrastructure, environmental regulation, markets, the role of governments, and international energy trade. Participation from industry, government, non-profit, and academic energy economists will enrich a set of robust, diverse and insightful discussions.

www.usaee/usaee2019/

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USAEE United States Association for Energy Economics

IAEE International Association for Energy Economics
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TOPICS TO BE ADDRESSED INCLUDE:

The general topics below are indicative of the types of subject matter which may be considered at the conference. In practice, any topic relating to energy economics, markets, energy policy and regulation, energy trade, energy pricing, drivers of energy demand, adoption of new energy technologies etc. will be considered.

- Global impacts of growing US energy exports
- How are energy markets responding to the shift of U.S. energy policy?
- Pathways to decarbonization of energy and the econony
- Oil prices, the role of OPEC and OPEC/ non-OPEC cooperation
- Energy implications of environmental regulations: future and impact
- The role and impact of distributed energy resources in developed and developing countries
- How are digital technologies, including blockchain and artificial intelligence and the Internet of Things impacting energy supply and demand
- What next for electricity storage technologies?
- Drivers and challenges for accelerated electric and autonomous vehicle adoption
- Effective policies to support growth in low-carbon energy
- The role of natural gas in the energy transition to a low-carbon world
- Other topics of interest including shifts in market structures and fundamentals, including those induced by policy and technological forces.

ADVANCE CALL FOR CONCURRENT SESSION PRESENTATION PROPOSALS

We are pleased to announce an advance call for Concurrent Session presentation proposals for the 37th USAEE/IAEE North American Conference, Energy Transitions in the 21st Century, to be held November 3-6, 2019 at the Omni Interlocken Hotel in Denver, Colorado, USA.

THE DEADLINE FOR RECEIPT OF PROPOSALS IS **MAY 31, 2019.**

CONCURRENT SESSIONS

The concurrent sessions at the USAEE/IAEE conference offer opportunities for students, academic staff, as well as energy economists and practitioners in the business, government and research communities to present current analysis, research or case-studies on topics related to energy economics and energy markets. Presentations may be based on academic papers, but this is not a pre-requisite requirement. We stipulate that presentation proposals submitted for inclusion in the concurrent sessions should not have been previously presented at or published by USAEE/IAEE or elsewhere. Presentations are intended to facilitate the sharing of both academic and professional experiences and lessons learned. Presentations should not advertise or promote proprietary products and/or services. Those who wish to distribute promotional literature and/or have exhibit space at the Conference are cordially invited to take advantage of sponsorship opportunities – please see www.usaee.org/usaee2019/sponsors.html Those interested in organizing a concurrent session should propose a topic and possible speakers to David Williams, Executive Director, USAEE (usaee@usaee.org). Please note that all speakers in organized concurrent sessions must pay speaker registration fees and submit abstracts.

Concurrent Session Presentation Proposal Format

Authors wishing to make concurrent session presentations must submit a proposal that briefly describes the topic, research or case study to be presented.

The proposal must be no more than two pages in length and should include the following sections:

a. Overview or summary of the topic including its background and potential significance
b. Description of the context, data used, or illustrative example of the topic
c. Summary of key insights, results or further questions
d. Conclusions: Lessons learned, business or market implications, recommendations for further work

Please visit www.usaee.org/USAEE2019/PresentationProposalTemplate.doc to download a proposal template. All proposals should conform to the format structure outlined in the template. Proposals should be submitted online by visiting www.usaee.org/USAEE2019/submissions.aspx Proposals submitted by e-mail or in hard copy will not be processed.

Presenter Attendance at the Conference

At least one presenter of an accepted concurrent session presentation proposal must pay the registration fees and attend the conference to make the presentation in person. The person submitting the proposal must provide complete contact details—mailing address, phone, e-mail, etc. Presenters will be notified by July 12, 2019 whether their proposal has been accepted. Presenters whose proposal are accepted will have until August 23, 2019 to submit their final papers for publication in the online conference proceedings. While multiple submissions by individuals or groups are welcome, the proposal selection process will seek to ensure as broad participation as possible: any person may present only one topic at the conference. No person should submit more than one proposal as its single author. If multiple submissions are accepted, then a different presenter will be required to pay the registration fee and present each paper.

www.usaee/usaee2019/

STUDENTS

In addition to the opportunities described at left, students may submit a paper for consideration in the **Dennis J. O'Brien USAEE/IAEE Best Student Paper Award Competition** (cash prizes plus waiver of conference registration fees). The paper submission has different requirements and a different deadline. **The deadline for submitting a paper for the Student Paper Awards is June 28, 2019.** Visit www.usaee.org/usaee2019/bestpapers.html for full details.

Students may also inquire about scholarships covering conference registration fees. Please visit www.usaee.org/usaee2019/scholarships.html for full details.

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CAEE

AMEE

Istanbul Autumn School a Success

The IAEE Summer School series continued with an Autumn School in Istanbul on the topic "Financial and Regulatory Risk in Energy". The two-day program took place on 21-22 October 2018 at the Boğaziçi University campus with renowned lecturers from Turkey, Norway and the United States. Professors Ilhan Or, Cem Avcı and Gönenç Yücel from Boğaziçi University, the Group Risk Manager of the Istanbul Energy Exchange EPİAŞ, and Alper Uğural, the CEO of Energy Pool Turkey were among the Turkish lecturers. The lecturers from Norway and the United States were Professor Nils-Henrik von der Fehr from University of Oslo and Glenn Labhart, partner of Labhart Risk Advisors Inc. The closing panel was chaired by Mustafa Karahan, Board Member of the Istanbul Energy Exchange EPİAŞ.

The IAEE Autumn School attracted participation from Brazil, Canada, Croatia, Indonesia and Turkey. The first day provided the necessary theoretical background while the second day was more practice-oriented including various case studies. The closing panel elaborated on a wide range of financial and regulatory topics in energy ranging from energy markets to geopolitics. Risk analyses were focused on both natural gas and electricity.

A total of eight lecturers taught in the 2-day intensive program who received their plaques of appreciation and gifts during the closing ceremony, followed by the certificates given to the attendees. A gala dinner at Kennedy Lodge with great view on the Bosphorus completed the social program. Overall, the IAEE Istanbul autumn school was marked by happy faces and pleasant feedback.

"I am new to Energy risk and have learned a great deal over the last few Days. I found the course to be organized and the content to be very relevant and beneficial as I work toward writing the GARP energy exam in the Spring."
Amanda Donohue, *Indep. Risk Analyst, Canada*

"The Autumn School on Financial and Regulatory Risk in Energy was a wonderful opportunity for us to dive into diverse issues related to Energy Economics and Electricity Trading.
The panelists, experienced professionals from three distinct continents, gave us a wonderful and broad view of energy scenarios on different parts of the world, besides discussing the future perspectives of the global energy scene.
On top of that, the course took place in one of the most beautiful spots on earth, the majestic city of Istanbul, within Turkey's most respected educational centre: The Bogaziçy University."
Virginia Parente, *President, Brazilian Association for Energy Economics, Brazil*

"It was great to see the differences of the Energy market risks in three countries; USA, Norway and Turkey. The risks on Energy market was clearly discussed in every aspects by multinational and very knowledgeable trainers."
Haluk Sayar, *General Manager, ENR-G Energy Consultancy*

Are Community Energy Systems the Solution for Growing Urban Energy Demand?

BY PALLAVI ROY AND PHILIP R. WALSH

Cities, the drivers of economic growth, are also major consumers of energy. Urban regions of the world hold over half the population of the earth and account for two-thirds of the primary energy demand.[1] Almost none of this energy is produced anywhere in or near the city but with technological advancements in renewable energy generation, the potential exists to meet some of this demand. As the price of modular and small-scale energy technologies fall, urban renewable energy options have increasingly become cost competitive with traditional sources such as centrally- generated electricity, natural gas, coal and diesel. According to the International Energy Agency, buildings in urban areas can provide space for local generation utilising solar photovoltaic (PV) arrays with the technical potential to provide up to 32% of urban electricity demand.[2] However, this sector is in a nascent stage and needs a further push for wide-scale adoption in urban environments. For urban consumers of electricity, the norm has been to rely on the provision of energy services by large energy companies and public utilities. This reliance has meant that most city dwellers are unaware and unsure of adopting renewable energy technology as an option for supplying their electricity needs. The concept of community energy systems, and the various models that have been developed for these systems, may be the answer for urban adoption of renewable energy.

With community energy, the idea is to create sustainable energy systems that improve economic, social and environmental conditions. These objectives can be achieved by involving more people in the profit sharing and empowering them to be involved from an early point in projects. Projects that do involve community ownership—through financial investment or managerial control by or on behalf of groups of 'members of the public'—have achieved this to different degrees and in different ways, mostly in the developed areas of the world. Some advantages of community energy projects include:

- New sources of capital in the local economy
- Energy costs that are locally spent, strengthening the local economy and creating jobs
- Less NIMBYism for renewable energy projects
- Promotion of community engagement and social interaction
- Reduction of greenhouse gas emissions from the use of energy from fossil fuels

In this article, we identify various motivators for community involvement and provide some examples of community energy projects with collaborative decision-making at various levels of active participation. Community energy projects empower participants not just to be consumers anymore but be prosumers, by generating their own energy and even selling to the grid or other adjacent communities. A number of European countries have been supporting the community and locally owned energy concept for some time now. Scotland set a target of 500 Megawatts (MW) of community-owned energy production[3] that was achieved in 2015 and in that same year Germany had over 770 energy co-operatives producing renewable energy.[4] The co-operative approach can be a solution to the challenges of financing renewable energy projects by presenting a reasonable business model that raises capital from private individuals and provides a return on that investment. However, return on investment alone may not drive adoption of community energy projects and it is important to recognize that other factors can motivate people to adopt local community generation. Table I summarizes the motivations that are important in encouraging positive attitudes and participation in community energy projects.

With community energy, the idea is to involve more people in the profit sharing, by empowering them to be involved from an early point in projects. Projects that do involve community ownership—through financial investment or managerial control by residents of the community or on behalf of those residents—have achieved this to different degrees and in different ways. The legal and financial models of ownership fall into three broad categories of community ownership; developer or municipally-owned with citizen participation in the form of investors (Community Direct Investments), community organizations in partnership with a private party that owns and manages development (Joint Ventures), and energy projects owned and managed by the community

Motivation	Description
Financial	Reduce energy bills, make money from selling energy, increase of property value
Environmental	Be more green, reduce GHGs
Security of supply	Not facing outages, future high costs of electricity and be more energy independent
Uncertainty and trust	Use of an innovative or high end technology leading to trust
Social norms	Following others' examples as well as being sensitive to the opinion of others

Table 1 Motivations for participation in community energy projects (after Dóci and Vasileiadou, 2015)

Philip Walsh is a Professor in the Center for Urban Energy, at Ryerson University, Toronto, Canada. **Pallavi Roy** is a student at the university. Dr Walsh can be reached at prwalsh@ryerson.ca

See foototes at end of text.

(Community-Owned and Managed). Figure 1 provides a visual representation of the spectrum of citizen participation in community energy projects.

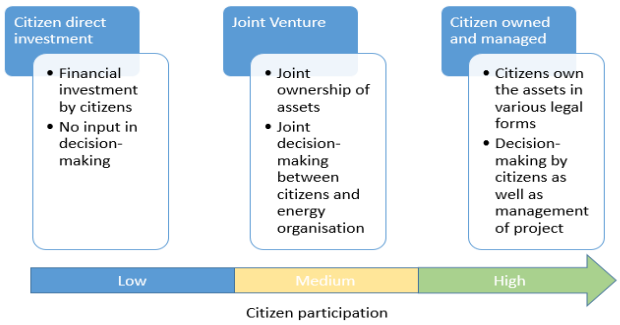

Figure 1 Spectrum of citizen participation in community energy

Table 2 provides examples of different types of community-owned renewable energy projects and we will focus on one example from each.

Project type	Project	Country	Project description
Community-owned and managed	Jühnde bioenergy village	Germany	Community-owned. Energy utilized to heat the village.
	Glimminge Vind	Sweden	Real estate commune
	Amsterdam Zuid	The Netherlands	Community owned solar collective
	Brooklyn Microgrid (pilot)	US	Individual ownership of resources who then supply to other peers
Joint venture	Middelgrunden Wind Cooperative	Denmark	50% owned by the 10,000 investors in the Middelgrunden Wind Turbine Cooperative, and 50% by the municipal utility company. Energy sold to the grid.
	Earlburn Wind Farm	Scotland	Joint venture between company created by the community and the developer.
	Neilston Community Windfarm	Scotland	This is a 4 turbine, 10 MW joint venture between the Neilston Development Trust and Carbon Free Developments Ltd. The trust owns a 28% stake, that can be increased to 49.9%.
Community Direct Investment	Sacramento Municipal Utility District (SMUD): SolarShares Program	US	Utility owned, community members buy shares.
	Solar community energy project in Recklinghausen	Germany	Small company ownership structure with shares owned by investors. Energy sold to the grid.
	Frieamt	Germany	Village of nearly 4300 residents which owns many different types of generation technology. Private company ownership structure with over 200 shareholders.

Table 2 Examples of different community owned project

Example of Community Owned and Managed

The Amsterdam Zuid project is a leading example of an urban community energy project, led, managed and owned by citizens themselves. A community located in the south of Amsterdam, this is a floating community consisting of about 80 houseboats, some of whom have been resident in the area since the 60s. With the government launching a solar subsidies program in 2008, a few of the houseboat owners were interested in purchasing solar photo-voltaic (PV) panels for their personal use. They set about recruiting others with the help of the local association. Social networks played a key role in getting more individuals to join the project. Policies were the key drivers for the investment decision by individuals, these included a tax exemption program called *Saldering (meaning balancing in Dutch)* that guaranteed that up to 5000 kW h/year the behind-the-meter produced electricity is exempt from VAT and energy tax.[5]

Example of a Joint Venture

While community owned and managed systems are exciting, not everyone is interested in managing projects. The joint venture approach allows for a community organisation to partner with a developer who then manages the project on behalf of the community. The Middelgrunden wind farm in Denmark is an example of a community-developer energy project. At the time of construction, it was the largest offshore wind farm consisting of 20 turbines at 2 megawatts (MW) each providing approximately 3% of Copenhagen's electricity needs. The Middelgrunden Wind Turbine Cooperative, with roughly 10,000 members, owns ten turbines, while the remaining ten turbines are owned by Ørsted A/S, a Danish energy company and project operator.

Example of Community Direct Investment

With the direct community investment model citizens are investors only in the community energy project with no involvement in the day to day running of the project. A good example is that of the solar community energy project in Recklinghausen, Germany where it was recognized that public roof surfaces in cities could be easily used for the generation of electricity and heat. The citizens of Reklinghausen decided to exploit this potential with a community power project that, since July 2011, has fed electricity from three solar photovoltaic (PV) systems into the power grid. The plant produces approximately 195,000 kWh of electricity per year. The city of Recklinghausen supports the initiative by the lease of the roof surfaces for the PV facilities with an invested cost of approximately €250,000. The project was 100% financed by the local community with participation starting at a minimum investment of €500 and an average investment of €3,300. In total three GbRs (Gesellschaft bürgerlichen Rechts – Companies of Civil Law) were established to own and notionally manage the project put it was the establishment of a union (Verein) SolaRE e.V. that was responsible for the construction and operation of the PV systems for the benefit of the three GbRs, each containing 70-80 citizens who provided the financing and receive the produced electricity.

The future?

While examples exist of successful community energy projects, it needs to be recognized that

(continued on page 12)

RGGI: Not a Proven Template for State Action Yet

BY SREEKANTH VENKATARAMAN

Since the launch of the Regional Greenhouse Gas Initiative (RGGI) in 2009, the North Eastern States and the Mid-Atlantic States have seen a significant reduction in the emissions of carbon dioxide and other pollutants emitted by the power sector. At the same time, the region has also reaped significant economic benefits. Through 2016, RGGI states had reduced CO2 emissions from covered power plants by 40% from 2008, the year before RGGI's program began. RGGI has demonstrated that emissions can be reduced faster and at a lower cost than typically assumed. Against the backdrop of the declining emissions, the RGGI state economies have outpaced the rest of the country demonstrating that climate change mitigation and economic growth can co-exist.

However, despite the impressive achievement of RGGI, it is not a finished product yet. Further changes and reforms are needed if RGGI aims to serve as a template for state action and be an example for its capacity to clean up the power sector while benefiting consumers. In the absence of the Clean Power Plan (CPP), RGGI becomes even more critical to a carbon free future.

Over the past few years, various NGOs and advocacy groups have strongly stressed the reforms needed for RGGI to be even more effective in reducing emissions and meeting the State's climate goals. The three key reforms that the RGGI states have been urged to adopt are:

a. Correction of the cap reduction trajectory to attain the necessary long-term reductions;

b. Restructuring or removal of the cost containment reserve to achieve the emission reduction targets;

c. Extending the RGGI cap to at least 2030 to provide clarity to the market.

While the above proposed reforms are certainly critical, the reforms are not limited to those alone. The objective of this paper is to bring into focus other areas of concern; while these concerns have been highlighted in the past, they have not been much in the forefront of the discussions on the reforms required.

- *Assumptions in the reference case need to be reworked*: RGGI states need to correct some of the assumptions in the reference case that they use to help understand the level of effort needed to achieve future RGGI caps. Firstly, the RGGI states need to account for the newly extended renewable energy tax credits that will drive significant investment in solar and wind energy. These tax credits are poised to bring another 50-55 GW of renewable energy nationally. The additional clean energy deployment will lower emissions and carbon prices.
- This will go a long way in making RGGI compliance less expensive. Secondly, the RGGI States need to use a more realistic assumption about renewable energy costs. The states have tended to rely on the cost estimates provided by EIA, who have always erred on being at the higher end. The States instead need to rely on the cost estimates provided by EPA who use more accurate prices used by National Renewable Energy Lab. Lastly, the RGGI states should ensure that their reference case also accounts for other RGGI state's clean energy policies that will make it even easier to meet a more ambitious RGGI cap. Most states like New York and Massachusetts have an independent renewable energy standard and an energy efficiency program. These programs will reduce carbon emissions independently of RGGI, thus making it easier to meet a future RGGI cap.
- *Current treatment of offset is likely to lead to illegitimate flow of offset credits*: RGGI States also need to have a relook at how they treat the offsets. Currently, RGGI uses standards approach as opposed to a performance-based approach for developing offsets and further limits offsets to 3.3% of source's allowance submission. This percentage is very low when compared to California's cap and trade program. The bigger concern with respect to the way the offsets are treated relate to the project types, which are:

  Landfill methane reduction;
  Sulphur hexafluoride reductions from certain industrial activities;
  Specific energy efficiency projects;
  Avoided methane from manure management practices;
  Forest questration projects.
- The number of project types for which offsets are not only limited (when compared to some Federal proposals) but also raise some concerns on the legitimacy of the emission reduction from the offset projects. If illegitimate offset credits flow into the emission trading program, the program could well cease to be a success.
- *Emissions Leakage can seriously undermine the program effectiveness*: Energy imports from non-RGGI states, a critical design detail, remains an

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issue of concern as it could lead to emissions leakage. The RGGI regime does not regulate emissions generated outside the region. The increase in electricity generation due to electricity imported from outside of RGGI States could well negate the emission reductions achieved by RGGI States. In one of the recent monitoring reports, which was published in August 2015, it was revealed that the electricity generation from non – RGGI sources increased by about 10% between 2011 and 2013 as compared to the period between 2006-2008. This increase in electricity generation was due to a 30% increase in the imports of electricity from non-RGGI states.

- Carbon neutrality of bio energy is a myth: RGGI currently treats bio energy as if it has zero carbon emissions. However, this is a myth. It is increasingly recognized that the day to day stack emissions from bio electricity plants exceed those of fossil fueled plants. Not reporting bioelectricity's carbon emissions will lead to a huge discrepancy between reported emissions and actual emissions. The expectation that it would take 45 years to offset emissions from a boiler using mixed wood as compared to a coal fired plant compounds the fact that the carbon emissions from biomass are more than a fossil fired plant. The equivalent carbon debt pay-off time relative to a natural gas plant is expected to be more than 90 years.
- The RGGI model definition of "eligible biomass" is not sufficient to ensure lower carbon emissions and a shorter carbon debt pay off time. It is important to realize that materials produced under federal, state, or private "sustainable" forestry programs do not necessarily lead to atmospheric carbon dioxide reductions within the relevant timeframe. The sustained yield forestry regulations and the private certification programs may ensure that overall growth exceeds harvest. However, that does not mean, that they can certify the carbon neutrality of biomass or can guarantee against net transfers of forest carbon to the atmosphere as compared to the outcome in the absence of biomass generation.
- The fundamental problem with the way biomass emissions are treated by RGGI states is that there is incompatibility between forest carbon offsets and bio energy. If increasing biomass is seen as a means for taking carbon out of atmosphere, by default, it means that bio energy emissions are not carbon neutral and hence should not be treated as such.
- Environmental justice needs to be integral to RGGI planning: RGGI needs to take cognizance of the fact that certain communities are at greater risk of climate change than others due to carbon emissions by the power plants. Therefore, RGGI needs to make environmental justice central to their planning and make sure that the communities that are at greater risk have a greater say in the way the RGGI policies are implemented and how funds are distributed by the states that are overburdened with the impacts of carbon emissions. This will ensure racial and economic equity in the application of emission reduction policies.
- RGGI modeling needs to be more inclusive: While the electric sector accounts for roughly two-thirds of the carbon emissions, the emissions from the transportation and the building sectors are not-insignificant. It is imperative that RGGI modeling is more inclusive and considers the emissions from transportation and the building sectors. In the absence of a more inclusive modeling exercise, the effectiveness of regional cap and trade programs like RGGI in helping the Federal Government meet their climate change obligations is going to be significantly diminished.

	Carbon emitted per MMBtu heat input	Facility Efficiency	MMBtu heat input required per MWh	CO_2 emitted per MwH	Biomass emissions (as% of emissions)
Gas combined cycle	117.1	0.45	7.4	883	343
Gas steam turbine	117.1	0.33	10.4	1,218	249
Coal steam turbine	205.6	0.34	10.15	2,086	145
Biomass steam turbine	213	0.24	14.22	3,029	

Table: Modeled carbon dioxide emissions from utility gas, coal, and biomass facilities
Source: Partnership for Policy Integrity (2011)

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The Future of World Energy

BY HISHAM KHATIB

Influencing factors

There are a few distinctive features relevant to the energy system which are going to influence its future

- The inertia of the energy system (political as well as economic). This is going to slow change (due to its size, huge existing assets embedded in the system, and enormous investments required if a low carbon world is to be achieved). Reshaping existing energy practices will take years and years.
- The existence of large reserves of currently relatively low cost, tradable and highly efficient naturally available fossil fuels.
- Money is becoming more expensive. Investors in highly capital energy projects are becoming more cautious (particularly global oil companies).
- Existing, but also growing, powerful environmental lobbies.
- There are real concerns about global climatic change and its potential consequences, but also uncertainties, which require carefully considered precautionary policies and actions.
- The IEA estimates cumulative global energy supply investment over the period 2016-2040 at $50 trillion (2015 $). Only 18% are in low carbon technologies.
- Large numbers of people remain unable to access electricity and other modern energy services.

The Future

All this is leading us into:

The powerful growing environmental lobby

This is strong (locally and globally) and it is getting stronger. It involves many well-intentioned people, organizations, and vested interests.

It is going to (slowly but surely) change the energy mix by negatively affecting the future share of fossil fuels (mainly coal). The speed and costs of shifting to a low carbon future remain uncertain, but there will be those adversely affected as well as beneficiaries. Insufficient attention is paid to costs and uncertainties – the latter including uncertainties about the scale and direction of global climatic change.

The proliferation of renewables, and it is gaining an unjustified share of the power market.

This is driven by the globally powerful "clean energy lobby".

The future of RE will continue to be uncertain due to the absence of economic storage on the required scale. The intermittency of wind and solar, the need to locate wind turbines and solar panels in optimal locations, and the desirability of transmitting the resultant energy flows to points of final consumption will provide ongoing challenges for lowering the costs and raising the efficacy of these forms of renewable energy. Exploitation of biomass and biofuels will raise challenges for sustainable development more widely. Other possible avenues, such as exploitation of hydrogen and wave power, have scarcely begun.

Vested financial and political interests can be expected to continue seeking ways of manipulating opinion and public finances.

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The demise of nuclear (in OECD countries)

Nuclear power (with proper regulatory measures) is very expensive > $10,000 /KW.

No rational OECD investor is going to put his money into nuclear where much cheaper and safer alternatives exist.

Nuclear, assisted by state subsidies, may continue to grow in centrally planned economies.

Overall nuclear share in the energy mix seems likely to continue to decline.

Decoupling of energy/the economy

The growth of the global economy is becoming less closely aligned to similar or proportional growth in energy use.

This is mainly due to technological advancement, the awareness and introduction of more efficient energy apparatus, particularly in lighting (LED). The emergence of non-traditional energy sources, particularly cheap shale gas; and an increasing share of cheap NG in the energy mix (CCGT), mainly at the expense of coal and nuclear.

Oil demand is going to continue to be strong or weaken only slowly. It is relatively abundant (at least for the next twenty years or so), highly efficient and tradable, and easy to use and handle. The world's vehicle fleet, especially of private passenger vehicles, is currently overwhelmingly dependent upon oil products. Electric vehicles will increase substantially in number, but the availability of electricity, the proximity of charging points, and the accessibility of vehicles with adequate ranges without re-fuelling, will continue to pose significant hurdles.

Electrification of (light) transport

This is likely to happen as indicated, so in a slow and orderly manner (not in a revolutionary way).

There are now one billion ICE cars on the roads.

These are not going to disappear, even in the very far future. But what about marine, air and heavy transport vehicles?

Do not write the ICE off. 2019 is likely to see the commercialization of the new energy efficient "Spark Controlled Compression Ignition (SPCCI)" cars. Less emissions, 18-20 kms./lit. Not far from EV but much cheaper and no range limitations.

Transport electrification is going to improve the fortunes of RE.

U.S. as an energy exporter

The U.S. is going to be a sizeable energy exporter (particularly for LNG) with wide political and global energy implications.

The Arabian Gulf is likely to become less important as a global oil and natural gas exporter.

Energy poverty

This term is defined as people who do not have access to modern energy services.

Over 2.5 billion people remain largely reliant upon, or are heavy users of, traditional biomass.

Over 1 billion people still remain without access to electricity, although since 2010 that number has been falling by over 100 million per year. Those still enduring energy poverty are mainly in India and elsewhere in South and South-East Asia; and in sub-Saharan Africa. These include some 240 million in India, some 350 million elsewhere in Asia (for China where the figure is reportedly under 10 million), and some 550 million in sub-Saharan Africa (Nigeria 80 million; Congo 68 million; etc.)

Energy/electricity poverty is declining slowly but surely.

Main impediments for its elimination are the investments required to provide sufficient power generation capacity and transmission, accessibility to and in remote areas, affordability, inadequate policies and regulations, and lack of institutional support and financing for potential off-grid suppliers.

The rather different concept of fuel poverty – usually defined as where household fuel consumption costs exceed 10% of household income – is a growing burden on families in many European countries.

The Evolving Utility Scene - The growing influence and participation of consumers

The slowly but surely evolving utility scene from command and control into consumer participation and partnership.

No more monopolies but peer-to-peer partnership (p2p). Partnership between the producer and consumer. Creating proconsumers and reproducers as well. `

Future prices of energy/oil

Investments in oil and gas production amounted to $700 billion in 2014. In 2018 it is expected not to exceed $400 billion.

Declining investments in the oil and gas sector worldwide (particularly by large oil companies) plus the political instability in the Iran/Gulf area means a tight future for oil production which also means that future oil prices will remain high.

Roy and Walsh: *Are Community Energy Systems the Solution for Growing Urban Energy Demand?* Continued from page 8.

regulatory and institutional support is crucial and that the multiplicity of jurisdictional governance associated with electricity generation, transmission, and distribution means that no one community energy model can necessarily be generalized. Add to that the complexity of urban energy infrastructure, and the need to refine the urban consumer's culture of energy, and the path towards cities made up of self-reliant yet inter-connected energy communities remains a long one.

Footnotes

[1] International Energy Agency [IEA], 2016

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[3] Government of Scotland, 2015

[4] German Federal Ministry for Economic Affairs and Energy, 2015

[5] https://www.hieropgewekt.nl/kennisdossiers/zelflevering-saldering

The Digital World Knocking at Electricity's Door: Six Building Blocks to Understand Why

BY JEAN-MICHEL GLACHANT AND NICOLÒ ROSSETTO

Highlights

- Digitalisation is invading the electricity sector. How will it play out? Six building blocks, grouped into three categories, can provide the analytical framework required to navigate through the emerging digital world and the transformations that are taking place in the electricity sector.
- Digitalisation builds on changes in infrastructure. Billions of digital devices interconnected by the internet provide the facilities to access the digital world and the multitude of digital products (building block one). Digitalisation also transforms physical networks in other industries and make them smarter, either to perform existing activities or to offer new and more interactive services (building block two).
- Digitalisation involves changes in markets too. A growing number of products are purely digital and the platforms providing them cannot be bypassed by consumers (building block three). Other digital platforms operate in two-sided markets: they do not create the product but act as intermediaries facilitating interactions between the sellers and the buyers of goods and services that are not necessarily digital (building block four).
- Digitalisation is a transformative process whose frontier is constantly moving. New technologies like the blockchain can offer disintermediated peer-to-peer transactions to digital communities (building block five). On the contrary, artificial intelligence and the Internet of Things (IoT) can become unavoidable and automated intermediaries, replacing direct human involvement in thousands of decisions concerning the management of vast sets of assets (building block six).

Introduction

Digitalisation is one of the main trends of today's world. A clear understanding of its implications for markets, business models and public policies is still in the making.

In this policy brief, we identify six fundamental building blocks that are driving digitalisation. They are (see Fig. 1):

1 infrastructure changes, which encompass the deployment of proper digital infrastructures, and the deployment of smart infrastructures internal to bricks-and-mortar networks;
2 market changes, which include the platforms for direct digital production and consumption, and the platforms for interaction within two-sided markets;
3 the digital frontier, which encompasses digital communities with disintermediated peer to peer (P2P) transactions, and virtual resorts for artificial intelligence (AI).

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See footnotes at end of text.

Building blocks one and two: infrastructure changes

The first building block is the deployment of "proper digital infrastructures" with the capability to transform data and pieces of information into series of zeros and ones that can be read, processed, combined, stored, transmitted, received and injected into a decision-making process, be it automated or managed by a human. This deployment started in the 1960s and 1970s with the early, expensive, disconnected and not user-friendly mainframes. It accelerated in the 1980s and 1990s with the first personal computers and the birth of the "internet", linking all the local digital networks. It is now proceeding at full speed with the introduction of billions of smartphones and tablets, plus optic fibre cables, Wi-Fi, 3G/4G wireless channels and cloud computing. This set of infrastructures, so different from that of 30 years ago, is ubiquitous and, in a sense, universal: Internet and the Android-iOS duopoly are interconnecting all the various "particular universes" of different devices, software and alternative operating systems and making them interoperable.

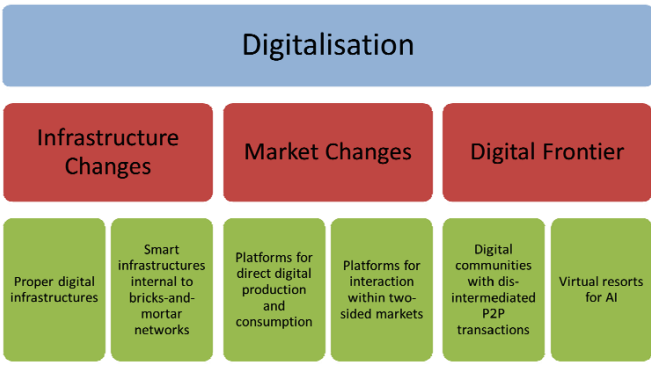

Fig. 1: The six building blocks to understand digitalisation.

Although essential, proper digital infrastructures are not the full story. Digitalisation also entails the deployment of "smart infrastructures internal to bricks-and-mortar networks". The following example is striking. Over the past decades, airline companies have digitalised their physical activities by enabling the sale of tickets and the fulfilment of check-in procedures online; they have also equipped their aeroplanes with sensors and control devices, making

things such as predictive maintenance and automatic piloting possible. All of this represents a form of "back-office digitalisation", where physical assets and their operation become smarter and may allow better and cheaper delivery of pre-existing services. However, smart infrastructures can also re-frame the way assets are managed and used in the production process, ensuring the delivery of innovative and highly customised services not available before. A case in point of this more "transformative digitalisation" is the home delivery loop for online shopping that companies like Amazon have developed thanks to the full integration of digital technologies in their warehouses and distribution fleets.

These infrastructure changes allow growing interconnection and interactivity, cost reductions, increases in service quality and safety, more targeted offers and innovative solutions appreciated by customers. At the same time, they also pose privacy and cybersecurity threats and raise, in combination with the market changes described below, issues such as customer discrimination, market power and concentration.

Implications for the electricity sector

Computer terminals, price algorithms and the internet have already changed the electricity sector in the 1990s, by enabling the development of the first wholesale markets, as the Power Pool in Britain or PJM in the U.S., and their effective combination with system operation.

Sensors and control devices have been deployed on top of electricity grids, first at the transmission level and later at the distribution one. They form the by now traditional smart grids which look more like back-office digitalisation of the classical electricity system and markets. Smart grids and smart meters "1.0", for instance, allow distribution companies and energy suppliers to reduce the cost of metering consumption and to detect electricity thefts better. They do not create a universal, interconnected space of operation, and – more importantly – they do not offer radically new services or personalised options to consumers.

A new wave of smart grids and meters is now coming.[1] It is conceived to address radical novelties that are popping up, such as distributed generation, decentralised storage, micro-grids, electric vehicles, smart buildings and cities. This "smart grid 2.0" may lead to a profound transformation of the business model of electric utilities. However, progress so far has been slow – most of the smart meters being rolled out are still relatively "dumb." Meanwhile, the digital revolution seems to be brewing somewhere else: instead of the public grid, it may target the space "behind the meter" and disrupt the traditional system from there.[2]

Building blocks three and four: market changes

Digitalisation brings profound novelties for markets. New trade arrangements and marketplaces emerge online when the production and consumption of digital products become more important and valuable in economic terms. The key concept here is that of platforms which come in two types.[3]

The first type is represented by "platforms for direct digital production and consumption". Digital products are provided to and consumed by the users directly on the platforms. Classic examples are internet search engines, e-mails and instant messaging, online voice calls, data storage, digital maps, e-books and e-journals, online videos and audio tracks, etc. Providers may be for-profit organisations or not, like Wikipedia, and consumers cannot bypass them to access the "ready to use" digital products: they can, at best, replace one specific provider with another (e.g., substitute Gmail with Yahoo! Mail). Within this category we distinguish:

- "fully centralised" platforms like Google Search and Google Maps, where the digital provider is the only producer of the product being consumed on the platform;
- "half decentralised" platforms like Gmail, Twitter, Instagram or Wikipedia, where users interact to co-produce the digital product being consumed within the digital frame provided by the platform.

In the digital world, other platforms are "platforms for interaction within two-sided markets". They do not produce anything to be consumed directly on them, but act as specialised intermediaries, bringing together buyers and sellers of goods and services that are not necessarily digital. These platforms for interaction offer a digital marketplace, permitting to display/search for a particular product, to present/identify the product characteristics, to select/locate a trading partner that can be trusted into the delivery and settlement process, etc. Here again, we distinguish:

- "low interaction" platforms which operate as a search engine coupled to a "home delivery loop" (typical of Amazon) or to a "direct online use" (as it is the case with Apple Music and the Apple App Store);
- "high interaction" platforms which address, via sophisticated information and incentive mechanisms, the deadlock between buyers and sellers that George Akerlof – Nobel laureate in economics in 2001 – identified as frequently arising due to information asymmetry and transaction costs.[4] These high interaction platforms represent the backbone of the sharing economy and allow companies like Airbnb or BlaBlaCar to thrive.[5]

Implications for the electricity sector

Digitalisation clears a path towards new arrangements for electricity trade. It did so 30 years ago when the previous wave of digitalisation made the establishment of wholesale markets feasible. It is doing so again today. First, we have online retail via digital

apps, where a customer can sign a supply contract and pay its bill entirely online. These applications look like the centralised digital platforms for direct production and consumption. They represent an interesting novelty, although it is not yet clear whether online suppliers with a light asset base can survive competition from more traditional market players.

Aggregators embody the next big novelty. They act as digital intermediaries, centralising the interactions between the wholesale market and the demand for balancing, or between the grid operators and the consumers. By aggregating the demand response or the electricity production of thousands of grid users, they reduce transaction costs and make possible exchanges that individually are not economically sensible.

Platforms for two-sided markets are possible and are emerging too. Although still at the demonstration stage, electric utilities in New York are developing distributed system platforms. Following the roadmap for "open grids" issued by the state authorities, they aim to provide a marketplace where buyers and sellers can manage, as they wish, their affairs for a full range of new products.[6] Going one step further, high interaction platforms could emerge and create trust among users, thereby making peer to peer (P2P) transactions related to self-produced energy, decentralised storage, electric vehicle charging stations and the like possible.

Building blocks four and five: the digital frontier

The last pair of building blocks represents the digital frontier, something more notional, being on the edge of both practice and knowledge. Nevertheless, so many radical innovations have already become a reality in the 21st Century that we should not restrain ourselves from looking in this direction.

Our fifth building block is "digital communities with disintermediated P2P transactions". Scholars like Elinor Ostrom – Nobel laureate in economics in 2009 – have shown that communities play a significant role in the economy and are as important as markets, companies and the state.[7] Under certain circumstances, individuals can and do eliminate intermediaries and third parties from their direct economic relations, relying instead on a community for the management of a common resource or the trading of a product. Recently, new technologies like the blockchain promise to make the possibility of direct P2P trading universal, without a central clearinghouse or intermediary. The beauty of the distributed ledger at the heart of the blockchain technology is its ability, thanks to abundant computing power and sophisticated cryptographic software, to trace all the direct P2P trades or any other form of transaction among the participants to the same blockchain network. All the members of this type of community are then able to verify whether a transaction occurred or not and whether or not the parties were entitled to make it.[8]

Once fully developed, pure blockchain networks pledge to generate the trust necessary to support economic relations among individuals, no longer resorting to private intermediaries and public third parties. However, the jury is still out and some scholars believe that the magnitude of the transaction costs associated to the use of the blockchain – e.g., the time and energy required to validate a transaction or manage errors and misinterpretations among a large number of parties – may limit the scope of the services offered by that type of networks and exclude their application to certain goods and services.[9] These concerns explain why less radical and more realistic blockchain networks appear attractive. By performing trades within a community of trusted peers, with an implicit or explicit set of rules and common governance, the complexity of pure blockchain networks can be reduced, and their operation simplified. Indeed, this hybrid form of blockchain is appreciated, and several companies and organisations are deploying private networks to deal, for instance, with subsidiaries and suppliers.

Beyond pure and hybrid blockchain networks, other types of communities can be built thanks to digital technologies and act as larger and less strictly organised entities with multiple purposes; examples include energy communities and smart cities.

The last building block to understanding digitalisation is somewhat intuitive, although not yet used as a concept by academics or practitioners. A "virtual resort for artificial intelligence" (AI) is a space where a human being surrenders its autonomy to the algorithms behind the AI. The human, be it a producer or a consumer, can at best set some parameters. Then, it is the AI, not the human, to take the decisions and manage the assets within the boundaries of the resort, according to the rules and procedures defined by its developer. While intermediaries are no longer needed in a digital community with disintermediated P2P transactions, a virtual resort for AI promises the replacement of people with machines: within it, decisions and actions by the users cease to be necessary.

Resorts for AI can be "single purpose", where the device benefiting from the AI has a specific goal to achieve in the best possible way (think of a driverless car), or "multi-purpose", where AI is in charge of various goods and services, delivered by the operation of a set of interactive devices (think of a smart home). The Internet of Things (IoT) is key to the development of multi-purpose AI resorts, while virtual personal assistants like Alexa from Amazon already show how to transform any human dialogue or interaction with the device into an AI automated, "smart and learning" decision-making process.

Implications for the electricity sector

By creating the trust necessary for transactions to take place, pure blockchain networks or hybrid solutions developed within communities pledge to end the need for intermediaries and enable truly decentralised, P2P trade of electricity and other scarce

products like green energy "certificates".[10]

In general, people can perceive renewable energy sources, distribution grids, storage assets, electric vehicles and the like as scarce local resources in need of a community approach and community governance. Digital technologies can support this perception and allow communities to manage and control the growing amount of assets located behind the meter.[11] The development of micro-grids, smart neighbourhoods and cities are among the many variants in which this possibility can materialise. Their impact on the current organisation of the electricity sector will be far from trivial.

Shortly, we could also see the flourishing of virtual resorts for AI just behind the meter of the public utility. Consider EVs and fleets of self-driving cars: sophisticated software will manage the batteries and interactions with the electric grid, charging or discharging the vehicles depending on the price of electricity or the system conditions. The input from human users will be reduced to the minimum, while the fleet will be professionally managed with algorithms as an integrated business. Similar instances will occur with smart buildings and distributed generation. People living in a smart building or owning a distributed generation unit will not be required to do much, as AI will take control of the various interconnected energy appliances and generation units, with the goal of optimising the use of local resources or minimising the overall cost of the energy service. Net-zero energy buildings that are mandated in jurisdictions like California from the next decade onwards will probably have to work in this way.

The establishment of these virtual resorts for AI can turn the electricity industry upside-down. Given the amount of energy consumed or stored by a fleet of thousands of EVs or given the amount of power that thousands of smart buildings can inject or withdraw from the public grid, it is likely that the companies developing and controlling these virtual resorts will play a major role.

Conclusions

Digitalisation creates new opportunities and risks that consumers, companies and public bodies are obliged to confront. To navigate through such uncertainty, we need references that help us understand how the world is changing around us. The six building blocks presented in this policy brief are just that. Not a fully-fledged theory about digitalisation but rather a toolkit to identify the key issues at stake and where we might go in the future.

Digitalisation involves a concurrent set of changes in the infrastructure and market arrangements that we rely upon to produce, exchange and consume a large number of goods and services. Even more, digitalisation looks so transformative that it may herald, at least in some instances and under certain circumstances, the end of the traditional intermediaries and the active role of customers.

Electricity is no exception. The sector first experienced digitalisation 20 to 30 years ago, but now a second wave is on the verge of unleashing new and profound changes. A revolution at least as radical as that represented by the creation of wholesale markets in the 1990s seems to be in the making. The six building blocks provided in this brief can be successfully applied to the sector, allowing consumers, companies, regulators and policy-makers to understand what digitalisation means for them, and to better prepare and manage the inevitable changes it will bring.

Footnotes

1 Vadari S. (2018), Smart Grid Redefined. Transformation of the Electric Utility, Artech House.

2 See below the implications, for the electricity sector, of digital communities and virtual resorts for artificial intelligence.

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OPEC Is an Important Energy Policy Tool to Keep Oil Markets Stable

BY MAMDOUH G SALAMEH

The Founding of OPEC

The Organization of the Petroleum Exporting Countries or OPEC is an intergovernmental organization of 15 nations founded in 1960 in Baghdad by the first five members (Iran, Iraq, Kuwait, Saudi Arabia and Venezuela) and headquartered since 1965 in Vienna, Austria. By the end of 2017, OPEC accounted for an estimated 42.6% of global oil production and 71.8% of the world's proven oil reserves giving it a major influence on the global oil market and prices that were previously controlled by the so-called "Seven Sisters" cartel of the world's largest multinational oil companies.[1]

The stated mission of the organization is to "coordinate and unify the oil policies of its member countries and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of oil to consumers, a steady income to producers, and a fair return on capital for those investing in the oil industry.[2] The organization is also a significant provider of information about the international oil market. The current OPEC members are Algeria, Angola, Ecuador, Equatorial Guinea, Gabon, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, the Republic of Congo, Saudi Arabia (the de facto leader), UAE and Venezuela.

The formation of OPEC marked a turning point toward national sovereignty over natural resources and OPEC decisions have come to play a prominent role in the global oil market and international relations. The effect can be particularly strong when wars or civil disorders lead to extended disruptions of supply. In the 1970s, restrictions in oil production led to a dramatic rise in oil prices and in the revenue and wealth of OPEC with long-lasting and far-reaching consequences for the global economy. In the 1980s, OPEC began setting production quotas for its member nations; generally, when the quotas are reduced, oil prices increase. This has occurred most recently from the organization's 2008 and 2016 decisions to trim oversupply.

The OPEC Reference Basket of Crudes has been an important benchmark for oil prices since 2000

Since the 1980s, representatives from Egypt, Mexico, Norway, Oman and Russia and other oil-exporting nations have attended many OPEC meetings as observers. This arrangement serves as an informal mechanism for coordinating policies.

How Influential Is OPEC?

The influence of OPEC has closely followed the peaks and valleys of the world's demand for oil. September 14, 2018 marked the group's fifty-eight anniversary — more than a half-century of existence characterized by embargo, conflict, and even war.

Today, economists and analysts debate how influential OPEC is. Conventional wisdom holds that OPEC has the world in its grasp. It can manipulate prices by tinkering with supplies. But the conventional wisdom is mostly wrong. For the most part, its actions lagged behind fundamental changes in oil supply and demand rather than led them. OPEC looks like a masterful cartel when, in fact, it is mainly just riding the waves.

Over the last five years, OPEC members have announced ever-higher price goals only after the market has already delivered those high prices. As the market has soared, OPEC has followed.

Today's OPEC, even more than in the past, is really about Saudi Arabia. The Saudis can adjust their output a bit since they are presumed to control nearly all of OPEC's spare capacity. The Saudis claim they have an ambitious plan to increase output by about one third over the coming decade, but they are finding that it will be a stretch. Their fellow OPEC members are in a similar situation, and those hard facts produce high oil prices. In fact, the Middle East members of OPEC are today producing at just the same level as they were three decades ago because none of them invested much in finding and producing new supplies. High prices into the future reflect these fundamental facts rather than the assumption that OPEC is a masterful cartel.

Decision-making inside OPEC is quite complicated most of the time. This is because the policies of its de facto leader Saudi Arabia sometimes differ radically from other OPEC members' in relation to prices and supplies.

When oil prices crashed in July 2014, Saudi Arabia decided to flood the global oil market in defiance of OPEC's time-honoured and agreed policy of cutting production to bolster oil prices. This time at its 166th meeting on the 27th of November 2014 OPEC decided under strong pressure from Saudi Arabia not to cut production.[3]

Saudi Arabia's oil strategy aimed at defending its market share, taking advantage of low oil prices to inflict damage on Iran's economy and weaken its influence in the Middle East in its proxy war with Iran over its nuclear programme and also slowing down the development of U.S. shale oil production.[4]

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See footnoes at end of text.

However, the Saudi strategy failed miserably in harming Iran's economy and disrupting U.S. shale oil production and inflicted huge damage on the Saudi economy, the economies of OPEC members and the global economy at large.

Saudi Arabia was forced to eventually discard its strategy and engineer with Russia an OPEC/non-OPEC production cut agreement whereby OPEC & Russia cut production by 1.8 million barrels a day (mbd) in support of oil prices effective the 1st of January 2017. As a result, prices have recovered from $40 a barrel to almost $80. The agreement has since been extended to the end of 2018 with talks going on about converting it into a permanent mechanism for cooperation between OPEC and Russia in what has been dubbed as OPEC+.

Anti-OPEC Bill Could Be a Game-Changer for Oil Markets

In its effort to wrest more control over global oil markets away from foreign producers, the U.S. Congress has been pushing a bill that would let the U.S. sue OPEC for an alleged oil price fixing. The bill called "No Oil Producing and Exporting Cartels Act," or NOPEC, was first introduced in May this year.[5]

Now, two Republican Senators and two Democrats introduced legislation on the 16th of July 2018 that's aimed at allowing the U.S. government to bring lawsuits against OPEC members for antitrust violations, which would be an amendment to the Sherman Anti-trust act of 1890.[6]

The Sherman Anti-trust act changed American business culture. It was the first legislation enacted by Congress to curb concentrations of power that interfere with trade and reduce economic competition. One of the act's main provisions outlaws all combinations that restrain trade between states or with foreign nations.

However, the NOPEC idea is nothing new and dates back to 2000. Both former presidents George W. Bush and Barack Obama threatened to use their veto power to halt it from becoming law. This time around, however, there is a good chance that President Trump would sign such a bill into law.[7] Trump has been critical of OPEC for years and during the 2016 presidential election that war of words escalated to the front pages of international newspapers.

While the Congress has every right to prevent concentrations of power that interfere with trade and reduce economic competition within the United States, it has no extra-territorial jurisdiction whatsoever on other countries' commercial practices. What commercial practices OPEC members agree to follow vis-à-vis their oil trade are their own affair and nobody else's. If the United States doesn't like OPEC commercial practices, then it should stop buying oil from OPEC members.

The United States has so far broken the rules of the World Trade Organization (WTO) by imposing sanctions on virtually everybody, walked away from United Nations-recognized Iran nuclear deal and also the UN-supported Climate Treaty without batting an eye lid. Moreover, the United States has been manipulating oil prices through the petrodollar and also through exaggerated claims about rises in U.S. oil production and huge build-up in its oil and refined products inventories in order to depress oil prices and achieve geopolitical and economic aims. One who lives in a glass house shouldn't throw stones.

If NOPEC ever becomes a law and the United States tries to sue any OPEC member under the NOPEC Act, OPEC members collectively could retaliate by withdrawing every single penny they keep in the United States and stop investing in the U.S. altogether. They could also nationalize American interests in their oil industries and discard the petrodollar and adopt the petro-yuan instead.

Political anger at OPEC tends to rise alongside oil prices; the first effort to use antitrust law against the oil cartel came in the late 1970s after a pair of nasty oil shocks. But subjecting foreign states to U.S. legal action is always a sensitive subject. At the time, lower courts avoided the political hot potato by ruling, among other things, that other governments have sovereign immunity from the long arm of U.S. law.[8]

Now, rising oil prices are again stoking predictable anger in Washington — prompting the same legislative exercise. "Every time gasoline prices go up, politicians scramble to see what actions they can take to provide relief for consumers," said Jason Bordoff, the director of Columbia University's Centre on Global Energy Policy. But the NOPEC bill, even if passed, would take a long time to play out in court.

Past administrations have generally been loath to turn over to the courts functions that have traditionally belonged in the diplomatic arena — including persuading Saudi Arabia and other big producers to pump enough oil for the global economy to keep humming. That's especially true because America's oil relations with countries such as Saudi Arabia must be balanced against other key interests from counterterrorism to efforts to rein in regional rivals such as Iran.

The whole debate might again be academic as it was nearly every year in the early 2000s, except for one thing: Donald Trump is now president. He supported prior Congressional efforts to revamp U.S. law to put OPEC in the antitrust crosshairs. And in recent months he has railed against the oil-exporting group on Twitter for allegedly driving up the price of gasoline.

Is OPEC Really a Cartel?

A cartel is defined as an association of manufacturers and suppliers whose goal is to increase their collective profits by means of price fixing, limiting supply, preventing competition or other restrictive practices. Antitrust laws attempt to deter or forbid cartels.[9]

While OPEC may resemble a cartel in some aspects, it is not a cartel. How could it be a cartel when it was founded as a counterweight against the previous "Seven Sisters" cartel of multinational oil companies which dominated every aspect of global oil through price fixing, limiting supplies and suppressing competition for the sole purpose of maximizing its profits.The main purpose behind the founding of OPEC was to give producers more control over their own oil.

When OPEC was founded in Baghdad in 1960, its constitution stipulated that its raison d'etre is to defend the rights of its members by ensuring a stable global oil market and stable prices. That is exactly what OPEC has been doing for the last 58 years and will continue to do so as long as it remains an organization of Petroleum Exporting Countries.

OPEC with its huge proven reserves and production capacity has every right to ensure oil prices are fair enough to provide its members with a reasonable return on their finite assets thus enabling them to explore for new oil and expand production capacity to meet global oil demand. In so doing, they are rendering a great service to the global economy from which the United States benefits. Furthermore, OPEC has never excluded competition. And the proof is that U.S. shale oil is being exported around the world.

One would expect a cartel to curb production in order to raise the price of its product as well as to share market among its members. However, OPEC has never once tried to fix a specific price nor has ever been able to achieve this goal. Wishing a certain price is totally different from fixing it. The fundamentals of the global oil market are the ones that have always determined the oil price helped occasionally by geopolitics. OPEC has no control on these fundamentals and therefore has no control on the movements of prices. It merely takes advantage of market conditions and follows the dictates of the market. For instance, OPEC was not able to prevent prices from falling in the 1980s even after it adopted the production quota system in 1982. Moreover, OPEC was neither able to temper oil prices in 2008 when prices rocketed to $147 a barrel nor was it able to stop the 2014 oil price crash. This raises the question of whether OPEC was ever able to increase the price of oil by curbing its production or whether OPEC simply took advantage of high prices caused by political problems and conflicts between some members.

However, since the economies of the OPEC members are heavily dependent on the oil revenue, they know what price they need to balance their budgets. The overwhelming majority of OPEC members need oil prices above $100 a barrel to "break even" in their budgets (see Figure 1).

When it comes to limiting oil supply, a true cartel like the "Seven Sisters" was able to do exactly that because it was virtually in control of global oil resources. OPEC has never been in such a situation. It only accounts for 42.6% of the global oil market with the rest of the oil-producing nations of the world accounting for 57.4%.

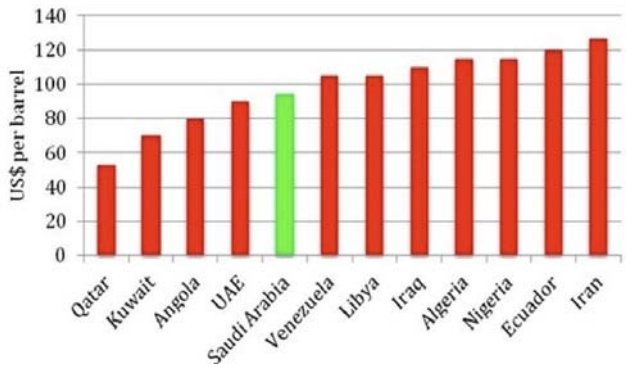

Figure 1. OPEC Median Budgetary Breakeven Price
Source: OPEC "Break-even" Prices (Matthew Hulbert/European Energy Review).

The United States and Russia both account for 12% each.

Furthermore, it was never ever the intention of OPEC to harm customers or the global economy knowingly. Any adverse impact on the global economy or on customers was merely a collateral damage resulting from international policies aimed at either undermining the economies of the OPEC members as a geopolitical tool or enabling their own economies to benefit from low oil prices at the expense of the OPEC members.

OPEC has not been involved in any disputes related to the competition rules of the WTO, even though the objectives, actions, and principles of the two organizations diverge considerably. A key U.S. District Court decision held that OPEC consultations are protected as "governmental" acts of state by the Foreign Sovereign Immunities Act, and are therefore beyond the legal reach of U.S. competition law governing "commercial" acts[10].

Still, OPEC shouldn't be unduly worried about the NOPEC Act. It has enough muscle to retaliate against the U.S. Were the United States to mount a lawsuit against OPEC or any of its members, the organization could stop all its oil exports to the U.S. and even cut its oil production to force prices up. This will harm the U.S. economy most being the world's largest consumer of oil. A case in point is Saudi Arabia's threat to retaliate against any U.S. punishment regarding the Saudi journalist's murder in the Saudi consulate in Istanbul. President Trump took the Saudi threat seriously enough to start back tracking on his threat of severe punishment on Saudi Arabia by floating the idea that "rogue killers" might have been behind the murder of the Saudi journalist.

Another measure OPEC and Saudi Arabia could take against the United States is to replace the petrodollar with the petro-yuan in their oil transactions. That would be the biggest ever retaliation against the U.S.

(continued on page 36)

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 headquaters 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 go 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 County. 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 entertaining. 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 organised 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 open 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 Presentatiion

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

The Opening Plenary was an international panel chaired by Herman Fransssen (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 contation" 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 U.S. 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 Electrobras. 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 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!

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 among all the panel members that 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 purchasing 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 pointing 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 by 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 trail 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 Demand 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 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 plummetted. 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 C02-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 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).

SCENES FROM THE 36TH USAEE/IAEE NORTH AMERICAN CONFERENCE SEPTEMBER23-26, 2018


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First IAEE Symposium in Bulgaria Sets Ground for National Affiliate

The First Sofia Energy Economics Conference "Southeast European Energy Challenges" took place at Sofia University "St. Kliment Ohridski" in Sofia, Bulgaria, on 7 December 2018. The Faculty of Economics and Business Administration (FEBA) at Sofia University and IAEE were co-organizers of the Symposium, which is also part of the 130th Anniversary celebrations of the university.

The conference was officially opened by the Vice-Rector of Sofia University – prof. Mariya Stoycheva, and by the Vice-Dean of the Faculty of Economics and Business Administration – Assoc. Prof. Atanas Georgiev. Prof. Stoycheva noted, that the university has been teaching master and PhD students in its energy economics program for 13 years and now has more than 200 alumni in this field, most of whom are working as managers and experts at companies, state administration, and NGOs.

Official addresses were also made by the Chairman of the Energy Committee at the National Assembly of Bulgaria – Delian Dobrev, and the President of IAEE, David Knapp. Mr. Dobrev pointed out that there are many challenges related to the decarbonization of the energy sector and the second panel in the conference would be very interesting for both policymakers and energy economists in Bulgaria. Mr. Knapp congratulated the university on its 130th anniversary and the Faculty of Economics and Business Administration for hosting the first IAEE event in Bulgaria.

The keynote speech was given by Jean-Marc Leroy, President of Gas Infrastructure Europe and Vice-President at Engie. His speech was about developing gas hubs and the needed prerequisites, namely liquidity and transparency. Mr. Leroy gave an overview of the important gas projects in the region and the significance of their development of the gas market in general.

The event was sponsored by AES Bulgaria and by ContourGlobal Maritsa East 3, and SeeNews.

Plenary Session 1 dealt with the topic "Southeast Europe: Crossroads of Energy, Economics and Geopolitics". Southeast Europe is unevenly endowed with conventional energy resources. It also exhibits varying patterns of local access to advanced energy technologies and relatively small cross-border trade volumes in energy and energy services. The energy markets in the region are at different stages of adopting the European Union's regulatory framework. The session was chaired by Assoc. Prof. Dr. Atanas Georgiev from Sofia University and included presentations by the following experts:

- Isabella Ruble, U.S. Department of Energy, Washington, D.C., United States – with the topic "Recent developments in the U.S. natural gas sector: What implications for South East Europe?"
- Sarah Jezernik, President of the Slovenian Association for Energy Economics, Deputy General Manager of Plinovodi d.o.o. – with the topic "New approaches (team work!) in the energy world"
- Ruslan Stefanov, Center for the Study of Democracy, Bulgaria – with the topic "Energy, Economics and Geopolitics in Southeastern Europe"

Session 2, with the title "De-carbonization of the Energy Sector: Impacts in Southeast Europe", was chaired by Julian Popov, Fellow at the European Climate Foundation, and dealt with many challenging topics. The integration of Southeast European countries in the Internal Energy Market of the EU would mean both liberalization and de-carbonization efforts for their energy sectors. At the same time, a large portion of electricity generation in the region is dependent on fossil fuels – lignite, hard coal, and natural gas. New generating capacities from renewables and nuclear are considered. The transition toward a low-carbon energy sector would require new investments and may affect costs for consumers – both industry and households. The effects on industrial competitiveness and energy poverty have to be included in this analysis as well. The speakers during this panel were:

- Konstantin Delisivkov, Executive Director of the Bulgarian Federation of Industrial Energy Consumers – with the topic "De-carbonization of the Energy Sector. What does this mean for Industry?"
- Gurkan Kumbaroglu, President of the Turkish Association for Energy Economics, Former President of IAEE – with the topic "De-carbonization of the Energy Sector: The Case of Turkey"
- Irena Mladenova, Head of Corporate Development at Resalta, and Managing Director of Resalta Bulgaria – with the topic about the ESCO market in Southeast Europe.

Session 3 of the conference was chaired by Boyko Nitzov, TSO Cooperation Officer, Team Leader for gas infrastructure development at the Gas Department of the European Union's Agency for Cooperation of Energy Regulators, and dealt with the topic "Economics of Oil and Gas". The speakers in the panel touched the following topics:

- David Knapp, IAEE President, made a presentation about oil market fundamentals;
- Prof. Ionut Purica, Professor at Hyperion University had a presentation about the crucial North-South interconnector in East Europe.
- Prof. Vilayat Valiyev, Director at the Institute for Scientific Research on Economic Reforms (ISRER), Ministry of Economy of the Republic of Azerbaijan had a presentation about "Oil: Demand-Supply and World Market Prices"

- The panel ended with the interesting presentation by Boyko Nitzov regarding natural gas economics and the choices made by energy companies during the investment process for pipelines and LNG trains.

The last panel in the conference was chaired by Konstatin Delisivkov, BFIEC, and its topic was "Financing New Power Generation in Liberalized Regional Electricity Markets". Some of the questions for the panelists were: what is needed in order to attract new investments in power capacities; is it possible to finance new generation without direct subsidies; is there a single vision for financing availability of large power plants; and how does this fit into the general investment environment for energy companies in Europe and abroad.

- The banker's point of view was presented by Andi Aranitasi, Associate Director, Senior Banker, Power and Energy, EBRD;
- Kostadin Sirleshtov, Partner, CMS Cameron McKenna Nabarro Olswang LLP, made a presentation on risk allocation, corporate PPAs, and challenges in the Bulgarian context
- Evo Stefanov, Managing Partner, Methodia AD, presented his experience from the UK in a presentation titled "Trends in world energy markets".

The Symposium also facilitated the discussion of the conditions and the requirements towards the establishment of the first Bulgarian Association for Energy Economics (BAEE) – an IAEE affiliate in Bulgaria. David Knapp, the President of the IAEE, and David Williams, the Executive Director of the IAEE, presented the next steps needed for establishing a Bulgarian Association for Energy Economics. They discussed in a final non-official panel together with Sarah Jezernik, Boyko Nitzov, and prof. Gurkan Kumbaroglu the speakers' experience from establishing affiliates in other countries.

As part of the Symposium's program, prof. Jorge de Sousa, President of ISEL – the High Institute of Engineering of Lisbon, presented the simulation "Investment and Trading in Electricity Markets" (ITEM Game) in front of students from the Master's program "Economics and Management in Energy, Infrastructure, and Utilities" at the Faculty of Economics and Business Administration of Sofia University on 6th December, before the official start of the conference. Prof. Jorge de Sousa and Assoc. Prof. Atanas Georgiev (FEBA) organized an online ITEM Game tournament for Sofia University students.

The future Bulgarian affiliate of the IAEE will be set up in the beginning of 2019 and will be supported by the Faculty of Economics and Business Administration at Sofia University "St. Kliment Ohridski". It is expected to gather as its members some of the most prominent Bulgarian energy economists.

IAEE - APEEN Student Prize for Portuguese Students

The joint meeting of the 3rd Annual Conference of the Portuguese Association of Energy Economics – APEEN and the 5th Meeting on Energy and Environmental Economics – ME3 took place 18-19 October 2018, at Braga, University of Minho. The joint conference of APEEN and ME3 2018 brought together specialists in environmental and energy economics to debate the many issues raised by the management of resources and waste, with the main topic: "Managing Resources and Waste: Challenges for Energy and Environmental Economics beyond 2030".

The event included keynote speakers Maria Loureiro (Universidade de Santiago de Compostela) and Martin Brocklehurst (Kempley Green Consultants) and also several parallel sessions.

The IAEE prize was promoted and offered by IAEE in an effort to encourage more students to join the Association, and to do research in the Energy Economics area. More than 20 articles of MsC and PhD students were presented at the conference, and were candidates for this prize.

The first prize of $300 was awarded to Susana Gonçalves, for her work "Energy Consumption, Macroeconomic and Financial effects over CO_2 emissions: A European Approach"; the second prize of $200, went to Stepanov Ilya, for his work "Conventional Energy Taxes vs. Carbon-Based Incentive Instruments in Emission Regulation" and the third prize of $100, was given to Yvonne Vogt Gwerder for her work " To what extent do market and regulatory factors affect investments in smart grid projects in Europe? "

In addition to the monetary prize, these students receive APEEN/IAEE membership for one year and the possibility of attending free events organized by the association.

APEEN also gives its Young Researcher Award with the objective of rewarding the scientifically relevant work in Energy Economics by young researchers, and promoting the growth and renewal of this scientific area in Portugal. The Young Researcher award has a

First prize: Susana Gonçalves

Second prize: Stepanov Ilya

Third prize: Yvonne Vogt Gwerder

Forget the Government: Promoting Renewables with Voluntary Action

BY LUCIANO I. DE CASTRO

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See footnotes at end of text.

Introduction

Climate change mitigation and the support for renewables have been part of the scientific and political discussion for decades already. The scientific warnings about climate change go back to the1950s with the work of Roger Revelle and as early as 1975 (Broecker, 1975) ponders whether we are "on the brink of a pronounced global warming." The United Nations (UN) established the Intergovernmental Panel on Climate Change (IPCC) in 1988 and since then, the issue has been a central theme in many international meetings, discussions and media articles and programs.

Nevertheless, the actual reduction of greenhouse gases (GHG) emissions has been frustrating. UN was able to secure relatively widespread support for the Kyoto Protocol and the Paris Agreement, but the general sentiment is that governments are not doing enough to curb emissions. It is useful to review the reasons for such a fact. First, the benefits of GHG emissions are local, but the costs, dispersed by the globe in a very heterogenous manner. In addition, they will affect more profoundly future generations than the current one. Inside each country, the economic burden of reducing emissions would fall on concentrated sectors, for whom emissions are associated to profitable activities. Therefore, the immediate interest of relevant polluters leads them to oppose environmentalists' efforts. Being a balance of competing political forces, the actions of government tend to be erratic. Sometimes and in some places, there are advances, which are later - or somewhere else - followed by opposite movements. The result is the slow and indecisive progress that we alluded to.

Of course, economic or catastrophic events may tip the balance of forces one way or another, but waiting for such occurrences does not seem wise. These considerations should persuade concerned people to look for approaches beyond the so far explored advocacy for government intervention. Diverting at least some of the efforts from this strategy is not easy, however. The problem is that state's power is too strong an attraction. After all, legal enforcement could obtain fast and important change if it could be unequivocally implemented. Additionally, it is not so clear what can be done without the government. While little can be done to solve the first difficulty, it is possible to tackle the second.

This article sheds light on possible paths of action that do not require the government and are under explored. We focus particularly on the promotion of renewables and its integration to the electric system. The reason for this choice is the notion that renewables penetration is one of the best routes to a cleaner energy matrix and less GHG emissions. Electricity generation practically ties with transportation as the biggest source of emissions, with around 28%.[1] With the tendency towards electrification of cars and everything else, being able to reduce emissions in the electricity sector seems an obvious priority.

From this observation, the next section discusses the economic and technical characteristics of renewables. Since renewables have zero (or at least very low) marginal costs, I argue that the main task is to build capacity. The natural market forces will then make sure they displace other conventional sources. I argue against incentives that distort the effective marginal cost perceived by producers. Instead, all support should be focused on funding the investment (capex). I also discuss the need for integration with other sources and the fact that renewables may be able to survive even if extra payments (or products) are defined for conventional sources. The folloing major section describes a strategy for supporting renewables penetration with voluntary platforms. I also discuss how such markets could be organized as private organizations in many different places. The last section acknowledges that the idea of voluntary platforms is not entirely new and mentions some organizations working along these lines. But it is highlighted that the article's main contribution is the call for private action, departing from the usual and almost exclusive dependence on governmental action.

It should be emphasized that the approach this article advocates is not construed to be an *optimal* strategy in any sense, but only a strategy with potentially higher payoff than the explored up to now. It is offered as an alternative, under the perspective that more government intervention is not forthcoming or has become difficult to achieve.

Economics of renewables and its integration to the electricity system

This section reviews some basic economic characteristics of renewables and its relationship to the electricity markets in which they operate. I begin by discussing its costs structure, common incentives and business models. The main observation from this discussion is the need to avoid giving incentives that create inefficiencies. The next section turns attention to some technical characteristics of renewables and its integration with other sources. All these observations are useful to inform and motivate the plan that is

subsequently presented.

Costs and incentives

Renewables are known to have relatively large fixed costs (capex) and small marginal or variable costs (opex). They have low marginal cost because they do not need to pay for fuel since renewable sources (sunlight, wind, flowing water, etc.) are free. This characteristic implies two things. First, the main difficult for increasing renewables penetration is funding the initial investment. Second, once capacity is built, selling electricity in the corresponding market should give adequate incentives to keep the production in almost all moments where it is available. That is, as long as the electricity price is above the small marginal cost, a renewable producer would be interested in producing. These observations will be useful below.

This cost structure has implications over the optimal way of financing and supporting the penetration of renewables. The first observation suggests that the main task is to provide funds or low interest for initial investments. In the case of solar panels in rooftops, this is precisely what many governments are doing. Indeed, this widespread form of distributed generation is usually supported by tax credits and lines of credit with reduced interest.

Notice, however, that the incentives for centralized (as opposed to distributed) generation with renewable sources usually are of a different kind. Perhaps the most common schemes are feed-in-tariffs, production tax credits, and tradable certificates.[2] The usual form of those incentives changes the perceived marginal cost of the producers, leading to inefficiencies in the dispatch. To understand this, recall that those incentives stipulate a value that is to be paid to the producer per each unit of energy produced. For example, let us say that the tax credit is $12/MWh, the capacity of a qualifying renewable producer is 100 MW and the marginal cost is zero.[3] This implies that even if the current electricity price at its location is - $5/MWh (negative) during, it is still profitable for this producer to keep sending electricity into the grid. The negative price intends to signal to producers that they should not inject energy into the system at that moment. The PTC allows the producer to ignore this signal, thus creating inefficiencies in the dispatch of the whole electricity system. In particular, the 100 MWh produced in one hour has to pay $500. While the firm is pocketing $700, tax payers are paying $1200, thus wasting $500. Everyone would be better off if the firm stops producing electricity and just receives $700 from taxpayers.[4]

Another way to understand the alluded problem is to observe that the PTC changes the supply curve of the market, making a producer of zero marginal cost appear as one of –$12/MWh, since the producer will keep producing as long as the price is above that level. Obviously, this change in the supply curve leads to a new and inefficient equilibrium. This is undesirable and should be avoided. It is not in the interest of society to devise incentives that lead to such inefficiencies

Technical characteristics and integration with electric systems

Perhaps the most important technical characteristic of renewables is their intermittency, that is, their lack of dispatchability. The power to control and vary the production of a supplier is valuable to the system operator, who has the obligation to maintain the balance between production and consumption. Another way of saying this is the following: the system operator needs other types of generators in order to meet the electricity demand, especially when renewables production unexpectedly vary.[5] In short, there is some complementarity between renewables and conventional sources.

This leads to an important observation: when we consider the social (environmental) costs associated to GHG emissions of different sources, it is important to observe their combined effect: after all, although renewables do not emit by themselves, they might require the operation of conventional sources in a way that emits more than their usual pattern of operation would do. Thus, it is possible that the introduction of renewables actually increases GHG emissions. This complementarity makes the concept of social cost of emissions difficult to apply.

It should be noted that a high penetration of renewables would tend to make the average price in markets low, since their marginal cost is close to zero. Low average prices may be detrimental to the existence of conventional sources. Since, as argued above, conventional sources are needed, their active permanence in electricity markets would require extra payments, in exchange for the services they provide and renewables cannot.

In any case, once we recognize that conventional sources are needed and require a proper remuneration for their services, we can accept that, sooner or later, payments for controllable and renewables sources will need to be different even if they produce the same amount of energy. Most likely, this difference will come into being through some market for dispatchability. But it is not our task to define or speculate the forms that such product will take. Suffice it to say that conventional producers will eventually have access to extra payments that would not be paid to renewables. And this is desirable, because it gives the proper incentives to balance the electric system. Once renewables producers recognize the need of such payments, we will make easier progress towards a better integration of all sources.

To be sure, the above point begs the question whether this lower payment for its energy would not hurt renewables. Remember that their marginal cost is close to zero. This means that most likely, they would be able to profitably produce even if the price of energy is very low. What about their return on equity? As we said before, this is related to ways to fund their initial investment in a convenient way. The production

itself, incentivized by the price of electricity can take its course in an efficient manner.

How to organize voluntary platforms to foster renewables

This section details a way of organizing voluntary markets for renewables. As discussed above, it is our view that the problem is funding the initial investments. The support for renewables would have to come in transfers that do not depend on quantity produced, thus not affecting the perceived marginal costs.

In order to adequately supply those investment funds, an organization should be created to perform two main tasks: obtain resources and select the projects that will be funded. In fact, many such organizations can and should be created. Their area of influence or activity may be restricted to a state or country, but could also cover many nations. Each of these organizations will act as a platform, connecting environmentally concerned individuals and firms, who are willing to fund renewables, to entrepreneurs, eager to advance their projects. We will next discuss the two main tasks that a platform would need to perform.

Obtaining funding money

One side of the platform would consist of environmentally concerned individuals and firms, who become convinced about the main point of this article – that is, we should stop concentrating all our hopes in the government – and decide to act directly on the support of renewables. One important task of the platform would be to find and connect those people and firms and present them the opportunity to transcend the unique strategy of government intervention in the climate change mitigation effort.

The platform would receive "investments" or contributions from these individuals and firms, in exchange for certificates of renewables capacity that their money helped fund. The platform would maintain a record of the electricity production of the funded investments or, rather, the amount of GHG emissions avoided by those projects. Additionally, it could estimate the CO_2 footprint of the individual or the firm and urge them to buy enough certificates to offset such footprint. A reputational value could be created for individuals and firms that contribute. A marketing strategy that allow such contributions to be shared through social media could spark interest. For this, perhaps a standard for certificates may be developed by the different platforms involved in this effort.

Two types of contributions could be considered: a gift or donation, in which the individual simply gives money to fund projects, without requesting anything in return; and low or even negative interest "investments". In this later case, the individual would put money to fund projects and would receive back an annuity, corresponding to a low or even negative interest, to be negotiated (or chosen) by the donor. The annuity would be paid back by entrepreneurs receiving funds for their projects, as we discuss next.

Selecting and managing projects

After amassing enough funds, the platform would organize periodic competitions or tenders for the selection of projects, prioritizing those with lower funding requirements. In this way, the platform maximizes the amount of renewables capacity that it supports. The competition makes sense for centralized generation. For distributed generation, a fixed scheme could be made available for interested households.

The funds may be provided without a repayment requirement or be organized as a more or less usual financing scheme, but with low interest rates. Obviously, the platform would have to balance all obligations it contracts to keep financially viable.

The participation in the tender should involve low costs for the entrepreneurs, in order to attract an abundance of projects. However, after their projects are awarded, a contract between the entrepreneur and the platform should be firmed, which specifies the schedule of payments between the parts (payments from the platform to the producer and repayments, if that is the case). The contract should also specify minimum conditions and indicators that the renewable producer should maintain. In particular, the supplier should be able to produce a minimal level, and suffer penalties if those targets are not satisfied. However, as we emphasized above, payments depending on quantity should be kept to a minimum, if not completely avoided. Further details are left for the agents involved.

Remarks

The idea presented in this article is not entirely new. In fact, it has been pursued by a number of organizations in one way or another. Most of those are private foundations that invest in climate change mitigation. But there are also governmental and intergovernmental organizations that serve a similar role. For instance, the International Renewable Energy Agency (IRENA) "is an intergovernmental organization that (...) serves as the principal platform for international cooperation."[6] Another attempt worth mentioning is the Chicago Climate Exchange, which tried to create a voluntary exchange for emissions reductions; see (Sandor, 2012). Most of these attempts, however, seem to presuppose or count on some kind of government intervention.

On contrast, the main contribution of this article is perhaps the call to shift the emphasis from governmental intervention to direct action by private citizens and organizations. Given the deadlock in which politicians have put themselves and the governments they run, it is better to stop waiting for their leadership. Although not easy, private and voluntary action is possible and may make a difference.

I hope this paper inspires actions beyond the appeal to central authority, towards the development

of voluntary platforms, whose creation and growth depend solely on the prowess of environmentally concerned agents.

Footnotes

[1] See https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions/, consulted on Aug 23, 2018.

[2] We do not explicitly discuss other forms of incentives, such as tendering, net metering, voluntary green power programmes, public funded research and portfolio standards. However, one could say that our main idea is an adaptation of the first.

[3] This is actually the Renewable Electricity Production Tax Credit paid in US for some eligible technologies. See http://www.energy.gov/savings/renewable-electricty-production-tax-credit-ptc/, accessed on Aug 23, 2018.

[4] One could argue that the social cost of GHG emissions, which are not present for renewables, could account as a benefit of these sources. However, such cost/benefits are subject to strong uncertainty and are of difficulty calculation. Moreover, as observed below, there are some complementarities between sources that make the whole concept of marginal social cost difficult to apply. For this reason, we think it is better to leave this out of the short run dispatch problem.

[5] It is possible to conceive a setting with only renewables generation and no conventional source, even without significant presence of storage capacity (batteries): if renewables are so widespread that even their minimal possible production is larger than the peaks of demand. In this case, it would be sufficient to curtail production in the many circumstances that production would be above demand. In such a world, the electricity prices would be consistently zero. However, this would require a huge installed capacity of renewables. With storage capability, this scale is reduced, but this setting does not seem realistic in the foreseeable future.

[6] See http://www.irena.org/aboutirena, accessed on Aug 23, 2018.

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Salameh: *OPEC Is an Important Energy Policy Tool to Keep Oil Markets Stable.* Continued from page 19

Footnotes

[1] BP Statistical Review of World Energy, June 2018.

[2] OPEC: General Information & Chronology, 1989, pp. 7-9.

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[4] Ibid.,

[5] Tim Daiss, "Anti-OPEC Bill Could Be a Game-Changer for Oil Markets", Oil-price.com, July 23, 2018, accessed on1 November, 2018.

[6] Ibid.,

[7] Keith Johnson, "Proposed Law Would Allow US to Sue OPEC for Manipulating Oil Market" FP, July 18, 2018.

[8] Ibid.,

[9] Wikipedia, the free encyclopedia

[10] Raymond J. Learsy, "NOPEC (No Oil Production & Exporting Cartels Act": A Presidential Issue & a Test of Political Integrity", Huffington Post, 10 September 2012..

During a side-meeting at the EPRG Winter Seminar in Cambridge, 3 IAEE executives exchanged views on new projects for energy economists. (l to r) David Newbery, Christophe Bonnery and Michael Pollitt

Implications of Global Developments within the Energy Industry in the Caspian and Central Asia Region

Report of the 3rd IAEE Eurasian Conference, 18-20 October 2018

Introduction

The third IAEE Eurasian Conference on the topic "Implications of global developments within the energy industry in the Caspian and Central Asia Region" was held on 18-20 October 2018, in Baku, Azerbaijan. It was part of IAEE's Eurasian conferences series. The 1st IAEE Eurasian Conference on the topic of the "Energy Economics Emerging from the Caspian Region: Challenges and Opportunities" was held on 28-31 August 2016 in Baku, Azerbaijan. The 2nd IAEE Eurasian Conference on the topic of "Energy in Eurasia: Economic Perspectives on Challenges, Risks and Opportunities" was held on 13-14 October 2017, in Zagreb, Croatia.

The objectives of these conferences were to address energy-related challenges in the Eurasian region with the participation of business, government, academic institutions and international organizations.

The organization of the third Eurasia conference, again in Baku, had an important significance. Azerbaijan was the major and only place in the former Soviet Union where dedicated education on upstream, midstream and downstream operations oil & gas, was delivered, and relevant scientific researches and engineering activities were conducted. Azerbaijani experts and scientists implemented the key academic and research activities on oil & gas in Russia and Central Asia, as well as in overseas countries.

Now, with its convenient geographical position, Azerbaijan plays an essential role in energy supplies to Europe and in regional energy security efforts during its 27 years of independence. Azerbaijan, where big energy companies of BP, SOCAR and Exxon are operating, has been hosting traditional Caspian International Oil & Gas Exhibitions and Conferences and other similar high-level events that incorporate top energy industry managers and specialists in a single platform. The necessity of today's reality is therefore to protect the existing scientific potential and academic traditions in the oil & gas industry, and to integrate the accumulated knowledge to overseas specialists and partners.

In this context, the 3rd IAEE Eurasia conference was an excellent platform to present and discuss in a broader audience with public, academic and business circles the issues on studying key challenges of energy economy, the analysis of contemporary global industry trends and the study and implementation of best international practice.

Event sponsorship

The publicity had high interest in the conference, which overlapped with the activities on IAEE's expansion in Azerbaijan. Oil & gas sector has a leading role in Azerbaijan's economy, and the State Oil Company of Azerbaijan Republic (SOCAR) and BP are two main players in the country's oil & gas sector.

SOCAR has diverse activities in Azerbaijan, covering exploration and exploitation of oil & gas fields, production, processing, transportation and sale of oil, gas and gas condensate, production of petrochemical goods, natural gas import & export and overseas sale, as well as the domestic sale of natural gas to residential and non-residential consumers. SOCAR also has multilateral regional and international business activities, including petrol stations in Ukraine, Switzerland, international trade of oil and oil products, ownership and operation of the largest petrol stations chain and the gas distribution networks in Georgia.

BP Azerbaijan Georgia Turkey Region (AGTR) is part of BP plc, a British multinational oil & gas company. BP AGTR has been operating in the Caspian region since 1992. Over the past 25 years, in partnership with the Government of Azerbaijan and our co-venturers, BP-operated world-class projects, namely Azeri-Chirag-Gunashli, Shah Deniz, Baku-Tbilisi-Ceyhan and South Caucasus Pipeline. These projects have contributed to the development of the Caspian Sea region as a modern energy center.

The appeals for the support of the event were immediately accepted by SOCAR and BP in a positive manner. SOCAR was the Platinum Sponsor, and BP was the Gold Sponsor for the conference.

Azerbaijan Energy Engineering & Consulting LLC (AEEC) provided silver sponsorship for the event. With 25 years of operation, AEEC is a leading local private company providing engineering and consultancy services in Azerbaijan covering all aspects of the energy sector including oil & gas, electricity and renewable energy. The Baku representative of Schneider Electric, and local private company AzEcoConsulting provided bronze sponsorship for the conference.

Moreover, SOCAR Turkey served as an Activity Sponsor in the event, and funded the participation of five selected students of Boğaziçi University of Turkey.

Conference Venue

The conference was held at the new campus of SOCAR's Baku Higher Oil School. The organization of the event at the Baku Higher Oil School was supported by the Ministry of Energy and SOCAR.

The organization of the event at Baku Higher Oil School seems important in terms of IAEE"s future expansion in the region. Baku Higher Oil School is currently one of the leading academic institution not just in Azerbaijan but also globally. Since its

establishment, the Oil School has been expanding its geography of cooperation, accomplishing academic success, supporting scientific researches along with education, and regularly hosting high-level academic events. All these efforts have contributed to its global recognition. The Oil School also serves as a hub for energy industry professionals, energy companies, academic and research institutions, and a center for laboratory and practical studies.

Welcoming Session, Presidential Address and Keynote Remarks

The representative of Baku Higher Oil School welcomed the participants on behalf of the school, followed by the presidential address by Christophe Bonnery, the Director of Economics and Foresight at ENEDIS and President-elect of IAEE.

The Government of Azerbaijan paid high attention to the event. Mr. Samir Valiyev, Deputy Minister of Energy, Mr. Niyazi Safarov, Deputy Minister of Economy, and Dr. Nurali Yusifbayli, Deputy Chairman of the State Agency for Alternative and Renewable Energy Agency of the Ministry of Energy of Azerbaijan Republic welcomed the participants on behalf of the Government of Azerbaijan, and expressed their wishes for a successful conference. Mr. Ramiz Aliyev, Head of the Strategic Development Department of SOCAR and Mr. Bakhtiyar Aslanbeyli, Vice President Communications & External Affairs, Strategy and Region, BP Azerbaijan-Georgia-Turkey Region also delivered opening remarks. Prof. Dr. Vilayat Valiyev, Director of Institute for Scientific Research and Institute on Economic Reforms under the Ministry of Economy of the Republic of Azerbaijan and Vice President of IAEE for Regional Affairs expressed his gratitude to all event supporters on behalf of the Conference Organizing Committee.

Plenary Sessions

The first plenary session on the topic "Global Challenges to Energy Security in Eurasia: Supply & Demand Curse" was moderated by Prof. Dr. Gürkan Kumbaroğlu, Director of the Energy Policy Research Center at Boğaziçi University, Founding President of Turkish Association for Energy Economics, and Past President of IAEE. The speakers for this session were Christophe Bonnery, Pres-dent Elect of IAEE, Mr. Ramiz Aliyev, Head of Strategic Development Department of SOCAR, Mr. Colin Allan, ACG (Azeri-Chirag-Gunashly) Planning and Commercial Manager of Henderson, BP Azerbaijan-Georgia-Turkey, and Mr. Elmir Musayev, Southern Gas Corridor CJSC. The session covered the presentations and discussions on the challenges to the energy industry in Eurasia region, SOCAR's and BP's activities to overcome these challenges, and the role of the Southern Gas Corridor project in these processes. The most intriguing part of the discussions was the supply and demand curse and relevant expectations caused by volatile market prices. The speakers addressed these matters from the perspective of their specific activities.

Having special significance for the Central Asian and Southern Caucasus and overall former Soviet Union countries, the second plenary session on the topic "Energy Markets and Regulation" was moderated by Prof. Dr. Vilayat Valiyev, Director of the Institute for Scientific Research and Institute on Economic Reforms under Ministry of Economy of the Republic of Azerbaijan and Vice President of IAEE for Regional Affairs. The speakers of this session delivered presentations on different regional and contextual aspects of energy markets and regulation, namely: Mr. Boyko Nitzov, Team Leader for Gas Infrastructure Development within the Gas Department, Agency for the Cooperation of Energy Regulators, talked mainly about operation principles, regulatory criteria and standards of the gas market in the European Union; Mr. David Narmania, Commissioner of the Georgian National Energy and Water Supply Regulatory Commission, delivered a presentation on the formation and regulation of the energy market in Georgia; Mr. Hikmat Hasanov, Head of Strategic Planning and Innovations Department of the State Agency for Regulation of Energy Issues under the Ministry of Energy of Azerbaijan Republic discussed the potential application of technical regulation standards in the Azerbaijan energy sector; Mr. Kenan Mamishov, Deputy Head of the Analysis and Regulation Department of the Tariff (price) Council Secretariat of Azerbaijan Republic talked about the key features and challenges of tariff regulation in Azerbaijan. It was stressed that the former Soviet Union countries still lack a comprehensive energy market, and the regulatory environment is therefore weak from an institutional and legislative point. Despite the formation of relevant market infrastructure and regulatory environment, Georgia needs to undertake more steps in this area. The panel session speakers also shared their thoughts on existing barriers impeding the establishment of regional energy markets.

The third plenary session on the topic "Electricity Supply Sustainability" was moderated by Prof. Dr. Nurali Yusifbayli, Deputy Chairman of the State Agency on Alternate and Renewable Energy Sources of the Ministry of Energy of Azerbaijan Republic. Recalling the two big power system blackouts that happened in Azerbaijan on July 2 and 4 this year, the topic was particularly important for the public generation & transmission company Azerenerji, the public distribution company Azerishiq and other energy sector public and private agencies. Given this matter, the speakers, Mr. Christophe Bonnery, Prof. Dr. Gürkan Kumbaroğlu, Prof. Dr. Ionut Purica (Professor at Hyperion University, Corresponding Member of the Academy of Romanian Scientists, former President (State Secretary) of the Romanian Nuclear Agency) and Dr. Osman Bulent Tor (Managing Partner and Director, EPRA - Engineering Procurement Research Analysis) touched upon the various facets of the sustainability and safe operation of the power system during their presentations. It was highlighted that it is vital to conduct system diagnosis and monitoring in automatic

mode in order to ensure system sustainability. Furthermore, the panel session participants proposed the arrangement of a half-day or full-day workshop by IAEE on electricity system sustainability.

The 4th plenary session on the topic "Energy Efficiency in Eurasia: Conventional Energy, Renewables and District Heating" was moderated by Mr. Ilham Mirzaliyev, Deputy Chairman of Azeristilitejhizat JSC, the state-owned district heating company in Azerbaijan. The speakers shared the experience on renewable energy and green technologies in different regional countries – Prof. Dr. Siyavush Azakov (Baku Higher Oil School) talked about the studies of SOCAR and Baku Higher Oil School in the field of renewable energy; Mr. Gursu Baskan (Schneider Electric) shared Schneider Electric's experience in energy efficiency and environmental conservation standards; Mr. Arman Kashkinbekov (Vice Chairman, International Center for Green Technologies and Investment Projects; CEO, Association of Renewable Energy of Kazakhstan) briefed the participants on the status of green technologies and renewable energy use in Kazakhstan and implemented projects, including strategic targets of Kazakhstan on renewable energy; Mr. Sahib Khalilov (Head of the Department for Assessing Alternate and Renewable Energy Sources and Environment, State Agency on Alternate and Renewable Energy Sources) delivered a presentation on the development of alternative and renewable energy sources in Azerbaijan, key activities and strategic targets. The panel session participants stressed that the Central Asia and South Caucasus regions have huge potential for joint use of alternative and renewable energy and for energy efficiency.

Another plenary session that had regional significance was the last plenary session on the topic "Oil & Gas: Economics, Innovation and Industry Development". The moderator Mr. Fuad Panahov (Deputy Director of Sumgayit Chemical Industrial Park) noted that the discussion of oil & gas use and industrial development had high importance for the region and Azerbaijan. The speaker Mr. Farid Jafarov (Chief Executive Officer of SOCAR Polymer) provided information on the recently built SOCAR Polymer Plant, natural gas use in the plant and applied new technologies. Dr. Erol Metin (Independent Consultant, SEM (Sustainability, Energy & Management) Consulting) talked about the impacts of oil & gas price fluctuations to industries and innovations, while Dr. Javid Valiyev (Head of the Department for Foreign Policy Affairs Analysis, Strategic Studies Center under auspices of the President of Azerbaijan Republic) emphasized that similarly in all sectors, global technological evolutions trigger core changes in the energy sector. Fuad Panahov discussed gas consumption by the residents of Sumgayit Chemical Industrial Park and the relevant strategic targets. The panel session participants highlighted the necessity of due consideration of technological innovations in the light of volatile prices, and regularly monitoring of industrial evolution trends.

Concurrent sessions

IAEE organized two concurrent sessions on the topics "Energy Markets, Supply Security & Trading" and "Efficiency in the Electricity Sector". The participants of concurrent sessions from Chile, Pakistan, Turkey, Azerbaijan and Kyrgyz Republic delivered presentations on the proceedings of studies on electricity markets, power plant operational efficiency improvement from an economic perspective, potential regional energy trading, energy supply security, smart metering in electricity grids, solar power technology improvements, and oil & gas exploration.

Session for students and Baku Higher Oil School Tour

IAEE also organized a dedicated session for students within the framework of the conference. The IAEE President-elect C. Bonnery delivered a presentation on IAEE covering information on members, affiliates and upcoming events. He and IAEE's member from Azerbaijan Fariz Mammadov answered the questions raised by the students on IAEE's regional and local activities and potential benefits for students and researches. Baku Higher Oi School then organized a campus tour for the participants of the 3rd IAEE Eurasian conference. Its staff showed and informed the participants on the School facilities including tutorial, sport, laboratory and research facilities.

Conference follow-up activities

The organization of the conference at Baku Higher Oil School will significantly contribute to potential future academic and research collaboration between this school and IAEE. The School has already sent a formal letter to express their interest in organizing the IAEE's next Eurasia conference at the school in 2020.

On the other hand, it is important both for Azerbaijan and for the region to define and put in place relevant contemporary alternate approaches in addressing a number of outstanding issues, namely: energy security and electricity supply sustainability; institutional reforms in energy sectors; formation of energy markets and regulatory environment including tariff improvement; and energy efficiency and renewable energy use. It is therefore important to build an enabling platform to incorporate public, academic and business entities in order to provide practical support and to build up capacities for exports, through IAEE's dedicated specialized workshops using its professional members and resources.

Moreover, it would be beneficial to launch collaboration with regional countries on publishing scholarly articles in IAEE's highly recognized journals and possibly, publishing special editions of IAEE's Energy Journal for regional countries.

Last but not the least, the establishment of IAEE's affiliate in Azerbaijan (to be named Azerbaijan Association for Energy Economics) was launched, and the relevant activities are ongoing.

Scenes from the 3rd IAEE Eurasian Conference October 18-20, 2018

The Role of Renewables in Nigeria's Energy Policy Mix

BY EMMANUEL OMONIYI FALOBI

Introduction

Nigeria is well endowed with abundant Renewable Energy (RE) technologies. Main RE technologies include, Small and Large Hydro, Nuclear Power, Solar PV, Wind, Geothermal and Biomass. The rapidly growing energy demand in the country is met principally through finite fossil fuel sources especially crude oil and natural gas. However, these have their attendant challenges of global warming through greenhouse gas (GHG) emissions and CO_2 pollutions. Nigeria's energy demand far outstrips current supply, and this has been the bane to industrial and economic development. Several government reforms have taken place in the past to address the energy challenges in Nigeria. The Power Holding Corporation of Nigeria (PHCN), a company responsible for power generation, transmission and generation was unbundled in 2010, into 18 different companies – 6 Generation Companies (GENCOS), 11 Distribution Companies (DISCOS) and 1 Transmission company, to improve energy efficiency and accessibility. This measure allowed for private participation, eliminating monopoly in the sector. Epileptic power generation and distribution over the years has negatively impacted economic growth and industrialization.

The national target of 40 GW by 2020 from the current level of 3,879MW could only be achieved and sustained with quick intervention from the country's huge untapped RE potentials. Nigeria's installed electricity capacity at year-end 2016 was 12.562GW comprising 15.42% large-hydro, 0.5% small-hydro and 84.1% fossil fuels. However, only 7.141GW of this was available. Due to inadequate grid capacity, an average of 3.879GW of this base figure became technically available within the year following constraints attributable to gas, water management, transmission, etc. Currently, electricity consumption is about 149kWhr/capita. According to IEA (2014), 93 million Nigerians are without electricity whilst the electrification rate stood at 45%, ranking Nigeria about the lowest in Africa. Government targets 75% by 2025 (Vision 20:2020 & FMP 2015 Rural Electrification Strategy and Plan).

Electricity Demand in Nigeria

Projections by International Researchers suggest an expected steady, sustained increased rate in electricity demand effective 2018 going forward (Figure 1). Expectedly, Off-grid supply should augment grid demand in meeting consumption in rural areas (Africa-EU RECP, 2016).

The 7% GDP Growth scenario of the RE Master Plan study conducted by Africa-EU RECP, (2016), gave electricity demand projections of 50,820MW, 77,450MW, and 119,200MW for 2020, 2025, and 2030 planning horizon, respectively.

Table 1 shows Nigeria's 25 grid-connected Power Generating Plants and their installed capacities. However, a number of these plants are unavailable for evacuation to the national grid because of the peculiarity of Nigeria's system – lack of maintenance and repair requirements, trip offs, faults and leakages. Most of these plants are fired by fossil (natural gas) thermal power (85%, i.e., 22 Gas Plants generating 10,632MW)

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See footnotes at end of text

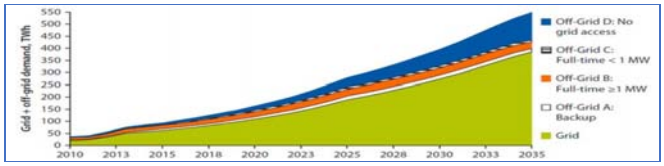

Figure 1: Projected Electricity Demand in Nigeria
Source: GIZ 2015 (FMP & PHCN Data and UN 2010 Rural/Urban Population Data (for Off-grid D Projections), RECP 2016

whilst the remaining 15% are accounted for by 3 hydroelectric power plants – Jebba, Kainji and Shiroro Power Stations generating 1,930MW (Africa-EU RECP, 2016).

Energy Supply in Nigeria

According to the International Energy Agency (IEA, 2011), Nigeria's total primary energy supply (TPES), excluding electricity trade, was 118,325 Kilo

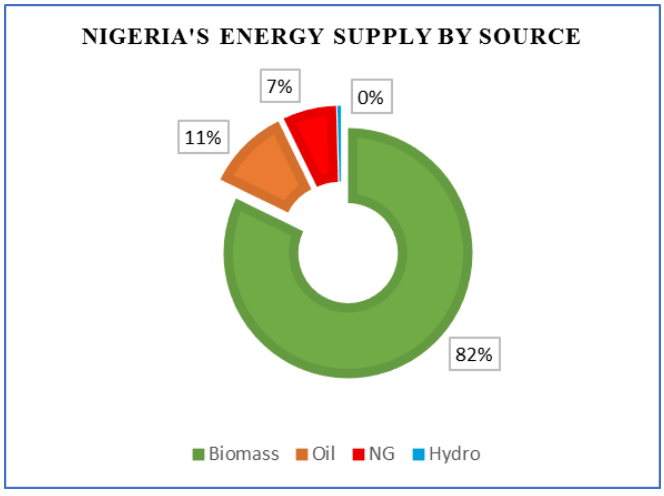

Figure 2: Nigeria's Total Primary Energy Supply by Source
Source: IEA, 2011, Author

Power Station	Fuel Type	Year Com-pleted	Installed Capacity (MW)	Average Available Capacity (MW)	Average Available Capacity (MW)
EGBIN	Gas	1985	1,320	941	539
AFAM VI	Gas	2009	685	587	455
OKPAI	Gas	2005	900	536	375
TRANSCORP UGHELLI	Gas	1990	480	463	374
JEBBA	Hydro	1986	570	431	262
OLORUNSOGO GAS	Gas	2007	335	277	189
IHOVBOR NIPP	Gas	2012	434	374	182
GEREGU NIPP	Gas	2012	450	328	179
KAINJI	Hydro	1968	760	444	173
OLORUNSOGO NIPP	Gas	2012	760	260	171
OMOTOSHO NIPP	Gas	2012	500	306	169
OMOTOSHO GAS	Gas	2005	335	280	163
SHIRORO	Hydro	1989	600	508	153
GEREGU GAS	Gas	2007	414	159	131
SAPELE NIPP	Gas	2012	450	184	111
IBOM POWER	Gas	2009	190	91	76
SAPELE	Gas	1978	504	219	69
ALAOJI NIPP	Gas	2015	720	158	67
ODUKPANI NIPP	Gas	2013	561	234	64
AFAM VI-V	Gas	1982	724	3	2
ASCO	Gas	?	294	270	-
OMOKU	Gas	2005	110	-	-
TRANS AMADI	Gas	?	150	-	-
AES GAS	Gas	2001	180	175	-
RIVERS IPP (Independent Power Producer)	Gas	2009	136	-	-
TOTAL			12,562	7,141	3,879

Table 1: Nigeria's Power Stations Situation (2016)
Source: Africa-EU RECP, 2016, Author's Update.

ton of oil equivalent (ktoe). In terms of energy demand, the residential sector accounted for the bulk of the energy consumed with a total final consumption of 116,457 ktoe. Biomass (including biofuels) and waste constituted (82.2%) and dominated TPES whilst RE sources accounted for just a little share of the energy supply with hydro power accounting for just a paltry 0.4%. (Figure 2).

Energy Consumption in Nigeria

Total Primary Energy Consumption (TPEC)

According to the U.S. Energy Information Administration (EIA, 2012) and IEA (2012), traditional solid biomass and waste dominated Nigeria's TPEC (Figure 3). Nigeria also consumed 35,00 short tons of coal in 2012.

Electricity Consumption by Sector

Data from IEA (2014) source, shows Nigeria's electricity consumption pattern (Figure 4). Here, the residential sector consumed 57% of the total energy demand.

In 2015, power supply averaged 3.1GW (Africa-EU, RECP, 2016) which was just about one-third of the minimum power demand in the country. Consequently, most consumers who could afford stand-by generators resorted to the use of generators to power their businesses and households to augment the intermittent power supply.

Energy Consumption by Economic Sector

Table 2 shows Energy Consumption by Economic Sectors. The residential

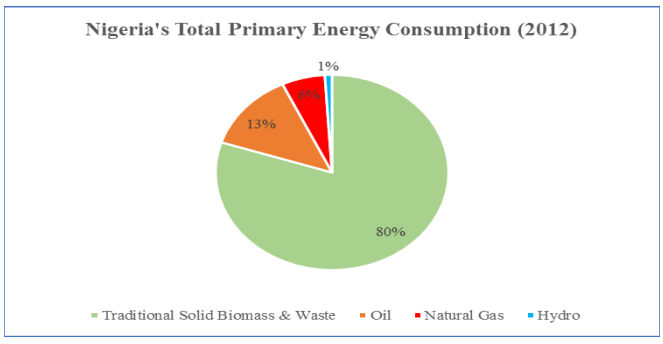

Figure 3: Nigeria's Total Primary Energy Consumption
Source: EIA, IEA, 2012

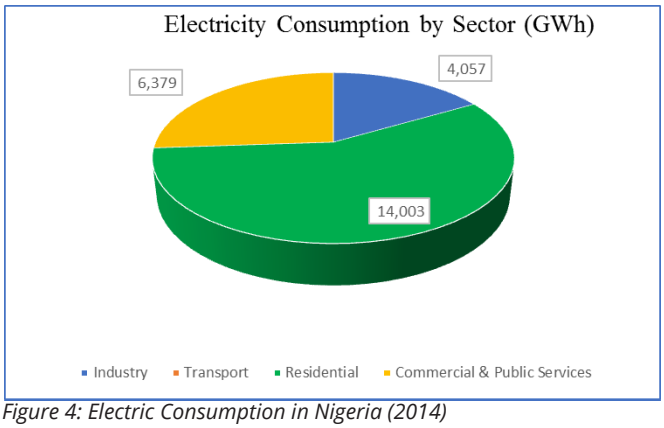

Figure 4: Electric Consumption in Nigeria (2014)
Source: IEA, 2014, Author

Economic Sector	Consumption (ktoe)
Residential	90,709
Industry	10,148
Transport	8,736
Commercial and Public Services	3,561
Non-specified	2,176
Non-Energy Use	1,123
Agriculture and Forestry	4
Fishery	0
T O T A L	116,457

Table 2: Nigeria's Energy Consumption by Economic Sectors
Source: IEA, 2011.

Sector accounted for the largest consumption with 90,709 kilo tons of oil equivalent.

RE Potentials in Nigeria

Agricultural Land Potential

Land is a key endowment to the development of

Figure 5: Map of Nigeria showing its vast Land Potential
Source: Wikipedia

RE in any nation. Nigeria has a total land mass of 92.4 million hectares (923,800 km^2 or 357,000 sq. miles). Land occupies 79.4 million hectares (86%) whilst the remaining 13 million hectares (14%) are water bodies. Hence, there is a huge land potential for cultivation and production of agricultural biomass without necessarily interfering with food security. The climatic and agro-ecological setting of the northern part of Nigeria is essentially arid and suitable for the cultivation of sweet sorghum, groundnut, millet, maize, sugarcane and jatropha; whilst in the southern rain forest belt, crops like, cassava, oil palm, and maize thrive readily. These crops are largely produced by small-scale farmers under relatively low labour costs[1] and are the key feedstock for first generation biofuels[2] production.

RE Potentials

RE potentials (Table 3) derive from the RE technologies including biofuels. Nigeria's RE Master Plan (REMP 2005, 2012 Revised) plans to increase on-grid renewable electricity supply from 13% of total electricity generation in 2015 to 23% in 2025 and to 36% by 2030. This would enable renewable electricity to account for 10% of Nigeria's total energy consumption by 2025 (ECN, Nov 2012; REMP 2012 Revised).

Government's Electric Power Sector Reform (2013) had set ambitious targets to increase installed hydroelectric power to 5.69GW, thermal to over 20GW and renewables to 1GW capacities by 2020. These targets aim at diversifying Nigeria's energy mix to reduce the age-long dependence on natural gas with its attendant environmental concerns.

Estimates of renewable electricity potential is presented in Table 4. Small- and Large-Hydro are

Energy Source	Estimated Potential (MW)	Percent Estimated (%)
Wind – On-Shore	1,600	1.70
Wind – Offshore	800	0.85
Solar PV Panels	7,000	7.45
Geothermal	500	0.53
Biomass	50	0.05
Small & Large Hydro	64,000	68.12
Nuclear Power	20,000	21.29
T O T A L	93,950	100

Table 4: Estimated Renewable Electricity Potential (MW)
Source: GIZ, 2015

Resource	Potential	Current Utilization and Further Remarks
Large Hydropower	11,250 MW	1,900 MW exploited
Small Hydropower	3,500 MW	64.2 MW exploited
Solar	4.0 kWh/m^2/day – 6.5 kWh/m^2/day	Significant potential for solar infrastructure – both for on-grid & off-grid use. Current estimates give 7,000MW from Solar PV Panels
Wind Onshore Wind Offshore Wind	2-4m/s @ 10m hub height mainland -1,600MW - 800MW	Electronic wind information system (WIS) available. Moderate wind potential in the country
Geothermal	500 MW	Requires Technology to fully harness this potential
Biomass (Non-fossil organic matter)	Municipal waste	18.5 million tonnes produced in 2005 and now estimated at 0.5kg/capita/day. 30 million tonnes/yr. in 2016
	Fuel wood	43.4 million tonnes/yr. fuel wood consumption. 11 million of forest & woodland
	Animal waste	245 million assorted animals in 2001
	Agricultural Residues	91.4 million tonnes/yr. produced. 72 million Ha of Agricultural land
	Energy crops	28.2 million hectares of arable land; 8.5% cultivated

Table 3: Summary of RE Potentials in Nigeria
Source: Energy Commission of Nigeria (ECN, 2014), Energy Implications of Vision 20:2020 and Beyond. Report No. ECN/EPA/2014/01

the prominent power source of renewable electricity accounting for about 68%.

RE Resources

Concerted efforts to harness Nigeria's vast untapped RE resources using appropriate technologies through its Agencies, the: Energy Commission of Nigeria (ECN), Nigerian National Petroleum Corporation (NNPC), Nigerian Electricity Regulatory Commission (NERC) and Petroleum Products Pricing and Regulatory Agency (PPPRA), are been driven by well-defined policies and all-encompassing reforms over the years.

Biomass Energy Resources

According to EIA, (2012E)[3], of the estimated 4.5 quadrillion British thermal unit (Btu) TPEC in Nigeria, traditional solid biomass and waste (fuel wood, charcoal, manure and crop residues) accounted for 80% and represents the use of biomass to meet off-grid heating and cooking needs, especially in rural areas. Fuel wood is largely found in the southern rain forest belt of Nigeria and serves as the main source of fuel for over 70% of the populace; thus, accounting for about 65% of TPEC in the country[4] and the negative effects of it has prompted government to discourage the use of fuel wood as an energy source. On December 12, 2012, the Lagos State Government, commissioned its "Waste-to-Energy Scheme" which aimed at generating about 50 MW of electricity from the various dump sites[5]. This typically is an example of the utilization of biomass for clean energy generation (converting municipal waste to clean energy).

Activity / Item	Timeline / Quantity		
	Short Term	Medium Term	Long term
1.Biomass Electricity (MW)	5	30	100
2.Improved Woodstoves (No.)	300,000	500,000	1,000,000
3.Biogas Digesters (No.)	500	6,000	8,000
4.Biomass Briquetting Machine (No.)	30	50	80
5.Biofuel (ML/day)*			
- Bio ethanol (B10)	5.3	9.7	24.2
- Biodiesel (B20)	2.0	3.4	11.7

Table 5: Biomass Programme and Government's Set Target
Source: ECN, (REMP 2005, 2012)

Biomass Targets and Timelines

Energy Commission of Nigeria conducted energy demand and supply studies under various growth scenarios using MAED and MESSAGE energy planning models of IAEA (ECN, NREEP, 2014). Table 5 shows the contribution of RE (biomass/biofuels) towards the realization of the set targets and timelines.

Hydroelectric Power Resources

Three main sources of hydro-power potentials and their installed capacities (totaling 1,930MW) in Nigeria are Kainji Dam (760MW), Jebba Dam (570MW), and, Shiroro Dam (600MW). A survey conducted in 1980 identified 277 sites across the country with potentials to generate 3,500MW of electricity (ECN, 2005). Large Hydro-Power promises an additional 11,250MW. In 2006, the Federal Ministry of Power and Steel came up with the possibility of additional 12,220MW from exploitable hydro sites in Nigeria (ECN, 2005).

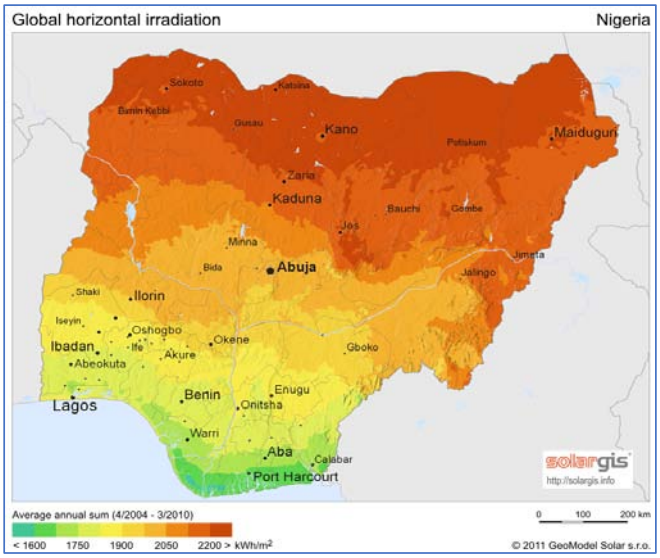

Figure 7: Global Horizontal Solar Irradiation in Nigeria
Source: SolarGIS, Africa-EU RECP, 2016.

Nuclear Power Resources

Nigeria has large deposits of uranium which can be tapped for nuclear power generation. With technological advancement, there are now fast breeder reactors that can conveniently generate up to 20GW of nuclear power on a sustainable basis.

Solar Resources

According to Africa-EU RECP, 2016, Nigeria's solar potential is enormous. With a well distributed solar radiation and average sunshine hour of about 6 hours per day, Nigeria's solar irradiation averages 19.8MJm^2/day. In Figure 7, Northern Nigeria has a higher concentration of solar radiation. The assumed potential for concentrated solar power and photovoltaic generation is estimated around 427,000MW.

Further investment in solar power projects in the country was witnessed in July 2016, when 14 Greenfield Independent PhotoVolataic (PV) Power Projects signed off their Power Purchase Agreements (PPAs) with the Nigerian Bulk Electricity Trading PLC (NBET), a wholly owned Federal Government entity, for a capacity generation of 1,125MW.

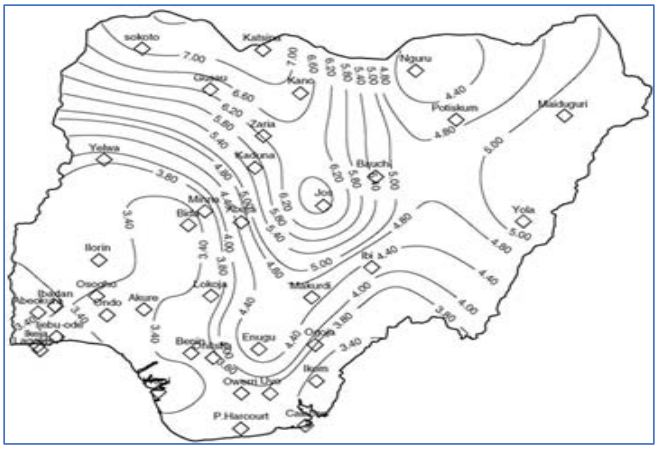

Figure 8: Wind Map of Nigeria (in m/s, determined from 40 year's measurements at 10m height.

Source: Nigeria Metrological Department, Oshodi, Lagos State. Nigeria (NIMET)

Wind Resources

Data obtained from the National Metrological Department, Ministry of Science and Technology reveals a record of an annual speed between 2m/s and 4m/s at the coastal area and heights of about 30m up north, respectively. This correlates well with the findings of Sambo (1987) who recorded annual speed ranges of 2.32m/s and 3.89m/s for Port Harcourt and Sokoto, respectively. Wind speeds of up to 5m/s have been recorded in some areas. These values are not sustainable for a meaningful investment on wind farms as the minimum speed to fully power a wind turbine is 6m/s (REMP, 2005).

Basin	Geothermal Gradient Range
Niger Delta	1.3 – 5.5°C/100m
Anambra	2.5 – 4.9°C/100m
Bida	2.0 – 2.5°C/100m
Borno	1.1 – 5.9°C/100m
Sokoto	0.9 – 7.6°C/100m

Table 5: Geothermal Gradient in Nigeria's Basins

Source: Avbovbo (1978)

Geothermal Resources

Potential for geothermal power generation is very high given the favorable records of geothermal gradient registered across the country. According to Avbovbo (1978), the earth's normal geothermal gradient ranges between 2 - 3°C/100m. Gradients above this range are considered good potential for geothermal power process. Table 5 summarizes what obtains in Nigeria's basins:

In addition, hot and warm springs are indicative of geothermal processes because of tectonic plate movement in the earth crust. The following are notable sites that have become tourist centers of attraction:

- Wikki Warm Springs, Yankari Game Reserve, Bauchi State – 32°C;
- Akiri Hot Spring in Benue State – 53.5°C;
- Ruwan Zafi at Lamurde in Adamawa State – 54°C; and
- Ikogosi Warm Springs in Ondo State. The warm spring has 70°C at source and 37°C at the confluence[6].

Given the right technology, these potentials, when harnessed have been projected to generate about 500MW of geothermal energy.

Thermal Resources

Nigeria's natural gas reserves are estimated at 192 trillion cubic feet (TCF). She currently ranks 9th in the world. Given this huge potential, about 90% of the installed plants are fired by gas thermal power.

RE Policies, Laws and Regulations

Relevant documents containing guiding policy statements for RE in Nigeria include:

RE Policy Guidelines (2006)

Sets out Federal Government's Vision, Policies and Objectives based on the constitution of each policy initiative. Renewables are to be developed on equitable and sustainable basis. This will facilitate the gradual transition from a fossil economy to a less carbon-intensive economy powered by natural gas and renewables. These guidelines include Policy documents on National Electric Power Policy (NEPP), Electric Power Sector Reform (EPSR), REMP, NREEP, Rural Electrification Agency (REA).

RE Master Plan (2005, 2012 Update)

Provides a roadmap for increasing the role of RE in achieving sustainable development (ECN; Nov 2012).

National RE and Energy Efficiency Policy (NREEP, 2015).

NREEP is a compendium of various other policies and strategies in one document. It calls for an

Milestone	Policy Initiative Milestone
2001	National Electric Power Policy (NEPP)–sets a target of 10% RE mix for all new connections by 2020
2003	National Energy Policy (NEP)
2005	Electric Power Sector Reform (EPSR) Act (2005)
2006	RE Master Plan (REMP)
2006	Rural Electrification Agency (REA) established
2010	International RE Agency (IRENA)
2012	REMP Revised
2013	RE Strategy Document
2015	National RE & Energy Efficiency Policy (NREEP)

Table 6: Key Policy Initiatives for RE Policy in Nigeria

Source: GIZ (2015), Africa-EU RECP 2016 and Compilation by the Author from various sources

Milestone	Targets
2015	300MW of Solar PV by 2015
	100MW of Small Hydropower (SHP)
2020	40MW of Wind Power
	30MW of Biomass-fired capacity
2025	4000MW of Solar PV
	760MW of SHP
	18% of electricity from RE sources
2030	20% of Solar PV by 2030

Table 7: Nigeria's RE Targets
Source: GIZ (2015).

RE Technology	Units	2013-2015	2016-2020	2021-2030
Large Hydro	MW	1,930	5,930	48,000
Small Hydro	MW	100	734	19,000
Solar PV	MW	5	120	500
Solar Thermal	MW	-	1	5
Biomass	MW	-	100	800
Wind	MW	1	20	40
Renewables	%	13	23	36

Table 8: RE Master Plan Targets
Sources: Area-net (http://area-net.org), Africa-EU RECP (2016). .africa-eu-renewables.org/market-information/nigeria/governmental-framework/

integrated RE & energy efficiency policy that will serve as a vehicle that limits future conflicts and promotes development of RE technologies in Nigeria (GIZ, 2015).

Policy Initiatives for RE Promotion

Table 6 presents a high-level summary of various initiatives for promoting renewables in Nigeria.

Table 7 summarizes RE Targets of the government.

RE Master Plan Targets are summarized in Table 8:

Conclusions

Diversifying Nigeria's energy mix beyond the current fossil fuel source has always been a major pre-occupation of government. Renewables are replenishable and cost-effective in providing ready solutions to energy issues. Several policies were developed in the past by government to support its efforts of proffering solutions through RE technologies to solve Nigeria's energy problems. Assuredly, renewables have vital roles to play in the energy equation of any nation that desires to run a low carbon economy and be green compliant, and Nigeria, a member of the Paris Accord, is no exception. The Power Sector Reform effort is laudable and will attract more investments. So also, the biofuel initiative to blend gasoline with ethanol by 10% (E10) will not only produce cleaner energy, safer environment, but also increase the country's energy security profile and encourage the use of biofuels for a healthier environment. New job opportunities especially in the rural areas will also emerge.

The government needs to pursue its energy agenda (especially the Power Sector Reforms) vigorously so that the country can be better for it. Power infrastructure is a sine qua non to any meaningful economic development and Nigeria is currently lagging in this critical area. Concerted effort is required to ensure uninterrupted supply of power for the nation's economic growth agenda. Government's vision of becoming one of the top 20 economies of the world by 2020 with a target of attaining 40GW of power is only realizable with dogged determination and unwavering effort by all stakeholders.

Footnotes

1 See http://www.fao.org/ag/agp/GPC/doc/Counprof/nigeria/nigeria.htm. Accessed on May 3, 2015.

2 First generation biofuels are derived from food crops sources, such as cassava, maize, wheat, sugarcane, sugar beet, sweet sorghum as feedstocks to produce typically, Ethanol and Biodiesel. Ethanol is used in petrol engines whilst Biodiesel which is produced from vegetable oils (jatropha, rapeseed, soya, oil palm) and used in diesel engines (SWAC/OECD, 2008).

3 http://www.eia.gov/countries/cab.cfm?fips=NI. Accessed last on May 14, 2015.

4 Sesan, Temilade , "Status of RE Policy and Implementation in Nigeria", 2008, Institute for Science and Society, Faculty of Social Sciences, Law and Education, University of Nottingham, United Kingdom.

5 https://www.vanguardngr.com/2012/12/lagos-generates-electricity-from-waste-lawma-boss/. Accessed last on December 05, 2015.

6 Wikipedia – Ikogosi Warm Springs.

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Renewable Energy Master Plan (REMP 2005, 2012)

UNFCCC (2017). United Nations Framework Convention on Climate Change.

Renewable Integration Impact Assessment: The MISO Experience

BY JORDAN BAKKE, MAIRE BOESE, ARMANDO FIGUEROA-ACEVEDO, BRANDON HEATH, YIFAN LI, NIHAL MOHAN, JAMES OKULLO, ADITYA JAYAM PRABHAKAR, AND CHEN-HAO TSAI

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See footnotes at end of text.

Midcontinent Independent System Operator (MISO) is a not-for-profit member-based reliability organization that ensures reliable, least-cost delivery of electricity across all or parts of 15 U.S. states and one Canadian province (Figure 1). Driven by economics, environmental regulations, technological innovation and aging infrastructure, the types of generating resources in the MISO footprint are changing in a profound way. Many of the legacy power plants that generated the bulk of the region's electricity for decades have either retired in recent years or been replaced by natural gas-fired resources and renewable energy facilities. Energy efficiency initiatives, demand-side programs, energy storage, and distributed energy systems are also growing in popularity. These changes represent a shift away from long-standing power system design and operational practices, and call for a detailed exploration of assumptions regarding the way the electrical grid will work in the future.

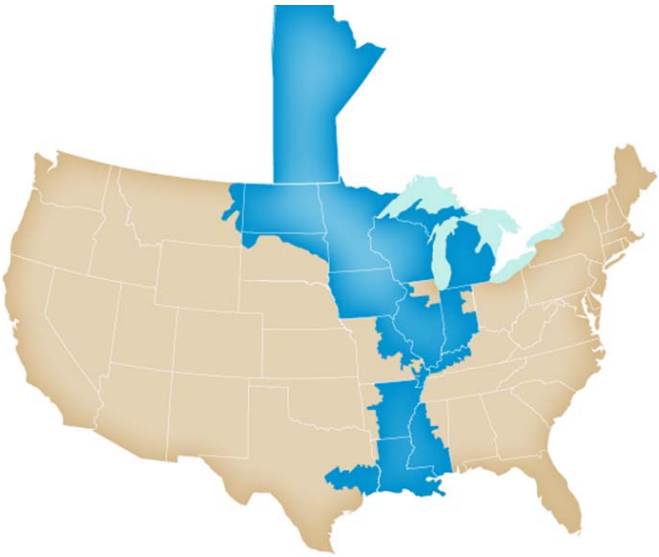


Figure 1: MISO reliability footprint as of July 2018.

Renewable energy, namely wind and solar resources, is currently the fastest growing and most prominent class of resource in MISO. Under current practices, MISO facilitates the integration of renewable resources in the energy market as dispatchable intermittent resources. Between 2014 and 2017, energy output from wind farms increased from 38 million MWh to over 50 million MWh, and accounted for 9% of MISO's energy needs in 2017. There is also 42GW of wind and 36GW of solar capacity currently in MISO's generation interconnection queue.[1] As renewable generation resources continue penetrate into the bulk electric grid, MISO expects their contribution to grid reliability services to increase. These reliability services are a fundamental component of the power industry. Hence, MISO deems additional analyses are necessary to gain better understanding of requisite resource performance on a regional scale as renewable penetrations reach higher levels.

Given the current characteristics of the electric system in MISO and its neighboring regions, including but not limited to physical infrastructure, operational practices, and regulations, there may be limits to how much renewable energy can be easily integrated into the bulk electric system. The complexity of overcoming these limitations is dependent on the types and distribution of renewable resources, the current operational characteristics and locations of existing assets, and the actions of neighboring regions. Because the exact points of these limitations are unknown, MISO developed an analytical framework, i.e., the Renewable Integration Impact Assessment (RIIA), to examine renewable integration over a wide range of penetration levels. Starting with the current system and examining penetration levels up to very high percentages of annual energy, RIIA aims to find inflection points of system integration (Figure 2). Industry studies have shown that the complexity of integrating renewables escalates non-linearly with increasing penetrations of renewables. Over

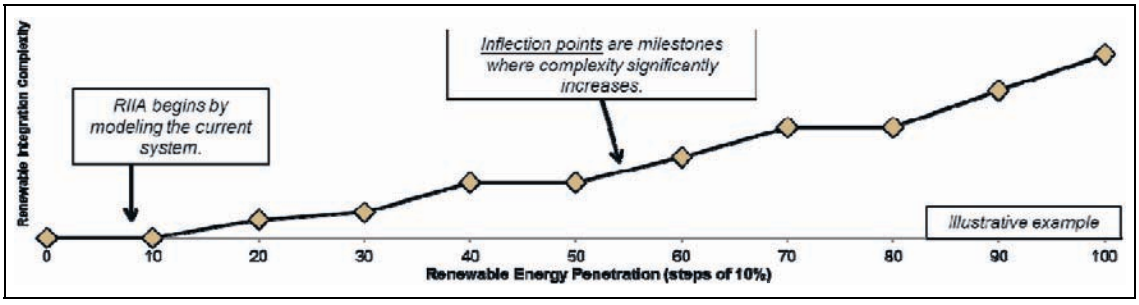


Figure 2: RIIA

certain ranges of renewable penetration, complexity is constant when there is adequate transmission and generation capacity in place. However, at specific renewable penetration levels when existing transmission and generation capacity are exhausted, complexity rises dramatically. These are system inflection points, where the underlying infrastructure and/or system operations require significant enhancement to achieve the next tranche of renewable deployment while keeping adequate levels of grid reliability.

To find system inflection points and to examine potential solutions for mitigating potential reliability risks, RIIA comprises three focus areas: Resource Adequacy, Energy Adequacy, and Operating Reliability. These three focus areas include three separate models that use mostly common assumptions.

Resource Adequacy

A key component of MISO's planning process is the Resource Adequacy analysis, pursuant to standards established by the North American Electric Reliability Corporation (NERC). The metric used to calculate the planning reserve margin (PRM) for a system is the "one day in 10 years" criterion for Loss of Load Expectation (LOLE). In other words, the system must have enough generation capacity above the gross peak load to cover load forecast errors, unexpected generation outages and planned maintenance of generation units.[2]

The integration of higher levels of renewable resources into the MISO market has driven the need to quantify the effect of wind resources on the LOLE target. MISO has adopted the effective load carrying capability (ELCC) to quantify the capacity value of wind during MISO's peak hours. In RIIA, the ELCC is quantified for each 10 percent renewable penetration milestone; each renewable technology being studied (wind, utility-scale solar distributed solar PV); the isolated collective solar technologies; and for each of the six different profile years studied (2007-2012) using load data from the real-time market and renewable generation data from the National Renewable Energy Laboratory (NREL). Figure 3 illustrates the effects of high levels of renewables penetration on the average net load shape in MISO footprint, i.e., total load minus renewable energy output (pre-curtailment).

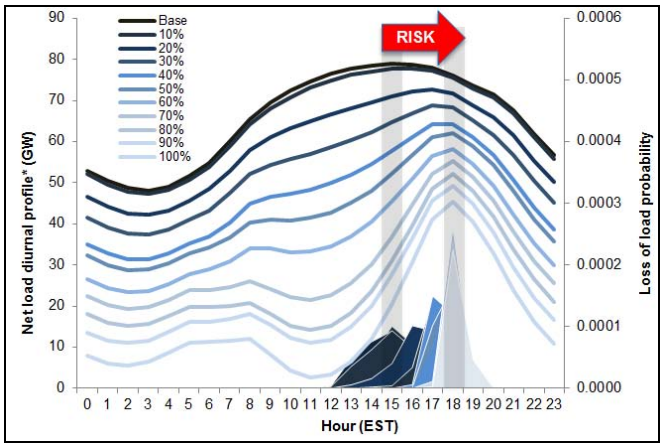


Figure 3: Risk of Losing Load

Figure 3 provides several key observations in the context of Resource Adequacy. First, as renewable penetration increases, the risk of losing load compresses into a small number of hours and shifts to later in the day. Second, at higher levels of renewables, this new period with the highest LOLE occurs when the performance of wind and solar drives a rapid increase in the net-load ramp. With this change in net load shape, the ELCC values for wind and solar are shown to decrease as penetration increases as illustrated in Figure 4. The ELCC for wind only decreases slightly along with increasing installed capacity. However, the ELCC for solar sees a steeper drop-off. Note that these approximated ELCC curves are specific to the assumed capacity mix and the siting of new renewable units. The

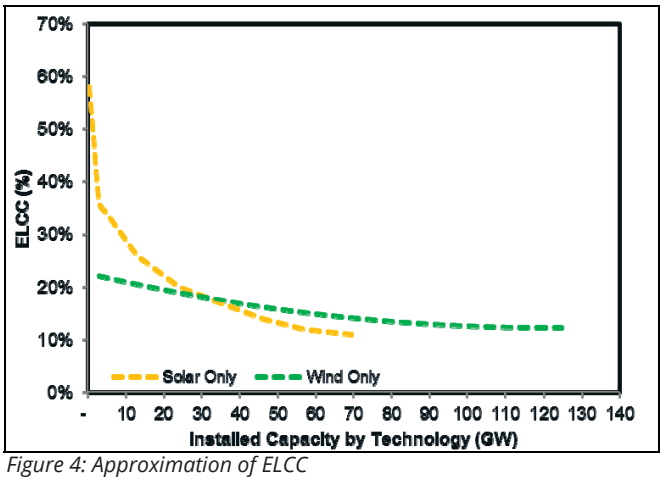


Figure 4: Approximation of ELCC

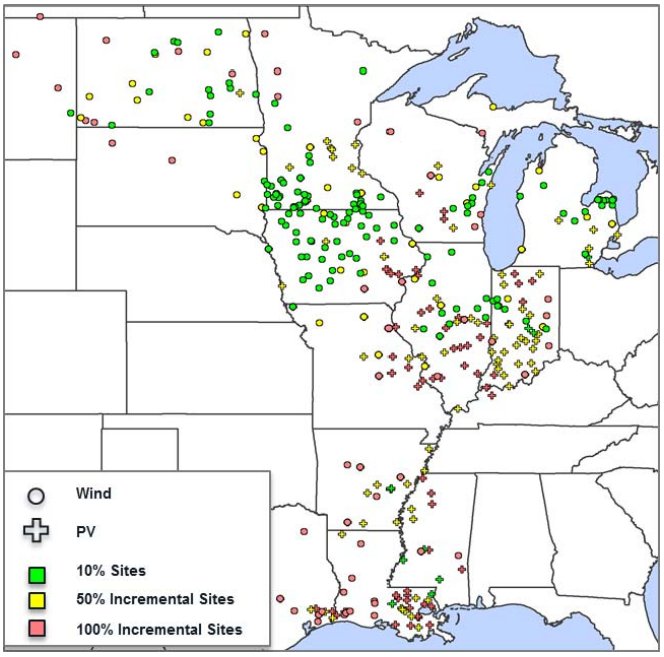
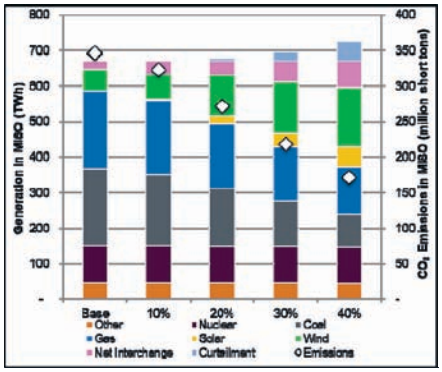


Figure 5: Geographic diversity of renewables citing

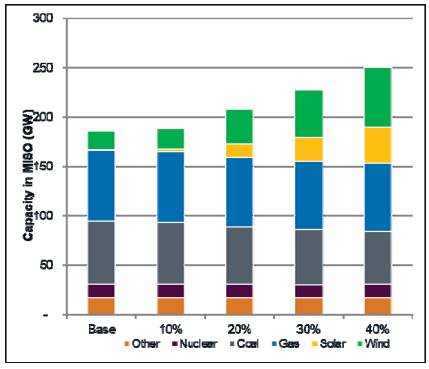
diversity of technologies and geography, as shown in Figure 5, would improve the ability of renewables to meet load (Heath and Figueroa-Acevedo, 2018).[3]

Energy Adequacy

The main goal of the Energy Adequacy assessment, defined as the ability of a bulk electric system to operate continuously, is to examine if and how the high levels of renewable penetration may affect hour-by-hour system operating conditions. MISO RIIA team develops resource generation and capacity scenarios for each milestone of renewable penetration (Figure 6 (a) and (b)), by incorporating the declining ELCC assumed for wind and solar from the previous Resource Adequacy analyses. Since Energy Adequacy assumes the planning reserve margin (PRM) holds constant, conventional generation is retired in each milestone to account for the added renewable capacity. Increasing renewable penetration along with its declining ELCC leads to an increase in total installed capacity in MISO (Figure 6 (b)).



(a) Generation



(b) Capacity

Figure 6: Generation and capacity in the MISO region

RIIA team then utilizes an hourly production cost model to take a closer examination of hourly generation mix, operating reserves, system ramps, renewable curtailments, and transmission congestion. The annual generation mix can be seen in Figure 6 (a). By comparing the capacity mix to the generation mix, it is clear that despite the retirement of some generation, conventional generation remaining online still sees a decrease in its average capacity factor as energy fulfilled by renewable sources increases.

RIIA team also finds that renewable curtailment increases across each milestone. If the curtailment of renewables is too high to prevent meeting the milestone percentage of renewable penetration, the RIIA team looks at ways to mitigate the curtailment (Figure 7). For example, in the 40% RIIA case, only 32% of MISO's load is served by renewable energy. This curtailment will be addressed as RIIA progresses.

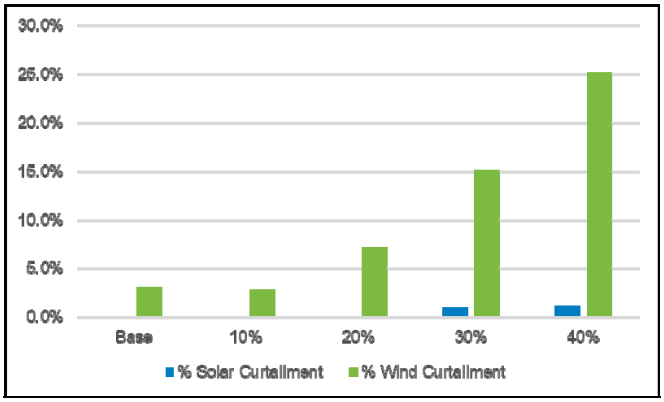
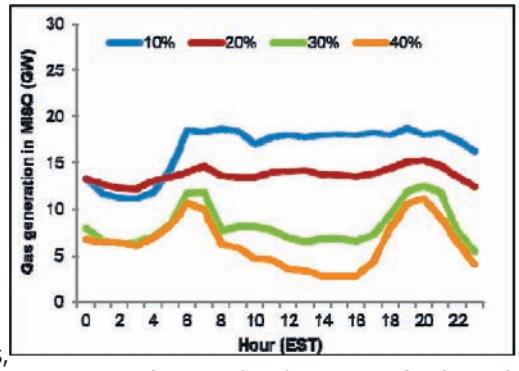


Figure 7: Wind and Solar curtailment under RIIA scenarios

System ramping behavior is another key metric examined as part of the Energy Adequacy assessment. Figure 8 represents gas and coal ramping behaviors on days with the highest amount of renewable generation. As renewable penetration levels increase, both gas and coal units see two significant ramps at the beginning and end of the day. The two ramps occur due the same behavior that reshaped the net load curve as previously discussed in the Resource Adequacy section.



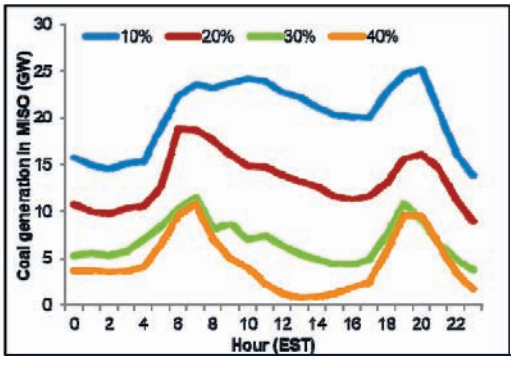


Figure 8: Hourly gas and coal generation for the peak renewable day

Operating Reliability

The RIIA Operating Reliability focus area investigates the steady-state thermal and voltage performance of the MISO system. This focus area also looks at the impact of high levels of renewable penetration on transient stability and MISO's obligations towards maintaining adequate frequency response. The RIIA team developed study models based on the generation

dispatch and demand levels obtained from the Energy Adequacy yearly production cost simulations, which project system-operating patterns under different renewable penetration levels. Based on results of hourly dispatch modeling from Energy Adequacy for the entire year, the RIIA team selected three snapshot points for AC contingency analysis, as a sample representative of system's most stressful operating

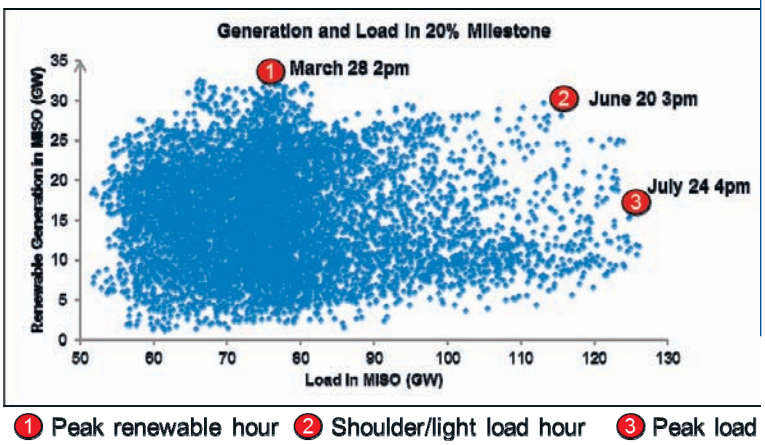
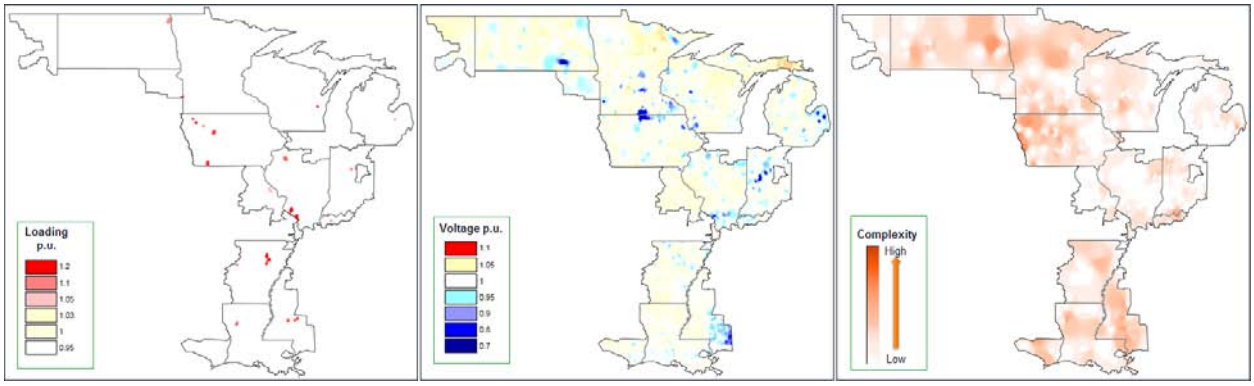


Figure 9: Stressful System Conditions

steady-state thermal and voltage issues from these snapshots, the team then utilizes a local transmission upgrade methodology to alleviate reliability issues (Figure 10), which reflects the traditional practice in industry to mitigate local area violations. The magnitude of transmission fixes needed to address those identified issues serves as a proxy for integration complexity. Steady-state assessment suggests that integration complexity for 20% renewable milestone is in general relatively mild for MISO footprint. (Figure 10).

The RIIA team also studies the impact of renewable penetration on frequency response by evaluating MISO's performance per NERC standards during a 60-second dynamic model simulation. MISO incorporates model updates such as asymmetrical dead-bands in existing governor models with generic values, removal of governor models for any unit that remains non-responsive to frequency events, and withdrawal of frequency support by certain units. MISO then validates the base dynamic model against actual system disturbances and responses. Figure 11 presents the simulation

(continued on page 54)



(a) Thermal loading *(b) Voltage issues* *(c) Integration complexity*

Figure 10: Thermal loading and voltage issues with integration complexity

points: (1) peak renewable output in MISO's footprint, (2) off peak load with highest renewable penetration, and (3) peak load with highest renewable penetration. (Figure 9).

The RIIA team evaluates transmission system performance by selecting a subset of contingency categories pursuant to NERC reliability standards, to focus on high-likelihood events that tend to cause severe reliability violations on the MISO system. Once the RIIA team identifies

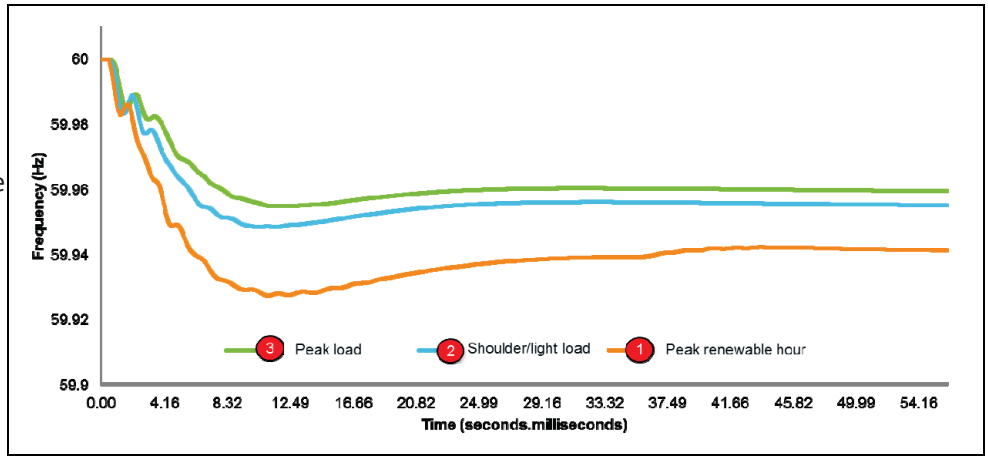


Figure 11: Base model frequency response simulation results

Technological Change in Service of the Environment

BY JONAS GRAFSTRÖM

Introduction

There is an increasing interest in developing, integrating and managing a growing share of intermittent renewables from solar and wind into electricity generation for both existing and new geographical areas. Studying and promoting these developing and integrating processes are highly important because human economic activity, which historically has been highly dependent on fossil fuels, is dramatically increasing the atmospheric concentrations of CO_2, exceeding 400 parts per million (ppm) compared to an historical value around 250 ppm (EPA, 2016).

It has been established that the anthropogenic emissions of greenhouse gases (GHGs) have a distinct impact on the global climate (e.g., IPCC, 2007, 2013). Although CO_2 is a normal component in our atmosphere, and has made life on earth possible in the first place, the increased concentrations may change our climate in ways that present a critical mix of dangers (e.g., changed weather patterns with increased variability, rising sea levels and droughts, etc.) (e.g., Dietz and Maddison, 2009; Suganthi and Samuel, 2012). One way to protect the global climate and limit the concentrations of CO_2 is to develop and diffuse new carbon-free or low carbon technologies, not the least in the form of renewable energy sources (Stern, 2007).

However, a large body of literature has shown that the market can fail in a substantial way when it comes to providing the socially efficient amount of resources aimed at generating technological and scientific knowledge in the environmental field (e.g., Nelson, 1959; Arrow, 1962). The uncertainties about the future returns to environmental R&D investments are particularly high, e.g., because of policy inconsistencies (Jaffe et al., 2002; Grafström 2018).

Global energy demand has risen more quickly in the past decade than ever before, and energy demand is predicted to continue to rise with economic development and population growth in the developing world (Suganthi and Samuel, 2012). It is likely, therefore, that the emissions of GHGs will also increase - even if the production of goods and services becomes less emission-intensive.

If the absolute demand for energy cannot be decreased sufficiently, then a supply-side solution offers an alternative for addressing the need for GHG mitigation. The mounting concerns of climate change, caused by mankind's accelerating use of carbon intensive energy since the Industrial Revolution, have led policy makers to highlight technological development in the renewable energy sector as a crucial and achievable remedy for the emission problem.

Following the above, the overall purpose of this paper is to briefly outlay and analyze the fundamentals of technological change in the renewable energy sector. Considering the threat of severe consequences of global warming, and policymakers' desire to focus technological change in renewable energy as one of the solutions, the contribution of this paper lays in its attempt to promote understanding of the technological change process, i.e., the drivers behind it and the possible development patterns for different countries. Such knowledge should enable policy makers to make more efficient decisions.

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Technological Change in Service of the Environment

This paper draws on an intellectual foundation from seminal contributions by Schumpeter (1947). In Schumpeter's work ideas around an economy's creative response to changes in external conditions were offered. Furthermore, several analytical approaches have been applied historically to analyze the process of environmental technological change, and a lot of inspiration from past works has been drawn from the extensive literature on induced innovation (primarily originating from, for instance, Hicks, 1932, and Arrow, 1962), which later has come to play an important role for the analysis of technological development in the renewable energy sector (e.g., Ruttan, 2000).

The technological change approaches have drawn from general economic thinking and been applied as tools in the empirical context of renewable energy. For example, in their pioneering work Nelson and Winter (1982) emphasized the importance for a country to develop its own technological capabilities, i.e., the ability to produce an output (e.g., patents), this to be able to be a part of further technological development. Hence, improvements of technological capability contain a broad range of efforts that are needed to access, absorb, and assimilate knowledge (e.g., Rip and Kemp, 1998; Unruh, 2000; Grafström, 2017).

Technological change in general – and in the renewable energy sector in particular – has commonly been characterized and analyzed as a process encompassing three major development stages: invention, innovation and diffusion. Empirically these stages have typically been analyzed separately from each other. Such approaches, however, come with

some drawbacks (Grafström and Lindman, 2017). The implicit assumption in the traditional stylized linear model of technological change is that technologies subsequently pass from one stage to another but with limited interactions between various stages, e.g., between diffusion and further inventions and innovations. In the systemic model, though, several feedback loops are suggested and these point at interactions between the different stages (Rip and Kemp, 1998). For instance, the diffusion of new technology will lead to further improvements in the performance of the technology, i.e., through learning-by-doing, and it may also affect the rate-of-return to additional R&D efforts.

Figure 1: The integrated technological development approach.

Technological change is almost uniformly considered a necessary, although not a sufficient, condition for a transition to a sustainable energy system (Reichardt and Rogge, 2014). Since the global climate issue is transcending national borders, global solutions are required to reduce GHG emissions. Economic analyses of ways to reduce environmental harmful actions through better technologies are based on the idea that the potentially harmful consequences of economic activities on the environment constitute an externality. An externality is a significant effect of one activity, where the consequences are borne (at least to some extent) by someone other than the externality-generating actor.

Technology can affect emission levels and change the number of units of goods created with the same amount of inputs. Hence, an improved technology can either allow us to emit a smaller amount of GHGs than before without reducing our current consumption level or it can enable us to consume more with the same level of GHG emissions (Del Río, 2004). A simplistic way to show the human impact on the environment is to apply the following three-factor equation:

$$I = P + A + T \qquad (1)$$

where I represent the environmental impact variable. It is a product of P, the population, A, the wealth (often proxied by GDP per capita) and T, the technology used in production. A decrease in T would indicate a gain in efficiency making the impact on I less profound. Hence, if the production technology becomes less polluting we can either have more people, P, consuming a good without an increased environmental degradation or the same amount of people can have a higher wealth, A, without any change in the overall environmental impacts.

In the context of equation (1) it is useful to consider two facts. First, the current population (P) of the world is estimated to be 7.5 billion (in 2017) and it is expected to reach 9 billion by the year 2038 (United Nations Department of Economic and Social Affairs, 2017). Second, the global wealth (A) is expected to rise; the GDP of the world is, according to the World Bank (2016), expected to grow by about 2.7 percent in 2017, and most of authoritative projections suggest continued global economic growth during the coming decades. Considering these two facts together, the aggregate environmental impacts are likely to be significant unless technological change can help reduce them.

Technological change in the renewable energy sector is developing fast. Figure 2 displays the development of total renewable energy patent applications in 13 EU Member States by country (the number of granted patents are lower). It shows that Germany and Denmark are the two countries with the most significant patent outputs. Moreover, the number of patent applications filed for renewable energy technology at the European Patent Office (EPO) has increased by more than 20 percent annually in recent years (as a reference, the average annual increase for all patent applications was around 6 percent EPO, 2016).

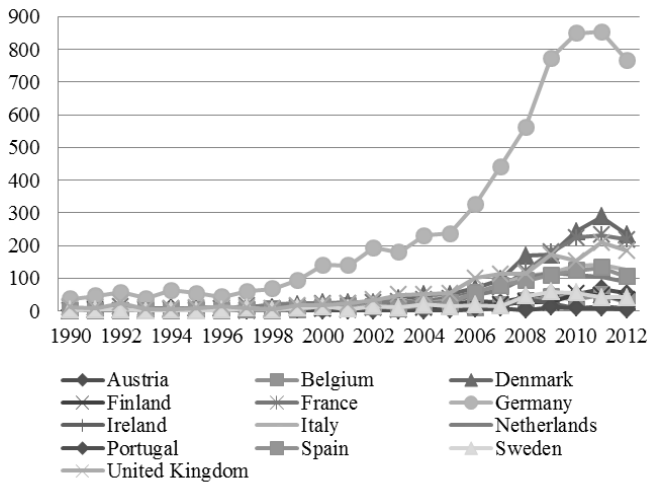

Figure 2: Total number of renewable energy patent applications in 13 EU Member States by country, 1990-2012. Source: OECD (2014).

Figure 3 displays the number of renewable energy patent applications in the same 13 Member States by technology. During the last ten years there has been a fast growth in wind and solar energy inventions while the other renewable energy sources also seem to have gained some momentum during the last decade.

Still, while renewable energy technologies have developed over time and improved their performance in terms of lower generation costs, this does not automatically imply that these technologies will be adopted in all countries (Grafström, 2017). One reason for this may be that countries with little of their own development activities find it difficult (or costly) to

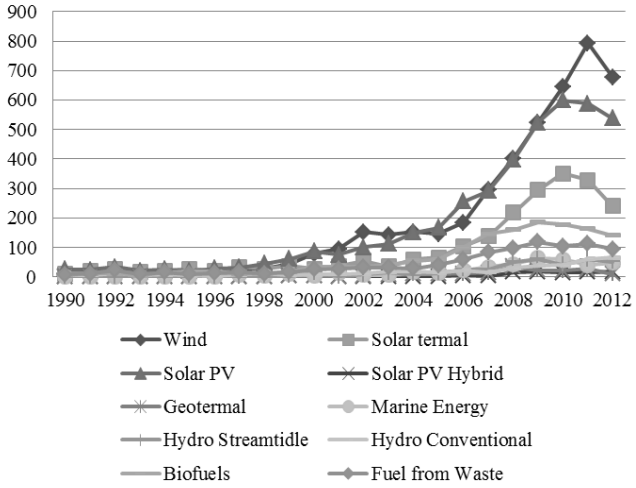

Figure 3: Renewable energy patent applications in 13 Member States by technology, 1990-2012. Source: OECD (2014).

make use – and implement – the knowledge generated in the leading countries.

In general, the speed of innovation will be higher if more countries are engaged in R&D (Nelson and Phelps, 1966; Baumol, 2002; Stöllinger, 2013). The same holds for the renewable energy sector (e.g., Costantini and Crespi, 2013; Costantini et al., 2015). The speed of innovation is of essence given the urgency of addressing the accumulation of GHGs in the atmosphere (GHGs accumulate over time and will stay for a long time). Hence, there exists a value in developing low-cost carbon-free technologies relatively quickly.

Concluding Remarks

This paper deals with the economics of renewable energy and technological change. The contribution of the paper lays in its attempts to provide a deeper understanding of technological change in the renewable energy sector, the drivers behind technological change and the development patterns that single countries will choose. Such knowledge enables policy makers (e.g., at the EU level) to make better and more informed decisions, e.g., on how to encourage an efficient and fair allocation of public R&D efforts across countries.

A major lesson is in line with Kirzner's (1985) observation; if one only looks at a specific part of the technological change chain one might miss "light-bulb-moments" that could have made a significant difference. It is perfectly fine to study the different steps (invention, innovation and diffusion) separately, but there is interconnection between different stages in technological development that policy makers need to be aware of. An increase in the diffusion rate may, for example, affect invention and innovation rates. At the same time, too little effort in terms of one of the development stages might lead to reduced effects of policies that are designed to influence the other stages.

Hence, technological development should be viewed as a system of interdependent parts. Policies aimed at reducing GHG emissions or increasing the share of renewable energy sources, may have limited effect at some stages at the technological development process, but could have important effects on other stages. Depending on what effects a policy maker wants, it is important for him/her to know where the effect will be and consider that there might be positive and negative unintended consequences. Thus, an important lesson for policy makers is that when designing policies in the renewable energy technology field, one must consider how different policy instruments interact since they can affect different parts of the technological change process.

Naturally, since this paper only attempts to provide answers to questions concerning a limited part of the entire technological development process, the field for future research should be wide. If we want to predict and understand how the new renewable energy technologies develop over time and what policy makers can do to stimulate this development, it is essential to continue to improve our understanding of the subject.

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results of frequency response for loss of a 1,120 MW generator in MISO. Key system performance indices are found to be within the acceptable criterion.

Conclusion and Next Steps

Though still ongoing, the RIIA study has thus far been successful in meeting our goal to enhance better understanding on the impacts of renewable energy growth in MISO over the long term. The technically rigorous analysis hasprovided concrete examples of potential integration issues and has explored possible mitigation solutions. The assessment is giving MISO and our stakeholers specific areas on which to focus our efforts, including: the potential changes in MISO's loss of load risk profile; expansion of transmission and non-transmission-alternatives; and the need for operational flexibility. Finally, given the expected changes to the footprint's resource-mix, the assessment has offered an important forum through which MISO and our various stakeholders are discussing the future composition, structure, and operation of the grid.

Footnotes

1 Projects with active generation interconnection status as of Q2, 2018.

2 Per NERC Standard BAL-502-RF-03, the Resource Adequacy analysis shall "[C]alculate a planning reserve margin that will result in the sum of the probabilities for loss of Load for the integrated peak hour for all days of each planning year analyzed being equal to 0.1." This is comparable to a "one day in 10 year" criterion.

3 Heath, B. and Figueroa-Acevedo, A. L., "Potential Contribution of Wind and Solar Generation in MISO System," in IEEE International Conference on Probabilistic Methods Applied to Power Systems, Boise, ID, 2018.

Solar PV Electrification in New Regions: International Low-carbon Energy Transition

BY HYUN JIN JULIE YU

Introduction

Energy is a basic component of human life, economic activity and civil progress and thus directly associated with national security and socio-economic development. The energy sector is undergoing a transformation and these changes would lead to public risks, uncertainty and challenges in the future energy systems. However, over 1.3 billion people in the world still have no access to electricity. The international community has been sharing the concern on how to address energy poverty issues and improve the global sustainability.

Solar photovoltaic (PV) energy has caught the eye of many governments as one of the front-runners of low-carbon technologies. Solar PV systems have experienced strong market growth and gained economic competitiveness over the last decade mainly supported by the national political reaction to the low carbon energy transition. The world cumulative installed solar PV capacity has been largely increased from around 600 megawatts (MW) in early 2000 to more than 400 gigawatts (GW) in 2018. The global module prices have declined significantly thanks to the globalization of the sector and this has helped enhance the economic competitiveness of PV systems. Module prices have been declined by a factor of about 10 since 2005 and they are now below € 0.3 per Watt Peak (Wp). Despite these favorable conditions, however, the global PV market recently went through a chaotic time due to the overproduction of PV products, fierce price competition and long-lasting trade disputes. The nation-wide approach to creating market demand is somehow limited in responding to the globalized PV industry capacity. Thus, there is a necessity to develop new PV markets.

In this context, this article aims to present a new approach to extend the international energy transition to diffuse low-carbon energies (e.g., solar PV) in new regions. It aspires to further deploy solar PV systems in less developed and developing countries, which are faced with energy poverty problems. The original contribution of this study is to extend the nation-wide vision of energy transition through renewable energies (e.g., solar PV) to an international perspective. This study provides the economic rationale of international energy transition mechanisms based on the case of the diffusion of small PV systems with Li-ion batteries. This study highlights the global economic benefits as a response to the current global PV industry crisis (new market) and the return on PV investments in the new regions.

Traditional way of thinking: nation-wide low-carbon energy transition & globalization effects

Over past decades, climate change has been the subject of serious international negotiations and transforming the energy system via de-carbonization is an important target of international energy policy. However, each government has a different approach or priorities to deal with these issues. The objectives in solar PV policy mechanisms will differ from one region to another according to the political strategic position, regional or national contexts and history.

Until recently, the policies to achieve the low-carbon energy transition in many countries has aimed to create a nation-wide virtuous circle of innovation between the supply-side (R&D and industry) and the demand-side (markets) to reduce costs. Watanabe's 'virtuous circle' provided a theoretical support to these policy initiatives to create the technology innovation process. It asserted the creation of a 'virtuous cycle' between R&D, market growth and price reduction for PV development based on an empirical analysis of Japan's PV development [2].

Germany has shown a good example of the mechanism that creates a national virtuous circle of innovation Figure 1. The country began to promote the use of renewable energies as early as the 1970's to overcome the oil crisis, and solar PV energy was one of the sustainable substitutes that could increase national energy security. Based on this innovation system, Germany has played a significant role in the development of the global solar PV market, being one of the

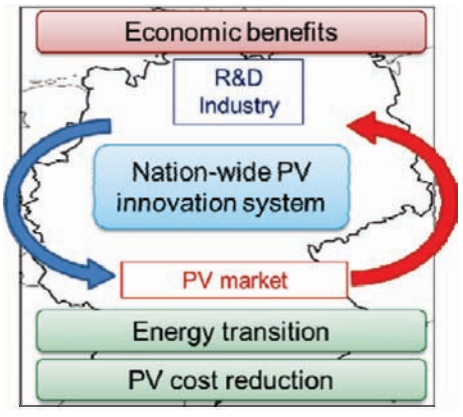

Figure 1: Nation-wide innovation mechanisms

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See footnotes at end of text

pioneering countries over the past few decades. The country followed the classic linear model of innovation from focusing on early R&D investment and then expanding to demonstration and commercialization. Since then, the country's development path has focused on both supply (R&D, industry) and the use of solar PV cells (installations). The German market demonstrated high growth as a result of the synergy between the successful technology-push and the market-pull policies (FIT)

However, PV globalization has changed this mechanism. The nationwide system to create the virtuous circle of innovation in the PV sector has been broken with the arrival of cheap Chinese products in the global market.[1] From the mid-2000's, however, the increase in demand in line with policy supports (FIT) in Europe has attracted Chinese players into the PV manufacturing market. Chinese production soared in a short time mainly supported by export-oriented political supports (i.e., easy access to capital) and managed to quickly reduce the cost based on the GW-scale production capacity. China's rapid market expansion without domestic market development brought unexpected results, with an oversupply of PV products and fierce price competition which destabilized the PV market [4]. Many PV firms in the world have since gone bankrupt [5]. For example, the German industry has declined accounting for only 2% of world production (c.f., around 20% in 2006). Moreover, the PV sector encountered long-lasting trade disputes between major countries.

This PV industry crisis increased difficulties for countries aspiring to implement green growth policies with the combined policy objectives of energy transition and economic growth through PV growth (e.g., in Germany).

The oversupply issue has remained unsolved until now. For example, the top 10-module suppliers (30% of the global production capacity) can almost meet the world's PV demand (~ 70GW) in 2016[6]. The principle of the 'virtuous circle' of Watanabe [1] can be valid on condition that the national policy is sufficiently ambitious and stable based on the long-term. The nation-wide approach to create market demand is somehow limited to respond to the globalized PV industry. The national PV installations are usually insufficient to feed the GW-scale supply volumes that are required to gain price competitiveness [7]. Therefore, new solutions for the currently unbalanced PV market should be sought in the international arena.

In this regard, this study focuses on the unexplored potential of the PV market in new energy poverty regions. It should be noted that over 1.3 billion people worldwide live a daily life without access to electricity even though energy service is a crucial element for modern society and human well-being. They reside mostly in the rural area in sub-Saharan African or developing Asia and these regions have good solar resources. However, they easily use diesel generators or traditional biomass to supply energies despite the high operating cost or negative impact on the environment or health.

Methodologies and data

This study aims to analyze to what extent solar energy is an interesting energy option in these regions. We will cover the subject from both the supply-side (industry) and the demand-side (energy transition) perspectives to present a macroscopic vision of energy transition on an international scale. According to the World Bank, energy access problems are concentrated in Africa and Southeast Asia. Interestingly, however, there are also significant solar energy resources in these regions. Our analysis is thus based on data concerning 49 countries in energy poverty regions with good solar resources, including the least developed countries in Africa, Southeast Asia, India and Bangladesh. They represent 1.06 billion people.

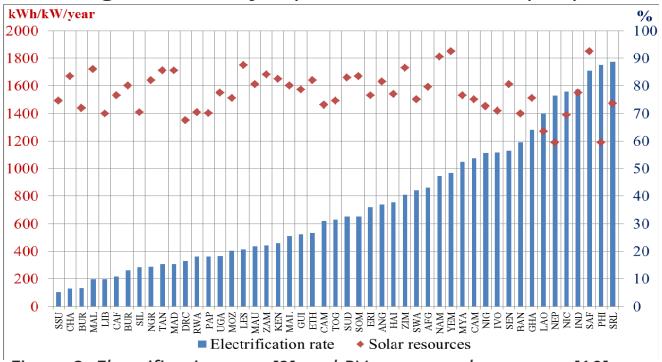

Figure 2: Electrification rate [9] and PV resources by country [10]

Our selection includes several major countries with a low energy trilemma index; 23 countries are ranked in the last 50 countries and 20 countries are unranked [8]. The average potential PV power output is 1548 kWh/kWp/year (about 50% higher than the average PV resources in Europe).

Our study aims to quantify the fact that the electricity demand in these areas can be supplied using the abundant solar energy resources. However, PV development in these regions is not without risk. Even though the risks differ according to each country, the financial risk is one of the great obstacles to developing PV markets in these areas. Institutional risks can also exist, e.g., a lack of standards or infrastructures. Therefore, it is hardly possible to supply electricity to all residents based on the grid-connection since it is a very expensive solution.[2] Diesel generators are the classical way of supplying power in these regions (substitute risks).[3] In this regard, as PV systems have the advantage of being able to provide decentralized power, the utilization of off-grid PV systems seems to be an appropriate solution in these regions.

In this regard, this study identifies the potential market size of the solar PV industry in new regions

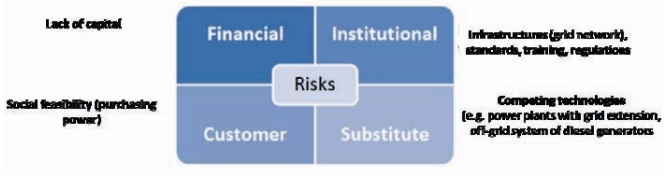

Figure 3: Risks analysis of PV development in new regions

based on combined PV systems with Li-ion batteries for residential applications. In order to define the system specifications, we have considered that those with no access to electricity would need the same amount of electricity as the average power consumed by the population with electricity. The calculated average is 922 kWh/year per capita in these countries[4]. Since the average potential PV power output in these countries is 1548 kWh/kWp/year, we concluded that a solar panel of 0.6 kWp/capita[5] would allow us to meet the electricity demand. We thus assumed the use of 2kWh[6] batteries coupled with the 0.6 kWp PV systems can store almost 80% of the average daily consumption.

Results and discussions

In this section, we describe the opportunities available for the world's energy transition by using solar PV systems in the selected countries. The maximum potential market size of solar PV industry is defined.

- **Potential market size of electrification:** we estimate that the total market size for full electrification in these regions is about 640 GWp (0.6 kWp x 1.06 billion people). This results in an electricity consumption of around 980 TWh/year (922 kWh/year x 1.06 billion people).

- **PV costs vs. diesel generators to meet the estimated demand**
  This section examines to what extent solar PV power is a more affordable energy option compared to diesel generators. We assumed that the diesel price would stay constant in the future so we could carry out a quick comparison. The fuel price is an important variable when defining the LCOE[7] of diesel generators. The LCOE of a diesel generator is c$ 29.7 / kWh to c$ 33.2 / kWh [9][8]. The LCOE of PV systems coupled with 2 kWh[9] batteries is calculated adjacent.
  Based on our calculation, it can be seen that electrification with the PV technology is less expensive than the power supply by diesel generators. In addition, even the combined PV systems with batteries are more economically feasible without jeopardizing the competitiveness of PV systems when the solar resource is over about 1550 kWh (24 of the 49 countries selected). Furthermore, if we include negative externalities in the energy system with respect to the generation of large quantities of CO_2 emissions, the real costs of diesel generators will increase.

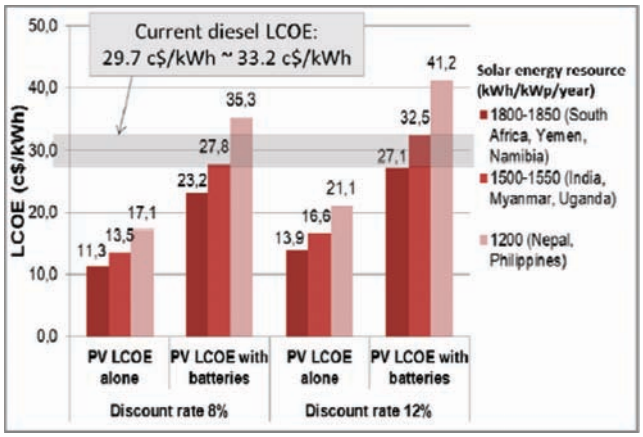

Figure 4: LCOE of PV systems coupled with 2 kWh batteries compared to the LCOE of a diesel generator

However, diesel generators require a low initial investment, but significant operating costs because of diesel consumption[10], while PV systems have a large initial investment cost but negligible operating costs (Table 1). Therefore, we can infer that residents use diesel generators because of their low initial investment costs despite their high fuel costs and negative impact on the environment

As defined, a total of 980 TWh/year is needed for full electrification in the 49 countries selected with an average consumption of 922 kWh/per capita/year. The CO_2 emissions will differ according to the energy technology employed. If we supply electricity with diesel generators, it will produce more than 1500 Mt CO_2 per year. This amount accounts for almost 5% of the current global emissions, i.e., 32.2 Gt CO_2/ year [10]. Therefore, we can conclude that PV systems provide a solution for electrification in a more eco-friendly way. About 1500 $MtCO_2$/year (1548 $MtCO_2$/year-49 $MtCO_2$/year) can be avoided compared with the use of diesel generators. In addition, PV systems can replace the traditional biomass for cooking and heating in the less developed countries, which poses hazards to human health and the environment [11,12]. However, the diffusion of PV systems cannot be created without international political reactions because of financing issues in these regions.

diesel generators	PV systems with batteries
US$ ~ 300 (upfront) + > US$ ~ 250/ year (fuel)	US$ ~ 2100 (upfront)

Table 1: investment comparison

New way of thinking: international -wide mechanisms for low-carbon energy transition

The proposed opportunities to include new frontiers for the global PV market growth would provide the PV industry with new outlets for the current oversupply of PV products. This approach expands the scope of the global PV market within the international context so as to solve current PV industry anxiety. The financial situation of PV firms is not the same as before the PV industry crisis led to fierce competition. The investment of an individual PV firm includes high risks. Players can consider joint investment strategy (e.g. strategic alliance, joint venture) to develop new markets together; the total costs can be shared with fewer business risks. Players can react differently to the markets to avoid reproducing the same situation as during the PV industry crisis. Furthermore, new regions could also benefit from the sustainable energy supply system for their socio-economic development.

In particular, this solution provides an interesting option to address the problem of world energy poverty. It would increase the world's electrification rate and eventually have a positive impact on global economic growth.

In this context, as shown in Figure 5 a 'virtuous circle' could be created in the PV sector on a global scale. The nation-wide perspective on energy transition can be expanded to include international markets so that energy transition on an international scale can lead to synergies between the supply-side (industry) and the demand-side (energy transition) in order to reduce global solar PV costs. As previously explained, the existing PV market growth is limited compared to the global PV supply capacity. By broadening the scope of the potential PV market to cover the entire international arena, the investment within an open economy to increase the foreign demand of PV installations will be partially returned to the participating countries. In addition, future PV costs would be reduced thanks to the enlarged market size and experience. It is important to note that the enhanced competitiveness of PV power would eventually contribute to future national-based installations in all relevant countries with reduced PV costs. In this context, based on our model, the energy transition can be implemented within an international context.

Solar projects in new regions can address several global issues such as energy poverty, climate change and PV market issues. However, the inhabitants in these regions are most likely to be reluctant to invest in PV systems due to high upfront capital costs. Common cooperative efforts to develop these regions are needed (financing, best practice sharing, standardization, etc.).

Global collaborative actions that widen the energy security frontier based on abundant PV resources are highly recommended for not only environmental sustainability, but also global economic benefits. Therefore, all stakeholders would benefit from the approach that encompasses new regions with improved energy access regardless of the political objective (industry or energy transition). As a result, a 'virtuous circle' in the PV sector can be produced on an international scale.

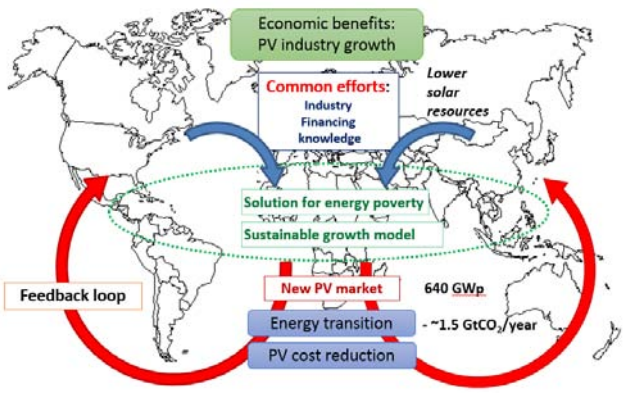

Figure 5: Global PV virtuous circle

Footnotes

[1] In addition, the market leader's production of PV modules was almost equivalent to the European PV demand in 2016 (~ 7 GW in 2016).

[2] Many countries among the selected countries have large territories to cover, which lead to high grid extension costs.

[3] Customers also tend to prefer to employ an energy option that generates the lowest initial investment cost (customer risks).

[4] To define a realistic power consumption pattern, we need to determine the average power consumption per capita with electricity access in these countries. We divided the power consumption per capita by the electrification rate based on the country data available from the World Bank

[5] 922 kWh / year per capita /1548 kWh / kWp / year = 0.6 kWp/capita

[6] A daily consumption of ~2.5 kWh/ day is necessary (~2.5 =922 kWh / 365)

[7] The levelised cost of electricity: LCOE of PV systems with batteries =

$$LCOE\ of\ PV\ systems\ with\ batteries = LCOE_{PV} + LCOE_{battery} = \frac{\sum_{t=1}^{n} \frac{I_{PV}^{t} + OAM_{PV}^{t}}{(1+r)^{t}}}{\sum_{t=1}^{n} \frac{E_{PV}^{t}}{(1+r)^{t}}} + \frac{\sum_{t=1}^{n} \frac{I_{battery}^{t}}{(1+r)^{t}}}{\sum_{t=1}^{n} \frac{E_{PV}^{t}}{(1+r)^{t}}}$$

[8] With a diesel price at 1.057 $/L

[9] Our calculation was based on the battery price of 500$/kWh[10][8].

[10] Diesel price between 1.5 and 4 $/gallon according to the supply chain.

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The Political Economy of Carbon Pricing After the U.S. Exit from the Paris Agreement

BY TILAK K. DOSHI

Singapore will implement its first carbon tax from 2019 in a world where the Paris Agreement pull-out by President Trump has upended all basic assumptions about international climate change policy. Readers were recently informed that the Prime Minister's Office is commissioning a comprehensive study of carbon pricing in a number of countries and local jurisdictions in Asia, Europe and the U.S. (The Straits Times, August 13, 2018). The study's objective is to inform policy-makers and interested citizens about the impact of carbon taxes on the international competitiveness of energy-intensive industries, a pillar of Singapore's export sector. This policy concern is now amplified in vastly altered circumstances.

Over the past decade or so, an increasing number of governments as well as regional and local authorities around the world have been imposing carbon or greenhouse gas (GHG) pricing schemes. To date, 88 countries of those (over 190) that submitted their "nationally determined contributions" to the Paris Agreement in 2015 have stated that they are planning to use carbon pricing as a tool to meet their commitments.

According to the World Bank's most recent annual survey on carbon pricing, 51 carbon pricing initiatives have been, or will be, implemented. This consists of 25 emissions trading systems (which let markets set the price of emission allowances) mostly located in provincial jurisdictions, and 26 carbon tax schemes implemented mainly at the national level. The carbon prices in these different initiatives range widely, from US$1/tCO2e (tons of carbon dioxide equivalent, a measure of GHGs emitted) to US$130/tCO2e. In most cases, carbon prices are relatively modest, with 99% of the schemes below US$30/tCO2e and 85% below US$10/tCO2e. (Singapore's carbon tax will initially be $5/tCO2e from 2019 to 2023, possibly increased to between $10 and $15 per tonne of emissions by 2030.)

Yet, within the past few years, the burden of carbon pricing has come as a surprise to many a politician's cost at national, provincial and city levels. Energy prices have mounted, often at astonishing speed, in many countries and localities – from Germany to California, Australia to Canada -- that have been at the forefront of "de-carbonizing".

A general sequence of events seems to be at work. In voting constituencies where "green" policy support seems to offer a quick route to political office, campaign promises are followed up by office holders with exuberant support for renewable energy. These policies include aggressive subsidies and carbon pricing schemes as well as non-price measures such as technology-based regulations and mandates favouring renewable technologies such as solar and wind power and electric vehicles. Such technologies invariably cost more relative to existing market-based arrangements, otherwise they wouldn't have needed taxpayer support in the first place.

When green legislation drives up the price of heating, cooling, transport and electricity which directly impact the average household budget, the median voter promptly throws the politician -- who is quite correctly perceived to have caused the pain -- out of office. The argument that the pain was caused to avoid some far-off "expected" catastrophe holds little water for those of modest means. While proponents of carbon taxes and renewable energy might occupy the higher moral ground, what matters in many elections is the pocket-book.

For Singaporeans, perhaps the most proximate example of this sequence of events is provided by the Australian PM Malcolm Turnbull's humiliating backdown over his efforts to seal the country's Paris Agreement pledges with legislation. With the prospects of an open party revolt and a leadership challenge, Mr. Turnbull tried to compromise but to no avail. Ultimately, he was forced to turn over leadership to his party's conservative faction which called for higher investments in the country's coal sector as well as energy policies to lower Australians' electricity bills. Escalating electricity bills for households in South Australia and other states which retired coal plants with expensive renewable energy to support climate change goals have been among the leading election issues gripping state and national level politics for some time.

Turning to another Commonwealth country, at the other end of the world from Singapore, the first act of the new Ontario provincial government led by "Canada's version of Donald Trump", Doug Ford, was to "fight any efforts by the Federal government to impose a carbon tax on the people of Ontario in court". Several provinces are already on record in joining Ontario in challenging Federal legislation on energy policy and climate change, including Manitoba, Saskatchewan, New Brunswick and Prince Edward Island. Rising electricity prices, a collapse in foreign direct investment caused by policies to phase out coal and heavy oil, and delays in approvals for resource development infrastructure such as pipelines and ports have led to an aggressive pushback by the provinces against the Federal government's carbon tax and other initiatives to support the Paris Agreement.

(continued on page 62)

Tilak Doshi is a consultant in the energy sector, and the author of "Singapore in a Post-Kyoto World: Energy, Environment and the Economy" published by the Institute of South-east Asian Studies (Singapore, 2015). A version of this article was published in Business Times (Singapore), 6 September 2018.

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Decarbonization, Efficiency and Affordability: New Energy Markets in Latin America

The **Latin American Association for Energy Economics (LAAEE)**, the International **Association for Energy Economics (IAEE)**, the **Instituto Torcuato di Tella (ITDT)** and the **Instituto Argentino de la Energía "General Mosconi"** have the pleasure to invite you to attend the **7th Latin American Conference** that will be held in **Buenos Aires, Argentina on 10-11-12 March 2019.**

Energy markets are changing. Renewable sources of energy are replacing conventional ones and energy efficiency becomes more and more important in the way to accomplish the mitigation commitments that almost all the countries of the world submitted in their National Determined Contributions (NDC) in the framework of the Paris Agreement, adopted in 2015 in COP 21.

Markets become more internationally integrated, but also more locally oriented.

Market players are reinventing their roles: incumbent producers are looking for new strategies, while energy consumers are becoming producers as well. Market rules need to be reconsidered, just as the energy policies of governments at the local, national and international levels. Energy markets need to be conducive to innovation and flexible solutions, but also to provide incentives for investments, while performing the usual balancing act between security, environment and affordability.

We invite you to be part of this transformation process by attending this conference. Join the round table discussions, present your paper, attend the plenary sessions with world-renowned speakers and enjoy the hospitality of the lively city of Buenos Aires.

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- **Oil and Gas markets:** Non-conventional resources, deep water production and exploration; international trade, role of LNG.
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- **Energy Demand:** demand elasticity, energy efficiency, behavioral economics,
- **Energy and development:** poverty and sustainability; universal access, affordability.
- **Climate Change:** promoting renewable energy and energy efficiency, electric vehicles, deep decarbonization.
- **Energy and Macroeconomics:** international trade, innovation, growth of investments in new technologies; fiscal Impacts of the energy sector, energy subsidies.
- **System Integration:** Interaction of different energy sources, sector coupling, international interconnections.
- **Regional Energy Integration:** Infrastructure and renewable energy.
- **Geopolitics of Energy:** Shale oil and shale gas in LATAM, deep water production.
- **Energy and Finance:** Climate risks, Financial markets, investments, hedging, funding of RES, insurance markets.
- **Country Studies:** energy transition, general lessons, developing and emerging countries.
- **Energy Policy:** Law and economics, network regulation, international institutions.
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Enhancing Renewable Energy for Sustainable Development in Nigeria

BY IYABO OLANRELE AND PIUS OKEH

Background

Non-renewable energy largely dominates energy supply in Nigeria. The growing concern is that they are exhaustible and adverse to the climate. In the country's electricity sector, natural gas (82 percent) and big hydro (18 percent) remain the major sources of electricity generation (IEA, 2018). No records of renewable energy exist, partly due to the fact that they are negligible in a size that will allow integration into the existing central grid system. The Sustainable Development Goal (SDG) 7 and the domestic Economic Recovery Growth Plan (ERGP), emphasize the importance of increasing energy access, especially clean energy for sustained development. With natural gas classified as a clean energy, its exploitation in Nigeria is not without negative externalities on the environment. Statistics on the breakdown of gas utilization in the country show that exportation of natural gas is more favoured than domestic gas utilization, and flaring is preferred to reinjection for productive ventures (DPR, 2016). At the heart of this, the existing pricing regime is a disincentive to domestic investment, considering that the natural gas price is regulated to subsidized electricity consumption. Also, the use of big Hydro, as adopted in Nigeria, is mostly associated with environmental degradation, making it less fashionable.

Policies promoting renewable energy

The increasing public and private interest in diversifying energy sources, and the need to stimulate investment have led to the adaption of diverse policy measures in developed and developing countries at promoting renewable energies. There is no gainsaying that Nigeria has huge renewable potentials. However, well informed comprehensive renewable policies are non-existent. In 2005 Renewable Energy Master Plan (REMP) was initiated to articulate a national vision and a roadmap for removing key barriers to renewable development in Nigeria. Accordingly, targets were set to enhance implementation. A short, Medium and Long-term target was set for the periods 2005-2007; 2008-2015; and 2016-2015, respectively, by the end of which 10 percent of energy supply is to be contributed from renewable sources. More recently, in 2015, a more comprehensive renewable policy was initiated, with strategies aimed at each element of renewable energy. Apparently, 14 years into the first plan, the development of renewables is new zero in the country.[1] Among the common barriers to renewable development in the country are: financial, market, technological, institutional, and socio-cultural barriers among others.

The renewables success story in South Africa, Ghana, and Kenya is hinged on strong national legislation that avails these countries sustained development in the integration of renewable energy. In 2003, for instance, South Africa fostered the uptake of renewable energy as recognised in a 1998 white paper on energy policy. The focal points of the renewable policy are on financial instruments, legal instruments, technology development, raising awareness, capacity building, education, market-based instruments and regulatory instruments. These have brought about the integration of renewables into the country's energy stream as presently constituted. Of the over 40,000MW electricity generated, electricity from renewables is about 3000MW (IEA, 2018). These and other factors explain the growing integration of renewables with conventional energy of many countries.

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See footnote at end of text.

Renewables for energy security and sustained development in Nigeria

The Nigerian national policy on renewable energy as articulated in the national energy policy (NEP) is aimed at achieving energy security through a robust energy supply mix. This is further stressed in the Economic Recovery Growth Plan (ERGP, 2017-2020) by placing particular focus on energy infrastructure to be provided by government directly or in collaboration with the private sector in public-private partnership.

Integrating the goals of energy development into National Sustainable Development Strategy (NSDS) such as the ERGP will enable the government's decision-making frameworks to track the progress of its development and accomplishment. Policy targets for renewable energy can help mobilize human and financial resources in the country toward the attainment of a national sustainable development strategy for low carbon, green development for job creation, energy security and access for the poor.

Renewable energy development in Nigeria should be encouraged through the feed-in-tariff system which guarantees preferential grid access and dispatch of electricity supply from renewable sources. The framework should have an advanced legal security for investors (where the amount of feed-in-tariff guaranteed by law is given sufficient period to at least amortize investment cost; preferably over equipment lifetime). This will lead to high effectiveness, investment security, high stimulation of domestic markets and

encouragement of technical innovation, job creation and increased efficiency/cost reduction potentials for renewable energy equipment as practiced in countries like; Ghana, Kenya, and South Africa.

Conclusion

A trend in economic history the world over indicates that electricity has served as a catalyst for economic growth and development. On the contrary, Nigeria has persistently remained at the bottom of the nations, with low electricity generation and consumption, with total generation averaging 3000 megawatts and consumption per capita below 200kWh. Nigeria is blessed with an array of renewable energy resources, that when properly harnessed can be used to realize the country's power sector goal with a nationally NSDS. To achieve this, major socio-cultural and technological changes are needed along with policies and regulations as stipulated in the ERGP to ensure a sustained, efficient and effective use of renewable sources and technologies. Additionally, a conducive business environment should be created to mobilize the much-needed human and financial resources into the sector. Finally, a local capacity development that will drive the renewable energy technology production and acquisition would be required to drive and sustain renewable energy consumption and investment required to achieve it.

Footnote

[1] In the existing electricity generation mix, the contribution of renewables is not officially documented.

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Tilak Doshi: *The Political Economy of Carbon Pricing After the U.S. Exit from the Paris Agreement.* Continued from page 59

The most profound blow to the international edifice of carbon pricing can of course be assigned to President Trump. His "America First" instinct pulled the U.S. out of the international accord in which he saw no symmetric and credible commitments by competitor countries such as China. As someone in tune with the pulse of his voting constituency, he also knew that higher energy prices for the average household and the cultural demonization by radical environmentalists of those working in the coal mines and oil and gas fields were issues that resonated among his supporters.

By retracting the US$2 bn contribution pledged by the previous Obama administration to the Green Climate Fund, the UN's major climate finance initiative, President Trump has also put paid to the idea that climate change policy was also to be a means of a massive global redistribution of funds from the developed to the developing countries. The future of the GCF itself hangs in the balance, with few projects, a looming cash shortfall and a boardroom locked in conflict.

While the consultant's report on the impact of carbon pricing around the world will be useful for policy analysts poring over details, the headline news is already out: politicians will appreciate the fact that making ends meet today is far more important to the average man on the street than speculative long-term scenarios of climate change which threaten a lower global GDP fifty or a hundred years from now.

6th Asian Conference in Wuhan China

On November 2-4, 2018, the 6th Asian Conference of the International Energy Economics Association (IAEE) was held in Wuhan, China. The theme of the conference was "Energy Exploitation & Cooperation in ASIA". Topics covered included:

- How should energy development and cooperation in Asia be addressed?
- What kind of competition and cooperation patterns should be taken and how should they be applied?
- Does the current energy supply and transport infrastructure ensure long-term security?
- What alternative solutions exist?

The conference received 202 submissions from 32 countries. More than 240 people from more than 20 countries registered including more than 60 international guests. A total of 16 conference speakers were invited from the United States, Canada, Japan, Finland, Turkey and other countries and regions.

The conference was hosted by the International Energy Economics Association(IAEE) and China University of Geosciences(Wuhan) and organized by the School of Economics and Management(CUG).

On the afternoon of November 2nd, Adonis Yatchew and David C. Broadstock, two editors of *The Energy Journal,* participated in a Ph.D Session and had face-to-face discussions with Ph.D students.

On the morning of November 3rd, the opening ceremony was chaired by Professor Ying Fan, chairman of the Scientific Committee. She expressed his gratitude to the guests and volunteers and introduced Professor Jinhua Cheng of the University of Geosciences (Wuhan), IAEE President David Knapp and Researcher Tiejun Wei, of the Ministry of Natural Resources

Professor Deyi Xu chaired the first plenary session on "Global and Asian Governance Mechanisms In The Energy Market". Timo Kuosmanen, professor at Aalto University Business School in Finland, spoke on "(De) regulation of the Energy Sector: Measuring Competition of Local Monopolies in Electricity Distribution". Professor Zhongxiang Zhang from Tianjin University's discussed "Global and Asian Governance Mechanisms in the Energy Market", and Masakazu Toyoda, Chairman and CEO of the Japan Energy Economic Research Institute, spoke on "How to Put into Practice Energy Cooperation in Asia ".

Professor Zhen Wang from China University of Petroleum chaired the first dual plenary session on "Energy Strategy: History, Reality and Future". Gurkan Kumbaroülu, professor from Boğaziçi University, Turkey, spoke on "Diffusion Prospects for Electric Vehicles, Infrastructure Requirements and Sustainability". He was followed by Philip Andrews-Speed, professor at the National University of Singapore, who discussed "Meeting Multiple Energy Challenges, an Institutional Perspective" .

The second dual plenary was chaired by Tulsa University professor Ronald Ripple. Xiliang Zhang, a professor at Tsinghua University, gave a report on "China National Carbon Market: Features and Perspectives". Then Govinda R. Timilsina from the World Bank, discussed "Carbon Pricing Policies for China".

A workshop entitled "Establishing and Integrating the Chinese Carbon Market" was held on the evening of November 3. Presided over by Dean Sun Yongping, vice dean from Hubei University of Economics, discussants included Professor Ying Fan from Beijing University, Dr. Xunpeng Shi from the University of Technology, Sydney, and Hanwu Liu, General Manager of China Hubei Emission Exchange. The three expressed their views on the theme of "Carbon Market Background, Principle and Current Development".

The first session of the second Dual Plenary on November 4 was on "Coping with the Challenge from Renewable Energy to Traditional Energy" was chaired by Professor Xiaoli Zhao of China University of Petroleum. Professor Lei Zhu from Beihang University discussed "Energy Investment and Technology Evaluation". Then Professor Yukari Niwa Yamashita from the Japan Energy Economic Research Institute spoke on "Will Energy Transition Be A Thorny Path?", Finally, Professor Hansong Cheng of China University of Geosciences (Wuhan) spoke on "Liquid Organic Hydrogen Carrier Technology: from Energy Storage to Fuel Cell Applications".

In the second dual session "Asian-Oceania Region Oil and Gas Markets", a report on "Natural Gas Markets in Asia-Oceania: Recent Developments and Future Prospects" was given by Professor Peter Hartley of Rice University in the United States. Professor Zhen Wang from the China Petroleum Policy Research Office discussed "The Key Role of Natural Gas in China's Energy Transition", and Professor Christophe Bonnery reported on "The Future Role of Oil and Gas in Power Markets in Energy Transitioning Economies".

The concluding Plenary Session was hosted by Professor Zhongxiang Zhang from Tianjin University. Ronald D. Ripple of the University of Tulsa discussed "Natural Gas Movements in the Region and into China". David Broadstock spoke on "Supporting OBOR Investment Through Socially Responsible ('green') Finance: Opportunities, Challenges and Policy Priorities".

Closing remarks was made by Professor Xiao Jianzhong of China University of Geosciences (Wuhan). On behalf of the University he expressed his sincere thanks to the partners of the conference, and thanked the scholars at home and abroad for their participation and expressed hope that such exchanges can continue to develop.

This conference was held for the second time in China. It has strong professionalism, standardized organization and a high degree of internationalization. It is a high-level international conference in this field. This conference promoted exchanges and cooperation between scholars at home and abroad to further enhance the international influence of relevant disciplines of China University of Geosciences (Wuhan).

Scenes from the 6th IAEE Asian Conference November 2-4, 2018

IAEE/Affiliate Master Calendar of Events

(Note: All conferences are presented in English unless otherwise noted)

Date	Event, Event Title	Location	Supporting Organization(s)	Contact
2019				
January 30 - February 1	XIV Spanish Association for Energy Economics Conference – Energy Transition, Industry and Employment	A Coruna, Spain		Amaia de Ayala http://www.aeee.es/en/
February 13-15	AAEE Conference *Heading Toward More Democracy in the Energy System – German/English Speaking*	Vienna, Austria	AAEE	Reinhard Haas *haas@eeg.tuwien.ac.at*
March 10-12	7th ELAEE Conference *Decarbonization, Efficiency and Affordability: New Energy Markets in Latin America*	Buenos Aries, Argentina	ALADEE	Gerardo Rabinovhich *grenerg@gmail.com*
April 14-16	*12th NAEE/IAEE International Conference Energy Efficiency and Access for Sustainable Development in Emerging Economies*	*Abuja, Nigeria*	*NAEE*	*Wumi Iledare wumi.iledare@yahoo.com*
May 6-8	*4th HAEE Symposium Energy Transition IV SE Europe and Beyond*	*Athens, Greece*	*HAEE*	*Kostas Andriosopoulos kandriosopoulos@escpeurope.eu*
May 8	*EVER-IAEE Symposium – Grimaldi Forum*	*Monaco*	*IAEE*	*Christophe Bonnery Christophe.bonnery@faee.fr*
May 29-June 1	42nd IAEE International Conference *Local Energy, Global Markets*	Montreal, Canada	CAEE/IAEE	Pierre-Olivier Pineau *pierre-olivier.pineau@hec.ca*
August 25-28	16th IAEE European Conference *Energy Challenges for the Next Decade:*	Ljubljana, Slovenia	SAEE/IAEE	Nevenka Hrovatin *nevenka.hrovatin@ef.uni-lj.si*
October 17-19	4th IAEE Eurasian Conference *Uncapping Central Asia's Potential: How Central Asia can Contribute to Global Energy Security?*	Astana or Almaty, Kazakhstan	IAEE	Vilayat Valiyev *waliyev@gmail.com*
November 3-6	37th USAEE/IAEE North American Conference *Energy Transitions in the 21st Century*	Denver, CO, USA	USAEE	David Williams usaee@usaee.org
2020				
February 9-12	7th IAEE Asia-Oceania Conference *Energy Transitions in Asia*	Auckland, New Zealand	IAEE	Stephen Poletti s.poletti@auckland.ac.nz
June 21-24	43rd IAEE International Conference *Energy Challenges at a Turning Point*	Paris, France	FAEE/IAEE	Christophe Bonnery *Christophe.bonnery@faee.fr*
2021				
July 25-28	44th IAEE International Conference *Mapping the Global Energy Future: Voyage in Unchartered Territory*	Tokyo, Japan	IEEJ/IAEE	Yukari Yamashita *yamashita@edmc.ieej.or.jp*
2022				
March	45th IAEE International Conference *Energy Market Transformation in a: Globalized World*	Saudi Arabia	SAEE/IAEE	Yaser Faquih *yasser.faquih@gmail.com*
August 7-9	8th IAEE Asia-Oceania Conference *Making the Transition to Smart and Socially Responsible Energy Systems*	Hong Kong	HAEE	David Broadstock *david.broadstock@polyu.edu.hk*
2023				
June 19-22	46th IAEE International Conference *Overcoming the Energy Challenge*	Istanbul, Turkey	TRAEE/IAEE	Gurkan Kumbaroglu *gurkank@boun.edu.tr*

16th IAEE European Energy Conference Ljubljana 25–28 August 2019

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CONFERENCE OVERVIEW

Energy markets are becoming increasingly complex. Over the past decades, we have witnessed tremendous changes in the industry's fundamentals induced by policy and technological advancement, which required redesigning of markets. Climate policies aimed at decarbonisation extensively contributed to changed energy mix. Recent shifts in geopolitical relations with the EU partners additionally add to the industry's complexity and uncertainty. The EU energy policy in the next decade continues to be directed towards achieving competitive, secure and sustainable energy system, which calls for huge investments in infrastructure and low-carbon technology with increased involvement of private capital.

The central topic of this conference will be to assess the impacts and identify the main challenges of these events for all energy segments: oil, natural gas and power markets through the entire value chain in order to design a sustainable policy for the following decade. The main question to be addressed is: Have we learned from the experience how to design effective policies for the next decade together with all stakeholders – consumers, companies and governments? We invite you to be a part of this debate by attending this conference and exploring vibrant city of Ljubljana, the capital of Slovenia and the seat of the EU Agency for Cooperation of Energy Regulators (ACER).

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PRELIMINARY DATES

Abstract Deadline: 15 March 2019
Author Notification: 26 April 2019
Full Paper Submission and Registration: 7 June 2019
Conference Dates: 25–28 August 2019

Location: Faculty of Economics, University of Ljubljana

TOPICS TO BE ADDRESSED

- Review of energy policies and scenarios: general lessons, country studies
- Evolution and redesign of energy markets for future needs
- Regulation of energy networks: lessons learned and challenges ahead
- Renewable energy sources: exploitation, investments and use
- Climate change technologies and policies: global and cross-country perspectives
- Energy efficiency: policies, investments and implementation by end-use sectors (transport, buildings, industry, households)
- Energy demand: consumer behavior, demand-side management, energy poverty and public attitude
- Energy supply security: strategies, policies, politics and economics
- Integration of smart technologies into energy markets
- Economics and geopolitics of oil and gas markets: current and future perspectives
- Energy access and economic development
- Energy modelling
- Strategies of energy utilities for the next decade
- Energy investments and asset management
- New business models and innovative solutions

METHODS

- Econometric studies (time series, cross-sections)
- Field experiments, lab experiments
- Surveys, conjoint analysis
- Techno-economic bottom-up models
- General equilibrium, macro models
- Game-theoretical methods
- Simulations (e.g. agent based models)
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- Business cases / case studies / benchmarking

Those interested in organizing a concurrent session should propose a topic and 4 possible speakers to iaee2019ljubljana@oyco.eu. The abstracts proposed for the special session should be submitted, following the general submission rules within the deadline 15 March 2019.

STUDENTS

PhD students and junior researchers are encouraged to submit a paper for the 6th IAEE European PhD Day, which will take place on Sunday, 25th of August, 2019. Students may also participate in the IAEE Best Student Paper and Poster Award Competition.

CONCURENT SESSION ABSTRACT FORMAT

We welcome contributions from researchers and industrial representatives. Authors wishing to make concurrent session presentations must submit an abstract that briefly describes the research topic to be presented. Poster submissions are also encouraged, where they are subject to the same procedures, general guidelines and topics applied to papers.

The abstract must be no more than two pages in length and must include an overview of the topic including its background and potential significance, methodology, results, conclusions and references. All abstracts must conform to the format structure outlined in the template. Please visit https://iaee2019ljubljana.oyco.eu/call-for-papers to download an abstract template. Abstracts must be submitted online by visiting: https://iaee2019ljubljana.oyco.eu/call-for-papers.

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At least one author of an accepted paper or poster must pay the registration fees and attend the conference to present the paper or poster. The corresponding author submitting the abstract must provide complete contact details - mailing address, phone, fax, e-mail, etc.

While multiple submissions by individuals or groups of authors are welcome, the abstract selection process will seek to ensure as broad participation as possible: each author may present only one paper or one poster in the conference. No author should submit more than one abstract as its single author. If multiple submissions are accepted, then a different author will be required to pay the registration fee and present each paper or poster. Otherwise, authors will be contacted and asked to drop one or more paper(s) or poster(s) for presentation.

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23-24 January 2019, Argus Middle East Petroleum Coke 2019 at Eastern Mangroves Hotel And Spa by Anantara, Eastern Mangroves, Abu Dhabi, United Arab Emirates. Contact: Phone: 97145683946, Email: prithika.manivel@argusmedia.com, URL: http://go.evvnt.com/305546-2?pid=204

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29-30 January 2019, Solar Finance and Investment Europe Conference in London at Grange City Hotel, 8-14 Cooper's Row, London, EC3N 2BQ, United Kingdom. Contact: Email: jandrews@solarmedia.co.uk, URL: http://go.evvnt.com/301809-0?pid=204

30-31 January 2019, 2019 Asia Pacific Energy Assembly and Awards Dinner at Raffles City Convention Centre,80 Bras Basah Road,Singapore,189768,Singapore. Contact: Phone: +44 20 7384 7963, Email: simon.hoare@energycouncil.com, URL: http://go.evvnt.com/261239-0?pid=204

11-15 February 2019, Public Private Partnership (PPP): Financing, Projects & Contracts - Singapore at Singapore. Contact: Email: vincs@infocusinternational.com, URL: http://www.infocusinternational.com/ppp/index.html

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05-07 March 2019, SPE / IADC International Drilling Conference and Exhibition | The Hague at World Forum, 10 Churchillplein, Den Haag, 2517 JW, Netherlands. Contact: Phone: +44(0)2072993300, Email: kdunn@spe.org, URL: https://go.evvnt.com/242664-0?pid=204

05-07 March 2019, SPE - IADC Drilling Conference and Exhibition at World Forum, 10 Churchillplein, Den Haag, 2517 JW, Netherlands. Contact: Phone: +44(0)2072993300, Email: kdunn@spe.org, URL: https://go.evvnt.com/242664-0?pid=204

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10-12 March 2019, 7th ELAEE Conference, Decarbonization, Efficiency and Affordability: New Energy Markets in Latin America at Buenos Aires, Argentina. Contact: Email: administracion@iae.org.ar, URL: https://7elaee.aladee.org/index.php

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09-10 April 2019, Solar and Storage Finance and Investments in Texas - April 2019 at Hyatt Regency Austin, 208 Barton Springs Road, Austin, 78704, United States. Contact: Email: jandrews@solarmedia.co.uk, URL: http://go.evvnt.com/302217-0?pid=204

16-17 April 2019, Wind Operations Dallas 2019 (April 16-17 TX) O&M, Asset Management, Storage at The Westin Galleria Dallas, 13340 Dallas Parkway, Dallas, 75240, United States. Contact: Phone: +44(0)2073757537, Email: benm@newenergyupdate.com, URL: https://go.evvnt.com/314610-3?pid=204

24-25 April 2019, PV India Tech Conference in Delhi - April 2019 at TBC, Delhi, 110 012, India. Contact: Email: jandrews@solarmedia.co.uk, URL: http://go.evvnt.com/302219-0?pid=204

29-30 April 2019, Smart Water Systems at Holiday Inn London - Kensington Forum, 97 Cromwell Road, London, SW7 4DN, United Kingdom. Contact: Phone: +442078276164, Email: nhoward@smi-online.co.uk, URL: http://go.evvnt.com/320624-0?pid=204

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