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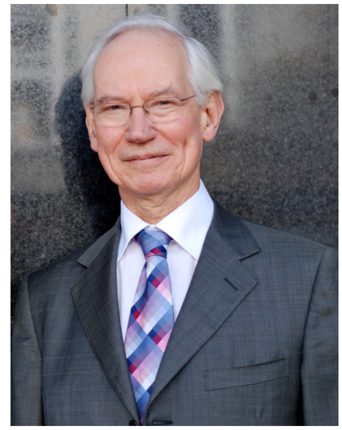
International Association for Energy Economics

IAEE Energy Forum

Fourth Quarter 2013 International Association for Energy Economics

President's Message



This year's IAEE conference schedule was more than unusually compressed, with three major conferences since the last Newsletter. The International Conference was held in Daegu in mid-June, my first visit to South Korea and an opportunity to experience the new high speed train from Seoul to Daegu. I would like to thank Professor Hoesung Lee for his excellent chairmanship of the conference and his dedicated Organizing Committee. The breadth and depth of this conference was a tribute to their hard work. I was particularly struck by the youthful energy and rhetorical skill of the Mayor of the City of Daegu, Bum-il Kim, who received us at the Cultural Dinner and who took great pride in the role his city took in hosting international energy conferences. Not surprisingly, nuclear power and the impacts of U.S. shale gas on Asian LNG prices were much analysed at the conference.

At the end of July the 32nd IAEE North American Conference was held in Anchorage, Alaska, where my plane landed in dazzling sunlight at 10pm, after flying over spectacular glaciers. Anchorage is a fine city, and many delegates hired bikes, often encountering urban moose. The venue was the Captain Cook Hotel, reminding us of that intrepid explorer's visit and the connections between Alaska and Japan, Russia and Australasia. The Alaska chapter of the USAEE and Conference Chair Roger Marks did a fine job in organising an excellent and highly professional conference, where my eyes were opened to the challenges confronting a heavily oil-dependent economy (almost all state revenues from petroleum taxes) when faced with declining production and popular resistance to reducing the distortive effects of that taxation on new development. We also heard of the challenges of delivering electricity to small isolated communities with no road access, where the cost of power makes wind look commercial, but integrating intermittent wind in small systems is tricky. For myself, the conference highlight was the remarkable quality of the Case Study presentations. Student teams are given the kind of data that a consultant would have to address a real-world problem, in this case to advise on Integrating Electric Vehicles into Distribution Grids. The competition is expensive (with significant financial prizes) and produces impressive reports that can attract company sponsorship. It gives students a taste of what it is like to be a practising energy economist, and provides exactly the right credentials for such a career. I hope this model can be imitated in other IAEE venues.

After visits to surprisingly sunny Alaska and then Oregon (to vist the Bonneville dam, one of the 19,565 MW total hydro capacity on the Columbia river) there was but a short gap before the European IAEE conference in Dusseldorf, impeccably delivered by the GEE under the chairmanship of GEE President Georg Erdmann. Naturally, much of the discussion was of the German Energiewende, or the energy policy U-turn that phases out nuclear power, and what that might mean with renewables already depressing prices for conventional back-up power. I was impressed by the quality of the industry presentations, most forgoing the chance to advertise their companies and instead offering quantified and analytical presentations that many younger speakers should aspire to emulate. One of the keynote industry speakers reinforced my Presidential opening remarks urging members to submit clear, policy-relevant articles to *Economics of Energy and Environmental Policy*, to engage in the policy dialogue.

These conferences keep us in close contact with our members and enhance numbers.

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Editor: David L. Williams

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The IAEE has grown more than 40% since 2006, from about 3,000 to over 4,200. It is good to see so many students at conferences - their number has more than doubled to over 800 since 2006. Our student members are the next generation and we rely on them to carry the Association to new heights, so I would encourage them remain members. The valuable professional and academic contacts that affords are increasingly important in this networked age.

Strong financial reserves are critical if the Association is to continue to innovate, and the IAEE is fortunately in good financial shape. Funding bodies increasingly mandate open access publication and we are taking a clear lead in becoming a Green Open Access Journal. We consider this necessary, but we can only take on the financial risk because of prudent husbanding of our assets. It should make our journals more attractive, increasing author's citation index (and that of our journals), even if it risks reducing the IAEE's reprint revenue.

The IAEE mission is to "advance the knowledge, understanding and application of economics across all aspects of energy and foster communication amongst energy concerned professionals." Our publications advance communication, and we are now looking to advance knowledge with Immediate Past President Lars Bergman launching the Energy Economics Education Initiative. This will start by documenting existing courses and programmes in energy economics, and then consider how best to promote and improve energy economics education. I think this initiative will have a lasting impact and I commend it for your attention and assistance when we mail out requests for information.

This is my last President's Message at the end of a travel-intensive but rewarding year. Travelling from country to country reminds me what an international and very collegial Association we enjoy, but this depends on the hard work of the conference organisers and especially that of Executive Director Dave Williams, who guides each incoming President and Conference Chair through their duties with tact and skill. The Council members continue to be both great company and effective leaders, and I would like to thank the outgoing council members, Mine Yucel, Jacques Percebois, Jacqueline Boucher, Ioannis Kessides, Ron Ripple, Lori Smith Schell and Christoph Weber, for their dedication and hard work. It has been a pleasure working with such a great group of people. I wish incoming President Wumi Iledare and all our members the very best in 2014.

David Newbery

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

Editor's Notes

This issue of the *Forum* focuses on electricity generation and transmission. We have eight articles on various aspects of this, with quite a geographical spread and including several by student members.

However, before that, we're fortunate to again have Christof Rühl and Joseph Giljum provide us with a summary of BP's latest *Statistical Review*. They point out the 2012 was a year of adjustment for energy markets and show that "markets are quick to adapt and may do so in unexpected ways."

We also have an article by Ralph Samuelson that posits that effective global action on climate change could start with the unilateral actions of individual countries, which will be facilitated if trade issues regarding border carbon adjustments are resolved. He explains this "bottoms up" rather than "top down", country by country approach to mitigating climate change. This is an interesting concept that in our opinion has not received the attention it deserves. If this strikes a chord with any our readers we'd like to receive your thoughts. It's possible we could devote an entire issue to the subject, if there is sufficient response.

Ross McCracken notes that electricity price relationships are showing distinct, new trends that are consistent with the build out of renewables, but incompatible with a market system based primarily on competition between fossil fuels. Operational flexibility has been lost and needs to be restored. Storage may be the rebalancing mechanism required to make electricity generation work both as a system and as a market.

Jay Zarnikau, Ian Partridge, John Dinning, and Daniel Robles report that the Sistema de Interconexión Eléctrica de los Países de América Central or SIEPAC transmission line project connecting the electricity grids of six Central American nations is now up and running. They ask: Can the region put this new infrastructure to good use?

Joel Darmstadter notes that along with increased reliance on wind and solar, a shift toward more nuclear power has frequently been cited as a way of lessening the carbon "footprint" associated with society's dependence on fossil fuels. A look at some key numbers appears to dim that prospect – at least, in the near- to mid-term. Both new U.S nuclear plants and a weighted average of fossil-fuel plants embodying a substantial carbon tax come in at a cost of roughly 12 cents/kwh within the next five years or so. At the very least, even a robust greenhouse gas mitigation regime would not seem to appreciably favor nuclear.

Saheed Bello writes that electricity supply is pivotal for the functioning of society, and the price of power is a significant determinant of the overall competitiveness of an economy. Therefore, the fundamental issue of tariffs needs to be addressed as one of the key steps in moving the Nigerian power sector to financial viability.

Gaia Stigliani report that microgeneration technologies, such as PV and micro-CHP allow consumers to generate electricity on-site. As the grid evolves into a more decentralized and more efficient energy system, microgeneration technologies in combination with storage devices could become the key enabler of a smarter grid.

Giorgi Kelbakiani and Norberto Pignatti state that the Republic of Georgia is rich in hydro resources and its government intends to use them to achieve energy independence and to make the country a net energy exporter. This article discusses how combining wind and hydropower electricity generation can allow achieving such goals more effectively.

Michael Davidson writes that China's impressive wind expansion achievements are being eroded by increasing forced curtailment. Unfortunately, the proposed solution – a massive ultrahigh-voltage grid expansion – faces significant institutional hurdles that threaten to delay or derail the benefits of interconnection.

Angelique Mercurio reports that in an increasingly technology-dependent society with growing energy needs, disturbances in electricity supply and quality can have severe implications. She explores North America's increasing reliance on a consistent power supply and the microgrid market movement towards full-scale commercialization.

DLW

37TH IAEE INTERNATIONAL CONFERENCE

JUNE 15–18, 2014 | NEW YORKER HOTEL | NEW YORK CITY, USA

ENERGY & THE ECONOMY

CONFERENCE OVERVIEW

The relationship between economic growth and energy becomes ever more important as economies around the world struggle to reinvigorate themselves and to develop energy resources in sensible, sustainable ways. Can economic growth be stimulated even with pressure to reduce if not forego certain forms of energy for environmental or safety reasons? Alternatively, can oil, gas and other energy development be a major force that stimulates economic growth? What policy framework would maximize the contribution of energy to growth while encouraging efficient substitution of sustainable for less sustainable sources?

The 37th IAEE International Conference, taking place in New York City in 2014, will focus on these and related issues. New York is the financial center of the United States, a place where multi-billion dollar bets are laid on future economic growth and on energy technologies, and therefore a place where analysis of subjects like these is constantly in demand. Some of the very best minds in energy economics in the world will assemble there for what promises to be one of the best IAEE Conferences ever. Economists from a number of countries will examine questions related to energy and the economy from a wide variety of perspectives. High level policy makers will talk about the challenges they face, while analysts will offer practical, evidence-based approaches to meeting such challenges. The agenda will be filled with top-notch speakers plus 3 days of concurrent sessions, places where the results of specific topical research will be presented and absorbed.

The conference also will offer networking opportunities through informal receptions, breaks between sessions, and student recruitment. These provide opportunities for attendees to renew acquaintances and to forge new ones. There will be special events for students, including paper, poster and case competitions. And as usual, an outside event will spice the conference agenda. If that weren't enough, New York City offers a myriad of cultural attractions from museums to musical, dramatic and athletic performances. Not to mention some of the best shopping in the entire world. It's a conference program and a venue not to be missed.

Topics to be addressed include:

The general topics below are indicative of the types of subject matter to be considered at the conference. A more detailed listing of topics and subtopics can be found at: www.usaee.org/usaee2014/topics.html

- Energy Demand and Economic Growth
- Energy Supply and Economic Growth
- Financial and Energy Markets
- Energy and the Environment
- Non-fossil Fuel Energy: Renewables & Nuclear
- International Energy Markets
- Energy Efficiency
- Energy Research and Development
- Political Economy of Energy
- Public Understanding of and Attitudes towards Energy
- Other topics of interest include new oil and gas projects, transportation fuels and vehicles, generation, transmission and distribution issues in electricity markets, etc.

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37TH IAEE INTERNATIONAL CONFERENCE CALL FOR ABSTRACTS

We are pleased to announce the Call for Abstracts for the 37th IAEE International Conference, *Energy and the Economy*, to be held June 15 through 18, 2014, at the New Yorker Hotel, New York City, USA.





CONCURRENT SESSIONS

There are two categories of concurrent sessions: 1) current academic-type energy economics research, and 2) practical case studies involving applied energy economics or commentary on current energy-related issues. This latter category aims to encourage participation not only from industry but also from the financial, analyst and media/commentator communities. In either instance, papers should be based on completed or near-completed work that has not been previously presented at or published by IAEE/USAEE or elsewhere. Presentations are intended to facilitate the sharing of both academic and professional experiences and lessons learned. It is unacceptable for a presentation to overtly 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/usaee2014/sponsors.html.

The deadline for receipt of abstracts for both the Concurrent Sessions and the Student Poster Session is Friday, January 10, 2014.

Concurrent Session Abstract Format

Authors wishing to make concurrent session presentations must submit an abstract that briefly describes the research or case study to be presented.

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

a. Overview of the topic including its background and potential significance
b. Methodology: how the matter was addressed, what techniques were used
c. Results: Key and ancillary findings
d. Conclusions: Lessons learned, implications, next steps
e. References (if any)

Please visit www.usaee.org/USAEE2014/PaperAbstractTemplate.doc to download an abstract template. All abstracts must conform to the format structure outlined in the template. Abstracts must be submitted online by visiting www.usaee.org/USAEE2014/submissions.aspx. Abstracts submitted by e-mail or in hard copy will not be processed.

Student Poster Session

The Student Poster Session is designed to enable students to present their current research or case studies directly to interested conference delegates in a specially designed open networking environment. Abstracts for the poster session must be submitted by the regular abstract deadline and must be relevant to the conference theme. The abstract format for the Poster Session is identical to that for papers; please visit www.usaee.org/USAEE2014/PaperAbstractTemplate.doc to download an abstract template. Such an abstract should clearly indicate that it is intended for the Student Poster Session – alternatively that the author has no preference between a poster or regular concurrent session presentation. Abstracts must be submitted online by visiting www.usaee.org/USAEE2014/submissions.aspx. Abstracts submitted by e-mail or in hard copy will not be processed. Poster presenters whose abstracts are accepted should submit a final version of the poster electronically (in pdf format) by April 14, 2014 for publication in the online conference proceedings. Posters for actual presentation at the conference must be brought directly to the conference venue on the day of presentation and must be in either ANSI E size (34in. x 44in.) or ISO A0 size (841mm x 1189mm) in portrait or landscape format.

Presenter attendance at the conference

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. Authors will be notified by February 27, 2014, of the status of their presentation or poster. Authors whose abstracts are accepted will have until April 14, 2014, to submit their final papers or posters for publication in the online conference proceedings. 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.

STUDENTS

In addition to the opportunities at left, students may submit a paper for consideration in the 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 February 13, 2014. Visit www.usaee.org/usaee2014/bestpapers.html for full details.

Students are especially encouraged to participate in the Student Poster Session. Posters and their presentations will be judged by an academic panel and a single cash prize of $1000 will be awarded to the student with the best poster and presentation. For more details including the judging criteria visit www.usaee.org/usaee2014/postersession.html

Students may also inquire about scholarships covering conference registration fees. Please visit www.usaee.org/usaee2014/scholarships.html for full details.

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Letters to the Editor

I started reading Mamdouh Salameh's article in the third quarter issue of the *IAEE Energy Forum* with great anticipation. However, I only had to proceed to the first table to realize that he was guilty of a common failing, that of drawing conclusions first, then, afterwards, attempting to justify those conclusions. When you are unable or unwilling to copy figures accurately from BP's publication, further machinations and assessments are questionable.

Had he reported accurately, the figures for 2012 for the U.S. are: Production -- 8.9; Consumption -- 18.6; Net Imports -- 7.9, or 42%. For year-to-date 2013, the production numbers are up more than 1.0, suggesting a reduction of net imports this year to a level of 37%, considerably less than his indication of 64%. The numbers for world supply and demand are similarly defective. Further, he has not taken into account the difference in the weight/volume relationship between crude and products.

He missed a wonderful opportunity to point out that "peak oil" in the absence of a price level is meaningless. There is a peak oil number for $30 oil (the commonly used number) and an entirely different one for $100 oil. Realistically, the price will move as necessary to completely avoid ever reaching a supply-limited peak.

William R. Edwards
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Dr. Salameh's response:

I refer to Mr William Edwards *Letter to the Editor* regarding my article on U.S. Shale Oil and would like to confirm unequivocally that I stand by every word and figure mentioned in my article. My figures about U.S. oil production came from very reliable sources including OPEC and the U.S. Department of Energy and also from my own research and calculations. Mr. Edwards has already written to me asking why I did not use the figures for U.S. oil production, consumption and oil imports for 2012 as reported in BP Statistical Review of World Energy. My reply then was that I question figures from BP Statistical Review and the International Energy Agency (IEA) since both represent the major consumers of oil and, therefore, have a tendency to exaggerate global oil reserves, production and discoveries and reduce global demand for oil in a blatant attempt to intimidate the oil price but the global oil market has seen through their ploys.

It is possible that Mr. Edwards was not happy about my conclusions vis-a-vis the U.S. shale oil potential, hence his robust (and dare I say, aggressive) comments to me about my article. However, I stand firmly behind my conclusions, namely:

1- U.S. shale oil production will hardly make a dent in the global oil supplies,
2- The U.S. will never be able to overtake Saudi Arabia or Russia in oil production by 2020 or become oil self-sufficient by 2030 and will remain dependent on oil imports for the foreseeable future, and
3- U.S. shale oil production will have no impact whatsoever on the peak oil theory and the fact that the U.S. is chasing an expensive unconventional oil such as shale oil/tight oil is proof enough that the peak oil theory is valid and alive.

Mamdouh G. Salameh
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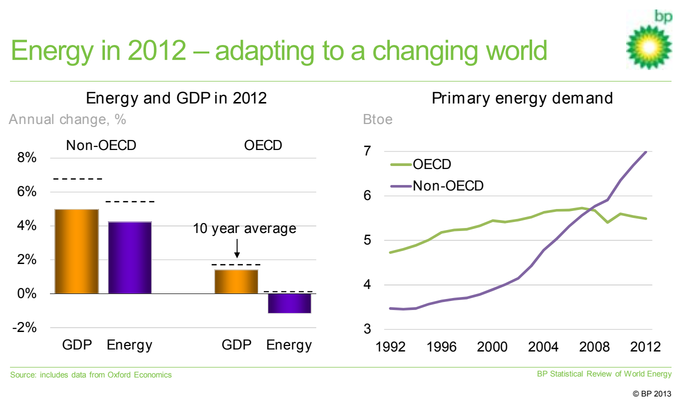
Energy in 2012 – Adapting to a Changing World

By Christof Rühl and Joseph Giljum*

2012 produced a fair number of headline figures. The U.S. led the world in both oil and gas production increases - and for oil, achieved the biggest increase in the country's history, ever. China's annual increase in hydropower outpaced that of any other country on record, while nuclear energy recorded the biggest decline ever. Three of the world's four largest economies (Germany, Japan, China), together representing a quarter of global GDP, ran their economies with a higher share of renewables than of nuclear. Meanwhile, LNG trade declined for the first time, while record amounts of coal, exiled from the U.S. by the shale gas revolution, found their way to Europe.

While individual fuels each have a unique tale to tell, the main theme that emerges from this review is how energy markets continue to adapt to a changing world. The energy system moves slowly, but it does move, and it is quite good at adjusting not only to structural changes but also to transitory disruptions. The following is a summary of those developments, adapted from the *2013 Statistical Review of World Energy*, a rigorous and objective review of last year's energy data.

On the face of it, energy developments in 2012 look unsurprising. Consumption growth slowed to 1.8%, below its ten year average, and that holds true for all fuels bar renewables and hydropower, and in all regions except Africa - quite in line with a lacklustre economic performance overall. However, to capture the many moving parts beneath the calm aggregate surface it is best to start by looking at 2012 in the context of long-term trends.

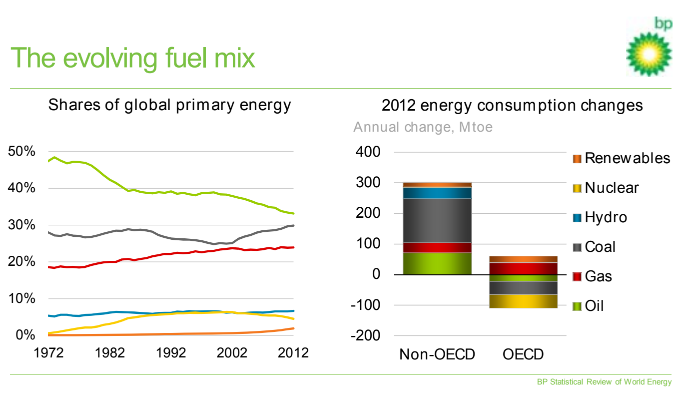


2012 in Long-term Context

First among these trends is the relentless shift of the world's economic center of gravity toward the emerging markets of the non-OECD. Over the last twenty years, global energy consumption increased by 52%. Over the last ten years alone, demand rose by 30%, almost all of which (99%) outside of the OECD. Then, over the last five years, OECD consumption fell four times; and in three of those years despite positive GDP growth.

2012 fits right in: OECD energy consumption declined by 1.2%, despite positive GDP growth and hard on the heels of a similar result for 2011. In primary energy consumption, the OECD is back to where it was in 2002 - despite cumulative GDP growth of 26%. We have long held that OECD oil consumption is in structural decline. While it is surely too early to make a similar call for primary energy; these numbers suggest that it is a development worth watching.

There is a rarely noted corollary to this shift in the center of gravity. As the non-OECD economies industrialize, they also unlock more energy resources. Many may have heard utterances about emerging market growth leading to energy shortages, but the data clearly illustrates that the industrializing world not only outpaces the OECD in terms of demand growth, it also contributes its fair share to production. Over the last ten years, the non-OECD accounted for 98% of the increase in global production. In 2012, this share was 92%, despite surging unconventional U.S. output and decelerating Chinese coal production.



A third significant trend over the last decade has been the unprecedented rise in energy prices. In inflation adjusted terms, average annual oil prices for the last five years were 230% higher than for the same period ten years ago; for coal, the increase was 140%; and for natural gas, 90%. Over the last five years, the spread across fossil fuel prices has widened as well. 2012 saw a moderation of sorts: oil remained relatively stable, but at record levels, gas prices bifurcated across regions, dropping massively in the U.S. but rising

* Christof Rühl is Chief Economist and Vice President at BP plc.; Joseph Giljum is an economist with the firm. The Statistical Review data and a more detailed analysis can be found at www.bp.com/statisticalreview

in all other regions of the world; and coal declined everywhere.

These higher prices are taking their toll. They impact demand, in particular in countries where economic growth is less energy intensive and consumers are not sheltered by subsidies. Changing price differentials also shape the global fuel mix and high prices eventually trigger supply responses. 2012 provides examples for all these effects. Oil, which (in energy terms) commands the highest value, continued the slide in its global market share that started with the first oil price shock in 1973. Last year oil was the only fossil fuel that lost market share in the OECD and the non-OECD alike. Meanwhile, price spreads between gas and coal triggered competition between them, often across borders; and in the U.S., record high oil prices triggered a migration from shale gas to tight oil activity.

To trace these developments in more detail, it's best to look at them fuel by fuel.

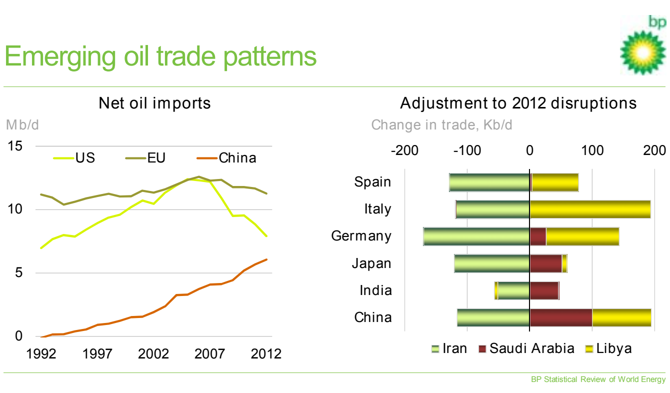
Fuel by Fuel

Crude oil

While oil remains the world's dominant fuel, it has lost market share for a remarkable 13 years in a row, and its share of global primary energy is the lowest in our records. Last year oil prices remained essentially flat, with Dated Brent averaging nearly $112 per barrel. This stability of prices, however, masks an apparent disconnect between supply and demand: global consumption rose by a below-average 890 Kb/d, but production rose twice as fast, by an above-average 1.9 Mb/d.

To explain this disconnect one must pay attention to the detail. Starting with supply, last year saw - after Libya in 2011 - another OPEC producer experiencing a significant decline in output. Iranian production fell by 680 Kb/d, due to international sanctions; adding in outages in several other MENA countries resulted in aggregate losses of well over 1 Mb/d. Yet global output rose strongly, with OPEC accounting for nearly three-quarters of the growth due to the recovery in Libya and large increases in Saudi Arabia, Iraq and Kuwait. Production outside of OPEC also increased (by 490 Kb/d) with the U.S. recording the largest increase in the world thanks to continued growth in tight oil supplies with output in North Dakota and Texas - the states with the most productive tight oil formations - increasing by nearly 800 Kb/d.

As for consumption, OECD demand fell again - by 530 Kb/d, the sixth decline in the past seven years. Europe and the U.S. drove the decline as, in addition to the economic slowdown in Europe, both regions saw strong consumer reactions to the sustained level of high prices, especially in the transport sector. The U.S., for example, saw the largest improvement in fuel economy for new light vehicles sales since 1980. However, this decline was more than offset by the non-OECD, where demand grew by a below-average 1.4 Mb/d. Even though growth was weaker than average in China, the country still registered the largest increment to oil consumption in the world for the 12th time in the last 13 years, with demand now surpassing 10 Mb/d.



These developments are also altering trading patterns. The strong growth in U.S. output, combined with weaker consumption, has dramatically reduced oil import requirements. Since peaking in 2005, U.S. net imports have fallen by 4.5 Mb/d, or 36% - a reduction nearly as large as the entire 2012 consumption of the world's third-largest consumer, Japan. Over that same period, Chinese net oil imports rose by 2.8 Mb/d or 84%. In 2005, the U.S. and EU imported similar amounts; in 2012, U.S. net imports were nearly one-third below those of the European Union.

Other events in 2012, including sanctions affecting Iranian exports and the return of Libyan production, also influenced trading patterns. As Iranian deliveries to Europe fell sharply, the region expanded its imports from North Africa. Asia also curtailed Iranian purchases, with higher Saudi production largely offsetting these lost volumes.

The question remains: given the large mismatch between aggregate production and consumption, how could prices remain flat? The answer lies in inventories. While the increase in OECD stocks was not enough to explain the gap, if the experience of the past decade tells us anything, it is that the OECD is no longer the main driver of oil markets. And indeed, estimates of inventory movements outside the OECD, while incomplete, nonetheless help to explain the disconnect: increases in non-OECD inventories account for nearly two-thirds of the global changes last year, thus helping to explain the oil market in 2012.

Refining

Global average refining margins improved markedly in 2012, although there was hardly any improvement in global capacity utilization. Large regional differences reflect the underlying strain of markets adjusting to new refining capacity in some regions, while there were closures elsewhere. Net global refining capacity additions last year totalled 360 Kb/d, but this masks significant changes - with China and India expanding the most and their additions closely matched by reductions in Europe and the Caribbean. In this way, the migration of refining capacity away from established markets continued in 2012.

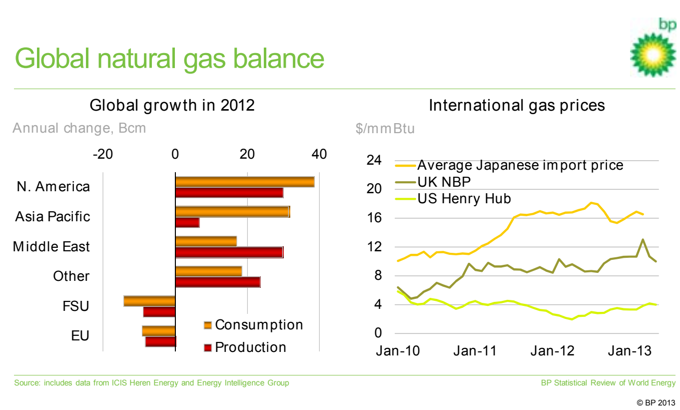
China accounted for almost two thirds of last year's 480 Kb/d growth in global crude runs and nearly all of the net growth in the non-OECD. In the OECD, crude runs grew by 160 Kb/d with reductions in Europe and Japan more than offset by growth in North America. Interestingly, since 2005 liquids demand has fallen by around 2 Mb/d in each the U.S. and Europe - but U.S. crude runs are down by 210 Kb/d over that period while European crude runs dropped by more than 2 Mb/d. The reason is that U.S. refiners benefit from more complex configurations, lower natural gas prices and in some cases, access to discounted North American crudes, all of which have helped to turn the U.S. into a major product exporter - a position it is unlikely to lose, at least as long as U.S. crude exports remain legally constrained.

Natural Gas

Two trends dominated the evolution of natural gas markets over the past few years: the rapid growth of shale gas in the U.S., and the expansion of global LNG. U.S. production continued to grow in 2012, if at a slower pace, but LNG trade declined for the first time on record. These developments, together with the continuing impact of Japan's post-Fukushima adjustment, shaped gas markets and in the event created an important example of inter-fuel competition between gas and coal.

But first the basics: consumption rose by 82 Bcm last year, faster than 2011 but below the ten year average. The U.S. saw the world's largest gain in consumption - an increase by itself bigger than that of any global region - followed by Asia on the back of strong LNG demand. Global production grew by 72 Bcm, also below average, with the European Union and the FSU registering the largest declines. Regional gas prices moved in lockstep with this pattern: Spreads widened, with U.S. prices recording their lowest annual average since 1999, Japanese import prices reaching a new average annual record, and UK spot prices edging up as the global competition for LNG tightened the market in Europe.

In the U.S., output continued to rise by 33 Bcm, but growth was below the record expansion of 2011. Lower prices and a reorientation of drilling away from gas and toward higher-priced oil drove the slowdown. The impact on gas output would have been much sharper without the rapid growth of associated and liquids-rich gas supply triggered by rising oil output. Meanwhile, a warm winter on top of record production growth in 2011 curtailed heating demand and pushed inventories to unusually high levels in early 2012. The only sector flexible enough to absorb this surplus was power - which required gas prices to fall far enough to be able to compete with coal. All told, an additional 44 Bcm of gas went into the power sector - the largest annual jump of any fuel used in U.S. power generation for at least 40 years.



Meanwhile, fortunes changed in the remarkable history of LNG. For at least two decades, international gas trade had grown on average 2.5 times as fast as consumption every year, and LNG trade more than 3 times as fast. Until last year, that is, when LNG trade declined. How did this happen?

The prime suspects would be the lumpy nature of capacity growth in LNG and under-utilization of existing capacity. Indeed, in contrast to the large additions that characterized past decades, only one new project was actually operating by the end of 2012. Utilization rates also fell, because either rising domestic demand or falling production crowded out feedstock for exports, or in the wake of unplanned outages and outright infrastructure damage.

The net effect was a decline in supply. With Asian demand for LNG remaining strong, and Japan facing a growing need to replace nuclear power post-Fukushima, the LNG market tightened. Japan increased imports to a record high of 119 Bcm and paid a record premium over European spot prices to attract supplies. China and other Asian countries increased LNG imports amidst solid economic growth, while a severe drought in Latin America also helped to push up demand. With no need to compete for

LNG at the Asian price level, European LNG imports declined by nearly 25%.

The lack of LNG should have been good news for traditional suppliers to the European gas market, such as Russia and Norway. Instead, they faced competition from an unexpected quarter - cheap coal. Much of it came from the U.S., exiled from power generation by the shale gas revolution. While coal prices were falling, European gas prices continued to rise as Russia maintained its oil-indexed pricing. This opened up a large gap between the costs of generating power from gas and coal, with coal on average 45% cheaper. Meanwhile, carbon prices were far too low to redress the balance in favor of gas. The result was a large switch from gas to coal in power generation - a mirror image of the U.S. experience, although on a smaller scale. The largest five European power markets used nearly 20% less gas in power. In volume terms gas lost around 17 Bcm of demand, compared to a 44 Bcm gain in the U.S..

Standing back from the detail, 2012 demonstrated once again the interconnections among regional gas markets. The market is not yet globally integrated like oil, but developments in one region increasingly impact others, either through the pricing of LNG or indirectly through the global coal market.

Coal

Global coal growth moderated last year, with consumption as well as production growth below average. Consumption growth decelerated to 2.5%, almost half the rate of 2011; and production growth slowed from 6% to 2%. Putting cross-Atlantic coal trade aside, in global terms coal remains a China story. The engine of China's industrialization, domestic coal production, rose by 135% over the last ten years. For this period, one fuel in one country accounted for more than one third of global energy consumption growth. Last year China consumed more than half the coal in the world for the first time.

Such volume comparisons will remain important. But the Chinese data also hint at a more intricate question. The Chinese authorities aim to rebalance the economy, from extensive growth toward a higher share of services and domestic consumption. If successful, this would lower China's coal intensity. The 2012 data appears to indicate that coal consumption may have re-entered a path of slowing growth which had started in 2003, when coal growth reached a staggering 20%. In 2009-10, this path was interrupted by energy intensive stimulus programs, administered to combat the global economic crisis. It is too early to tell, but this is yet another development worth watching.

Outside of China, the slow-down of consumption growth was widespread. By region, there was notably faster growth only in Africa and the EU. By country, the main exceptions were Japan, where coal helped to mitigate the consequences of nuclear outages; and India where coal demand rose substantially to replace gas in power generation. Production growth outside China was dominated by the coal exporters of Indonesia, Russia, and Australia. Meanwhile, coal continues to internationalize, with trade outpacing consumption for the 10th consecutive year.

Non-fossil Fuels

Despite near average precipitation, hydroelectric output grew by an above-average 4.3% in 2012, with all the net increase in one country. On the back of a massive program of capacity expansion, China accounts for more than half the global increment over the last ten years; in 2012, it booked the largest annual increment on record. Nuclear generation suffered a second year of record decline of nearly 7% driven by the near-complete shutdown in Japan and as a result its share in primary energy fell to the lowest since 1984.

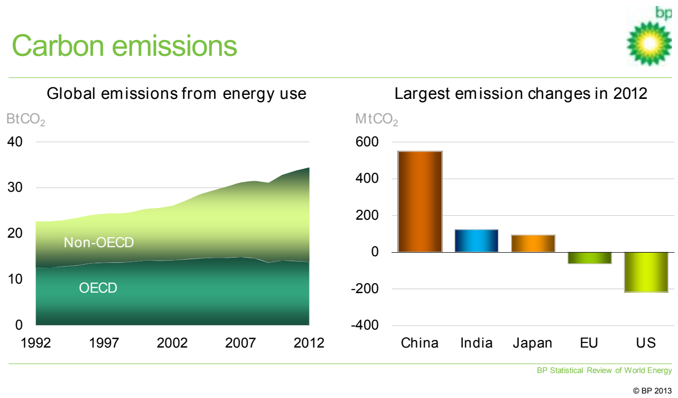
Renewable power generation grew by 15% in 2012, just above the ten year trend, but also experiencing its first serious slowdown. However, with relatively slow growth in total power generation, renewables continued to gain market share, rising to nearly 5% last year. Growth was led by three countries: China, the U.S., and Italy which together accounted for almost half of global generation growth. Meanwhile, China overtook Germany as the second largest renewable power producer, behind the U.S.

While renewable power growth slowed, biofuel production fell by 0.4%, led by the first fall in U.S. ethanol production since 1996. With the worst drought since the 1950s and falling gasoline consumption, U.S. ethanol was squeezed between high corn prices and the "blend wall", forcing several ethanol plants to close. However, renewables in aggregate continued to increase their share of primary energy consumption despite declining biofuels and slackening growth in renewable power, from 2.2% in 2011 to 2.4% in 2012.

Carbon Emissions

Global carbon emissions from energy consumption rose by 1.9% in 2012, slightly faster than primary energy consumption. Unsurprisingly, the largest growth came from China and India, but Japan also recorded a significant increase as it adjusted to the loss of nuclear energy. The U.S. recorded the largest reduction, dropping much faster than the EU. This surprising development is largely due to fuel switching in power generation - from gas to coal in the EU, and from coal to gas in the U.S.

Given that a coal plant emits roughly twice as much CO_2 per kilowatt hour as a modern gas plant, the net effect of higher gas and lower coal consumption in the U.S. was an emission reduction of 164 Mt; the opposite effect in the EU was an increase of 21 Mt. The EU is known for being heavily invested in climate policy, not so the U.S. So what went wrong? Ultimately, it is a price effect: weak gas prices crowded out coal in the U.S., and weak coal prices together with high gas prices subsequently favored coal in Europe.



In theory, the EU ETS carbon price was designed to offset just such a cost advantage. However, it would have taken a carbon price in the range of €40-45/tonne to keep gas competitive in power, whereas the actual carbon price averaged just €8/tonne last year, due to the build-up of a large surplus of allowances. To some extent this surplus reflects the impact of the recession in Europe (the ETS has no built-in adjustment to changes in economic fortune and hence energy demand). But it also reflects the unintended consequences of related but poorly integrated energy policy interventions, specifically the mandated renewable and energy efficiency targets that were not anticipated when the ETS was designed. The support of these targets by various subsidy mechanisms outside the EU ETS contributed directly to reducing the demand for and hence the price of carbon permits. In this way, it is fair to say that one part of climate policy (the carbon price) has fallen victim to the success of another (the renewable and efficiency targets).

Conclusion

There were many examples of adjustment in this year's *Statistical Review of World Energy.* Some of them reflect long established trends, such as demand patterns between OECD and non-OECD. Others reflect adaptation to disruptions for a variety of reasons, such as the Iranian sanctions or record low gas prices in the U.S. Correspondingly, some of these adjustments may turn out to be temporary while others should have a more lasting impact. Importantly, it matters for policy design to recognize the nature of these changes in a system so complex and internationally integrated as the global energy system, as the example of the European climate policy demonstrates. Markets are quick to adapt and may do so in unexpected ways.

Careers, Energy Education and Scholarships Online Databases

IAEE is pleased to highlight our online careers database, with special focus on graduate positions. Please visit http://www.iaee.org/en/students/student_careers.asp for a listing of employment opportunities.

Employers are invited to use this database, at no cost, to advertise their graduate, senior graduate or seasoned professional positions to the IAEE membership and visitors to the IAEE website seeking employment assistance.

The IAEE is also pleased to highlight the Energy Economics Education database available at http://www.iaee.org/en/students/eee.aspx Members from academia are kindly invited to list, at no cost, graduate, postgraduate and research programs as well as their university and research centers in this online database. For students and interested individuals looking to enhance their knowledge within the field of energy and economics, this is a valuable database to reference.

Further, IAEE has also launched a Scholarship Database, open at no cost to different grants and scholarship providers in Energy Economics and related fields. This is available at http://www.iaee.org/en/students/ListScholarships.aspx

We look forward to your participation in these new initiatives.

Scenes from the 36th IAEE International Conference June 16-20, 2013








Welcome to Daegu
36th Annual IAEE International Conference
Cultural Dinner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Report of the 36th Annual IAEE International Conference, Daegu, Korea, 16-20 June 2013

The 36th IAEE International Conference was held at EXCO in Daegu, Korea on 16~20 June 2013. This was the first IAEE conference ever to be held in Korea. The conference venue, Daegu's exhibition center, along with a hotel just next to the venue, is an excellent facility for arrangement of all the plenary and concurrent sessions, with luncheons and coffee-breaks served within the facility.

More than 450 participants attended the conference, some 220 papers were presented in 56 concurrent sessions, and a number of topics on energy, economy and environment were covered in 8 plenary and dual plenary sessions during three full conference days, under the general conference theme: ***Energy Transition and Policy Challenges.***

The first day of the program included the opening ceremony, opening plenary and dual plenary sessions about Energy and Climate Change and Energy Security and Poverty. In the opening ceremony, we had Vice-minister Mr. JinHyun Han who addressed the energy challenges in Korea. Guest speakers for plenary sessions include Kenichi Matsui, James Sweeney, Yuba Sokona, Kilaparti Ramakrishna, Ioannis Kessides, Masakazu Toyoda, Jae Edmonds, Toshihiko Masui, Keywan Riahi, and Kejun Jiang.

The following day focused on specific energy issues such as Natural Gas, Nuclear, Electricity, and Energy Efficiency. At the closing plenary of the third day, the topic was Energy and Environment: Lessons Learnt and Uncertainty. We had Ambassador Richard Benedick who addressed the "The Tipping Point: Careless Energy, Economic Greed, and Nature's Revenge" and John Jimison, on the issues of the electric system transition in the U.S.

The Conference served as a forum for representatives from all sides of the energy sector to interact and to build intellectual bridges. Three invited concurrent sessions were tried in this conference to provide a framework of wider discussions on what can be done to direct energy cooperation in the future.

The social events added extra value and attraction to the conference. The gala dinner on Tuesday night took place at the Fashion Centre with Korean traditional cuisine and traditional performances including Boo-Chae-Choom, a group fan dance, and Nong-Ak, an instrumental music performance of peasants. The Mayor of Daegu Metropolitan City hosted the gala dinner and delivered a welcome address to the conference participants.

The organizing committee is particularly grateful for the companies and institutions that supported the conference. A heartfelt word of thanks goes to the two main hosts; Korea Resource Economics Association (KREA) and Korea Energy Economics Institute (KEEI). Without the sincere support from both organizations, this conference could not have been able to achieve its goal. And also thanks go to the members of the local organizing committee, under the general chairmanship of Professor SeungJin Kang and Dr. JinWoo Kim, ably assisted by the Professor Hi-Chun Park, Eunnyeong Heo, JongDu Choi, Hojeong Park, Jong-Dal Kim and Dr. Ho-Seok Kim and the efficient PCO team of the Daegu Metropolitan City and EXCO, for organizing a most successful conference. We also wish to thank all contributors and participants of this event for making it an unforgettable experience and insightful arena for our agenda.

Our best wish and thanks go to IAEE itself. We much appreciate the intellectual opportunities and values that the IAEE provides to its members and the energy community world-wide. We are very pleased that we had the opportunity to serve the energy community and contribute to success of the IAEE. We hope the 2014 IAEE, New York conference will be another huge success.

Hoesung Lee
General Conference Chair
Vice Chair, Intergovernmental Panel on Climate Change
Professor, Korea University

Putting Emission Limitation on a Solid Foundation: Why Effective International Cooperation Needs to Start with Trade Issues

By Ralph D. Samuelson*

Introduction – The Current Dilemma

Imagine a world where governments considered themselves unable to require imported automobiles to meet any air pollution control standards. In this world, air pollution from automobiles could be dealt with only by imposing standards on domestic carmakers. What outcome might we expect? There are at least two. First, we could expect the domestic carmakers, and everyone whose livelihood depends on them, to intensely oppose any air pollution control standards for domestic automobiles. They would argue, quite sensibly, that such standards would put them at a competitive disadvantage relative to their foreign competitors. As a result, we could expect pollution control standards for domestic automobiles to be weak. Second, we could expect many consumers to buy imported automobiles. This may be because, as in today's world, they prefer them for various reasons. But in this imaginary world they would also buy them because by doing so they can avoid the cost of any pollution control systems required on the domestic automobiles. So only a portion of the automobile fleet would be subject to air pollution control standards of any kind. For both reasons, we could expect little progress in controlling air pollution from automobiles in this imaginary world.

Editor's comment:

Ralph Samuelson calls attention to an interesting approach to climate change which, in our view, has not received the attention it deserves. We encourage comment and follow up articles on this from our readers. If there is sufficient interest we could devote an issue or major part of an issue of the ***Forum*** *to the subject.*

DLW

This system sounds quite absurd, yet it is strikingly similar to the system that international agreements have been seeking to use to control greenhouse gas emissions globally. Under the Kyoto Protocol, 37 wealthier countries and the European Union agreed to limit the greenhouse gas emissions produced in their territories over the five-year period 2008–2012, while their consumers remained free to buy products produced anywhere. The results were predictable. First, there was intense opposition to the proposed emission limits, and the emission pricing needed to enforce them, from domestic industries that would suffer competitive disadvantages. For this reason, the United States never ratified the Protocol, while other countries (they know who they are) never took their obligations very seriously, and even the regions that did implement emission pricing (such as the EU and Australia) adopted systems which have low emission prices, incomplete coverage, and which face an uncertain future. Meanwhile, consumers in wealthier countries continued to consume growing amounts of imported products, embedding huge amounts of emissions, from developing countries (see Davis and Caldeira, 2010). The results were dismal enough that a post-2012 successor agreement with binding limits has attracted meager participation thus far. Little progress is being made.

An Alternative – Action from the 'Bottom Up' Rather than the 'Top Down'

What is happening can be viewed as a classic market failure. Economic principles tell us that markets work when consumers pay the full cost (including environmental costs) of the products they consume, and that any departure from this principle produces 'market failures' that give consumers an incentive to behave in ways that are not in society's best interests.

Yet under the Kyoto Protocol, with its limits on the territorial emissions in each country, the consumer has a perverse incentive to avoid paying the environmental costs they are imposing on society by purchasing products produced in countries with weak or no emission regulation. The outcome is that producers in countries with weak emission regulation stand to be rewarded in the marketplace, while those in countries with effective emission regulation stand to be penalized. Production can shift to countries where emissions remain uncontrolled, weakening the impacts of any emission regulation ('leakage'), and penalizing the economies of countries that implement effective emission regulation.

This article will argue that a major step toward effective global action on climate change is, in principle, quite simple: within a given country domestic and imported products should compete on a fair basis, especially regarding emission pricing. And we don't have to wait for the ever-elusive comprehensive global climate agreement to make this happen: each country should enforce compliance on imported products at their own borders with an appropriate border carbon adjustment (Helm, 2012, p. 193-194). Once the competitive playing field is levelled between imported

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See footnotes at end of text.

products and domestic products, there would be the beginnings of a politically viable global emissions control scheme. Policymakers in each country would gain the scope to take action, either unilaterally or in concert with other like-minded countries.

Of course, enforcing compliance with emission regulations at borders creates two risks that should be taken very seriously.

1. Developing countries fear that border carbon adjustments could be used to shift the burden of emission reduction from the wealthier countries to them (Böhringer, et al, 2012).
2. There is a general concern that border carbon adjustments could be used as a cover for protectionism (Weitzel, et al, 2012).

If these risks are not properly addressed, the outcome could be further setbacks to international cooperation on climate change mitigation and/or trade disputes that could damage the world economy. However, both concerns could be addressed through proper design of the border carbon adjustments, including internationally agreed-upon rules for their implementation.

Given the lack of progress with the current approach to climate negotiations, a new strategy is obviously needed. Rather than the current strategy of focusing on a comprehensive global agreement from the 'top down', a more promising approach is to build from the bottom-up, starting with agreements that make it more attractive for individual countries to take unilateral actions. And since trade issues are likely to pose the greatest barriers to unilateral action, international cooperation on climate change needs to start with trade issues.

Current Barriers to Unilateral Action

Currently any country is free to take a broad range of unilateral actions to reduce its emissions. Most economists would probably identify putting a price on emissions, such as through a carbon tax or emission trading scheme, as the most important such action (Tyson, 2013). Unlike 'command and control' regulation, an emissions price would impact on the full range of decisions by firms and consumers, and thus produce the largest reduction in emissions at the lowest cost. Also, a price on emissions would provide incentives for technology improvements (Aldy and Stavins, 2012). Indeed, given the size of the emission reductions that will be required to deal with climate change--50-85% by 2050 compared to the year 2000 being called for by climate scientists[1] --promoting a 'low carbon technology revolution' should probably be the most important goal of international cooperation (Mattoo and Subramanian, p. 50, Helm, p. 213).

Analysis suggests that adopting a unilateral emission price in wealthier countries should not be economically damaging. For example, an Energy Modeling Forum analysis (EMF 29) of model results from 12 different expert groups found that to cut territorial emissions in 2004 by 20% in the Kyoto Annex 1 Regions (including the USA but excluding Russia) would have reduced the GDP of these regions by 0.6% or less in 11 of the 12 models (Böhringer, et al, 2012, Figure 6). And if the revenues from emission pricing were used to reduce the income tax, thereby eliminating pre-existing tax distortions, the impact could be significantly less (perhaps even negative) (Parry and Williams, 2010).

So What is the Problem?

1. In politics perceptions matter. And policymakers tend to see a unilateral emission price as something akin to putting a tariff on their own country's products not faced by their foreign competitors. Basically, they are being put in the perceived position of having to choose between jobs and economic growth or environmental protection. As long as the choice has to be framed in these terms, environmental protection will lose.
2. It is not just a matter of perception. Emission pricing turns the usual politics of government programs on its head: the benefits (climate protection) are diffuse, but the costs are concentrated on a few energy-intensive and trade-exposed industries. And these industries strongly resist.

Given the politics, a 'race to the bottom' for weaker emission regulation would seem to be the natural outcome, and it largely has been. A border carbon adjustment would directly address these concerns. It would level the competitive playing field, thereby making unilateral action on climate change more akin to other environmental regulation that is taken for granted in industrialized countries.

Would a border carbon adjustment actually help to mitigate climate change? The literature on this topic is enormous[2]. The conclusions are best described as mixed. For example, the EMF 29 results from 12 modeling teams suggest that border carbon adjustments would significantly reduce emission leakage under an emission price, but they would have only a small favorable impact on emissions and GDP

(Böhringer, et al, 2012). The EMF 29 results also suggest that border carbon adjustments would significantly reduce the impacts on energy-intensive and trade-exposed industries, which, given the politics of emission pricing, may be the most important result.

Addressing Border Carbon Adjustment Design Challenges

How would such a border carbon adjustment scheme work? Clearly there are many design options, but here is one proposal that might work. We start with the observation that since the consumer is the key decision-maker in any market, and the one ultimately responsible for greenhouse gas emissions, what we should be seeking to control in each country is not emissions from domestic production but emissions embedded in what is domestically consumed, regardless of where it is produced. 'Emissions embedded' refer to the emissions that were caused by the production of the product. (see Helm, 2012, p. 189-190).

As shown in Figure 1, for products that are both domestically produced and domestically consumed, emission pricing could work exactly as it works without border carbon adjustments: producers of fuels or other specified emission-intensive primary products would be required to pay a carbon tax or, under an emission trading scheme, procure emission credits. The cost of the carbon tax or emission credits would then be passed through automatically in the market to consumers of final products made from these inputs.

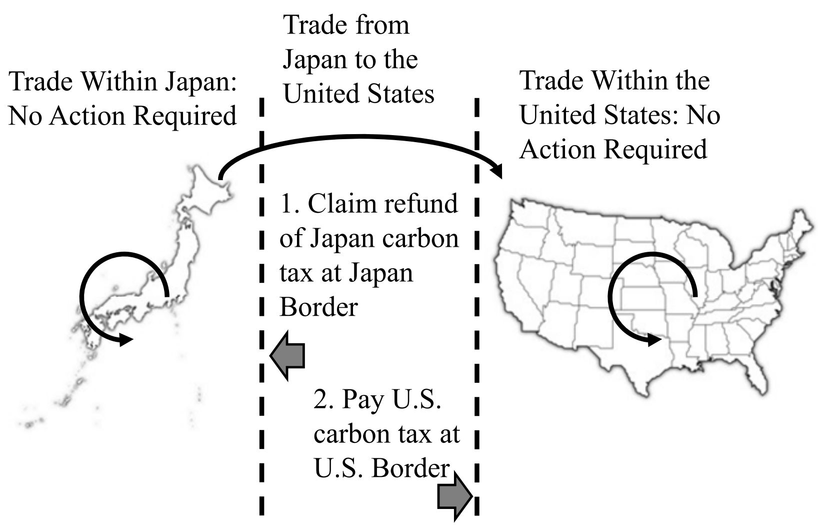

Figure 1. Example of Application of Border Carbon Adjustment Assuming both Japan and the United States have a Carbon Tax.

Under the framework proposed here importers would also be expected to comply with the same emission pricing requirements as the domestic products. So if the importing country has a carbon tax or emissions trading scheme, importers would be required to pay the carbon tax or procure emission credits for the emissions embedded in their imported products. And, in order to protect the competitiveness of domestic products in export markets, exporters would receive a rebate designed to match the emission pricing incorporated in the cost of their product. This framework for border carbon adjustments would be similar to today's value-added taxes, which are also charged on imports and refunded on exports (Lockwood and Whalley, 2008).

Note that if different countries have different emission pricing schemes, this design automatically provides coordination between them. Every exported product gets a rebate of the emission price paid in the country where it is produced and pays the emission price in the country where it is consumed. In the end, every product is charged the emission price applicable in the country where it is consumed. No agreements between countries are required for this coordination.

Measuring the Emission Content

But how do we measure the emissions content of these imported and exported products? To get it exactly right is a hard, perhaps impossible, problem. However, to quote Helm (2012, p. 191), "it is better to be a bit right than exactly wrong". Without border carbon adjustments, we are essentially assuming that imported products have zero emission content. Anything we do is better than that.

Ideally, we would charge an emission price on each imported product based on its specific embedded emission content, taking into account the actual fuels and other inputs used to produce it. This would have the benefit of giving exporting countries an incentive to reduce the emissions embedded in their products regardless of whether they have emission pricing. Unfortunately, attempting to base border carbon adjustments on specific embedded emission content raises two very serious challenges.

1. Data. The importing country would have difficulty collecting data or conducting audits in the exporting country, even if the data is available, which it may not be. At best, the administrative burden for both exporters and importing country governments would be large (see Persson, 2010).
2. Impact on developing countries. Border carbon adjustments based on the specific embedded emis-

sion content of the imports would be what Mattoo and Subramanian (2013, p. 24) refer to as the "nuclear option" in terms of its trade consequences for developing countries. The reason is that many developing countries have much more emission intensive production processes than the wealthier countries. For example, Mattoo and Subramanian estimate that a border carbon adjustment based on actual emission content imposed by the wealthier countries could reduce the exports of China and India by 20 per cent. This assumes the wealthier countries adopt an emission price which allows them to cut their emissions by 17 per cent by 2020 compared to 2005 levels.

An alternative approach that would address both challenges would be to charge an emission price on imported products based on the estimated embedded emissions of similar domestic products. This approach should change the competitive landscape very little compared to a world without emission pricing; Mattoo and Subramanian (Table 5-4) estimate the result would be about a two per cent reduction in China and India's exports. Tables of the emission content for various classes of products could be applied by customs authorities based on model results, thereby minimizing the administrative burden for business.

The framework outlined here should address both risks of border carbon adjustments discussed above. First, since it would change the competitive landscape very little, it does not shift the burden of emission reduction from the wealthier countries to the developing countries. Second, it is clearly not protectionist; indeed, as Helm (2013, p. 191) points out, not to have emission pricing is a trade distortion, since it represents the subsidizing of polluting exports.

The Happy Ending: Facilitating International Cooperation

Policymakers in the wealthier countries should find this framework to be a step in the right direction, since it would allow them to use the most powerful of tool for reducing emissions—emission pricing—without being perceived as undermining their own economy. And policymakers in the developing countries, who are probably more exposed to damage from climate change than the wealthier countries (see Mattoo and Subramanian, pp. 15-16), should like it, too, for at least three reasons.

1. At little cost to developing countries, it would give the wealthier countries the tool to do what the developing countries have been demanding of them: effective action to reduce emissions.
2. By focusing on consumption rather than production, it would (quite properly) shift more of the responsibility for emissions to the wealthier countries.
3. The developing countries will ultimately also need emission pricing if the world is to meet the challenges of climate change and developing country policymakers, too, will want to avoid being perceived as undermining their own economies.

But aside from facilitating unilateral actions, border carbon adjustments can also lay the groundwork for wider international cooperation on climate change. Once there are effective emission measurement and control regimes in place in many countries, pledges to reduce emissions can become credible, their implementation can become transparent to all, and there is little risk to the pledger in making them legally enforceable. Now all kinds of deals become feasible; these include the Kyoto-style "I'll reduce my emissions if you reduce yours", international emissions trading, or emission reductions in return for some type of assistance. Effective global action would finally be possible.

Footnotes

[1] See the Intergovernmental Panel on Climate Change (2007), especially Table SPM.6.

[2] A good place to start is the special supplement to *Energy Economics*, Volume 34, December 2012, devoted to "The Role of Border Carbon Adjustment in Unilateral Climate Policy: Results from EMF 29".

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13th IAEE European Conference Report

The 13th IAEE European Conference this August in Dusseldorf was organized by the German GEE under the headline *Energy Economics of Phasing out Carbon and Uranium*. More than 300 delegates discussed the status of energy transformation in Europe which is characterized, among others, by unexpectedly low CO_2 prices in the European emission trading system (EU-ETS) and rather high natural gas prices (as compared with the U.S.). Another observation is a significant disintegration of the single European electricity market due to national uncoordinated renewable energy support schemes and proposed national capacity mechanisms. Another topic worthy of mentioning is the merit order effect of the increasing wind power and photovoltaic capacities on the European power markets due to which gas and even some coal fired power stations are today out of the money.

There is little hope that there will soon be political initiatives dealing with these challenges because in May, 2014 the EU parliament will be reelected and a new EU commission will be established. Therefore, the IAEE conference was in something of a reflection period. Actually energy economists have a bit of peace and quiet to develop new and appropriate answers that may guide future European energy policy. At the IAEE conference, business leaders invited energy economists to engage themselves in this direction as scientists have more credibility than industry lobbyists.

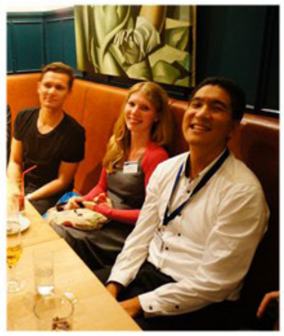
In fact a lot of concepts were discussed showing the engagement of IAEE delegates in addressing the relevant issues. However, at the conference it also became clear that scientific models provide unambiguous answers only under precise assumptions. Thus they may even risk delivering misleading conclusions if the complexity of the issues are disregarded. An example was the rather controversial discussion on whether or not power capacity markets should complement the energy only electricity market and – if yes – what design would be effective and efficient.

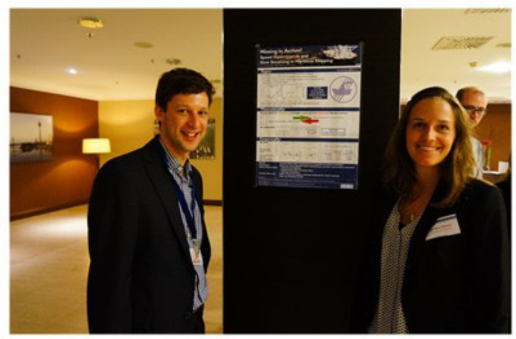
But there was at least some agreement on the appropriate priority of the next steps. Most important is getting the prices of the EU-ETS right so that carbon friendly technologies that are close to price competitiveness have a chance to access the markets without further support schemes or subsidies.

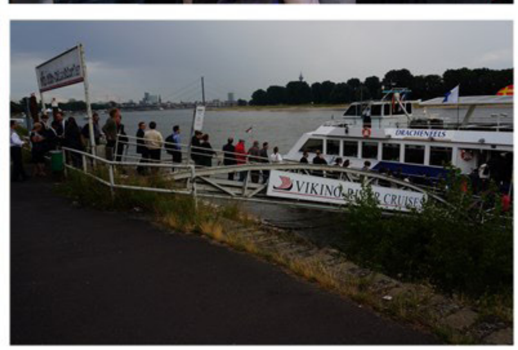
So the overall impression is that energy economists face a lot of unanswered questions that deserve more scientific research. Regarding the many good papers based on sound theory and methodology and the fine engagement of the delegates during the discussions one can expect that significant progress will characterize coming European and International IAEE conferences.

Georg Erdmann, GEE President
Christoph Weber, Dusseldorf Conference Chair

Scenes from the 13th IAEE European Conference August 18-21, 2013

















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4/13Forum

Electricity Storage: The Essential Rebalancing Mechanism

By Ross McCracken*

The energy world has for the last three or more years been consumed by the American shale gas revolution, which has morphed into a liquids revolution that has profoundly changed perceptions about U.S. energy security and its international relations. This has overshadowed a revolution no less profound, but of a very different kind – the decarbonization of power generation in Europe in pursuit of sustainable non-hydrocarbon-based energy systems.

This could reshape Europe's energy relations with the outside world every bit as much as shale is doing for the U.S. Both of these revolutionary fronts have one aspect in common – they are driven by technology. But otherwise they are arguably in conflict; one offering a climate endangering extension of a hydrocarbon-based energy system, the other a radical, more sustainable alternative.

The U.S. revolution is in many ways simple; it promises major industry upheaval in terms of gas-for-coal displacement in the power sector and gas-for-oil displacement in transport, but it does so on the basis of standardized commodities, for which well-functioning and well-understood markets, transport and storage systems already exist.

Renewables are much more complex, involving the integration of multiple new technologies, each with their own operating characteristics, into conventional power systems, and working with electricity, which is difficult to store in efficient and affordable ways. Oil, gas and coal storage are relatively simple matters by comparison. They may be an unexciting part of those markets, but they are fundamental to the way in which they function. The physical ability to store and retrieve a commodity, and the affordability of doing so, define how a commodity is traded. The extension of storage in the electricity market can, therefore, be expected to have some weird and wonderful effects.

Storage Prospects

There are good grounds to be skeptical about the prospects for electricity storage for three main reasons. First, if built out at scale, storage undermines its own profits. It is hard to make a business case for it unless there are enduring differences in price at different times of the day and night that more than compensate for the loss incurred in storing the electricity. As storage is built out, the difference in Peak and Baseload prices should trend towards the average efficiency of the storage fleet. The returns for this fleet, should, in turn, trend towards zero, making it a relatively undesirable investment.

This is a problem from the viewpoint of a standalone storage facility, but what is really happening is a shift in beneficiaries. The value of storage increasingly accrues to generators, rather than to the storage operator directly. This makes the business case harder to make as the value of storage is spread across the system. It can, therefore, only be justified in the long-term within a diversified generation portfolio. Arguably, even then, the benefits accrue in part to generation outside of the portfolio. The delivery of system-wide benefits suggest some form of socialized compensation, which does not sit well with the current market structure, and generally requires regulatory and political approval.

The second reason is that the costs of storage are very high compared with the value of the commodity. Not only does an operator have to bear the capital cost of the investment, but take a substantial hit on what is returned. In the absence of any other form of payment, the operator has to make back in price the loss incurred by storage, which for pumped hydro is about 20%, and for emerging storage technologies more. Natural gas storage by comparison may not be free, but at least it returns the same amount of gas that has been put in.

Third, given the likely low margins, scale is important, but again difficult. Take the Dinorwig pump hydro station in Wales, the UK's largest storage facility, with a capacity of 1,728 MW. It can operate over six hours before running out of water, which equates to 10.3 GWh. By contrast, the Rough gas storage facility in the UK stores around 35 TWh of natural gas and can deliver 113.75 GWh in six hours, carrying on for months on end. It may be an unfair comparison in some ways, as Rough is a very large facility, but it makes the point that in a low margin business, scale is important. Emerging storage technologies are relatively small in scale.

The Need for Storage

The fact is that electricity systems have got by pretty well without storage, or with a limited amount of storage in the form of pumped hydro, up until now. Electricity demand varies both within the day and seasonally, while demand and supply has to balance at all times. The reason storage hasn't been necessary is that generation is flexible.

* Ross McCracken is Managing Editor of *Energy Economist*, Platts.

Some forms of electricity generation can be brought on and off-line relatively easily, or can economically incorporate a degree of load variation within certain parameters, avoiding a total shutdown.

The reason for storage now is that it provides operational flexibility, and the reason electricity systems need greater operational flexibility is that new forms of electricity generation have been introduced into the system. The shared characteristic of the two most widespread renewable generation sources, wind and solar, are that they are variable ‘must-run’ generation. They are variable in that output cannot be predicted with any greater degree of accuracy than the weather and they are ‘must run’ because they have no fuel cost. They make sense to run no matter how low the price is, and, where subsidies are included, they can even bear a certain level of negative prices.

Assuming no or low growth, which is fairly reasonable given the current economic situation in Europe, the build out of renewables has two primary impacts; it reduces the amount of electricity required from existing traditional forms of generation and it imposes on them much greater demands in terms of flexible generation. This, it turns out, is not particularly optimal. Gas-fired generation suffers most, partly because it has the operational capacity to be flexible and partly because it has the highest fuel costs. Gas-fired plants are operating less time overall and have to display greater operational flexibility, neither of which is good for returns.

Gas may appear the most complimentary generation technology for renewables from an operational perspective, but that is not the way it is working out within the current hybrid subsidized/market system. This raises an interesting question: does the EU need a power system, in which storage is a necessary piece of kit, like a transmission line; or is storage a business proposition, built on a commercial basis that makes a profit from the dysfunctionalities that are increasingly evident within the EU electricity markets?

Dysfunction

The emergence of increased incidents of negative electricity prices in recent years have been well documented. First in northern Europe, then in ERCOT West in Texas, an area with a lot of wind farms, but only limited interconnectivity with other areas of the ERCOT system. In June, at the Mid-C hub in the U.S. a combination of high hydro and wind output sent wholesale prices plummeting towards zero. All these areas have high levels of wind capacity.

The most recent and dramatic manifestation was in Europe in June when negative prices struck across EU borders, ironically combining Germany’s large build out of solar and wind with north European experiments in market coupling, which in many other respects have been highly successful. Less promising from a market integration perspective have been Poland’s attempts to build infrastructure designed to limit surges of excess power coming through its electricity system. Both are evidence of growing problems.

French, Belgian and German/Austrian spot power prices turned negative for delivery June 16 with some hourly prices falling to minus €200/MWh ($262/MWh), owing to low demand and high levels of non-flexible generation. Baseload prices in France and Belgium cleared at minus €40.99/MWh and German/Austrian baseload at minus €3.33/MWh. Prices for German/Austrian day-ahead peak cleared at minus €18.99/MWh. French day-ahead peak cleared at minus €20.29/MWh.

The cause was low consumption on a warm weekend day and high levels of nuclear, hydro, wind and solar power production in France, Germany and Belgium, causing a generation surplus. Combined German wind and solar output peaked at 1400 hours June 16 at 29.5 GW, according to EEX transparency data. The Netherlands did not have a surplus, but could not absorb more electricity, owing to a lack of import capacity. Day-ahead baseload for the Netherlands cleared at plus €36.16/MWh.

Negative power prices only affect a very small amount of traded electricity, but they are the visible tip of a larger process in which wholesale prices are depressed by must-run subsidized renewable generation. On the one hand, the differentials between Peak and Baseload prices in Germany have been compressed, reducing the potential arbitrage and economics of short-term electricity storage. On the other hand, negative pricing incidents create a valuable arbitrage in themselves, and their occurrence is growing.

These events are clear evidence that there is less control over the generation side of the power system as a result of renewable energy sources. Negative prices represent ‘wrong-time’ electricity. A recent report on liquid air as a potential storage technology, published by the UK’s Centre for Low Carbon Studies, said that the UK is on course to build 31 GW of wind capacity, compared with 20 GW of baseload demand. The result will be large amounts of ‘wrong time’ electricity.

All EU countries, at different speeds, are on the same general course. The construction of multiple interconnectors and the extension of market coupling will delay the problem, but only re-create it on a grander scale in the longer term.

Price Trends

The EU's wholesale electricity markets will find it hard to work with increasing incidents of negative prices. They may be rare for the moment and account for very small volumes of traded electricity, but larger trends are at work. Strange things are occurring in terms of electricity price relationships.

In the Germany/Austria area, the average difference between Baseload and Peak power appears to be contracting. For the April-June period, when solar irradiance starts to have more of a seasonal impact, the average price difference has fallen steadily each year since 2010 from €5.7/MWh to €2.79/MWh in 2013.

The number of days in which Baseload and Peak time prices were inverted was 22 in April-June 2013, compared with just 5 in the same period in 2010. The average difference between Peak prices and Off-peak II, representing hours 21-24, went negative in 2012, growing to minus €2.86/MWh in 2013, compared with plus €2.72/MWh in April-June 2010. These calculations are based on Phelix database prices provided by the European Energy Exchange.

These trends have significant implications for storage technologies, which need to make money from the differences between electricity prices at different times of the day and night. Based on EPEX spot auction market prices for Germany/Austria, such a facility trading the difference every day between Peak and Baseload prices in an automated fashion would have made big losses.

However, it only makes sense to generate when the requisite price difference is there. This opportunity occurred on 21 days in the April-June period in 2009. In the same period this year it didn't occur at all. In fact, it would bizarrely have been more profitable to buy selectively Peak electricity and resell it as Baseload -- this arbitrage worked six times between April-June in 2013, returning an average €3.46/MWh.

Average difference between Peak and Base load (April-June)

	2010	2011	2012	2013
Average price	5.7	4.37	3.43	2.79
No. of price inversions (days)	5	9	19	22

Average difference between Peak and Off-Peak I (April-June)

	2010	2011	2012	2013
Average price	15.73	12.08	11.28	9.81
No. of price inversions (days)	0	1	6	5

Average difference between Peak and Off-Peak II (April-June)

	2010	2011	2012	2013
Average price	2.72	0.51	-1.98	-2.86
No. of price inversions (days)	25	31	44	49

Off-Peak I Hours 01-08, Off-Peak II Hours 21-24

Phelix Future is a financial derivatives contract referring to the average power spot market prices of future delivery periods of the German/Austrian market.

Phelix Price Data, German/Austria Market Area (€/MWh)

Source: EEX, author's calculations

	2009	2010	2011	2012	2013
No. of Peak/Baseload price inversions (days)	0	5	9	19	22
No. of Peak/Night price inversions (days)	0	0	4	8	6
Av. Peak load price (€/MWh)	38.83	47.21	57.98	43.8	35.39
Av. Baseload price (€/MWh)	32.38	41.52	53.61	40.39	32.6
Difference (€/MWh)	6.45	5.69	4.37	3.41	2.79
Av. Peak load price (€/MWh)	38.83	47.21	57.98	43.8	35.39
Av. Night price (€/MWh)	17.76	28.52	42.66	29.9	22.35
Difference (€/MWh)	21.07	18.69	15.32	13.9	13.04

EPEX Spot Market Auction Germany/Austria

Source: EPEX Spot, author's calculations

For storage developers, the idea that Baseload and Peak time prices are moving closer together is a disaster, but they may in fact simply be passing each other by. The difference between average Peak and Off-Peak II prices narrowed to parity and then kept on going. It may have been an average minus €2.86/MWh in 2013, but that was wider than the minus €1.98/MWh in 2012 and the plus €0.51/MWh average of 2011. It doesn't matter to the storage developer whether the differential between time periods is positive or negative so long as it is there.

A second aspect to this is that averages do not reveal changes in volatility. Take, for example, trading Peak prices against Night in the German/Austria area, where the differential is significantly larger than between Peak and Baseload.

The average difference in price between Peak and Night got smaller for the April-June period each year between 2009-2013. It fell from €21.07/MWh in 2009 to €15.32/MWh in 2011. The average profit to be made from 80% efficient storage also plummeted from €13.45/MWh to €7.07/MWh over the same period. Worse still, the number of days on which it was profitable to operate dropped from 90 in April-June 2009 to 66 in 2011. Price and volume were both down.

From 2011 to 2013, the average Peak/Night differential for April-June contracted further from €15.32/MWh to €13.04/MWh, but, perhaps surprisingly, the average profit from storage rose from €7.07/MWh in the April-June period in 2011, to €8.84/MWh in 2012 and €9.30/MWh in 2013, while the number of days of profitable operation stayed broadly the same – 66 in 2011, 65 in 2012 and 68 in 2013. A similar pattern is displayed for the Phelix prices for the Off-Peak I period versus Peak. The increase in price was less, but the increase in the number of days of operation was greater.

A third factor of interest is that the inversions seen between Baseload and Peak for the EPEX data and between Off-Peak II and Peak for the Phelix data can be highly complementary to the main trade -- Night versus Peak and Off-Peak I versus Peak respectively.

Looking at the Phelix data, there were 49 Peak/Baseload inversions in April-June 2012. Of these, 24 produced a price difference making storage profitable. Of these, 20 were more profitable than the same day Off-peak I versus Peak trade. And, of these, 13 occurred on days when the main trade was negative. As a result, on seven days the complimentary trade boosted price return and on 13 days it provided not just a positive price but additional volume. However, it should be noted that while this had a big impact in 2013, and sizeable effects in 2010 and 2011, it had no impact in 2012.

Daily trading Baseload v Peak			**Daily trading Night v Peak**		
April-June	**Av. profit (€/MWh)**	**No. of Days**	**April-June**	**Av. profit (€/MWh)**	**No. of Days**
2009	-1.32	91	2009	13.30	91
2010	-3.75	91	2010	9.25	91
2011	-7.22	91	2011	3.72	91
2012	-5.35	91	2012	5.14	91
2013	-4.28	91	2013	6.00	91

Profitable days only -- Baseload v Peak			**Profitable days only -- Night v Peak**			
April-June	**Av. profit (€/MWh)**	**No. of Days**	**April-June**	**Av. profit (€/MWh)**	**No. of Days**	**Inc. Adjusting for profit & volume (daily = 100)**
2009	1.74	21	2009	13.45	90	100.02
2010	1.42	6	2010	10.80	81	103.93
2011	3.67	1	2011	7.07	66	137.84
2012	0.80	2	2012	8.84	65	122.85
2013	0.00	0	2013	9.30	68	115.82

Profitable days only -- Baseload v Peak			**Optimization - Night v Peak and Peak v Baseload**			
April-June	**Av. profit (€/MWh)**	**No. of Days**	**April-June**	**Av. profit (€/MWh)**	**No. of Days**	**Inc. Adjusting for profit & volume (daily = 100)**
2009	0.00	0	2009	13.45	90	100.02
2010	0.00	0	2010	10.80	81	103.93
2011	2.70	1	2011	7.00	67	137.95
2012	0.35	1	2012	8.71	66	122.90
2013	3.46	6	2013	8.83	74	119.67

Trading Possibilities: EPEX Spot Market Auction Germany/Austria

Source: EPEX spot

For the EPEX data, optimizing Night versus Peak by combining with Peak versus Baseload provides similar results, but on a much smaller scale as both the number of inversions and profits generated are smaller. But it may not be unreasonable, based on the rising incidence of Peak/Baseload inversions, to expect that the profitability of this trade will also grow.

Profit in Storage

The introduction of renewables, while wholly positive in terms of a geopolitical definition of security of supply and in terms of emissions, are undermining the flexibility profile of the generation side of the industry and producing increasing amounts of wrong time electricity. The impact can be seen in the form of increased incidences of negative pricing and in the changes in relationships between pricing periods in the wholesale market. Some analysts predict that solar in Germany will account for the whole of summer peak time demand within three years, and potentially more, eating into baseload. Peak demand will exist; peak pricing will not.

Decades of painfully slow effort have gone into creating competitive, integrated wholesale markets based primarily on competition between fossil fuels to create a marginal price that provides useful signals for investment. More recently, an increasingly large subsidized sector, in which the generation sources have very different operating characteristics, has grown up alongside this market. As a result, the market's operation has become distorted and the price signals it produces increasingly unhelpful from a conventional point of view.

The implication is a generation mix that has a huge amount of installed capacity in comparison with actual electricity demand, split between under-utilized conventional generation and renewables, like solar, with low capacity factors. It is a very expensive mix, but one which will increasingly demonstrate the value of storage, the implied value of which is represented by the capacity payments that will have to be made to keep conventional generation plant economic.

There are grounds to argue that the current market system simply isn't compatible with the growth in renewable energy generation without major adjustments. But it may be that the changing pattern of price relationships is starting to produce the right signals. In a system undergoing such rapid transformation, those price signals and relationships should be different from anything seen before. Arguably, they are beginning to show that electricity storage is the essential rebalancing mechanism that could make a renewables-based energy system work both as a power system and as a market.

Daily -- Off-peak I versus Peak (€/MWh)

April-June	**Av. profit**	**No. of days**
2010	6.33	91
2011	1.19	91
2012	2.64	91
2013	2.80	91

Profitable days only -- Off-peak I versus Peak (€/MWh)

April-June	**Av. profit**	**No. of days**	**Inc. adjusting for profit & volume (daily = 100)**
2010	7.92	76	104.50
2011	4.86	52	232.00
2012	5.8	59	142.40
2013	5.85	62	142.30

Optimization -- Off-peak I v Peak and Peak v Off-peak II (€/MWh)

April-June	**Av. profit**	**No. of days**	**Inc. adjusting for profit & volume (daily = 100)**
2010	7.94	80	110.30
2011	5.7	57	298.30
2012	5.8	59	142.20
2013	7.64	75	224.90

Off-Peak I Hours 01-08, Off-Peak II Hours 21-24

Phelix Future is a financial derivatives contract referring to the average power spot market prices of future delivery periods of the German/Austrian market.

Trading Possibilities: Phelix Price Data, German/Austria Market Area

Source: EEX

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We are pleased to announce that the 4th IAEE Asian Conference will be held in Beijing, China on September 19-21, 2014. We welcome you to Beijing, the capital of the People's Republic of China, with a rich history and modern cultural developments. There are two categories of concurrent sessions: 1. academic-type energy economics research, and 2. practical case studies on current energy-related issues from government agencies or industries. Experts who are interested in organizing special tracks are encouraged to propose their topics and possible speakers.

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The conference will be held at the new auditorium of Chinese Academy of Sciences and the International Conference Center (GICC) of China University of Geosciences.

KEY DATES

Tracks proposal deadline: March 1, 2014
Abstracts submission deadline: April 1, 2014

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Sincerely we welcome you to the 4th IAEE Asian Conference in Beijing, China.

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Edited by Hillard G. Huntington and Eric Smith

This special issue is an important outgrowth of the Stanford University Energy Modeling Forum (EMF) 23 working group. The volume explores nascent modeling efforts to represent international natural gas markets and trade for improving the understanding of key policy and investment decisions. Although formal modeling is not required to describe the growth of liquefied natural gas or the role of spot markets, decision makers can gain powerful insights from these frameworks.

Following the editor's introductory and overview chapter, the volume includes 12 technical papers by participants in the EMF study. Seven chapters provide unique perspectives on the regional price, volumes and trade estimates from individual modeling frameworks. These systems include competitive models of world natural gas markets as well as strategic models of European markets with market power. The remaining five chapters cover important topics discussed by the working group during the study.

The range of issues is comprehensive and intriguing: trans-Atlantic price convergence, the linking of oil and gas prices through future gas-to-liquid (GTL) capacity additions, the critical role of Middle Eastern natural gas supplies, the extraordinary potential for Russia supplies if key constraints can be overcome, potential collusive behavior by Russian and Middle East exporters, the dynamics of transportation and storage capacity adjustments in response to market power opportunities, European markets reliance upon Russian natural gas exports, the interrelationship between resource constraints and market power, reserve appreciation in known North American fields, and improving insights and decisions through use of quantitative models.

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Will the SIEPAC Transmission Project Lead to a Vibrant Electricity Market in Central America?

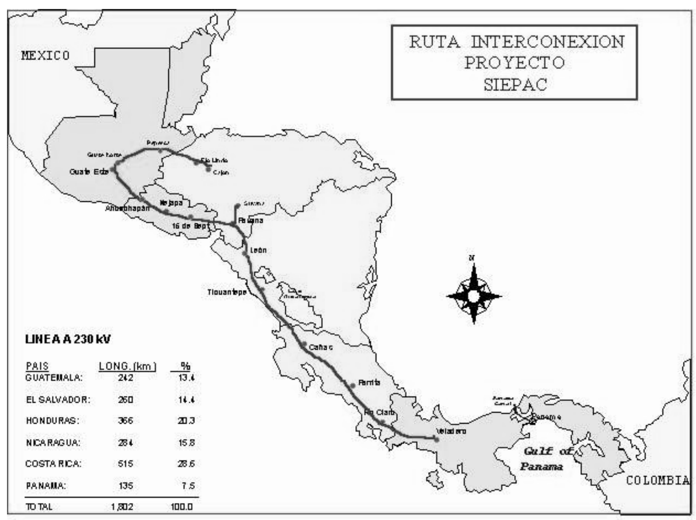
By Jay Zarnikau, Ian Partridge, John Dinning, and Daniel Robles*

New Opportunities for Central America[1]

Following years of debate, study and delay, the Sistema de Interconexión Eléctrica de los Países de América Central or SIEPAC transmission line project was largely completed earlier this year. With a mere 300 MW of transfer capability, SIEPAC might seem an inconsequential project at first glance, but it could be a milestone in the economic development of the region. It also presents an interesting test for cooperation within this region.

With the 1,800 km 230 kV transmission project, the electricity grids of Panama, Costa Rica, Honduras, El Salvador, Guatemala, and Nicaragua are now interconnected into a single transnational grid with an independent system operator, or EOR.[2] The project is owned by Empresa Propietaria de la Red or EPR -- a public company with private participation whose shareholders include the transmission network operators from the six SIEPAC countries as well as Endesa (Spain), CFE (Mexico), and ISA (Colombia). A regional electricity market (Mercado Eléctrico Regional or MER) has been established.[3] An adjacent and complementary project – the Mesoamerican Information Highway – supplements SIEPAC with an advanced fiber optic communications infrastructure. In theory, this should lead to improved reliability of service and lower overall electricity and telecommunications costs for consumers in Central America. This should, in turn, improve the region's competitiveness in attracting manufacturing operations and lead to a higher standard of living.

The interconnection could also affect the regional generation mix and perhaps enhance investment opportunities for large-scale renewable energy projects. Nearly half of the region's generation requirements are presently satisfied with hydroelectric power. Although the region has enormous potential for the development of wind, solar, and geothermal generation as well as additional hydro (see Johnson, 2012), the share of power production from renewables has increased very slightly in recent years. During the 1990s, the share of total generation from oil-fueled plants increased. More recently there has been some expansion in coal-fired capacity. The net results of these changes include a rise in carbon emissions from the Central American electricity generation sector and increased exposure of the various national electricity markets to volatile imported fossil fuel prices. A transnational electricity market could open opportunities for larger renewable energy projects in this region of high energy demand growth. It may also reduce the dependence of some nations on high-cost and high-emissions oil-fueled power plants.



An existing link between Guatemala and Mexico is being expanded to carry 200 MW north to south and 70 MW south to north, according to the CEAC regional generation plan. This is likely to be integrated into the SIEPAC system, and proposals exist for the construction of a link between SIEPAC and the Colombian grid. The SIEPAC system has been built using towers capable of carrying a second 300 MW circuit.

But, Challenges Remain

The physical infrastructure has been largely in place since June 2013. But the establishment of effective energy policies is lagging.

Complicating matters, each of the six nations has different electricity industry structures with different degrees of government ownership and control. Guatemala's generation sector is competitive. At the other extreme, electricity service in Costa Rica is provided through a vertically-integrated monopoly. Existing regulatory bodies at the national level are being retained. Private investment in the power sector is welcomed in some countries, but not possible in others. Thus,

* Jay Zarnikau, Ian Partridge, John Dinning, and Daniel Robles are all affiliated with the LBJ School of Public Affairs at the University of Texas at Austin. Jay Zarnikau may be reached at jayz@frontier assoc.com
See footnotes at end of text.

the market-wide rules being established through the Regional Electric Interconnection Commission or CRIE must recognize these differences in ownership and energy policies. And the regional governments must in turn harmonize their domestic policies, pursuant to the 1998 Central American Market Treaty.

As is common when barriers to trade are removed, winners and losers will emerge. A new low-cost generation project in one nation with the ability to sell to consumers in other nations in the transnational market may lead to less power production in other nations. Protectionist measures are a common response from the potential losers, unless the overall benefits to consumers from a more-efficient lower-cost regional electricity supply are appropriately recognized. These protectionist impulses must be resisted if the market is to succeed.

Success also hinges on the progress of the member countries in reaching an agreement on the terms and conditions of transmission access. The regional electricity market officially opened on June 1st, 2013 when the final set of regulations outlined by the CRIE took effect. However, implementation issues such as allocation of long-term transmission rights to firms and guarantees of capacity in contracts still need to be worked out. Investments in new power plants and long-term wholesale transactions may hinge on the availability of long-term transmission rights.

The magnitude of transactions of electricity across national borders remains low due to these ongoing regulatory and policy uncertainties. Yet, the substantial economic benefits which would accrue if the policy challenges are overcome may provide one with some optimism.[4]

Conclusion

Regional electricity markets that integrate several national markets are becoming common and Central America provides an interesting case study. SIEPAC has the potential to contribute to economic development and political stability in this region if the remaining policy and regulatory challenges can be successfully addressed.

Footnotes

[1] In our research into this topic, we benefited greatly from discussions with Ross Pumfrey (The University of Texas and Texas Council for Environmental Quality), Jeremy Martin (Institute of the Americas), Soll Sussman (Texas General Land Office), Silvia Alvarado (Comisión Nacional de Energía Eléctrica de Guatemala), Robert Zerrenner (AES), Ignacio Rodriguez (TetraTech), Matt Cullinen (Carbon War Room), and Lorenzo Mauricio Meyer Falcon (Mexico Comision Reguladora de Energia). We of course remain responsible for any errors.

Tragically, we recently lost the leader of our research team, Prof. Shama Gamkhar. We will forever be grateful for her leadership and friendship.

[2] All authors are affiliated with the LBJ School of Public Affairs at the University of Texas at Austin.

[3] Note that there has been some limited interconnection between the utility grids among these countries since 1976. See Bickford (2012).

[4] For a discussion of market operations, see: Economic Consulting Associates Limited (2010).

[5] See Martin (2013).

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Evaluating the Methodology of Setting Electricity Prices in Nigeria

By Saheed Layiwola Bello*

Introduction

The methodology in setting electricity prices in Nigeria has been ill-defined and opaque since the Nigerian electricity sector was established. Electricity was considered a public welfare service to be provided by the government. Therefore, the electricity price had traditionally been subsidized.

Prior to the 2008 Multi-Year Tariff Order (MYTO), a uniform pricing structure was used in which the electricity tariff remained fixed for years despite a continuous rise in the price of natural gas. Interestingly, over 80 per cent of Nigeria's power is generated from gas. The Power Holding Company of Nigeria (PHCN) tariff was last set in February 2002 and averaged from N4.50/kwh to about N6/Kwh. Following that setting, the company still operated with monthly deficits of nearly N2 billion(figures in $). This lead to its inability to tackle the problems of inadequate and unreliable electricity service. In 2011, the government approved electricity prices of between N4/Kwh and N6/Kwh for single-phase consumers; between N6/Kwh and N8/Kwh for industrial users; and between N8/Kwh and N12/Kwh for the highest demand users, but the cost of electricity production was N10 per Kwh. This pricing regime discouraged the entry of profit oriented private investors (the existing law or absence of enabling legislation was a greater deterrent to private investment than the tariffs). There is need for appropriate policy to institute transparency in tariff determination and provide stability and predictability in electricity pricing.

Owing to this, the Nigerian Electricity Regulatory Commission (NERC) was established to develop a new tariff regime based on industry revenue requirements. This led to the new tariff regime that took effect through a Multi–Year Tariff Order (MYTO) in 2008.

The MYTO-1 (2008)

The MYTO-1 was based on the new entrant cost profile for generation companies and the building block approach to electricity pricing of transmission and distribution services, all with an underlying set of pricing principles and cost assumptions. MYTO-1 was mainly aimed at providing the industry with a stable and cost-effective pricing structure to guarantee a modest return on investment for efficient industry operators. Concomitantly, the tariff order would safeguard consumers against excessive pricing.

The MYTO-1 employed the efficient new entrant model for pricing and the Long Run Marginal Cost(LRMC) method was adopted in determining the unit price of an efficient plant. The LRMC Method calculates the full life cycle cost of the most efficient new entrant generator considering current costs of plant and equipment, return on capital, operation, maintenance and fuel costs, etc. Its advantage is that it has its basis in economic theory and encourages new investment to enhance capacity whilst striving to maintain the lowest cost of generation. It aims at providing a reasonably efficient price as it is set at the lowest cost of a new entrant and should help to keep costs and tariffs at a minimum.

The Building Blocks approach to electricity pricing of transmission and distribution services was adopted because it guaranteed the efficient recovery of operating costs, reasonable returns on investment and capital recovery for replacement of fixed assets. Also, it protected end users against exploitative pricing.

The 2008 MYTO set tariffs for electricity consumers for a five-year time period, while providing a 15-year projection on the evolution of tariffs with time. The new tariff regime also provided incentives for reducing technical and non-technical losses, and signals for suppliers to invest more and consumers to adjust their consumption style efficiently. Tariffs for the initial five years, ranged from N9 to N11.50 per Kwh with an average of N10 per Kwh. Thus, the average electricity price which had stood at N6 per Kwh was increased substantially. Owing to this marked tariff increase, the Federal government designed a strategy that allows for a gradual rise in the price over four years (2008-2011) but without an increase in the first year; increases then occurring in years 2, 3 and 4. The tariff would become fully effective in the fourth year, 2011. In order to keep the sector financially viable, the government closed the gap between the required tariff and what consumers were actually billed. Unlike the previous uniform pricing regime, only the most needy tariff classes would enjoy a subsidy. The gradual removal of the subsidy is expected to reduce the burden on consumers while allowing them to adjust to the new price. The exit of the Federal government subsidy would occur when power availability rises sufficiently to enable a further rebalancing of the tariff.

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In addition, the NERC provided different pricing options for arriving at tariffs to power generators. The MYTO model was designed to be applicable to all industry participants and end users and incorporate major and minor reviews of the electricity tariffs. Four variables considered in the minor reviews are the inflation rate, gas prices, foreign exchange rates and actual daily generation capacity while a comprehensive review and overhaul of all the assumptions in the MYTO model are considered in the major review. The major review gave room for evaluating the methodology, adding inputs to the existing models, incorporating Feed-in-Tariffs(FITs) for renewable energy and developing tariffs for coal generation among stakeholders. The assumptions reviewed include available generation capacity; forecast of electricity demand; expansion of the transmission and distribution networks; capital expenditure; operating costs; fuel costs; interest rates; weighted average cost of capital; revenue collection efficiencies; and subsidies, etc.

Some Identified Challenges in MYTO-1

The commission identified substantial changes in gas prices and the exchange rate employed in the MYTO model and this made the rates unattractive to prospective participants. Also, it noticed that some potential investors in the generation segment of the electricity industry intended to enter the market using other sources of fuel for generating electricity such as coal, wind and solar, etc. which the MYTO-1, did not consider. However, its major disadvantage is that it fails to consider the different conditions that new or existing generators face. Owing to the above-highlighted challenges, NERC resolved to carry out the major review of the Tariff Order much earlier than the 2013 major review year.

MYTO-2

MYTO-2 was designed for the period 1st June 2012 to 31st May 2017 with effect from May 31, 2012. It was aimed at being cost effective and providing financial motivations for needed incremental investments in the industry. Invariably, these investments would lead to increasing improvement in the energy quantity and service quality enjoyed by the consumer.

The MYTO-2 introduced a wider review scope compared to the 2008 MYTO-1. For instance, material variation was incorporated into the MYTO-2 which is defined as a price variation of plus or minus five per cent (+/-5%) in any of the above mentioned elements (inflation, exchange rate etc.). In addition, its regulatory model was based on data obtained from market participants. Industry costs and tariffs developed in its financial model are formulated from estimates and forecasts supplied by the participants and establishments in the industry.

Furthermore, a bi-annual minor review was considered in the new MYTO-2 which included retail tariffs and effective corrections would occur if variables such as inflation rate, US $ exchange rate, daily generation capacity, capital expenditure and operating expenditure requirements differ significantly from that employed in the original calculation of the tariff.

Some noticeable changes in the MYTO-2 include more flexibility in wholesale generation pricing, the consideration of many other essential variables during the minor reviews as well as other fuel types such as coal. In addition, the MYTO-2 created fourteen different classes of customers who would pay different rates according to their class. Consumers that use less than 50Kwh/month would enjoy a special benefit of not paying a fixed charge for their electricity and they are regarded as *Lifetime Consumers* (class R1). Further, the movement of R1 consumers to the next tariff class (R2) was based on the average monthly electricity consumption of the previous three months. For example, if the calculated average consumption for three months is above 50Kwh, the R1 consumer will be advanced to the next tariff class. However, an R1 consumer could use more than 50 Kwh of power in one or two months of the three, but still remain classed as R1 so long as the average usage for the three months was less than 50 Kwh.

Conclusion: Future Issues

Little or no attention has been given to the issue of fuel availability, particularly natural gas, (the considered fuel for the duration of MYTO-2). Paradoxically, gas, which as mentioned, provides 80% of the fuel for thermal generation is mostly concentrated in the Niger Delta region where the issue of insecurity, oil theft and pipeline vandalism is rampant.

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More (Climate-friendly) Nuclear Power? The Economic Challenge

By Joel Darmstadter*

Along with increased reliance on wind and solar, a shift toward more nuclear power has frequently been cited as a way of lessening the carbon "footprint" associated with society's dependence on fossil fuels. Alas, the likelihood of such a scenario appears to be dimming.

For more than two decades, the nuclear share of total U.S. electricity generation has stood at around 19 percent. If nuclear could successfully compete with coal or natural gas, market realities alone could promote a shift. Unsurprisingly, things aren't that straightforward. A set of recent studies makes it possible to illustrate three key issues that need to be confronted. We must first face up to the social cost of carbon (SCC) resulting from fossil-fuel emissions. Second, we need to determine the impact of that cost on the overall cost of fossil-based electricity generation in new power plants. Third, we require a sense of how that added cost burden alters the competitive relationship between fossil and nuclear energy. It is that crucial third step, which, as we'll see, makes the prospect of a robust U.S. nuclear revival problematic.

To keep things simple, let's adopt an SCC centered on around $50 per ton (in 2012 dollars) by the year 2020, based on the most recent federal interagency estimates. The second step is to rely on another recent study—in this case, by the Congressional Budget Office (CBO)—which calculated the approximate economic impact of the social cost of carbon on the U.S. economy. The CBO analysis allows one to approximate the increment to electricity generation costs that a $50 carbon tax would result in. I judge that additional cost to be around three cents per kilowatt hour of fossil-based power.

To round out this series of calculations, it's necessary to get a sense of electricity costs in newly commissioned power plants absent greenhouse-gas constraints. EIA estimates (in a stylized picture—once again, for around the year 2020) point to an average per-kWh generating cost for fossil fuels combined (in effect, a weighted average of coal and natural gas) of between 9-10 cents/kwh. Applying to that number the assumed carbon-charge increment of three cents yields a rounded figure of 12-13 cents. As it happens, EIA estimates generation costs for a new, advanced nuclear plant to also come to around 12 cents/kwh.

So where does that fossil-nuclear comparison take us? If nuclear power requires a carbon tax even greater than $50/ton to have cost advantages over fossil energy, its renaissance may have to await advances in its own technology (e.g., the feasibility of small modular reactors that don't sacrifice the scale economies associated with 1,000 megawatt nuclear plants). And a $50/ton carbon price isn't on the table. It is hard to defend a reluctance to risk large investments in nuclear electricity in a climate of blurred policy signals and mixed public support.

Underscoring that state of affairs, a just-released report by the Center for Strategic and International Studies (CSIS) acknowledges the prospect of "a substantial contraction of [U.S.] commercial nuclear energy in the coming years," citing both the transformational impact of attractive natural gas prices and hesitancy in dealing with greenhouse gas mitigation. (Even as one of the few U.S. nuclear expansion prospects—Southern Company's Vogtle complex in Georgia—proceeds apace, Duke Energy has just announced a halt to a planned facility in Florida. And generous state financial provisions may have helped spur the decision in the Georgia case.)

Pending renewed growth of U.S. nuclear power in the long term, the CSIS report urges an interim focus on the U.S. as a supplier of nuclear technology, fuel, and services in international markets. With nuclear power stalled domestically, that course could at least ensure some of nuclear's benefits materializing in those places around the world where the outlook for nuclear market penetration may be less clouded.

But even in that respect, there's the inevitable "on the other hand." Japan's nuclear future remains unclear in the wake of Fukushima. And with other major industrial nations, like Germany and France, pondering nuclear retrenchment—a phase-out in the former country and, as voiced by President Hollande, a one-third reduction in France's nuclear electricity share by 2025—the bottom line for nuclear must be, at best, ambivalent: recourse to nuclear power as a significant antidote to greenhouse gas emissions seems—at least in the U.S.—unlikely in the short term and uncertain in the long term.

If what I've considered here points to an approximate standoff between the monetary cost of fossil- and nuclear-based electric generation, it is nonetheless important to recognize the limited perspective this brings to bear on the much

(continued on page 38)

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Microgeneration, Storage and the Smart Grid

By Gaia Stigliani*

Microgeneration technologies such as Solar PV, wind turbines and micro-CHP allow consumers to generate electricity on-site. The installation of such technologies gives consumers in many EU countries the benefits of receiving financial incentives from feed-in-tariff payments as well as significant bill savings from not having to import electricity from the grid. Over the past few years, Solar PV in particular, has enjoyed enormous success. Latest cost projections1 show that as the market enlarges, PV installation costs are set to decrease further, making the Solar PV investment even more attractive. However, with electricity prices set to rise and feed-in-tariffs to decrease over time in many EU countries, consumers will have to increase their independence from the grid in order to obtain the same level of financial benefits from microgeneration. How?

Storage recently appeared in the top 10 list of disruptive technologies that will transform life, business and the future global economy2. Financial benefits for consumers that install PV systems are currently limited to the amount of electricity that consumers can utilize from in-house generation. PV panels generate electricity during daytime, when most consumers would be outside their houses and would therefore have to rely on electricity imported from the grid during the evenings. Storage batteries in combination with Solar PV could allow consumers to store the surplus electricity generated during the day for later use or export, reducing consumers reliance on the electricity imported from the network. In a smart grid world, where decentralized energy generation prevails, consumers would be able to generate their own electricity, store it but also trade it on the market at community level. Generating and consuming electricity at community level would also reduce the costs associated with electricity transmission losses.

Benefits of installing microgeneration technologies in combination with batteries will not be limited to consumers that install such technologies. Electricity generation is predicted to become increasingly more intermittent and inflexible, while electricity demand from the heat and transport sector is set to increase further, suggesting that the electricity grid may incur more periods of system stress. Microgeneration technologies in combination with storage would alleviate this by making consumers grid independent. In addition to this, distributed generation would reduce the need to replace old generation plants.

Feed in tariffs are designed to give Solar PV installations rate of returns in the range of 4.5% to 8%3, depending on the PV system and on the amount of electricity that is consumed on-site. Due to high battery costs, rates of return from installing Solar PV and storage would be insufficient and unable to attract market interest. Germany has seen the potential of storage batteries and in May 20134 introduced a grant and loan scheme to accelerate deployment of storage devices up to 30 kW. The scheme is planned to cover up to 30% of battery costs and should encourage consumers, both at the domestic and commercial level to rely on electricity self-consumption.

Storage is a capital intensive technology and as such it requires different income streams in order to make financial sense at this stage, but has the potential to become cost-effective in the future. Grants and loan facilitation schemes can point the market in the right direction but could be more effective if coupled with radical changes in the way electricity tariffs are set. Time-of-use tariffs that reflect the real cost of generating electricity at different points in time could provide a strong signal to the market while reducing the need to rely on subsidies over the longer term. Initial trial5 results have demonstrated that consumer electricity bills could be reduced if time-of-use tariffs were introduced on the market.

Switching to time-of-use tariffs has the potential to enhance the value of self-consumption and storage, increasing consumers' 'independence from the grid. An alternative solution would be to implement changes in current European feed-in-tariff schemes, which currently do not reflect the real value of feeding electricity into the network. Under new arrangements, storage should allow consumers to gain from exporting electricity to the grid when its value is above average or to increase the value of domestic generation.

Storage is set to become a key enabler of the smart grid. However, consumers remain at the core of the electricity market and as such their ability to interact with the grid should remain at the center of market development. Several trials5 are currently testing consumers' reaction to time of use tariffs, with most trials suggesting that introducing electricity tariffs would need to be simple and explained to consumers in non-technical language in order to obtain positive effects on consumer behavior.

Footnotes

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More (Climate-friendly) Nuclear Power? The Economic Challenge (continued from page 35)

wider challenge of energy decision-making. Beyond a carbon-oriented comparison, a more exhaustive look would need to consider still elusive environmental issues in, say, gas- and shale-oil fracking; land disturbance and coal dust in mining and transportation; and, on the nuclear side, risks associated with safety, waste-management, and proliferation.

How the balance of advantage would shake out in that wider interfuel context can't be predicted. What is certain is that such a broader framework would expose issues of monetizing externalities which, if not on the scale of greenhouse warming, would present their own set of imponderables. This ensures, in turn, a burden on public decision-making that makes the best use of what we know, while humble about the gaps in knowledge that aggressive pursuit of research needs to help fill.

Introducing Wind Generation as a Way to Reduce the Seasonal Volatility in Electricity Generation in Georgia

By Giorgi Kelbakiani and Norberto Pignatti*

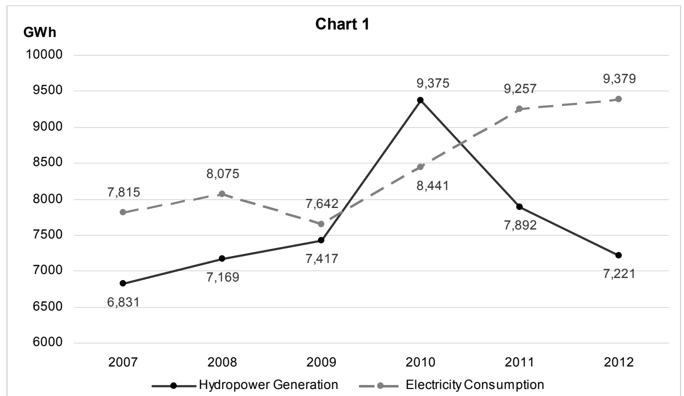
Introduction

Due to the geomorphological characteristics of its territory and to its geographical location, the Republic of Georgia is rich in hydro resources. According to the Georgian Ministry of Energy and Natural Resources, so far Georgia has exploited only about 20% of its hydro resource potential.

Since 2006 the Georgian government has been planning to utilize these resources to not only meet domestic demand, substituting hydro fully for electricity imports and thermal power plant (TPP) generation (burning imported gas), but also to turn Georgia into a regional provider of electricity.

Initially, thanks to the rehabilitation of existing hydro power plants (HPPs) and to improvements in the regulatory environment of the Georgian electricity sector realized in the wake of the Rose Revolution, this program seemed relatively easy to achieve.

The generation of cheap hydropower did increase and partially substituted for thermal energy generation and electricity imports. After a steady increase from 2007, finally, in 2010, total annual hydropower generation (9 375 GWh) in Georgia exceeded the country's total electricity consumption (8 441 GWh) (chart 1).



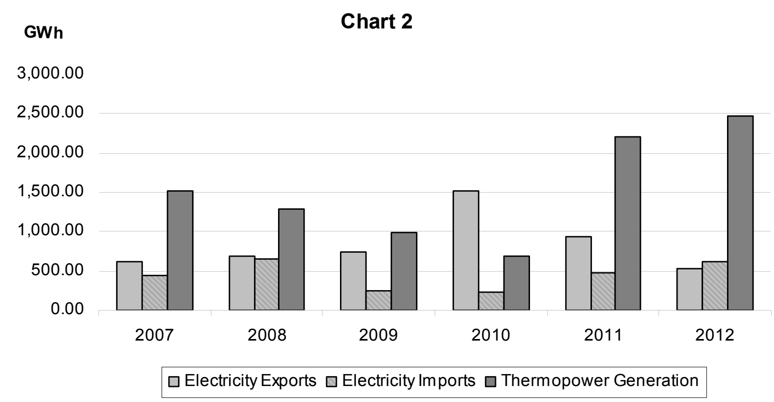
Source: ESCO

Parallel to this the construction of new transmission lines started to increase the export capacity to Turkey and a number of Memoranda of Understanding were signed with investors in relation with the realization of 40 new HPP projects.

The Importance of Seasonality

Despite this promising start, however, the situation did not evolve in the desired direction. Due to adverse climatic conditions the generation of hydropower declined in 2011 and 2012, while consumption kept rising.

As a result, Georgia lost its newfound status as a net electricity exporter in 2012 (chart 2).



Source: ESCO

Chart 2 allows us also to identify another important aspect that does not appear looking at total hydropower generation and total electricity consumption. Even in the best year (2010) of Georgian hydropower, both thermal power generation and electricity imports stood quite high (683 and 222 GWhs, respectively) due to the monthly distribution of the hydropower generation and the electricity consumption of the country.

The seasonal nature of both hydropower generation and electricity consumption created excessive generation in summer months and a gap in the winter of 2010 (chart 3). In other years, the gap was even more pronounced.

This seasonal pattern can also help explain another reason why hydropower generation has not been increasing as fast as hoped: sluggish investment. From the investors' point of view the excess of supply during summer months is problematic. In this period, in which new HPPs would generate the highest amount of electricity, they are going to meet very tough competition domestically from the already existing HPPs (old, large, often fully amortized, which are operating at very low costs). This lowers the expected profitability of investments in new HPPs (which could be increased only by a substantial increase in the demand for Georgian electricity in the region) and might explain the slower than expected realization of the planned investments, despite the signed memoranda.

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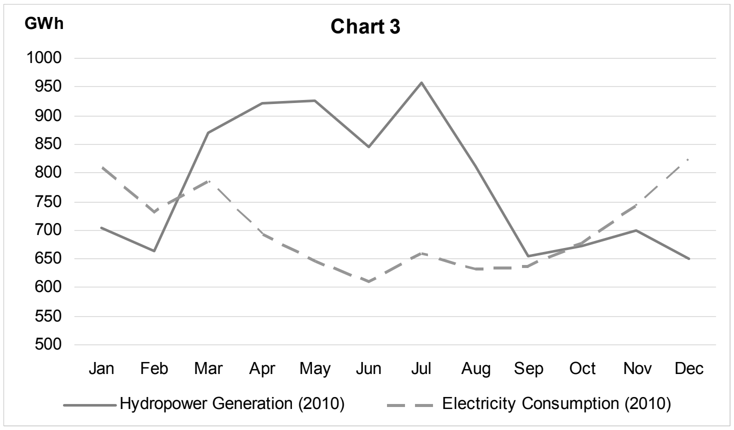
Source: ESCO

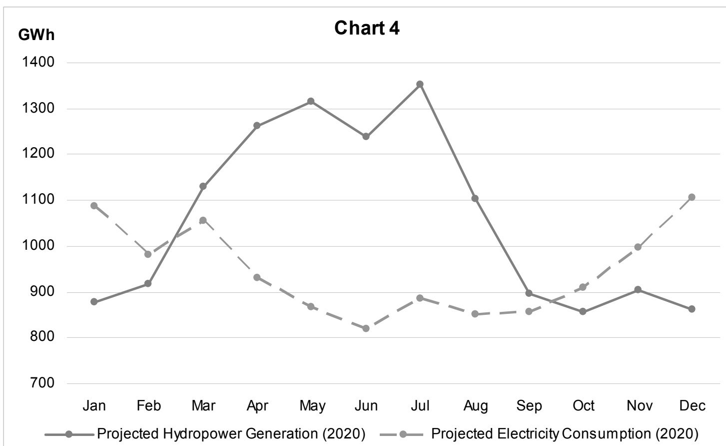


Source: ESCO

Even putting aside the concerns about the profitability of new power plants, additional investments in new hydro power plants seem not to be an effective way to close the gap in winter, especially considering the steadily growing consumption.

Chart 4 shows a simple projection for 2020: The prospective generation of three large HPP projects (Khudoni, Namakhvani Cascade and Faravani with total potential installed capacity of 1661 MW) is added to the hydropower generation of the year 2010 and is compared to the projection of electricity consumption in 2020 (assuming 3% growth per annum).

This scenario is quite optimistic: First of all, we are assuming that existing hydropower will maintain the 2010 level of production (the highest so far recorded). Secondly, the assumed growth rate of electricity consumption (3%) is slightly lower than the growth rate observed in the period 2007-2012. Interestingly enough, despite these assumptions, the predicted winter gap is increasing, as well as the excess generation in summer.



Source: ESCO

New small HPPs will not be able to make much difference as far as the winter gap is concerned. Without the ability of collecting water in dams, their generation capacity in winter months is reduced even more sharply than in the case of large HPPs with dams.

The persistence (and the potential increase) of a gap between generation and consumption in winter and the volatility in the generation of electricity during the year, in absence of an integrated regional electricity market capable of absorbing excess production and to cover for the winter gap in a reliable way and at reasonable prices explains why the Georgian government seems to be starting to consider a number of alternative ways to achieve its goals.

Blowing Wind into the System

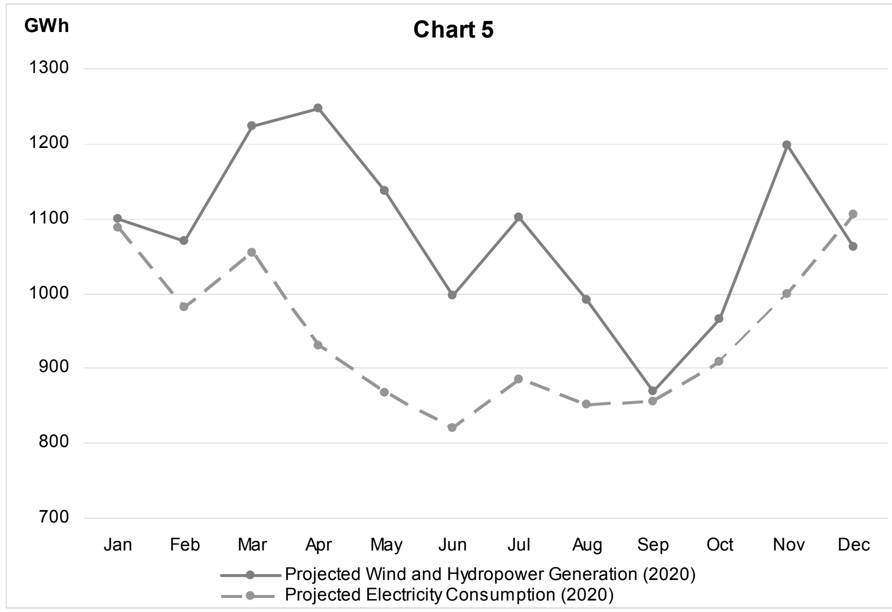
Considering the points raised above, a possible solution seems to be the identification of a renewable energy source with a pattern of generation complementary to that of hydropower generation, able to generate electricity mostly in winter. Wind power, at this stage, appears to be the most promising alternative.

According to the Wind Atlas data produced by the Karenergo (a Wind Energy Scientific Center based in Tbilisi), Georgia has considerable wind energy generation capacity. The strongest argument in favor of wind energy, however, is that in a majority of the most promising wind sites winds are blowing harder in winter, when the excess demand and electricity prices are the highest. Consequently, optimally placed wind farms can fill the gap in green energy production, contributing in a more effective way to the government's long term objective to reduce country's dependence on electricity imports and thermo power (which itself depends on imported gas).

To demonstrate the potential benefit of wind power in terms of electricity sector independence, we produced chart 5 based on our calculations. In contrast to the chart 4, chart 5 shows what could happen if Georgia built appropriate wind farms (with total potential installed capacity of 1270 MW) instead of HPPs (total installed capacity of 1661 MW). All other projections are similar to those from chart 4.

Investing in wind generation might have one more potential benefit. At some point Georgia might want to start building "pumped-storage" reservoirs for some of its dams. These devices are storing excess (otherwise non-storable) electricity produced by variable renewable sources (such as wind) by using it to pump the water up into the reservoirs when demand is low. In this way, the same water can be used when the demand is high. So far, the "pump-storage" technology has not been utilized in Georgia since excess electricity produced by small HPPs in summer months could not be stored for lack of spare storage capacity (water reservoirs are quite full in summer). This technology could instead be easily employed to store excess wind electricity (e.g., at night) when reservoirs are half empty during the winter. The result would be higher daily production by both HPPs and wind farms.

Clearly, wind energy development faces many technical challenges such as variability, dispatch-ability and storability. However, the global trends in wind energy generation provide evidence that these challenges can be successfully addressed even in countries where wind accounts for a relatively large share of total electricity production.



Source: ESCO

So far the main reasons for the lack of investment in wind generation in Georgia have been the high level of startup costs and the lack of support from the government. Yet, considering global trends in wind energy technology and the evolution of the Georgian electricity market it may be high time to prepare for tomorrow by investing in relevant education, experimental wind farms, and pump storage facilities.

This seems, indeed, to be the direction taken by the Georgian government. At a press conference on July 17 the Minister of Energy, Kakha Kaladze, announced the intention of the government to embark on the construction of wind power plants; a new step in the path that should lead Georgia to independence in the electricity sector and become a major electricity exporter in the region.

Politics of Power in China: Institutional Bottlenecks to Reducing Wind Curtailment Through Improved Transmission

By Michael Davidson*

Grid-connected wind capacity has increased thirty-fold in China in the six years since the Renewable Energy Law was passed. At the end of 2012, China led the world in cumulative wind installations with 63 gigawatts (GW), while approved projects planned or under construction exceeded 44 GW (He, 2013). Despite the lead in capacity, however, China generated 30% less electricity from wind than the United States, which was a close second in terms of total installations.

Reduced capacity factors have been attributed to high amounts of forced curtailment, which reached as high as 50% in some regions last year. The causes of curtailment are manifold: high penetrations of wind in provinces far from load centers, inflexibility of the coal-heavy generation mix, and institutional barriers owing to incomplete power deregulation. To address these shortfalls and other chronic power challenges, China's grid companies propose to significantly expand long-distance ultrahigh-voltage (UHV) interconnections as well as strengthen interprovincial and intraprovincial ties. These will reportedly double wind utilization by 2020 (State Grid, 2010). However, institutional hurdles to better integrating wind, ranging from an intense debate within China over the future structure of the grid to inflexible transmission operation and pricing, threaten to delay or derail benefits of interconnection.

Overview of Current and Proposed Transmission Network

China's transmission and distribution assets were restructured in 2002 into two large grid companies, State Grid and Southern Grid, as well as a handful of separately governed provincial grids. State Grid and Southern Grid encompass six multi-provincial regional grids with various degrees of interconnection, from 500 to 1000 kV. AC transmission ties between provinces within the same region were put in place in the 1980s and 1990s, which except for the northwest at 330/750 kV, are at 500 kV (Zhou et al., 2010). Both interprovincial and interregional ties are targets of ongoing grid planning efforts.

The power grid of the future is being designed around several emerging challenges: increasing wind penetration is but one of them. In its 12th Five-Year Energy Development Plan (2011-2015), China identified geographic barriers between all of its major energy resources – coal, hydro, wind, and solar – and demand centers as a priority area for work (State Council, 2013). In the case of transporting coal from west to east, congestion concerns on road and rail are particularly pressing. "Bundling" coal, hydro, wind and solar, transmission corridors would reduce the ratio of coal to electricity exports from 20:1 to 4:1 (State Grid, 2010). In addition, increasing energy demands, particularly varying residential loads, raise concerns about local grid stability.

State Grid

The East-West Transmission Project began during the 10th Five-Year Plan (2001-2005) sought to connect energy resource regions with load centers through three sets of UHV lines: two in State Grid's service area in the north and central, and a third in Southern Grid. The northern route connects coal-rich regions, upper Yellow River hydro resources and wind power bases in the northwest to North China Grid. Using AC lines up to 1000 km, these have strengthened the synchronous grid across northern China. Three Gorges hydroelectric dam, completed in 2012 at one end of the central route, is now connected via 500 kV DC lines ranging from 1000 – 2200 km to the East China Grid and Southern Grid (Pittman & Zhang, 2010).

In wind-rich northwest, several 750 kV interprovincial lines were added in the last decade to upgrade the existing 330 kV backbone. This region, home to Gansu and Xinjiang provinces, saw high wind curtailment in both 2011 and 2012. It is also home to the majority of China's grid-connected solar installations. Instantaneous UHV export capacity to the central and northern grids reached 8.1 GW in 2012 (NWCGC, 2013). Currently, an additional tie to Xinjiang is being tested and a 7.6 GW line to the eastern grid is being planned. See grid diagrm on next page.

State Grid's UHV grid expansion plans do not end here. As early as 2004, State Grid began envisioning a massively expanded backbone network consisting of several high capacity 1000 kV AC lines crisscrossing the country. The "three-by-three" pattern of north-south and west-east lines was designed primarily as an AC grid, establishing a large synchronous grid over the entire country except the northwest. Two of the lines could help allevi-

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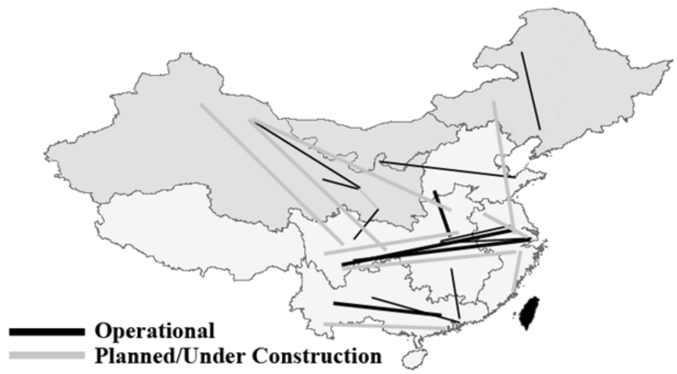
ate congestion in high wind curtailment areas to the north and northeast. State Grid promoted this "electricity superhighway" as the key solution to solve the geographic mismatch between energy resource and demand regions (21CBH, 2013). Yet wider plans of a "five-by-six" grid connecting neighboring Russia, Mongolia and Kazakhstan is proposed for 2020 (CEC, 2012).

UHV Transmission* above 3 GW, 2015



*Only AC lines above 500kV are shown

Source: State Grid 12th Five-Year Plan, State Grid Yearbook 2011, Electricity Reliability Report 2011, Lei (2011)

Southern Grid

The southern route of the East-West Transmission Project, beginning in hydropower-rich Yunnan and coal-rich Guangxi provinces, has been built to meet surging demand in coastal Guangdong province. These lines – a mixture of AC and DC – may deliver power from west to east up to 27 GW by 2015, 58 GW by 2020, and 73 GW by 2030 (Zeng et al., 2013). Though not mentioned explicitly, these interconnections may also help integrate wind. In 2012, owing to large rainfall, wind in Yunnan was curtailed significantly for the first time (Lu, 2013).

Institutional barriers to increased transmission

AC vs. DC

The extensive remaking of China's power grid has sparked considerable controversy. As a powerful state-owned enterprise, State Grid's proposed broader synchronization through 1000 kV AC lines has rekindled concerns of overreach, adding to voices calling for further competition in the power sector. Most of the debate, however, centers on fundamental disagreements on the engineering and economic merits of a centuries-old debate: AC vs. DC.

Models put forward by the Chinese Academy of Engineering (CAE) and the Electric Power Planning & Engineering Institute (EPPEI), a government advisory body, disagree on the stability of UHV-AC lines over long distances. Experts have also attacked the UHV-AC proposal on cost grounds. For example, a handful of current and former electricity officials claimed that at more than 1500 km, sending coal is cheaper than sending electricity, undermining a key claim by State Grid (21CBH, 2013). There is, unfortunately, little to back up either claim: China's experience with 1000 kV AC is limited to a single 640 km line in operation since December 2009. The result has been delay in line construction: State Grid now expects the "three-by-three" to be completed by 2017 (Wang, 2013).

Fragmented Transmission Authorities

Assuming a vast, synchronous grid is eventually put in place, China's idiosyncratic regulatory structure would complicate attempts to utilize it properly. Regional grids are composed of provincial grids, where most dispatch decisions are made on the basis of balancing production and consumption inside borders. Provinces must craft bilateral contracts (typically, annually) stipulating how much electricity can be transmitted across each boundary; except where specific consideration for large energy or transmission projects is given by the central government, these often must net to close to zero at the end of the year. These are relics from the era of the Ministry of Electric Power, and ensure that all power companies in the province achieve their minimum generation quota.

The primary reason for creating a wide, interconnected grid is the ability to flexibly smooth out generation and load over a large number of units, but this kind of optimization is nigh impossible without centralization of dispatch and transmission. Even with the currently well-integrated northern grids and extensive long distance ties, the effective balancing area of wind may not be much larger than in their absence.

Pricing

Both investment and operation issues are compounded by non-market, semi-transparent transmission pricing principles. Grid companies are compensated mostly based on the residual between the retail and wholesale power prices, both regulated by the central government. Revenue is not subject to robust cost accounting. Between provinces, additional difficulties arise. Line losses are typically not reimbursed and neighboring provinces may have different FIT levels, complicating wind power trading (Zhao et al., 2012). Costs for large, interregional transmission projects are likely socialized as well, because the energy tariffs designed to cover them are insufficient, which may limit grid companies' willingness to make further investments on behalf of wind (Zeng et al., 2013).

Hard Road to Reform

Record curtailment in 2012 prompted a strong central government reaction, which strengthened existing regulations such as priority dispatch for renewable energy as well as laid out new reform agendas such as compensation schemes for ramping services. Together with increased pressure on grid companies to accommodate transmission requirements, these appear to have had an impact: all provinces except Hebei saw an increase in utilization hours in the first half of 2013 (CEC, 2013).

Ten years after China's power sector began deregulation, most of the challenges to reforming transmission policy are deep-seated but well understood: vested interests and centrally-administered pricing tend to dull the effectiveness of infrastructure investments. If China's central planners are to meet the 2020 target of generating 390 TWh of electricity from wind (roughly 5% of production under business-as-usual), they will have to come to a consensus on an appropriate grid structure and allocate sufficient investment. This may be much easier, however, than the difficult political reforms necessary to ensure the infrastructure is used efficiently and cost-effectively.

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Microgrids and Energy Security: The Business Case

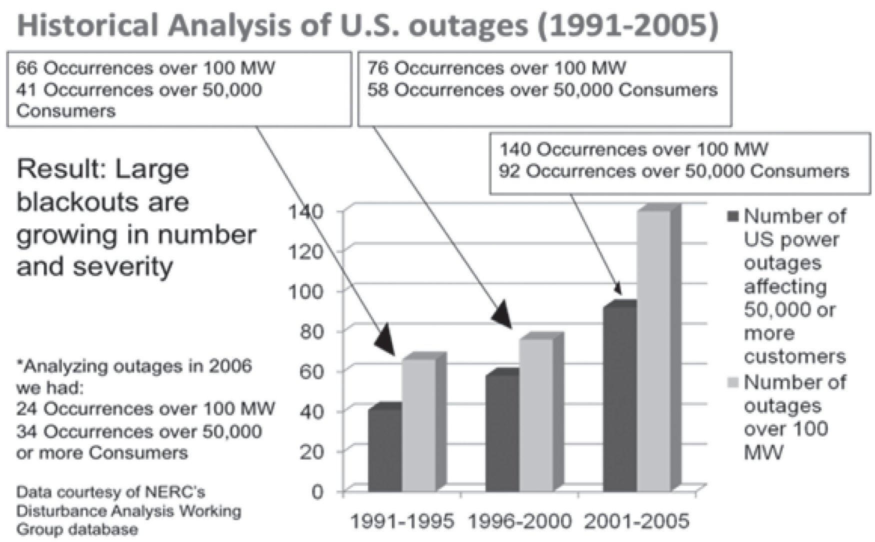
By Angelique Mercurio*

Introduction

In an increasingly technology-dependent society with growing energy needs, disturbances in electricity supply and quality can have severe implications daily. They can cause significant losses of information, efficiency and productivity as interruptions crash computers and the critical services reliant upon them, such as life support systems, or cause automated equipment to shut down completely.

Both power supply and quality play an important role for U.S. businesses and government agencies. Power outages cost the U.S. approximately $104-$164 billion annually, half of which are specifically felt by the industrial sector and digital economy. Even brief outages can damage equipment or idle labor, which wastes critical resources, and losses can have further effects for downstream firms.

Losses from outages are increasing over time due to congestion and a lack of investment in transmission infrastructure. In the second half of the 1990s, there were 41% more outages than in the first half affecting 50,000 or more consumers. Further, U.S. power outages affecting 50,000 or more customers rose from 197 to 312 from the 2001-2005 period to the 2006 to May 2010 period. There is a clear need for a stronger electrical grid. Microgrids offer substantial resiliency and cost-savings benefits. Governments, businesses, and educational institutions are exploring microgrid technology as a potential avenue to securing a more reliable energy future.



Source: Dr. Massoud Amin, University of Minnesota

Market Drivers

In the wake of increasing blackouts and brownouts, and particularly after facing the recent power outages caused by Hurricane Sandy, the need for a more reliant grid is undeniable. One solution is to consider isolated systems that consist of distributed energy sources, which can be conventional, renewable, storage, etc. These systems—microgrids—operate either independently or parallel to the main grid, and help ensure reliable energy supply for consumers while also reducing the stress felt by the larger transmission and distribution system.

Microgrids can offer efficiency benefits as resources are optimized independently, and can also increase security measures to protect against cyber and physical attacks, reducing how many consumers such attacks affect. In addition to these quality and resiliency benefits, microgrids can also accelerate deployment of cleaner fuel sources.

There are critical factors that drive demand for microgrids, including cyber security, growing energy demand, and the general need for more secure electricity. Reliance on modern technology continues to increase, which makes power systems vulnerable to cyber attacks with particularly drastic implications for research labs, educational campuses, and the military. Reducing outages and increasing quality of energy supply can significantly benefit sectors that are reliant upon constant power supply, such as data centers, infrastructure critical to national security, and critical service providers such as hospitals.

Market Trends and Potential

As prices for certain distributed renewables, particularly solar photovoltaics, continue to decline, interest in microgrids is rising. Dozens of pilot projects have proven successful, and as the ability to island from larger utilities when necessary is becoming increasingly apparent, the market is moving into full-scale commercialization.

The last few years have been characterized by an increase in microgrid uptake as new vendors enter the market. According to Navigant Research, a total

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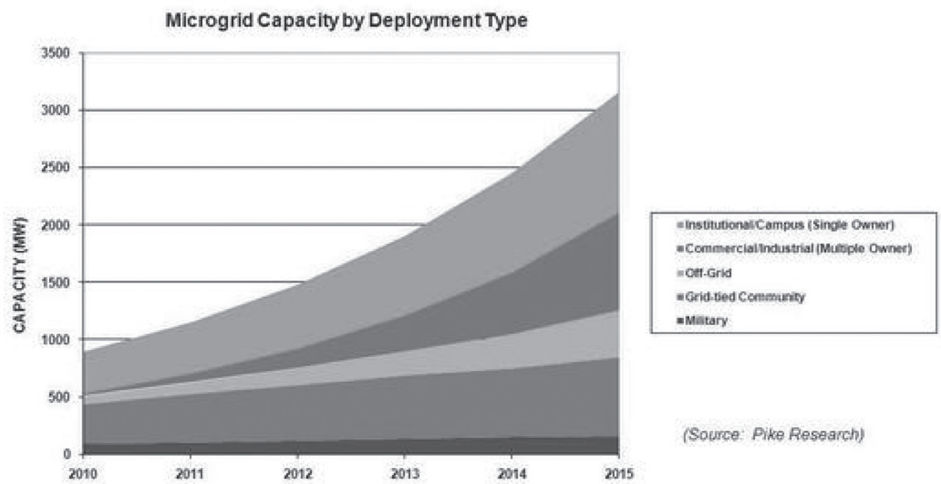
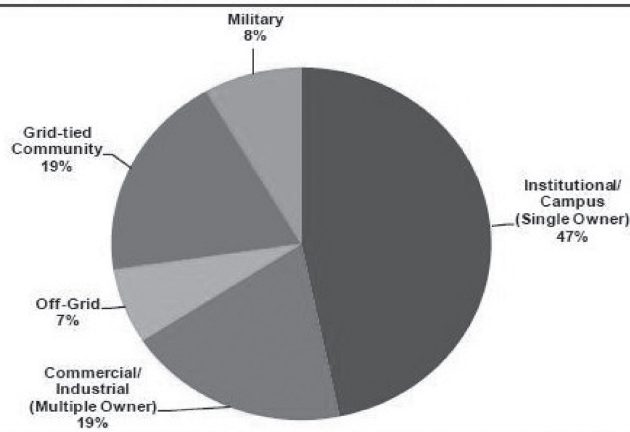


of 3,793 MW of global microgrid capacity existed as of 2Q 2013 compared to 2,179 MW in 4Q 2012. Leading the world market, North America has a planned, proposed, and deployed capacity of 2,505 MW, 66% of global capacity, including an additional 55 projects from 4Q 2012 to 2Q 2013. North America currently has 1,459 MW online and more than 1,122 MW planned, proposed, or under development. In terms of aggregate capacity, the U.S. has particularly represented the best market for all microgrid segments. The following chart illustrates overall microgrid capacity by deployment type.

While reliability and security are clearly energy priorities for the government sector, especially for the military, commercial institutions may find microgrids attractive also from a revenue generation perspective. Navigant Research projects that, globally, revenue from microgrid deployment could reach just under $10 billion in 2013, and potentially increase to more than $40 billion annually by 2020. The following chart breaks down revenue generation projections for 2015 by sector.

Market Sector Revenue Breakdown, North America: 2015



(Source: Pike Research)

Recent Applications and Success Stories

The Military

Military bases are seeking to maintain operations despite disruptions in the larger grid as the U.S. Department of Defense (DoD) works to mitigate energy security threats. More than 40 DoD military bases currently either have operating or planned microgrids, or have pursued demonstrations or studies, according to the Secretary of Defense. Pike Research projections indicate that U.S. military microgrids for stationary bases could potentially reach 54.8 megawatts by 2018.

Fort Bliss, Texas

In May 2013, the U.S. Army launched its first grid-connected microgrid demonstration at Fort Bliss, Texas, integrating renewable resources and energy storage. The $2.4 million project, funded through the DoD's Environmental Security Technology Certification Program, will integrate 120 KW of solar, 300 KW of energy storage, grid interconnection, on-site backup generators, and a control system.

The project aims to reduce greenhouse gas emissions and energy costs while also offering energy security benefits by allowing the base to operate off the grid, reducing the risk of power outages and cyber security attacks. Costs will be lower and energy storage will enable peak-demand to be met. The demonstration phase is set to continue through July.

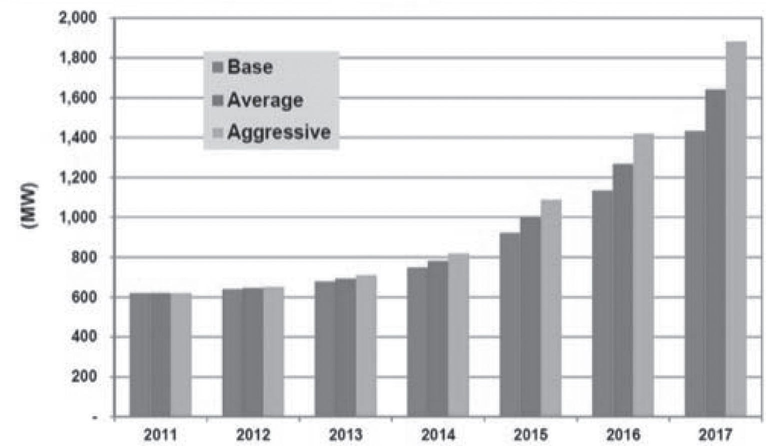
Campuses

Institutional campuses are also beginning to implement microgrids to help reduce energy use. According to Pike Research, total installed generation capacity strictly for campus microgrids will increase by 164 percent from 2011 to 2017. The market for campus microgrids could reach $777 million by 2017. The following chart demonstrates the potential increase in campus microgrid planned capacity from 2011 through 2017.

Santa Clara University

Santa Clara University became one of the first universities in the Bay Area to launch a smart microgrid, a project that is estimated to reduce energy consumption by 50 percent and to save approximately 20 percent in energy costs.

Chart 1.1 Campus Microgrid Planned Capacity by Scenario, World Markets: 2011-2017



(Source: Pike Research)

Consisting of a 1-megawatt solar PV system, a wind turbine, a 60-collector solar thermal system, and a smart microgrid system that regulates the campus sources, the Santa Clara University system will manage and optimize energy on the campus from production to storage to consumption.

Not only is the university able to better manage its energy sustainability and reliability, but the system gives them the best return on investment for its 106-acre campus. The university has been able to grow its campus size by 30% while still reducing energy costs and use.

Utilities

Electric utilities have approached microgrids in a variety of ways. While some remain skeptical, many have moved forward with projects despite significant obstacles. U.S. utilities that have pursued microgrid activities include San Diego Gas & Electric (SDG&E), American Electric Power (AEP), Sacramento Municipal Utility District, DTE Energy, and Consilidated Edison. However, because the most prominent obstacle for utilities in this case is justifying costs passed on to ratepayers, the business case still needs to be thoroughly explored and quantified.

Conclusion

The market for microgrids in the U.S. is moving towards full-scale commercialization. There are not only reliability and security benefits, but revenue generation and cost-savings opportunities as well. There remains tremendous potential particularly for industrial and educational campuses as well as the commercial and industrial sectors. As governments continue to aim to meet clean energy deployment goals while reducing energy costs, microgrids offer an attractive option.

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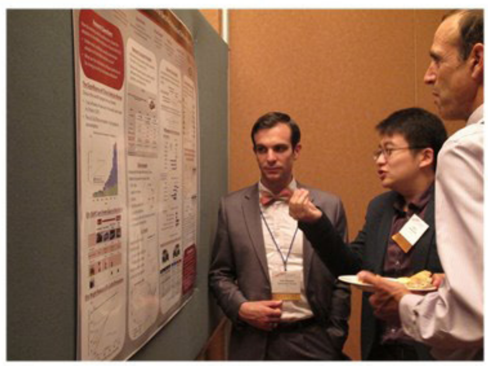
Scenes from the 32nd USAEE North American Conference July 28-31, 2013




USAEE


Captain Cook


USAEE

Anchorage, North American Conference Overview

Attendees of USAEE's first ever North American conference to be held in Alaska were treated to three days of stimulating presentations and great networking opportunities as well as great weather and magnificent scenery. Highlights of the conference included the exceptional plenary sessions that covered a wide range of topics relevant to energy economics, from oil and gas markets to isolated electric power grids. Each session made a point to relate the discussion to issues in Alaska, giving conference-goers a taste of the unique energy challenges facing Alaskans today.

Sunday, July 28

The 32nd USAEE/IAEE North American Conference began on Sunday evening (July 28) with an Opening Reception and a series of Networking Dinners. We returned to the hotel in the bright sunshine of Anchorage's 20+ hour daylight, which gave everyone plenty of opportunity to explore the city before and after the conference's daily activities.

Monday, July 29

Opening Session

On Monday morning (July 29), USAEE President Lori Smith Schell officially opened the conference and introduced Senator Lisa Murkowski, ranking member of the Committee on Energy and Natural Resources, who welcomed us to Alaska by pre-recorded message from her office in Washington, DC. Senator Murkowski recognized the importance of the field of energy economics and the value of hard working, knowledgeable economists. The Senator focused on the importance of domestic energy production, noting that domestic production has risen 30% in the past 5 years, creating thousands of jobs and revenues for state and local governments. Domestic production has reduced global price volatility, and restrained prices at the pump for U.S. consumers. Senator Murkowski concluded by noting that Federal action is needed to develop many of the untapped energy resources of Alaska.

We were next welcomed by Dan Sullivan, the mayor of Anchorage. Mr. Sullivan discussed Anchorage's approach to energy development: diversification. The areas surrounding Anchorage, including the Cook Inlet, contain a wealth of natural resources, including 4 - 5 good, undeveloped oil and gas resources and world-class coal seam formations. The city is also working to develop nontraditional resources, including a wind farm on nearby Fire Island, geothermal energy from nearby volcanoes, tidal energy in the Cook Inlet, and electricity from municipal solid waste.

After the welcomes by Senator Murkowski and Dan Sullivan, David Newbery, Professor of Economics at University of Cambridge and the president of IAEE, gave some highlights on the organization's status. IAEE continues to prosper, with membership growing from 3,000 to 4,150 in the past 6 years. Student membership has doubled to 780 members over the same time period. *The Energy Journal* continues to be highly regarded and widely read, while members feel the new *Economic of Energy & Environmental Policy* journal fulfills its purpose as a less technical but more widely accessible policy journal.

Opening Plenary – Energy Development in the Arctic

The conference's first plenary discussed the geopolitics of Arctic energy development and the peculiarities of operating in the region's extreme conditions. The first speaker was Francis Ann Ulmer, Chair of the U.S. Arctic Research Commission and formerly, Alaska's Lieutenant Governor (1994-2002). Ms. Ulmer described the Arctic as an ocean surrounded by countries with a range of policies, laws, and plans for Arctic development. Arctic exploration has recently become a hot topic, as resources have become newly available. This new availability is due to climate change, which has reduced the extent of the Arctic sea ice by 50%, and improved technologies. Ms. Ulmer noted the United Nations Convention on the Law of the Sea, first established in 1958, an international agreement that sets sovereign rights to a country's extended continental shelf. Although 160 nations have ratified the Law of the Sea, the U.S. has not, which may put the nation's Arctic resources at risk.

The next speaker was Admiral Tom Barrett, U.S. Coast Guard (ret.) and President of the Alyeska Pipeline Service Company. Adm. Barrett discussed the challenges in operating the Trans-Alaskan Pipeline System (TAPS). TAPS extends more than 800 miles, crosses 34 rivers, 4 mountain ranges, and encounters some of the worst weather on the planet. The pipeline, completed in 1977, is still in good overall condition. Production peaked at 2.1 million barrels/day in 1988, and has since dropped to 450,000 barrels. Less production makes the line more challenging to operate, increasing the risk of ice and wax forming on the inside of the pipe. However, operators continue to maintain high reliability and safety standards. (Members had an opportunity to see TAPS in action during Technical Tours to Prudhoe Bay and Valdez before and after the conference, respectively.)

The last speaker was Roland George, member of the Canadian National Energy Board. Mr. George gave the perspective of an Arctic development regulator. The National Energy Board focuses on three areas: safety, protecting the environment, and conserving Arctic energy resources. The board receives 15 exploration applications a year by energy developers, and expects an Arctic deepwater exploration application by Exxon Mobil before 2015.

Luncheon

Monday's luncheon speaker was John Roderick, a former mayor of Anchorage. He has been active in the state's oil industry for more than four decades. Mr. Roderick gave us a history of Alaskan energy development, as summarized in his book, 'Crude Dreams'. Oil development began in 1901, when a British consortium drilled a shallow well at Katalla, producing 50 barrels per day. Development was slow until 1957, when oil was discovered on the North Slope. One year later, Alaska received statehood. Two days after Christmas in 1967, North America's largest oil field was discovered on the North Slope, containing more than 9 billion recoverable barrels. After the discovery, the Trans Alyeska Pipeline was built over an 8-year period. Since the late 1980's, oil production on the Slope has decreased. As to the future, Roderick believes that relaxed Federal drilling regulations would allow Alaska's oil production to again increase rapidly.

Afternoon Plenaries

Natural Gas Markets

Unlike oil, natural gas production and trade are fractured into several regional markets. Larry Persily, the Federal coordinator of the Alaska Natural Gas Transportation Projects, began the session by discussing Alaskan gas issues. Alaska has abundant reserves on the North Slope, estimated at 800 tcf. However, this gas currently cannot be moved to where it is needed in South-Central Alaska. Two strategies are being pursued to move North Slope gas: either export to Asian markets via an LNG export terminal or to Canada and the lower 48 via a pipeline.

Next, Surya Rajan, the Director of Upstream Research and Global Gas at IHS CERA, presented several scenarios for the future of global gas. A key takeaway of their research is that there is a growing resource base with geographic diversity. Gas will continue to gain market share until 2040 when it becomes the largest fuel source. North American exports will remain cost competitive, which will have little effect on global gas prices but will prevent domestic gas prices from dropping further.

The final speaker was Ken Medlock, the Senior Director of the Center for Energy Studies at Rice University's Baker Institute. Professor Medlock demonstrated that the newly discovered shale resources are much closer to population centers than traditional gas resources. His research shows that although companies advertise their highest output wells, there is a wide range in well output. He finds that the average break-even cost is over $4/Mcf in the Barnett formation.

Isolated / Dedicated Power Grids: Making Them Work

This plenary's speakers discussed the challenges of operating isolated power grids in Alaska. The first speaker was Steve Gilbert of the Alaska Village Electric Cooperative (AVEC). AVEC operates grids in 55 villages that vary in population from 86 – 1,124. Operating these grids poses several challenges, including the logistics of moving fuel and equipment, operating in extreme weather and unstable permafrost, and delivered fuel prices that have more than tripled in the past decade. To face these challenges, AVEC has established a series of goals, which include reducing annual diesel fuel consumption by 25% from 5 million barrels, reducing the number of diesel generators by 50% from 165, and reducing non-fuel costs by 10%. AVEC plans to meet these goals by increasing their use of wind, hydropower, and increasing interconnection between villages.

The session's other two speakers discussed the technical challenges of operating hybrid diesel-wind microgrids. Marc Mueller-Stoffels of the Alaska Center for Energy and Power discussed research into optimal control of diesel-wind systems. His research shows that although diesel is the prime mover of such systems, with advanced control strategies the systems can reliability achieve 70% wind utilization. Brian Hirsh, from the National Renewable Energy Laboratory (NREL), explained that when access to a central grid is available; hybrid diesel-wind systems only make sense if high reliability is necessary. Mr. Hirsh is working with the Marine Corps Air Station MIRAMAR to design a system that is 50% powered by renewables and more reliable than the central power grid. Mr. Hirsh believes the microgrid industry may be posed for exponential growth.

Tuesday, July 30

Morning Plenaries

Managing Resource Wealth

How governments manage resource revenues and distribute them among citizens can affect the size and structure of regional economies and change wealth distribution. The session began with Rögnvaldur Hannesson, professor at the Norwegian School of Economics, who discussed the downsides of Norway saving the rents gained from their petroleum resources. Next, Gregg Erickson from the Alaska Budget Report discussed Hartwick's rule and Alaska's allocation of petroleum rents. Hartwick's rule is named for Canadian economist John Hartwick, who demonstrated that total utility and aggregate welfare is maximized if authorities collecting rents from exhaustible resources follow a simple rule: "Invest all profits or rents from exhaustible resources in reproducible capital." Finally, Melville McMillan, professor at the University of Alberta, discussed the history of Alberta's Heritage Savings Trust Fund.

Unconventional Oil and Gas Development

The session's first speaker was Billy Harris, a Senior Petroleum Engineer from Wagner & Brown, Ltd. Mr. Harris noted the many complexities of extracting unconventional resources. Complexity breaks down into three areas: geologic, engineering, and evaluation. Advanced technologies and analysis tools are being used to address these complexities. An example of emerging technologies is mud pulse telemetry, which sends signals in real time from the drill bit to the operator on the drill bit's location and orientation. Next, Gurcan Gülen, an economist from the University of Texas, spoke on natural gas resource assessments. Dr. Gülen and his colleagues have developed an integrated approach to estimate both the size of a resource and its production outlook.

Finally, Benjamin Schlesinger of Benjamin Schlesinger and Associates gave a brief history of the U.S. shale revolution and its implications for the global gas trade. The effect of U.S. shale is still underappreciated by many; were it a country, U.S. shale would be the world's 3rd largest gas producer. More recently, economics have driven production of tight oil and natural gas liquids to increase as dramatically as shale. Globally, development of shale has been hindered by the domination of long-term foreign gas contracts tied to fuel oil, and less vibrant and innovative energy sectors.

Luncheon

The luncheon speaker was Mark Finley, BP's General Manager of Global Energy Markets and U.S. Economics, who presented the 2013 BP Statistical Review of World Energy. World energy consumption increased 1.8% in 2012, below historical averages due to the still-weak global economy. Mr. Finley's presentation highlighted the growing importance of the developing world. Over the past 20 years, developing countries have accounted for 99% of the growth in energy consumption, and 98% of energy production. China now accounts for more than 50% of all coal burned on the planet and 25% of global auto sales.

In contrast to the developing world, the U.S. had the largest single reduction in energy intensity of the past 30 years in 2012. U.S. oil consumption dropped by 400,000 barrels per day. Even though U.S. efficiency is improving, domestic production has increased rapidly. In 2012 the U.S. had the single largest increase in oil production of any country, and the largest increase in the nation's history. The combination of improved efficiency and increased production has dropped U.S. oil import dependence by 1/3 in the past 5 years.

Afternoon Plenaries

Petroleum Fiscal Regimes

There are widely different goals and strategies among sovereign jurisdictions for collecting rents from petroleum production, and vastly different ways government take materializes. Marianne Kah, Chief Economist of ConocoPhillips, began by discussing the role governmental fiscal regimes play in the competitiveness of company investments. Governmental characteristics such as transparency and stability encourage investment. Irena Agalliu, Managing Director at IHS CERA, discussed her firm's work on analyzing the fiscal competitiveness of different national systems. Finally, Matthew Foss of the Alberta Department of Energy discussed Alberta's policy goals in maintaining a competitive fiscal regime.

Industrial Energy Use and Efficiency

Industrial energy efficiency is an area with large potential for improvement both within Alaska and the U.S. as a whole. Skip Laitner from the American Council for an Energy Efficient Economy kicked off the session with a discussion of the U.S.'s efficiency as a whole. Mr. Latiner's work has shown that the U.S. economy is less efficient than other developed economies such as France that have strong top-down support for efficiency programs. He highlighted the potential for game-changing technologies like Big Data to unlock efficiencies that have yet to be thought of. An example he gave was the city-wide optimization of streetlight timing, which could substantially improve the efficiency of all vehicles.

Next, Karen Matthias from the Council of Alaska Producers discussed industrial efficiency within Alaskan mining companies. Alaska has several large mines, including gold and coal mines. Due to the high cost of energy in Alaska, the Alaskan mining industry has been a leader in improving operational efficiency. Ms. Matthias concluded by discussing possible hydropower projects that would allow for cost-effective electricity for mines.

Finally, Jeff Rickert from the AFL-CIO discussed the labor movement's views on energy efficiency. The labor movement has been a leader in encouraging industrial energy efficiency and views it as necessary to sustain U.S. manufacturing. The AFL-CIO has consulted with industrial partners to improve efficiency of industrial facilities. On the finance side, the union has worked to find innovative ways to invest in efficiency through its pension fund.

Wednesday, July 31

Morning Plenaries

Developments in Electricity Generation and Distribution

The subject of this plenary was new technologies such as smart grids to integrate alternative energy sources into existing power grids. Presiding over the session was David Newbery, the President of IAEE and professor at University of Cambridge. Professor Newbery spoke on the European experience of integrating wind into power systems. Also speaking were G. Scott Samuelsen, professor at University of California-Irvine, and Meera Kohler, President and CEO of the Alaska Village Electric Cooperative, who spoke on the logistical and technical challenges of managing small, rural Alaskan microgrids.

Arctic Transport: Technology and Opportunities

The melting sea ice in the Arctic Ocean increases the potential for marine transportation and resource development. Lawson Brigham, Professor at the University of Alaska Fairbanks, discussed the findings of the Arctic Marine Shipping Assessment (AMSA). AMSA recommended three themes for future Arctic exploration: improvements to marine safety, protection of Arctic people and the environment, and the building out of the Arctic marine infrastructure. Next, Alex Iyerusalimskiy from ConocoPhillips discussed the development of Varandey, a large, icebreaking crude oil tanker. Finally, Patricia Cochran, Executive Director of the Alaska Native Science Commission, discussed how climate change might affect the indigenous people of Alaska.

Closing Plenary

The Interconnection Between Industry and Government

The concluding plenary discussed the role of government in regulating the energy industry, and the public's perceptions of energy issues. Branko Terzic, Executive Director, Deloitte Center for Energy Solutions, began by introducing the fundamentals of the regulatory relationship. The first role of government is to establish national energy policy objectives – efficiency, reliability, environmental stewardship, and maintaining appropriate social subsidies. Mr. Terzic concluded with describing the characteristics of attractive regulation – transparency, timeliness, fairness, mechanisms for future review, and independence from political influence.

Next, Ethan Schutt of Cook Inlet Regional gave a practitioner's viewpoint of working with regulators to establish an energy project in Alaska. Mr. Schutt described the challenges of establishing the Fire Island wind project, an 18 megawatt wind farm 3 miles from Anchorage that became operational in September 2012. The project had to create an exemption to Alaska regulations that traditionally only allow utilities to produce electricity and banned independent power producers. Mr. Schutt went on to discuss several other regulatory challenges to the project, such as direct governmental involvement in some energy projects leading to market distortions.

Finally, Mike Canes, Distinguished Fellow, Logistics Management Institute and incoming president of USAEE, gave a presentation on public opinion and energy policy. Overall, the public cares strongly about energy issues. Of all public policy issues, energy ranked 4^{th}, gas prices ranked 5^{th}, and the environment ranked 7^{th}. The public prefers energy efficiency and renewable energy to increased production of oil and gas by a ratio of almost 2 to 1. The public's favorite energy policies include standards to improve vehicle efficiency, R&D spending on renewable energy, and opening up government lands for oil and gas exploration. The public favors carbon legislature as long as it doesn't cost too much and if the monies are returned directly to taxpayers. Mr. Canes concluded by noting that policymakers and the public look to economists to inform them of the consequences of policy actions.

Roger Lueken
PhD Student, Engineering and Public Policy
Carnegie Mellon University

Welcome New Members

The following individuals joined IAEE from 6/30/13 to 8/31/13

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Esid de Lyon
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Claudio Agostini
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Mansoor Ahmad
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Cabrera Serrenho Andre
Instituto Superior Tecnico
PORTUGAL

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CHINA

IAEE/Affiliate Master Calendar of Events

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

Date	Event, Event Title and Language	Location	Supporting Organization(s)	Contact
2014				
February 17-18	7th NAEE/IAEE International Conference *Energy Access and Sustainable Economic Development for Africa*	Abuja, Nigeria	NAEE	Adeola Adenikinju *adenikinjuadeola@gmail.com*
June 15-18	37th IAEE International Conference *Energy and the Economy*	New York City, USA	USAEE/IAEE	USAEE Headquarters *usaee@usaee.org*
September 19-21	4th IAEE Asian Conference *Economic Growth and Energy Security: Competition and Cooperation*	Beijing, China	CAS/IAEE	Ying Fan *yfan@casipm.ac.cn*
October 28-31	14th IAEE European Conference *Sustainable Energy Policy Strategies For Europe*	Rome, Italy	AIEE	Andrea Bollino *bollino@unipg.it*
2015				
May 24-27	38th IAEE International Conference *Energy Security, Technology and Sustainability Challenges Across the Globe*	Antalya, Turkey	TRAEE/IAEE	Gurkan Kumbaroglu *gurkank@boun.edu.tr*
2016				
June 19-22	39th IAEE International Conference *Energy: Expectations and Uncertainty Challenges for Analysis, Decisions and Policy*	Bergen, Norway	NAEE	Olva Bergland *olvar.bergland@umb.no*

Calendar

08-10 October 2013, 2013 Arctic Energy Summit: Richness, Resilience, and Responsibility - The Arctic as a Lasting Frontier at Akureyri, Iceland. Contact: Conference Secretariat. URL: www.institutenorth.org/arcticenergysummit,

08-10 October 2013, Energiemarkten at To be determined. Contact: Janet Smid, Course Manager, Energy Delta Institute, Netherlands. Email: smid@energydelta.nl, URL: http://www.energydelta.org/mainmenu/executive-education/introduction-programmes/energiemarkten-2,

13-17 October 2013, 22nd World Energy Congress Daegu 2013 at Daegu, Korea. Contact: Conference Coordinator, Conference Connection Pte Ltd, 135 Middle Road, 05-01 Bylands Building, Singapore, 188975, Singapore. Email: Info@cconnection.org , URL: http://www.wec2013-cc.com/,

14-15 October 2013, Master Class Gas Pricing Strategies at Dusseldorf. Contact: Thiska Portena, Energy Delta Institute, Netherlands. Email: portena@energydelta.nl, URL: http://www.energydelta.org/mainmenu/executive-education/specific-programmes/master-class-gas-pricing-strategies,

14-16 October 2013, 4th International Conference Drivetrain Concepts for Wind Turbines at Swissôtel Bremen, Hillmannplatz 20, Bremen, 28195, Germany. Contact: Barakaki Vasiliki, IQPC DE. Email: eq@iqpc.de, URL: http://atnd.it/12KsZeG,

14-16 October 2013, International Conference Transport and Installation for Offshore Wind at Swissôtel Bremen, Hillmannplatz 20, Bremen, 28195, Germany. Contact: Barakaki Vasiliki. Phone: +49 (0)30 20 91 32 74, Email: eq@iqpc.de, URL: http://atnd.it/142OyE3,

21-23 October 2013, International Conference Wind Resource Assessment at Swissotel Bremen, Hillmannplatz 20, Bremen, 28195, Germany. Contact: Barakaki Vasiliki, IQPC DE, Friedrichstrasse 94, Berlin, Berlin, 10117, Germany. Email: eq@iqpc.de, URL: http://atnd.it/142Nv6N,

21-25 October 2013, International Gas Value Chain Course at Amsterdam. Contact: Janet Smid, Account manager, Energy Delta Institute, Netherlands. Email: smid@energydelta.nl, URL: http://www.energydelta.org/mainmenu/executive-education/introduction-programmes/international-gas-value-chain,

21-22 October 2013, Advanced Contract Risk Management Training at Marcliffe Hotel and Spa, North Deeside Road, Pitfodels, Aberdeen, Scotland, AB15 9YA, UK. Contact: Nicole, Abbott, IQPC UK, 129 Wilton Road, London, London, SW1V 1JZ, United Kingdom. Phone: 44 0 207 368 9300, Email: enquire@iqpc.co.uk, URL: http://atnd.it/1fj7YsJ,

28-30 October 2013, Green Middle East at Sharjah Expo Center, Al Taawun Street, Sharjah, United Arab Emirates. Contact: Vidhya Suman, IQPC Middle East, 0. Phone: +971-6-5770000, Email: enquiry@iqpc.ae, URL: http://atnd.it/15sNmzI,

29-30 October 2013, Gas Transport and Shipping Course at Groningen. Contact: Thiska Portena, Account manager, Energy Delta Institute, Netherlands. Email: portena@energydelta.nl, URL: http://www.energydelta.org/mainmenu/executive-education/specific-programmes/gas-transport-shipping-course,

30-31 October 2013, Australian Gas Turbines Conference at Hilton Hotel, 190 Elizabeth St, Brisbane, 4000, Australia. Contact: John, Wilson, Informa, Level 2, 120 Sussex Street, Sydney, NSW, 2000, Australia. Phone: +61 2 9080 4037, Email: info@informa.com.au, URL: http://atnd.it/ZXrjvk,

30-31 October 2013, Australian Gas Turbines Conference at Pullman Melbourne Albert Park, 65 Queens Road, Melbourne, Victoria, 3004, Australia. Contact: John, Wilson, Informa, Level 2, 120 Sussex Street, Sydney, NSW, 2000, Australia. Phone: +61 2 9080 4037, Email: info@informa.com.au, URL: http://atnd.it/ZXrjvk,

04-06 November 2013, Green Electronics 2013 at Budapest, Hungary. Contact: Markus Rothensteiner, Mag., International CARE Electronics Office, Gurkgasse 43/2, Vienna, 1140, Austria. Phone: +43 1 298 20 20, Email: info@care-electronics.net, URL: http://www.care-electronics.net/greenelectronics/,

11-15 November 2013, Underground Gas Storage Course at Groningen. Contact: Thiska Portena, Account manager, Energy Delta Institute, Netherlands. Email: portena@energydelta.nl, URL: http://www.energydelta.org/mainmenu/executive-education/specific-programmes/underground-gas-storage-course,

11-15 November 2013, Large Energy Projects Course at to be determined. Contact: Ricard Sanders, Account manager, Energy Delta Institute. Email: sanders@energydelta.nl, URL: http://www.energydelta.org/mainmenu/executive-education/executive-master-programmes/executive-master-of-gas-business-management/,

12-13 November 2013, European Autumn Gas Conference 2013 at Le Plaza Brussels, Blvd Adolphe Max 118-126, Brussels, 1000, Belgium. Contact: Lynne Roberjot, European Autumn Gas Conference 2013, Dmg Events, Le Plaza Brussels, Blvd Adolphe Max 118-126, Brussels, 1000. Phone: +44 20 7323 0450, Email: hello@evvnt.com, URL: http://atnd.it/XfQwAk,

18-20 November 2013, Digital Oilfields Global Summit 2013 at IQPC (TBC), 129 Wilton Road, London, SW1V 1JZ, UK. Contact: 44 020 7036 9300, Digital Oilfields Global Summit 2013, IQPC UK, 129 Wilton Road, London, London, SW1V 1JZ, United Kingdom. Phone: 44 020 7036 9300, Email: enquire@iqpc.co.uk, URL: http://atnd.it/19ICNKp,

18-20 November 2013, Contract Drafting and Risk Management Training for Oil and Gas 2.0 at The Woodlands Waterway Marriott Hotel and Convention Centre, 1601 Lake Robbins Drive, Woodlands (Houston), Texas, 77380, USA . Contact: Abbott, Nicole, IQPC UK, The Woodlands Waterway Marriott Hotel and Convention Centre, 1601 Lake Robbins Drive, USA. Phone: 207 368 9300, Fax: 207 368 9300, Email: enquire@iqpc.co.uk, URL: http://atnd.it/1fjauPW,

25-29 November 2013, Fundamentals of Gas Strategy at Groningen. Contact: Ricard Sanders, Account manager, Energy Delta Institute, Netherlands. Email: sanders@energydelta.nl, URL: http://www.energydelta.org/mainmenu/executive-education/specific-programmes/gas-strategy-course,

09-09 December 2013, Quality for Photovoltaics at Berlin. Contact: Amelie Wachner, Solarpraxis AG, Zinnowitzerstraße 1, Berlin, 10115. Email: info@solarpraxis.de, URL: http://www.solarpraxis.de/konferenzen/quality-for-photovoltaics-2013/allgemeine-informationen/,

09-11 December 2013, Digital Oilfields USA Summit at Houston, Texas. Contact: alysha.malik@idga.org, Marketing Manager, IQPC, New York, New York, 10017, United States. Phone: 646-253-5526, Email: alysha.malik@idga.org, URL: http://bit.ly/14e0RAw,

09-11 December 2013, Health and Safety in Offshore Wind 2013 at Swissotel Bremen, Hillmannplatz 20, Bremen, 28195, Germany. Contact: Barakaki, Vasiliki, IQPC Germany, Friedrichstrasse 94, Berlin, Berlin, 10117, Germany. Phone: 49 0 30 20 9130, Fax: 49 0 30 20 913312, Email: info@iqpc.de, URL: http://atnd.it/1fotI6D,

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