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IAEE Energy Forum

Third Quarter 2014 International Association for Energy Economics

President's Message

It was indeed a pleasure to see quite a number of you at our 37th International Conference in New York. The conference logged several remarkable records including the highest number of particiapnts at an IAEE event. The previous record was set in Stockolm in 2011. The number of abstracts submitted for concurrent sessions and the number of concurrent session papers presented were also unprecedented. In fact, the IAEE Council meeting had its own record setting in terms of the number of IAEE past presidents present. I am sure you will understand my sentiment if I state that 25 delegates attended the IAEE conference from Nigeria for the first time ever. This is personally gratifying to me.

It is also delightful to report that approximately 65 percent of the attendees came from outside North America. This was incredible, and we were able to register close to 200 new members at the conference. The student mentorship program that was substituted for the traditional Council dinner night was a success and I am hopeful that the investment in our students will add value to IAEE in the long run. I also must add that I had the priviledge of attending the Ph.D dissertation presentation session, a pre-conference event, and I was impressed. It was a new event held for the first time at any IAEE conference. Perhaps we can learn something from this event and explore the possibility of introducing a pre-conference workshop at IAEE international and regional conferences in the future.

Thus, let me pause briefly to express my sincere appreciation to the USAEE President, Mike Canes, the USAEE Council Members, the IAEE and USAEE Conference Vice Presidents, the Conference Planning Committee members, and of course, Dave Williams Jr and the AMS staff for a job well done. The 37th International Conference was indeed a great success. I do hope you have taken time to provide us with your perspectives on the conference through the survey emailed to delegates immediately after the conference. Your opinions on our conferences are important to us.

Let me state unabiguously that the strategic focus of the International Association for Energy Economics continues to be on advancing knowledge, promoting understanding and the application of economics across all aspects of energy--issues, challenges and outlook. IAEE must, therefore, continue to position itself strategically to facilitate the flow of information on energy economics and policy issues amongst energy professionals in government, industry, and academia. The gaps between costodians of knowledge in and tools for energy economic education and the users of this knowledge and tools in business and government must be minimized. Thus, the IAEE Council has to periodically review, revise, and adopt its strategic plan to govern its functionality and accomplish its primary objectives for membership, communications, conferences, publications, and energy economics education. As I mentioned in my closing remarks at the New York Conference, please feel free to suggest any new tactics we can adopt to grow IAEE membership in new regions; grow institutional memberships in government, academia and industry; and retain existing members to foster closer interaction among these sectors.

Further, IAEE Council wishes to increase awareness of the IAEE program and benefits within government institutions, energy and energy related business communities, and industry sectors; the press and public at large through its website. The proposal to establish an IAEE "Distinguished Lecturer" Program is expected to enhance and promote interactions across our Affiiates. As to how to enhance IAEE branded conferences,

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your opinions are important to the IAEE Council as it develops its 2015-17 strategic plan for conferences. As I urged above, please provide us with your perspectives on the New York conference through the survey emailed to conference attendees right after the conference. The strategic goal is to strengthen IAEE international and regional conferences so as to facilitate quality and relevant energy information exchanges amongst the membership. The IAEE Council publication objective is premised on its vison and mission requiring the enhancement of the reputation of its publications.

In closing, I would like to offer a perspective on the international implications of the energy renaissance in the U.S. This was brilliantly discussed by three distinguished speakers at the opening plennary session in New York. There are some basic facts that are, perhaps, incontrovertible. First, the easy to find conventional oil and gas resources are on the decline and a new energy landscape is emerging as technology makes unconventional hydrocarbon resources desirable and accessible. Second, energy needs are rising globally, especially in the emerging economies and more specifically for the transportation sector, which, for the nearest future, may have to still depend primarily on oil and perhaps gas, ceteris paribus. So access to affordable, sustainable, and clean energy remains a noble policy goal worlwide. Third, the world after all may not be running out of petroleum resources soon, but, perhaps, because of fossil fuel exploitation economics, alternative fuels for transportation may come sooner than later, so crude oil price dynamics still matter.

Further, one can liberally speculate that the world is endowed with as much if not more of unconventional resources as conventional resources, but the key challenge is how the oil and gas industry can safely extract these resources with minimal damage to the environment. The postitve implication of the surge in unconventional hydrocarbons production in North America, that one can hope to happen in countries outside North America, is namely unconvetional technology transfer. This aspiration is premised on the diffusion of deepwater technology from the U.S. Gulf of Mexico deepwater to other deepwater regions worldwide. Perhaps another positive impact of the surge in U.S. unconventional oil and gas production on hydrocarbon resource rich countries, like Nigeria, is the outright elimination of the "elite capture" mindset. Subsequently, the economy of such resource rich economies may be transformed from a rent-seeking and rent-sharing economy to a value added driven economy.

I am confident the unconventional resource exploitation issue and its global implications will continue to be relevant in our conferences. The 4th IAEE Asian Conference to be held in Beijing, China on Sept 19-21, 2014, is expected to offer another platform for this analysis. The theme of the conference is *Economic Growth and Energy Security: Competition and Cooperation*. In addition, the 14th IAEE European Conference slated to be held on October 28-31, 2014, in Rome, Italy, would also offer energy professionals networking opportunity. The theme of the conference is *Sustainable Energy Strategies for Europe*. IAEE is determined to strengthen these established IAEE conferences with a view to increasing attendance and improving quality and relevance to its entire membership.

I certainly look forward to seeing you in Beijing, China and/or in Rome.

Wumi Iledare

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

We have a guest editor, Einar Hope, for this issue of the *Forum*, which focuses on some of the concurrent sessions at the 37th Annual International Conference in early June. The conference, held in New York City, from June 15th through the 18th was the largest ever for the Association and was attended by more than 570. Dr. Hope's introduction to the twenty-one articles is on page 6 and the articles begin on page 8.

DLW

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Newsletter Disclaimer

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中國科學院
CHINESE ACADEMY OF SCIENCES

First Announcement and Call for Papers

The 4th IAEE Asian Conference
Beijing China, September 19-21, 2014

Energy Economics: New Challenges & Solutions

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.

TOPICS (including but not limited)

- Energy outlook
- Energy security
- Energy transportation and pipelines
- Regulation and deregulation
- Electricity prices and uncertainties
- Energy policy
- Non-carbon energy technologies
- Prospects for nuclear power
- Geopolitics of energy
- Smart grid and power industry deregulation
- Climate Policy and Emission Trading Scheme
- Effective CO_2 removal
- Energy efficiency
- Energy Investment
- Oil & Gas reserves and production
- Prospects for shale gas development

SUBMISSION OF ABSTRACTS

Abstracts in PDF format, maximum 2 pages in length, covering Overview, Methods, Expected results and References should be submitted via conference website **iaeeasia.csp.escience.cn**.

VENUE

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

CONTACT

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

Center for Energy & Environmental Policy Research, IPM, CAS **www.ceep.cas.cn**
School of Humanities and Economic Management, CUGB **www.cugb.edu.cn**

Introduction to the Selected Conference Papers

When the IAEE Executive Director, David Williams, asked me if I would be willing to edit a special issue of the Energy Forum, based upon a selection of papers to be presented at the 37the IAEE International Conference in New York in June, I accepted the invitation straight on without much hesitation. On second thoughts, however, I realized that making a representative selection of 15-20 papers from the 320 papers accepted for presentation at the Conference would be an almost insurmountable task. So I quickly rescinded the idea of full representativeness across the different subject areas into which the papers could be classified, or into Specialization Codes, as defined by the Conference Program Committee, in order to give some topical concentration to the selection. At the same time the selection of papers should, hopefully, reflect the great diversity in terms of topics, methods, analytical approaches, results, and policy implications represented in the whole collection of accepted conference papers.

More precisely, I have concentrated the selection to four out of the twelve Specialization Codes defined by the Program Committee, i.e., Energy and the Economy, Renewables, Electricity, and Energy Modeling[1]. This is partly a reflection of my own professional interests, but it is also the Specialization Codes with the largest number of papers listed under each code. There will, necessarily, be some arbitrariness in the allocation of papers to the different codes, and some overlap, or classification ambiguity, is therefore unavoidable. This is particularly the case for the Energy Modeling code, which by its nature may span almost all the conference subject areas.

Within each code I have selected five papers. In addition to the selection criteria mentioned above, I have also put some emphasis on the geographical dispersion of topics and authors. The IAEE is becoming a truly international association and its International Conference should, in particular, reflect the international composition of the portfolio of papers represented there. This selection criterion might conflict with the quality criterion in the selection process, but I do not think that this is the case here.

Authors were asked to write a summary version of their papers on the standard Energy Forum format, limited to approximately 1500 words, taking account of the space for tables and/or figures that might be included. In spite of a rather tight deadline for the submission of articles to the issue, I noted with great satisfaction that the invited authors, almost without exception, enthusiastically accepted and delivered within the stipulated deadline.

I would like to thank all the authors for their willingness and extra effort to prepare an article for this Special Issue, and for pleasant cooperation in the editing process. Thanks go also to David Williams for inviting me as Editor and for stimulating cooperation, as always in IAEE matters, in the production process of the EF volume. I hope that readers will find the collection of articles interesting and worthwhile to study. If this editing exercise may also stimulate readers of the Energy Forum and members of the IAEE to come to the international conferences of the Association (and to its regional conferences for that matter) to get access to the wealth, and the scope, breadth and depth, of knowledge and insights of the changing energy scene represented in the large volume of papers presented there, plus in the many plenary sessions, that would indeed be an additional stimulus and incentive in itself.

Einar Hope
Norwegian School of Economics
Past President, IAEE

[1] The other Specialization Codes were: Petroleum, Energy Security and Geopolitics, Energy Investment and Finance, Natural Gas, Coal, Nuclear Power and Uranium, Unconventional Fossil Resources, Energy and the Environment.

Energy and the Economy

Energy and Economic Growth: The Stylized Facts

By David Stern, Zsuzsanna Csereklyei, and Mar Rubio*

What overall patterns, or stylized facts, characterize the relationship between economic growth and energy use both across countries and over time? Energy economists and economic historians have investigated these issues, but existing research has either looked at how energy use and economic development vary across countries at one point in time or how they evolve over time in individual countries or groups of countries. Researchers have not linked together the cross-sectional and time series behaviors despite their obvious dependence on each other.

We investigate the links between the time and cross-sectional (or income per capita) dimensions using two datasets. One is a dataset for 99 countries from 1971 to 2010 that uses IEA and Penn World Table data. The other comprises historical data for the U.S. and a number of European and Latin American countries that extends back to 1800 for the U.S. and some Northern European countries and to later dates in the 19th and early 20th century for the other countries.

In recent years, economic historians, including one of the authors of this paper, Mar Rubio, have been working to reconstruct the energy history of many countries in Europe and the Americas for the years before the Second World War. Some of the historical data we use was prepared for the recently published Power to the People, authored by Astrid Kander, Paolo Malanima, and Paul Warde and published by Princeton University Press. Mar Rubio collaborated with Kander et al. on the Spanish data for that volume and led a team that developed historical data for Latin America. Though these data are obviously much more uncertain than those for recent years, they can provide insights into the long-run relationship between energy and economic development.

Our key finding from the recent data is that there has been a fairly stable relationship between countries' GDP per capita measured in purchasing power parity adjusted Dollars and their per capita energy use over the last 40 years. A 1% increase in income per capita across countries is associated with a 0.7% increase in per capita energy use. This implies that energy intensity (energy use/GDP) is lower in richer countries and that on average a 1% increase in income per capita is associated with a 0.3% decrease in energy intensity.

The relationship is also stable in the sense that the average energy use per capita associated with any given level of income per capita has not changed over the four decades. This means that the typical country only managed to reduce its energy intensity by increasing its income per capita. A different way of looking at the same data is to compare countries' average GDP per capita growth rate from 1971 to 2010 to the rate of change in their energy intensity over the same period. This relationship is shown in Figure 1:

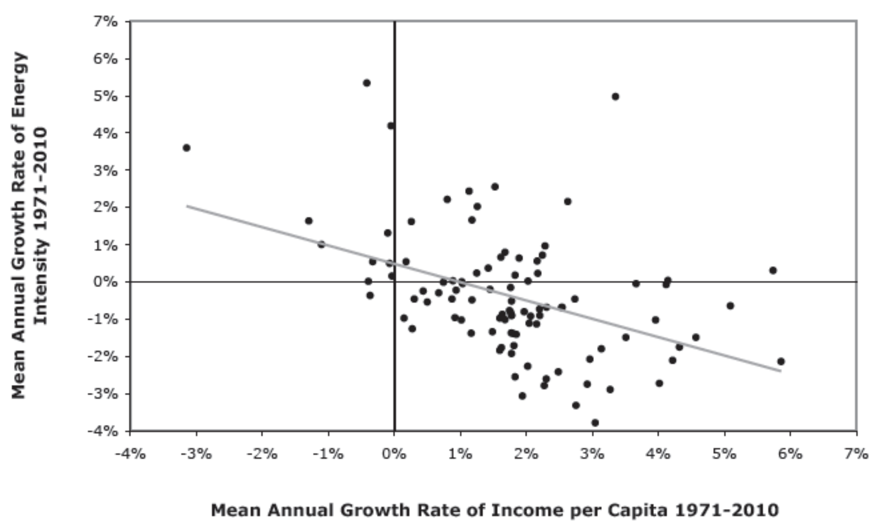

Figure 1. Relationship between the growth rates of energy intensity and income per capita for 99 countries from 1971 to 2010. Source - IEA and Penn World Table 7.1.

The graph shows that higher rates of economic growth are associated with higher rates of decline in energy intensity. The graph also shows that if a country's economic growth was zero then not only did its energy intensity not decline, but actually it increased on average.

Figure 1 also indicates that there are many countries where energy intensity rose despite economic growth. Our second main finding is that there was convergence in energy intensity over time and that the countries whose energy intensity rose typically had low energy intensity at the beginning of the period. Countries that were very energy intensive typically saw declines in energy intensity. There is now a tighter relationship between income and energy use than there was forty

* David Stern is with Crawford School of Public Policy, The Australian National University, Zsuzsanna Csereklyei, Vienna University of Economics and Business, and Mar Rubio, Department of Economics, Universidad Publica de Navarra.

years ago.

In other words, though there has been some degree of "decoupling" of energy and growth in some formerly energy intensive economies, this has not been the common experience. Rather, there has been a homogenization, with countries increasingly resembling each other, while energy intensity globally has declined, but not by enough to reduce energy use.

This picture is borne out in the historical data too. Figure 2 shows the evolution of energy intensity and income over the last two centuries for four representative countries. Energy intensity appears to have declined the most in the United States, which was the most energy intensive economy in the 19th Century. On the other hand, energy intensity has been fairly stable in Spain, which was a very low energy intensity economy in the 19th Century. These time-paths are superimposed on the global distribution of energy intensity and income in 2010. This shows that in the past the United States was more energy intensive for its income level than any countries are today but that in the last few decades it has ceased to be remarkable in that way. On the other hand, the time paths of Sweden, Brazil, and Spain are mostly within the present day energy intensity distribution.

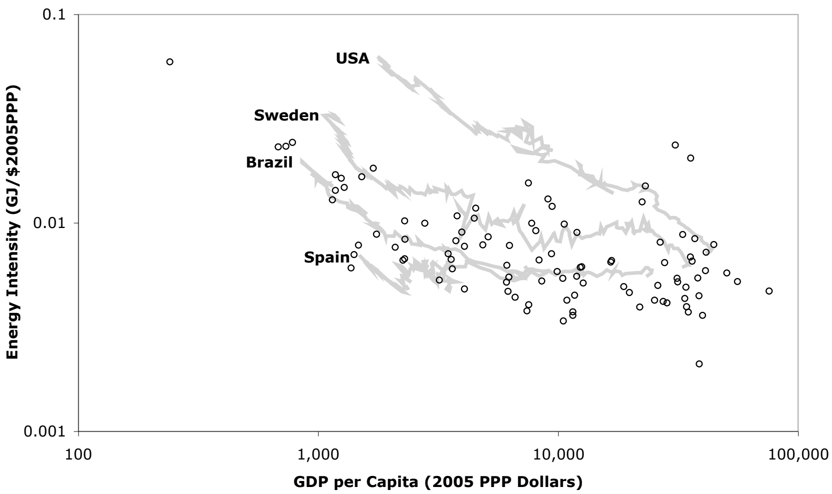

Figure 2. Relationship between energy intensity and GDP per capita. Circles: 99 countries in 2010. Sources – IEA and Penn World Table 7.1. Lines: Historical development of energy intensity and income per capita for the four countries marked. US and Swedish data are for 1800-2010; Spain, 1850-2010; Brazil, 1890-2010. Sources – see conference paper for details.

Our paper in the online proceedings also covers other regularities in the data. Specifically, there is some evidence that the share of energy in costs declines over time. But this "stylized fact" is still more of a prediction than a proven regularity. As is well known, the quality of energy increases over time and with income as countries have transitioned from traditional biomass, to fossil fuels, to primary electricity over time. We also find that the energy/capital ratio, which is an alternative to energy intensity as an indicator of overall energy efficiency, behaves somewhat similarly to energy intensity.

Future theoretical models of the relationship between energy use and economic development will need to take these stylized facts into account and make sure that their predictions match the facts. The stylized facts might also be useful for developing simple business as usual energy use scenarios.

Energy Use and Economic Growth 1965 – 2012

By Rögnvaldur Hannesson*

Abstract

Does energy use grow in tandem with GDP? Does it grow faster than GDP in poor than in rich countries? Does it grow more slowly relative to GDP as countries get richer? Has energy use grown more slowly as the price of oil has risen? The paper uses the BP Statistical Review of World Energy together with data on GDP from the World Bank to answer these questions. Given the strong link between energy use and economic growth, a further rise in the prosperity of nations will have to be sustained with increased use of energy. This is unlikely to be accommodated by renewable energy alone, and so we are unlikely to see a decline in the use of fossil energy.

Introduction

Economic growth and growth in the use of energy are closely related. Which causes which is a moot point; most of the things and even the services we produce require use of energy, but energy production gives rise to income which in turn results in demand for goods and services and, ultimately, for energy.

In this note we use energy and GDP statistics to investigate the said relationship. Does energy use increase one for one with growth in GDP? Is energy use more sensitive to GDP growth in poor than in rich countries? There is reason to believe this; poor but rapidly growing countries go through a process of industrialization where production of goods, which is typically energy intensive, takes precedence over provision of services, which are less energy intensive. If this is true, it should be reflected in a weakening of the relationship between growth in energy use and GDP growth as individual countries grow richer, and in a more rapid growth in energy use than in GDP in countries that are poor or only medium rich. Both of these will be investigated.

Energy has a price, and over time the price of energy, and in particular the price of oil, has risen substantially. This should have encouraged economizing on energy use, in particular the use of oil. The price of oil has an influence on the price of other forms of energy, in particular the price of natural gas, which is often indexed to the price of oil. This strengthens the negative influence one expects to find between the price of oil and the use of energy. We also investigate this by looking at whether a rising price of oil has weakened the relationship between the growth in energy use and GDP growth.

The Data

The data on primary energy are taken from the BP Statistical Review of World Energy 2013. They comprise commercial energy both from fossil fuels and renewable energy and are expressed in oil equivalents. The data series begins in 1965 and ends in 2012. Individual country data are not reported for many small, mainly developing countries. For GDP and GDP per capita we have used data from the World Bank, expressed in 2005 US dollars. We have omitted countries for which an unbroken record for the entire period 1965-2012 is not available, due to break up of countries (Pakistan and Bangladesh, Ethiopia and Eritrea, the Soviet Union) or unification (Germany). For three countries we have missing values for up to six years. Some countries are missing from the World Bank GDP-series. All in all we have data for 43 countries.

Analysis

We postulate the following relationship between the growth in energy use (Ge) and growth in GDP (Ggdp):

(1) $$G_e = a_o + a_1 G_{gdp} + a_2 GDPCAP + a_3 P$$

where GDPCAP is GDP per capita and P is the price of oil. We expect GDP to be less energy intensive the richer a country is, implying a2 < 0. We also expect energy use to become less sensitive to the GDP growth the higher is the price of oil (P), implying a3 < 0.

Our data covers 43 countries over 48 years (1965-2012), with twelve missing values divided among three countries. A regression for the entire panel gives the results shown in Table 1. All coefficients are significant and have the expected sign. The use of energy grows with GDP, but each percentage point of growth in GDP produces less than a percentage point of growth in energy use (a1 is significantly less than one, but greater than zero). The higher the GDP per capita or the higher the price of oil, the less sensitive is the growth in energy use to growth in GDP.

We shall not reproduce detailed results for all countries here, but the ones for the United States and Canada are illustrative (Table 2). In terms of signs of coef-

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GDP growth	GDP/capita	Price	Constant	R2
.5932005***	-8.52e-07***	-.0001989***	.0368004***	0.28
(.0280706)	(8.49e-08)	(.0000376)	(.002718)	

Table 1:Estimation of Equation (1) by ordinary linear regression for the entire sample.

	GDP growth	GDP/capita	Price	Constant	R2
United States	.7605614***	-2.17e-07	-.0003268**	.0121393	0.65
	(.1281457)	(3.41e-07)	(.0000971)	(.0118123)	
Canada	.60892***	-1.35e-06*	-.0000802	.0434096**	0.47
	(.1572832)	(5.61e-07)	(.0001179)	(.0161671)	

Table 2: Estimation of Equation (1) by ordinary linear regression for the United States and Canada.

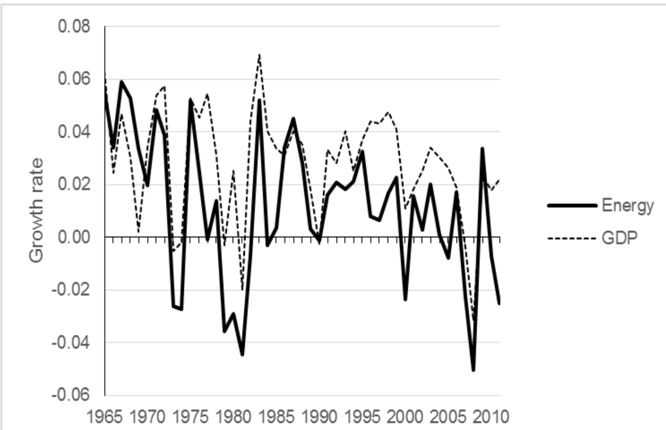

Figure 1: Growth rate of energy use and GDP in the United States 1965-2011.

ficients they are similar, but we see that for the US the effect of the price of oil on the growth in energy use is significant, but not the effect of GDP per capita, while for Canada it is the other way around. Most likely this is due to the correlation between GDP per capita and the price of oil; both have risen over time, so the effect of one gets confounded with the effect of the other (the correlation between the two is 0.4 for the US and 0.48 for Canada).

Figure 1 shows the rate of growth of energy use and GDP in the United States. Clearly they are closely related.

Summarizing the results for the individual countries, for most of them we get a significantly positive relationship between growth in energy use and GDP growth. For 14 countries a1 is not significantly different from zero, but only for only one country (Ecuador) do we get a negative (and insignificant) coefficient. For a2, the effect of GDP per capita on energy use, all but two significant coefficients are negative, the exceptions being Trinidad & Tobago and Venezuela. For a3, the effect of the price of oil on energy use, all but three significant coefficients are negative. The exceptions are Mexico, Ecuador and Algeria, all of which are oil producers, so the result is not altogether surprising; a substantial part of their GDP consists of oil production. Nevertheless we do not get this result for the other oil producing countries.

The countries with a greater growth in the use of energy tend to be the poorer ones; the dividing line is close to 20,000 USD (2005) per capita. China and India are two important exceptions; for both of these the growth in GDP outpaced the growth of energy use over the period 1965-2012. Other exceptions are Columbia, Chile and Hungary, in all of which GDP grew more than the use of energy. Belgium, Spain and Greece are the exceptions in the other direction; all are in the rich country league, with a greater growth in energy use than in GDP, but Greece is close to the dividing line of 20,000 USD. It is tempting to conclude that the use of energy rises faster than GDP in poor and medium rich countries going through the phase of industrialization, despite the results for India and China.

Conclusion

There is clearly a strong link between economic growth and energy use. It shows no signs of being "broken," but it seems to weaken somewhat as countries become richer, presumably because services are less energy intensive than manufacturing or commodity production. Nevertheless, this may be a chimera; what has happened over time is that manufacturing has been "outsourced" from rich countries to newly industrializing developing countries, China in particular. The loosening of the link between economic growth and energy use that we see occurring in rich countries is to some extent due this outsourcing (on an analysis of the UK economy, see Helm (2012)).

The implication is that further economic growth, and in particular further development of the still poor or only moderately rich countries of the world, will require a corresponding increase in the use of energy. Where is it going to come from? It is unlikely that it will come from wind and solar and certainly not from those alone; we are unlikely to be able to do without fossil fuels and even without an increase from those sources, with all the side effects this entails, if we want to maintain and raise the prosperity of all nations.

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The Role of Energy Technologies in Long Run Economic Growth

By Roger Fouquet*

What will be the implications of a transformation of the global energy system for economic growth? A first step towards answering this question is to understand the powerful effects previous periods of energy system transformation have had on economic growth and development. Afterall, the transition out of coal and towards oil, and the associated low oil prices between 1945 and 1973 and again from 1986 to 2005, were undoubtedly critical to the booms after the Second World War and in the 1990s and early 2000s (Hamilton 2013)[1].

Similarly, cheap coal has been seen as pivotal to the Industrial Revolution in Britain (Allen 2009). Along with cheap energy sources, these periods experienced dramatic technological development. Together, the cost of energy services (Nordhaus 1996) – that is, of heating, power and transportation - fell dramatically over the last two hundred years (see Figure 1). However, a lack of data has previously hampered attempts to assess the influence of energy and related technologies on long run economic growth.

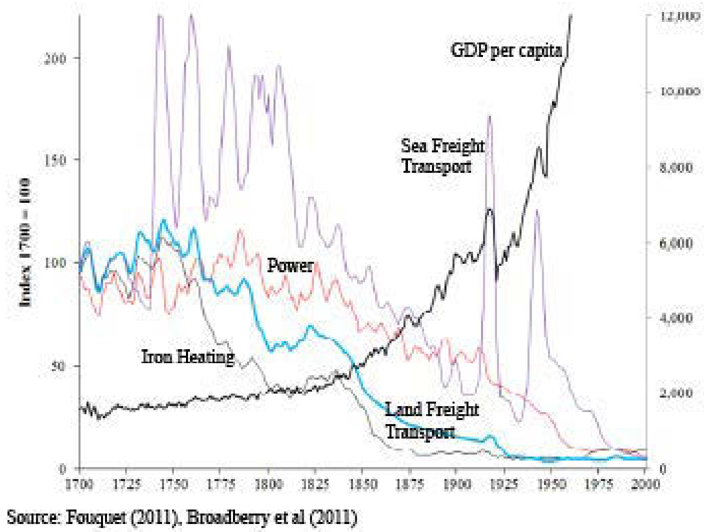

Figure 1. Price of Energy Services (and GDP per capita) in the United Kingdom, 1700-2010

Purpose and Methods

By combining two new data sets on GDP per capita (Broadberry et al 2011) and the price of energy services (Fouquet 2011), this study offers preliminary evidence on the impact of the changing effect of energy service prices on the First (1760-1830) and Second (1870-1913) Industrial Revolutions. Following the similar approach as Fouquet and Pearson (2012) and Fouquet (2014), a vector error correcting model was used to provide an econometric analysis of the data and the trends, and (where non-stationary was present) estimate the cointegrated relationship between GDP per capita and energy service prices.

By looking at energy services, this study effectively combines the physical capital and energy as complements into a single variable. While it is accepted that many other variables are relevant for determining past economic growth (and there is a risk of omitted variables), this study focusses on the three key energy services for productive and distributive activities, heating, power and transport.

Results

The preliminary econometric estimates indicate that the British economy benefitted from a series of declines in energy service prices. However, their influence on growth varied considerably over time and at different levels of economic development. To identify the pivotal declines in energy service prices, it is important to compare the econometric results in Figure 2 (showing when changes in energy services price had a greater impact on per capita GDP) with the data in Figure 1 (showing when enery service prices actually fell).

Based on this evidence, the First Industrial Revolution (1760-1830) may have been kick-started, from the late 1750s, by the decline in the costs of industrial heating for iron production (or smelting, to be more precise). Charcoal had traditionally been used for smelting iron. While Abraham Darby had introduced a new method for smelting iron by using coke in 1709, it only became cheaper to use from the 1740s (Fouquet 2008). Also, these new coking furnaces were relatively large and capital-intensive, requiring significant and initially risky investments. In addition, they needed major and reliable supplies of coal. As their efficiency improved (the fuel requirements fell from ten to four tonnes of coke per tonne of pig iron produced (Smil 1999 p.167)) and freight transport improved, the price of iron smelting fell. Pig iron production rose from 28,000 tonnes in 1750 to 285,000 tonnes by 1800 - accounting for more than 10 percent of total British coal use (equivalent to one million tons of oil). Coke iron

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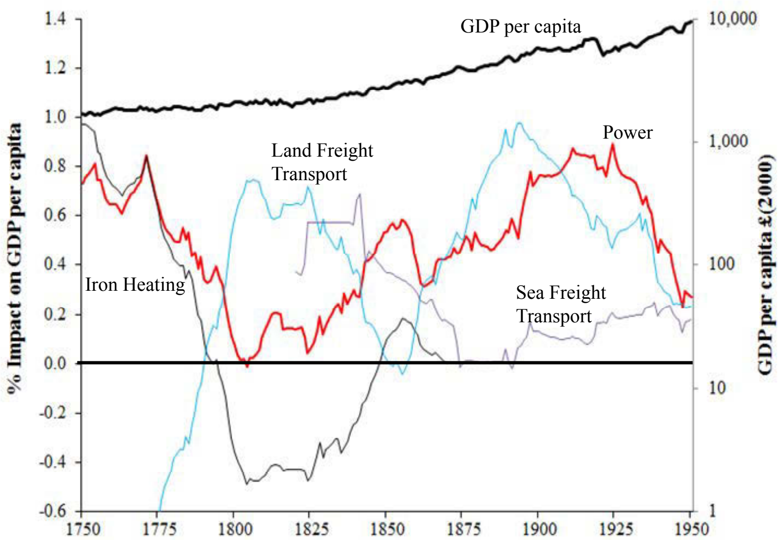
See footnote at end of text.



Source: see Appendix

Figure 2. Impact of % Decline in Energy Service Prices on % Increase in GDP per capita, 1750-1950

was particularly valuable for cast iron products, such as stoves, firebacks, and steam engines.

The econometric evidence also indicates that, during the First Industrial Revolution, cheaper power, from the 1780s, boosted economic growth, until about 1800. Prior to the Industrial Revolution, animals, particularly horses, provided around 70% of all the power needs in Britain (Fouquet 2008). So, the supply of energy (i.e., fodder or provender) for most power depended on agricultural production. While water and wind mills provided around one-tenth of the power during the eighteenth century, the major decline in the price of power occurred as steam engines were gradually adopted - first, from the early 1700s, to extract coal, then, from the 1750s, to bellow coke iron smelting, and, from the late 1780s, for cotton spinning (Nuvolari et al 2011).

Finally, in the 1780s and 1790s, the economy appears to have also been stimulated by declines in the prices of land freight transport. These declines were prinicipally associated with improvements in transport management, including better road maintenance, road surfaces and horses. As mentioned, these were critical for driving down the costs of fuel inputs for iron production, as well as most other industrial activities, and delivering products. Thus, the evidence from the data and econometric results indicate that energy transitions and energy efficiency improvements, combined with better transport services, were pivotal to the First Industrial Revolution.

A 'Second' Industrial Revolution appears to have been kick-started, in the 1830s and 1840s, by cheaper land and sea freight transport. The expanding railway network provided cheap and rapid distribution of goods around the country. From the 1830s, the improvements in sailing ships and then their eventual replacement by steam ships enabled Britain to export its low-cost products around the World.

Despite the apparent role of steam power in the First Industrial Revolution, its widespread use only occurred during the second half of the nineteenth century, as the efficiency of steam engines tripled between 1850 and 1900 – leading to fourfold decline in the price of steam power and a halving of the average price of power (Figure 1). While transport's role started to ebb from 1890s, the influence of industrial power on economic growth continued to increase until the 1920s, peaking with the advent of electricity. In addition to the declining prices for power, the shift from steam engines to electricity enabled a much more flexible and decentralised production process (Devine 1983).

Conclusions

Despite the prelimary nature of the results and the limitations of transferring lessons from the past (especially distant past), this analysis provides a number of insights for the potential implications of future energy system transformations. First, cheaper energy and particularly major improvements in energy efficiency appear to have had (and are likely to have) major influences on economic growth and development (including possibly changing the nature of production and consumption processes). Second, the energy services that will kick-start and drive major periods of economic growth and development change – and these will be particularly hard to anticipate. For instance, despite major innovations that reduced the cost of iron production greatly in the mid-nineteenth century (including the use of hot blasts and waste gases), these only had a modest impact on increases in GDP per capita. Thus, it is worth considering which energy services have the potential to kick-start and to push forwards a New Industrial Revolution, and what transformations in the global economy they are likely to stimulate.

Footnote

[1] See Ayres and Warr (2009), Stern and Kander (2012) and Ayres and Voudouris (2014) for other studies of the impact of energy on economic growth.

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Power System and Economic Growth: Twenty Years After the End of the Soviet Era

By Malika Saidkhodjaeva and Kh.R. Saidkhodjaeva*

Overview

Twenty years after the end of the Soviet era, the Central Asian electrical power system has come to a very critical stage. The technical conditions of generation and transmission equipment as well as the distribution systems are totally depreciated and cannot satisfy the needs of the growing economy of the region. In the past twenty years, investments to rehabilitate the electrical power systems have been insufficient and many power plants and substations have reached the end of their technical lifetime. Current analysis shows that, in Kazakhstan, 44% of the generation capacity is more than thirty years old, in the Kyrgyz Republic, 64%, and in Tajikistan and Uzbekistan, 74% and 75% respectively. Less than 20% of the power plants are under twenty years old. Thus, the age of the generation equipment is the main risk for the supply of electricity in Central Asia. On the Map of Central Asain Energy System (CAES), (220 -500 HVL) is seen the significant size of the role of the CAES in order to increase the supply of electricity to Afghanistan and Pakistan.

Source: Coordination Dispatch Center of Cenatral Asain energy system "KDC Energiya".

During the Soviet era, the architecture of the electrical power system was designed without considering national boarders, and energy resources in the whole region were shared between the countries. However, more recently, the generation and transmission planning of the individual countries in Central Asia has focused on energy independence from neighboring countries. Turkmenistan and Tajikistan are no longer connected to the Central Asian Power System (CAPS), and only Kazakhstan, the Kyrgyz Republic, and Uzbekistan continue interconnected operations of their electrical power systems. In Northern Kazakhstan, CAPS is connected to the Russian system via IPS (Interconnected Power System) / UPS (Unified Power System of Russian Federation). However, stable operation of the electrical system is becoming increasingly difficult because economic growth in each country is causing violations of agreed generation dispatch, especially in the winter. The main reason is a severe winter power shortage in each country. This is causing the interruption of synchronous operation, partial blackouts, and frequent load shedding.

Funding factors contribute to the currently unsustainble situation. First, most of the reconstruction and construction of new power plants is financed by international development banks, like the World Bank (WB), Asian Development Bank (ADB), Islamic Development Bank (IsDB), Europian Bank for Reconstration and Development (EBRD) and other donors as separate projects. Although a number of projects, which have been implemented in the past are still at the implementation stage, the support is mostly to maintain the existing level of electrification. Nor are electricity tariffs of any Central Asain countries able to fund the needed expansion. Unfortunately, tariffs do not even cover the cost of electricity generation, transmission, and distribution, and commercial losses (illegal connections, low collection rate, and so on). The system is still operational mainly because of

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extensive maintenance and repair works, for which a large workforce is still available in the utilities. In many cases, however, the countries have not been able to finance the major maintenance and repair works that are usually required. Because of the age of the equipment and a lack of financing for repair works, the available capacity is much lower than figures reported. In addition according to data from CDC (Central Asian Coordination Center) the Kyrgyz Republic is a net exporter of electricity, mainly to Kazakhstan. Uzbekistan and Tajikistan are net importers of electricity, whereas Turkmenistan was also a net exporter of electricity.

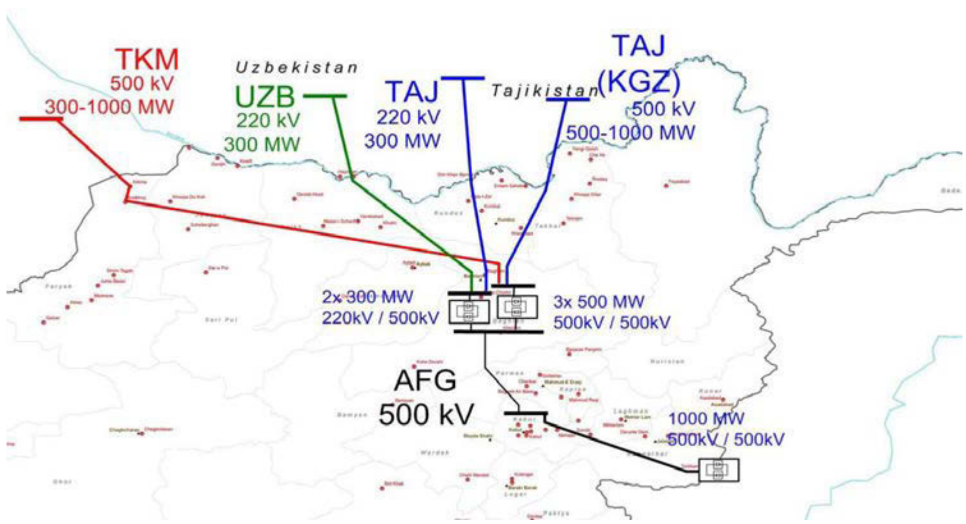
Turkmen power system initiated the construction of 500 kV HVL from Mary TPP to Kerky (Atamyrat) and further to the Afghan-Turkmen border, however, Kyrgyzstan and Tajikistan together with Afghanistan and Pakistan are working on a project called CASA-1000. Harmonization of CASA-1000 project with neighboring countries is pretty hard. The main reason is that the project affects the interests not only of the project participants , but also the entire region of Central and South Asia. In a regional content, CASA 1000 covers only Tajikistan and Kyrgyzstan. At the same time, power supply via this link will be associated with water regimes, which is affecting negatively all countries' economy in the region. The proposed scheme could work 3-4 months a year only and as a result would not contribute to improving the regional energy trade systems of CAPS.

This article overviewes, especially from an economic perspective, the growth of the regional energy system and how to synchronize it with economic growth of each country within the region, as well as regional integration, including part of development the Afganistan

Methods

The corresponding author was a regional senior economist in a team of consultants to develop a Regional Energy Sector Master Plan, financed by Central Asia Regional Economic Cooperation, (CAREC) and an Asian Development Bank program. According to the project goals, this team of experts developed forecasts of load and demand for the Kyrgyz Republic, Tajikistan, Uzbekistan and the southern part of Kazakhstan, that are connected to CAPS. We based our model parameter estimates on a simplified econometric modeling approach and made forecasted from 2011 to 2031. This approach has been selected owing to a lack of data for meaningful econometric analysis. It has been applied by various studies in a similar way before, but this is the first time it has been done for the Central Asian Power energy system. Data for annual electricity consumption in CAPS between 1993 and 2010 has been provided by the "Energy" CDC in Tashkent. Other availble data was the balance of imports and exports between 2000 and 2010 for each country.

The approach, which has been applied for Electricity Demand Forecast is confined to two main explanatory variables, which are (i) the development of the GDP of a country, and (ii) the development of the average tariff of electricity (in real terms). The link in the model is then established through the income elasticity of demand and the price elasticity for electricity demand. While the future income elasticity is estimated at between 0.5 and 0.8, depending on the country and the period, price elasticity is assumed to range from -0.1 to -0.2, mainly depending on the degree of the tariff increase in a year. The values of income elasticities mostly decrease over time. Such development reflects the potential for the implementation of Demand Side Management (DSM) measures. In addition, the forecast takes into account expected improvements in technical and commercial losses, unserved energy, and modifications in the load factor.



Results

We find that gross electricity consumption (or "electricity sent out to the grid" as it is also known) is expected to increase in Central Asia from 95,748 GWh to 162,644 GWh between 2011 and 2031 in the base case scenario. This is an increase of 66%, or 2.6% per annum, on average over the period. If we compare the expected gross consumption in 2031 with actual consumption in 2009, which allows us to take unserved energy into account, the gross electricity consumption increases by 82%, or 2.8% per annum. Growth rates of future gross energy consumption, however, differ between the countries and over time. Apart from Southern Kazakhstan, growth rates in the second decade of the forecasting period are expected to be higher than in the first decade.

The forecasting exercise also develops low and high scenario cases. The low scenario is based on lower future growth rates and lower income elasticities, whereas the high scenario assumes higher economic growth rates, higher income elasticities, and in some cases, a deferred tariff adjustment process. Total gross consumption is expected to reach 208,976 GWh in the high scenario and 124,039 GWh in the low scenario in 2031. The development and growth of the peak load is marginally different from the development of gross consumption, due to minor modifications of the load actor in various countries. Analysis shows that expected development of peak load in the region from 2011 to 2031 requires an increase of sector capacity from 17,537 MW to 29,557 in 2031 (in the base scenario), which will increase consumption by 69%, or 2.6% per annum; while in the low scenario, peak load is expected to reach 22,573 MW in 2031, compared to 37,963 MW in the high scenario.

In this project, as a part of Regional Energy Sector Master Plan, the consultant team suggested an alternative scheme, named as a "Project TUTAP" (Turkmetinstan, Uzbekistan, Tajikistan Afganistan & Pakistan). This solution should suppose all countries to be part of the power trade system between the countries of Central and South Asia. The ADB and CAREC programs would like to support this development in order to obtain cooperation between all regional countries' power systems . Proposed new option suggested to organize the interface between the substation of Puli Khumri through the converter-inverter system of substations in Afghanistan which will be supported by construction the 500 kV HV lines and could be valuable basis for the United Energy System of Afghanistan also.

Conclusions

Demand Side Management (DSM) should be a critical part of the region's strategy for expansion planning of the power system. DSM saving could reduce the growth of power demand on the consumer side in order to reduce required installations of new power generation capacities on the supply side. DSM should mainly be based on three types of measures: load management, increasing energy efficiency, and changing behavior of consumers. As analysis shows, a major part of future demand growth of the Central Asian states comes from the residential sector. This growth will run parallel to the economic growth of the region. Together with economic growth, the prevalence of electricity consuming appliances and, therefore, their consumption will increase.

Implementing a standards and labeling policy may avoid excessive growth of electricity demand. The consumption of refrigerators and air conditioners, in particular, can be addressed by means of a standards and labeling policy, as a label displaying the consumption of a fridge enables the consumer to choose a more efficient product. The economic criterion of the DSM assessment is to identify measures on the consumer side that can be realized with lower long-run marginal costs compared to those of investments for new power generation capacities on the supply side. Similar situations, with classification of the Central Asian republics into hydro resources and water suppliers (the upper riparian states of the Kyrgyz Republic and Tajikistan) and water users (the lower riparian states of Kazakhstan, Uzbekistan, and Turkmenistan), the Central Asian republics can be classified as producers of hydropower and producers of power by fossil fuels respectively. The pattern of power energy usage can be seen jointly with the assessment of water supply systems

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Oil Price Shocks and Welfare Social Consequences

By Marc Joëts and Tovonony Razafindrabe*

The recent and unprecedented surge observed in energy prices, and especially in the price of crude oil, from 2003 to 2008, has given rise to heated public and academic debates about the true nature of these shocks. Due to the potential impact of these huge movements on most economies (Sadorsky (1999); Hamilton (2003); Edelstein and Kilian (2007); Kilian (2008), among others), the effectiveness of economic policies strongly depends on the identification of the major causes of oil prices movements. Since Greenspan's (2004) intervention regarding the existence of speculators in oil market, a popular view of the origins of the price surge has been that these movements cannot be attributed to economic fundamentals (such as changes in the conditions of supply and demand), but were caused by the increasing financialization of commodities. This financialization should in turn cause volatility clustering phenomena, extreme movements, higher comovements between oil, financial assets, and commodity prices, as well as an increased impact of financial investors' decisions (such as hedge funds, swap dealers, . . .).

While several papers have documented the specific nature of oil price (see among others, Büyüksahin et al.(2009), Büyüksahin et al. ()2010a), Büyüksahin et al. (2010b), Alquist and Kilian (2010), Silvennoinen and Thorp (2010, Brunetti et al. (2011), Hamilton and Wu (2012), Joëts (2013) limited works have been done about the welfare consequence of these movements. However, this question appears to be of primary importance from both the economic and the political point of view. For instance, the recent financialization of oil price and the potential welfare social consequences raise the economic question of the trade-off between private and public interest, since financialization is often defined as being beneficial from the private perspective without any beneficial considerations from a social planner's point of view. Politically, the debate is even more relevant since it lends credibility to the regulation of the markets for commodity derivatives in the same way that the G20 governments try to regulate financial markets by limiting speculative behavior.

In this review we expose and discuss preliminary results about the social cost of oil price from the paper "What is the welfare social cost of oil price movements?" (Joëts and Razafindrabe (2014)). By considering an economy that is populated by four types of agents in a dynamic stochastic equilibrium framework ((i) home firms that are composed of a continuum of monopolistic, competitive firms that produce non-oil intermediate goods, a continuum of energy firms that import crude oil in the international market and produce refined-oil intermediate goods, (ii) final good firms that produce homogenous goods to be used in consumption, investment and government purchases, (iii) households which consume, invest and supply labour, and (iv) a central bank, we investigate the welfare social cost of oil price depending on the origin of shocks (i.e. oil supply shock, oil demand shock, speculative demand shock). This framework allows us to see the shock which affects the most the oil price and the consequence in terms of welfare in an oil importing country.

It appears that social welfare is affected in different ways depending on initial shocks. Fundamental shocks have usually less impact on welfare than speculative shocks. More precisely, fundamental shocks from physical supply and demand conditions are largely anticipated compared to speculative ones. In consequence, the welfare cost is less affected when the fundamental component of the oil price is dominant, since households usually smooth their consumption of refined products. However, when speculative shocks occur, evolution of the oil price seems to be more uncertain and then future evolution less predictable leading to more impact on welfare. A frequency analysis which separates short-term and long-term movements of the oil price, further shows that persistent shocks affect social welfare in a larger manner, because the smoothing behaviour of households seems to be limited at longer horizons. Finally, large oil importing countries are impacted by oil price shocks depending on the origin of shocks. If a shock is not predictable it has generally a stronger effect on welfare.

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IAEE President Wumi Iledare addresses April 22 ALADEE/IAEE Energy Economics Meeting entitled "Energy Polices and Economic Dynamics of the Energy Industry" at EPM in Medellin, Colombia. The 5th ELAEE meeting will take place in Medellin, March 15-18, 2015. Stay tuned to http://aladee.org/ for general conference information.

Renewables

Costs and Benefits of U.S. Renewables Portfolio Standards

By Galen Barbose, Jenny Heeter, Lori Bird, Samantha Weaver, Francisco Flores-Espino, and Ryan Wiser*

Renewables portfolio standards (RPS) obligate electricity suppliers to procure a specified amount of electricity from renewable sources, often with increasing targets over time. Adopted by 29 states, Washington D.C., and Puerto Rico, RPS policies have helped spur a roughly eightfold increase in U.S. renewable generation capacity over the past decade. Still, concerns exist about the effect of these policies on electricity costs and the economy. At least a dozen states have proposed repealing, reducing, or freezing RPS requirements over the past several years. At the same time, other recent legislative proposals have sought to expand state RPS policies. Understanding the actual historical costs and benefits of existing RPS policies is critical to informing these legislative debates, but the subject is poorly understood. To inform the debate, we examined the historical and potential future costs of RPS programs as well as key issues surrounding cost-estimation methods. We published our findings in the 2014 report, *A Survey of State-Level Cost and Benefit Estimates of Renewable Portfolio Standards*.[1] That report also synthesizes recent estimates of the broader societal benefits of state RPS programs, though those findings are not summarized here. Compared to the summary of estimated RPS costs, the summary of RPS benefits is more limited, as relatively few states have undertaken detailed benefits estimates, and then only for a few types of potential policy impacts. In some cases, the same impacts may be captured in the assessment of costs. For these reasons, and because methodologies and level of rigor vary widely, direct comparisons between the estimates of benefits and costs are challenging.

Estimating Incremental RPS Compliance Costs

We present estimated RPS compliance costs for 25 states with data available for the 2010–2012 period. The analysis focuses specifically on the *incremental* cost to the utility—the above-market cost or the cost of RPS resources "net" of the avoided costs of non-renewable generation. Incremental costs are estimated using different approaches, depending on the retail electricity market structure of each state.[2] Restructured states achieve RPS compliance principally through purchasing renewable energy certificates (RECs), which represent the renewable energy "attribute" and are a commodity separate from the underlying electricity. We estimate RPS compliance costs for those states based on REC and alternative compliance payment (ACP) prices and volumes.[3] In contrast, states with traditionally regulated electricity markets typically achieve RPS compliance through long-term power-purchase agreements or utility-owned renewable generation facilities encompassing both the REC and the underlying electricity commodity. Estimating incremental costs for regulated states is more complicated, requiring a comparison of the gross cost of RPS procurement against the cost of resources that would have been procured but for the RPS. For those states, we synthesize compliance-cost estimates published by utilities and regulators, which rely on widely varying methods and conventions.

We estimate incremental costs in terms of two metrics: dollars per megawatt-hour ($/MWh) of renewable energy required or procured, and percent of average statewide retail electricity rates. The first metric represents the average incremental cost per unit of renewable electricity used for RPS compliance compared to conventional generation. It answers the question: On average, how much more was paid for each unit of renewable energy than would otherwise have been paid? The second metric represents the dollar magnitude of RPS compliance costs relative to the total cost of retail electricity service (generation, transmission, and distribution). It answers the questions: How significant are RPS costs compared to the overall cost of retail electricity service, and what impact would that have on retail electricity prices and consumer electricity bills were those costs passed fully and immediately to customers?

Results: Incremental Costs are Typically Less Than 2% of Average Retail Rates

Incremental costs per unit of renewable electricity generation ranged from -$4/MWh in Oregon (i.e., a net savings) to upwards of $60/MWh in Ohio, with costs in most states and years below $20/MWh. When multiplied over the volume of renewable energy purchased and divided by average retail electricity rates, these costs typically constituted less than 2% of average retail rates (as illustrated in

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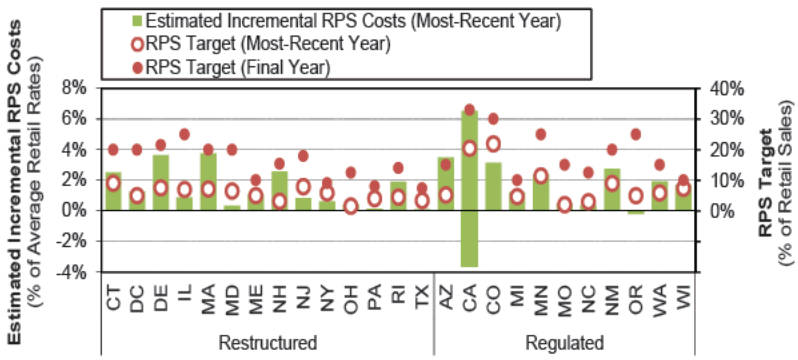
See footnotes on page 32.

the figure, which shows costs for the most recent year available). That said, substantial variation clearly exists, which is due to several factors. RPS costs are partly a function of the RPS target (the open circles in the figure)—higher costs occurred in states with more aggressive targets and lower costs in states with more modest targets. In restructured states, cost variation also reflects differences in REC pricing, which can be volatile depending on whether the available REC supply is greater or less than the compliance target in a particular year. The structure of the target also affects compliance costs; in particular, costs can be higher in states with large solar or distributed-generation set-asides, given the relatively high cost of such resources. Utilities in regulated states often procure solar or distributed-generation resource credits through rebates or other financial incentives, which "front loads" the costs. Methodological differences also contribute to cost variation across regulated states. For example, compliance costs tend to be relatively high when calculated by comparing gross renewable energy procurement costs to contemporaneous wholesale electricity market prices. As a case in point, California used two alternate methods, which produced very different cost estimates.



* For most states shown, the most-recent year RPS cost and target data are for 2012; exceptions are CA (2011), MN (2010), and WI (2010). MA does not have single terminal year for its RPS; the final-year target shown is based on 2020. For CA, high and low cost estimates are shown, reflecting the alternate methodologies employed by the CPUC and utilities. Excluded from the chart are those states without available data on historical incremental RPS costs (KS, HI, IA, MT, NV). The values shown for RPS targets exclude any secondary RPS tiers (e.g., for pre-existing resources). For most regulated states, RPS targets shown for the most-recent historical year represent actual RPS procurement percentages in those years, but for MO and OR represent REC retirements (for consistency with the cost data).

Estimated incremental RPS costs compared to recent and future RPS targets[4]

RPS targets in most states are scheduled to increase, often substantially, by the final program year (the solid circles in the figure). Those rising targets could put upward pressure on RPS compliance costs; however, future compliance costs will depend on many factors, such as underlying renewable energy technology cost trends, natural gas prices, federal tax incentives, and environmental regulations. Cost-containment mechanisms, which are built into many state RPS policies, are an important limiting factor. Many states, for example, cap RPS compliance costs with ACP mechanisms; future RPS costs in those states are generally capped at less than 6%–9% of average retail rates. Cost-containment mechanisms in other states are generally more stringent, typically limiting future compliance costs to less than 4% of average retail rates, and in some instances have already become binding.

Conclusions: RPS Costs Appear Modest, but Improved Data and Methods are Needed

States have largely complied with RPS targets thus far. Based on our data, they appear to have done so with modest impacts on retail electricity rates. Because of the limitations of the underlying data and methods, however, those findings must be interpreted with caution. For example, the incremental cost estimates for many states omit potentially important costs (such as renewable energy integration costs) and some benefits to customers (such as wholesale electricity market price and natural gas price suppression). These data also neglect broader societal costs and benefits, which may be important for evaluating RPS programs as public policies.

We anticipate that evaluating RPS costs and benefits—and the associated impacts on economic growth—will become even more important as RPS targets rise and cost caps increasingly become binding (potentially curtailing achievement of RPS targets). As our analysis reveals, however, the methods and quality of data available for analyzing RPS costs vary widely. Those data and methods must be improved to meet the emerging analytical demands of utilities and regulators as they assess the costs and benefits of RPS policies.

See footnotes on page 32

The Cost Effectiveness of Renewable Energy Support Schemes in the European Union

By Arjun Mahalingam, David Reiner and David Newbery*

Overview of EU Climate and Energy Policy and Challenges to Decarbonization

The EU Renewables Directive (2009/28/EC) aims to deliver by 2020 a 20% share of renewable energy supply (RES) in gross final energy production, as part of the 2020 climate and energy package. It also includes a binding target of reducing greenhouse gas (GHG) emissions by 20% relative to 1990 along with an energy efficiency target of reducing energy consumption by 20% relative to projected 2020 levels. In January 2014, the European Commission published A Policy Framework for Climate and Energy in the period from 2020 to 2030, which proposed an EU-wide target of a 40% reduction in GHG emissions by 2030 (relative to the 1990 levels) which would be translated into binding national-level GHG targets, complemented by an EU-wide renewable energy target of 27% (European Commission, 2014a).

This GHG target for 2030 is equivalent to a 43% decrease for the sectors covered by the EU Emissions Trading System (ETS) and is likely to require even greater reductions in the electricity sector. The Policy Framework argued that there was no need for country-specific RES targets since the 40% GHG target would likely deliver the proposed 27% EU-wide renewables target. The 2020 RES targets would, however, remain binding. Member States (MSs) are at their liberty to choose their own policy instruments such as green taxes, investment subsidies and feed-in tariffs in order to meet their national targets, provided they accord with the State Aid Guidelines (European Commission, 2014b). The electricity sector offers the greatest potential for switching to RES as it only requires changes to generation and leaves the final product unchanged, thereby requiring the least adaptation by consumers. Many MSs, like the UK, have begun the process of reforming their electricity markets to better support the required share of renewable electricity.

Climate change mitigation is predicated on taking the future seriously, which requires discounting future damage at a rather low discount rate (Stern, 2007). Low-carbon technologies, particularly electricity RES (RES-E), which are highly capital intensive but have low running costs become more attractive at lower discount rates. The key to achieving cost-effective decarbonization is thus to find effective ways of lowering the cost of capital.

Decarbonization was initially facilitated by high CO_2 prices in the ETS, while fuel switching was encouraged by low gas prices. Due to the economic crisis in 2008 and the failure of the 2009 United Nations Climate Change Conference at Copenhagen, the ETS carbon price collapsed. The combination of the trebling of EU gas prices and the shale gas revolution in the U.S., which drove down the world coal prices, put EU decarbonization at risk. Even with an adequate carbon price, less mature renewable technologies would not be commercially viable. Additional RES support can then be justified by the public good they create in the form of induced innovation and reduction in costs from mass deployment. Absent legally binding contractual backing, the cost of financing these highly capital-intensive investments from the private sector becomes excessive and further reduces support for the climate change agenda.

Risk Allocation and Minimizing Costs of Renewable Support

The major cost of supporting RES-E is its high capital cost per MWh. The public sector discounts future social costs and benefits at a lower discount rate than RES-E developers. The cheapest form of support is an up-front capital grant sufficient to lower the cost of the generation investment to the point where it becomes commercially viable selling into the wholesale market. Subsidies could be further reduced through a Feed-in Tariff (FiT) at the expected wholesale price (net of any imbalance costs), thereby transferring the risks of marketing and balancing to their cost minimizing locus with the System Operator.

The cost of risk rises as the square of the income fluctuations, which yields two important implications. First, the total cost of risk decreases proportionally with the number of participants who bear it. Second, the cost of risk depends on its correlation with other risks that the participant bears so uncorrelated risk has much lower cost. Transferring weather forecasting, marketing and balancing actions from large numbers of small wind farm developers to a single large System Operator reduces transaction costs dramatically unless generators are better placed to manage them. As a result, the only cost it is efficient to impose on RES-E is the location cost – the cost of strengthening the transmission

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grid to deliver the power from its location plus incremental transmission losses. The objective is for all generation to be located and operated to deliver power to final consumers at the least total system cost.

Finally, the favoured system of financing RES-E support by imposing the costs on electricity consumers is fiscally illiterate (as well as being regressive). Given that such support is justified by the public good of driving down costs so as to benefit all future users of RES-E and thereby the environment, these funds should come from general taxation and should neither be inefficiently loaded on to the production sector nor by raising the tax on one specific final good, electricity.

The State Aid Guidelines requires that interventions or support must be "compatible with the internal market within the meaning of Article 107(3)(c) of the Treaty" so that they do not "affect trading conditions to an extent contrary to the common interest." (§3 (23)), as well as other requirements to ensure that markets are not needlessly distorted. In doing so, the Guidelines advocate auctions to establish the least cost means of supporting RES-E. If suitable sites with planning and environmental permission and grid connections could be secured, then each site could be auctioned off for the least cost of support and allow the site rent to be transferred from developers and/or land-owners to consumers. As different developers may have different financial and construction costs, it may be desirable to run a multi-dimensional auction (Che, 1993). Bidders submit possibly several bids, each of which specifies aspects they consider cost-relevant. They could offer a required up-front subsidy per MW capacity, or a fixed price per MWh for 10 years, a lower fixed price for 15 years, and a discount if balancing is provided, etc. The auctioneer chooses the option that has least public cost.

One way of reforming deployment subsidies is to comprehensively reform RES Research, Development, Demonstration and Deployment (RDD&D) support. The EU's aspirations for the Strategic Energy Technologies (SET) Plan of trebling energy R&D lacks adequate financial support but offers only modest additional EU funds. RES deployment targets could be replaced with a roughly equivalent financial target. MSs could work out a burden sharing arrangement for national-level financial targets similar to that for the RES or climate targets. Credit for MS support actions could be benchmarked, so that for supporting, say, advanced solar PV, the MS would be credited with an annual value per kWp based on the extra annual revenue needed to justify installation in a reference sunny location (such as southern Spain) compared to a CCGT there.

The method for financing renewables would be determined by technology readiness. For immature technologies, EU-wide competitions are probably best; this logic has been applied, for example, in the NER300 competition to support carbon capture and storage (CCS) and 'innovative' renewable technologies. For demonstration plant and for near-market technologies, tender auctions for feed-in tariffs per MW of available capacity would likely be preferable.

Conclusions

The main cost in decarbonizing electricity is the cost of financing the capital-intensive investment required. Transmission investments are regulated and benefit from a low Weighted Average Costs of Capital. Most low-carbon technologies such as renewable electricity, nuclear power and CCS are costly to finance in liberalized markets subject to uncertainty over future carbon prices and policy risks unless they are provided with credible contracts that allocate risks to those best placed to manage and bear them. Given the intermittency of RES-E, that means the System Operator who, with necessary regulatory and/or Government support, can offer a fixed payment per MW or MWh, ideally with the lowest transfer of rent to developers. Carefully designed multi-dimensional auctions that are consistent with the new State Aid Guidelines are probably the best way to reveal the least cost solution. Finally, there seems to be a growing mismatch between the large subsidies provided to RES-E support and underinvestment in low-carbon RDD&D that has been exacerbated by privatization and liberalization.

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Rethinking How to Support Intermittent Renewables.

By Patrick A. Narbel*

Most intermittent renewable energy technologies are not yet competitive at current market prices. Countries seeking their benefits have thus implemented various policy instruments in order to stimulate investment in intermittent renewable energy. Both effectiveness and efficiency of a policy instrument are traditionally measured in terms of the direct cost of energy, although some researchers are now suggesting a move towards instruments based on the realized value of energy instead. I look here at how efficient policy instruments are at deploying valuable intermittent renewable energy, highlighting the need for a new policy instrument.

Definition of a *Valuable* Renewable power Station

I define a valuable intermittent renewable power station based on a combination of two metrics: the spot price and the cost of intermittency.

Each intermittent renewable power station has a unique electricity production pattern. These production patterns will match differently the market needs (i.e. the spot price), making some renewable power stations more valuable than others.

The second metric pertains to the cost of intermittency. Given the inherent characteristics of intermittent renewable energy, the security of supply cannot be guaranteed by solely relying on intermittent power stations. Consequently, dispatchable capacity is needed to balance demand and supply of electricity at all times. Yet, the deployment of intermittent renewables negatively affects the economics of the extant generation mix, since in the presence of intermittent renewables, existing power plants spread their fixed cost over fewer units of electricity. Past a threshold, a number of plants may be decommissioned, threatening the security of supply. In such situation, policy makers may be forced to introduce capacity payments to ensure that dispatchable power plants remain online. Capacity payments thus reflect the intermittency cost induced by intermittent renewable energy sources.

Combining the intermittency cost to the ability to produce electricity when the market needs it, a valuable intermittent power station is a power station which produces electricity during high prices hours and which limits the need for mechanisms to guarantee the security of supply.

Without financial support, expectations on future spot prices should suffice to lead to the construction of valuable power projects. However, implementing policy instruments affect the prices perceived by the plant owner. The effectiveness of specific policy instruments at facilitating the deployment of valuable intermittent renewables is measured in the paper this article refers to via a deterministic numerical analysis based on historical data for West Denmark.

West Denmark is an interesting case because its geographical area is limited in size and wind power already contributes to about 30% of its electricity supply. In addition, Denmark is thermal based and does not have large-scale storage systems to mitigate the intermittency issue of its wind turbines. With a limited potential for hydro and increased biomass use, intermittent technologies such as solar- and especially wind power, are the most mature technologies available to increase the country's share of renewable electricity.

Results of the Numerical Analysis

In a numerical analysis, I assume that two power stations are available to increase West Denmark's share of renewable electricity: a wind farm and a solar power station. The cost of producing electricity from the solar power station exceeds this of the wind farm by 30%. Both power stations are unattractive financially in the absence of financial support.

A negative correlation exists between market prices and production of electricity from the extant intermittent electricity production in West Denmark. The production profile of the suggested wind farm would correlate with the extant intermittent production, whereas the production from the solar power station would not. Consequently, the latter would produce during hours with comparatively higher prices. Despite this advantage, the economics of the solar power station remains slightly less attractive than the economics of the wind farm.

Assuming that these power stations were deployed, the economics of the extant thermal generation mix would be negatively impacted. The solar power station has the characteristic that its deployment would allow for a reduction of the dispatchable capacity needed to balance the system, thus contributing to a limited need for capacity payments. This lower intermittency cost for the system compensates for the higher cost of the solar

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power station on a direct cost basis, effectively making the solar power station more valuable.

Nevertheless, the net present value of investing in either power station being negative in the absence of subsidy, some type of policy instrument will be needed if West Denmark wants to increase its share of electricity from renewable energy sources.

A first option is a feed-in tariff (FiT), which guarantees a price set in advance for each MWh fed into the grid for a fixed period of time. Since prices are guaranteed, the revenues of the plant owner are independent from the wholesale energy market prices and a power station owner has therefore no incentive to react to market signals. To be efficient, in the sense that a FiT delivers the most valuable energy first, a FiT requires to administratively define what the value of energy is. This process can prove to be challenging given the uncertainty underlying the cost of the technology, the future energy supply and the wind and solar conditions for instance. An inefficient FiT will facilitate the deployment of intermittent renewable energy as long as it is generous, although a fraction of it might be of little value to the system. Consequently, a FiT appears inappropriate to efficiently facilitate the deployment of valuable intermittent renewable energy.

A second option is the feed-in premium (FiP). A FiP rewards each unit of electricity fed into the grid with a constant premium on top of the wholesale electricity market price. Under the FiP, the station owner will curtail its production if the price perceived (spot price and premium) does not exceed the marginal cost of producing power. Hence, compared to a FiT system, the FiP creates an incentive to produce electricity when it is needed most because the plant owner total remuneration will rise with increasing electricity prices. Everything else being equal, investors will favor projects which deliver electricity when prices are high, hence facilitating the integration of intermittent renewable energy into the electricity system. However, this type of policy instrument does not reflect the intermittency cost and a FiP will, for that reason, not necessarily promote the most valuable intermittent power stations.

A third option is a quota system (QS). A QS is a quantity-based policy instrument where policy makers set how much renewable energy needs to be delivered. A plant owner will obtain revenues from the electricity markets and from the sale of green certificates, the price of which depends on how many certificates are available in the market. This type of policy instrument is deemed to be more efficient than price-based instruments (FiT and FiP), because the least costly technology will be built first and more efficient producers are favored. However, a quota system is not necessarily efficient if the full cost of energy is considered. The numerical analysis shows that a QS would facilitate the deployment of the wind farm when the solar power station has a higher value.

Of these three policy instruments, the quota system appears to be the most efficient. However, a quota system may still fail to deliver valuable power to the system. There is therefore a need for policy instruments which better reflect the value of energy.

A new policy instrument should pursue two goals. First, the revenues of a plant owner shall reflect the market needs. Second, the deployment of an intermittent power station should allow for a reduction in the capacity of dispatchable power needed to ensure the security of supply. A possible approach in achieving these goals simultaneously is to increase the variation in spot prices to force the deployment of power stations which deliver at times of high residual load and prices, thus increasing the chance that dispatchable capacity can be reduced. A premium multiplying the market prices by a fixed coefficient would be an option. Based on the numerical analysis, this multiplicative premium would deliver the most valuable intermittent energy source first.

Conclusion

A valuable intermittent renewable energy source is a source of energy which requires little financial support and which allows for an effective reduction of the quantity of dispatchable capacity needed to ensure the security of supply.

Given the comparatively higher cost of intermittent renewables, policy instruments have been implemented to facilitate their deployment. If the quota system seems to be the most efficient on a direct cost basis, it still ignores the cost of intermittency. A new policy instrument, a multiplicative premium, was suggested to reflect the perceived value of a power station. This policy instrument rewards power stations producing during high residual loads and high prices hours, forcing the deployment of intermittent power station during these hours. A multiplicative premium may therefore be more efficient at deploying valuable projects than current policy instruments.

Local Impacts of Wind Farms on Property Values: A Spatial Difference-In-Differences Analysis

By Yasin Sunak and Reinhard Madlener*

Introduction

Over the last two decades, fostered by strong financial incentives, wind power in Germany has seen a rapid market diffusion. The promotion policy in the form of guaranteed feed-in tariffs for renewable energies such as wind power often rewarded investors in these technologies with extraordinary economic returns. However, today's investment decisions in large-scale onshore wind power projects in Germany are no longer determined only by the investment's economic benefit, but also by the mitigation of public concerns and thereby the increase of social acceptance. Despite a mostly positive attitude towards the expansion of wind power, local public concerns refer to the common assumption that the proximity to large-scale wind farms devalues property prices in the surroundings. In addition, the average hub height and rotor diameter of newly constructed wind turbines have increased tremendously over the last years, causing a substantial change in the landscape of the affected regions. In turn, the change in the landscape can be supposed to have an impact on the view of those properties that are affected by the construction of a wind farm in their proximity, and thus exert a negative impact on the properties' value.

The aim of this study is to investigate local visibility impacts of wind farms on the development of property prices. Overall, four wind farm sites located in the federal state of North Rhine-Westphalia, Germany, are investigated.

Spatial Difference-In-Differences

To examine the potential devaluation of properties close to wind farm sites, we use a quasi-experimental technique and apply a spatial difference-in-differences (DID) approach. A spatial DID analysis allows for a comparison of the observed changes in the values of the treated properties against the values of a control group (Parmeter and Pope, 2013; Heckert and Mennis, 2012).

In our model, the treated properties (treatment group) are defined as those with a direct view on the wind farm, while the properties which experienced no treatment (control group) are those without a view on the constructed wind farm. By applying viewshed analyses in ArcGIS, we were able to infer the view of those individual properties that were directly affected by the newly constructed wind farm. The treatment and control groups are determined by an interaction term that indicates the degree of visibility and the time of construction of the wind farm.

In contrast, most studies adopt simple distance measures as proxies for visibility (Heintzelman and Tuttle, 2011; Hoen et al., 2013). In order to make a comparison between the two measures, we perform the same analysis in a second model, where we use distance measures as indicators for visibility. In this case, the treatment group comprises properties in the range of 1 to 3 km around the wind farm sites. Through differentiation between simple distance measures and visibility, we tried to draw a more distinct picture of the potential local impacts in order to better understand the obtained 'wind farm treatment'.

Results

For the region around the considered wind farm sites, our dataset includes 2,141 property transactions in the period from 1992 to 2010. The four wind farms were put into operation between April 2001 and July 2002, determining the exogenous change of the environmental attribute 'visibility', which is supposed to be reflected in the property prices. By applying viewshed analyses in ArcGIS on the basis of a high resolution 3D digital surface model, it was possible to establish that 608 properties have a direct view of at least one wind turbine. Figure 1 gives an overview of the study area and the affected properties. The extent of the turbine visibility for the different properties varies between one and 25 turbines. We distinguish three classes of visibility treatment: low visibility (view on 1 to 3 turbines, which pertains to 262 properties), medium visibility (view on 4 to 8 turbines, which pertains to 228 properties), and high visibility (view on more than 8 turbines, which pertains to 118 properties). In reference to the second model specification using distance measures, 28 properties are found to be in the range of 1 km, 120 properties are in the range of 2 km, and 469 properties are located in the range of 3 km around the wind farms.

According to overall performance of the models, we find that all model speci-

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fications perform very well with respect to the adjusted R^2 obtained (0.866 - 0.867). Moreover, both models are consistent regarding the expected signs and significance levels of the coefficients with respect to the structural, neighborhood, and spatial variables considered. However, we do find significant differences between visibility and distance variables regarding their ability to capture local wind farm impacts on property prices.

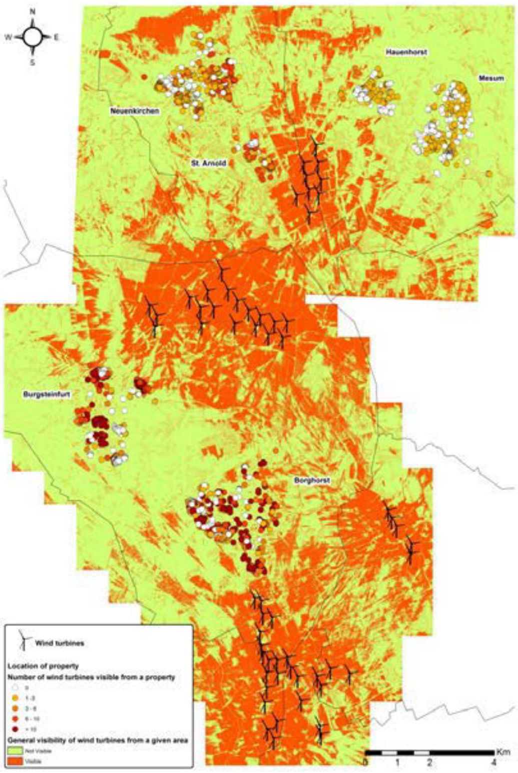

Figure 1: Wind farm visibility (Source, Own illustration)

Using distance variables, we find a negative impact of about -9% (at the 10% significance level) for properties within the range of 1 km. Unexpectedly, the 2 km distance variable is found to be statistically not significant. The variable capturing the properties within the 3 km range indicates a negative impact of about -11% (at the 1% significance level) after the treatment. Certainly, the results obtained from the three distance measures depend on the number of transactions in each range. In particular, the low number of transactions within 1 km may affect the interpretability of the results, as one expects the strongest negative impacts in the close vicinity.

On the contrary, a general wind turbine visibility (irrespective of the extent of visibility) only has a moderate negative impact on property prices of about -3% (at the 10% significance level). While low and medium visibility have no statistically significant impact on property prices, high visibility depresses prices by about -8% (at the 1% significance level). According to our results, it is not the visibility per se that leads to decreasing property prices, but rather the extent of visibility.

Overall, we find a negative impact on the development of property values due to the 'wind farm treatment'. Yet, the two alternative measures which are often used to capture similar local effects lead to widely differing results.

Conclusions

In order to analyze the local impacts of wind farm proximity and, in particular, wind farm visibility, we apply a spatial DID approach to four wind farm sites in Germany. By isolating the treatment effect caused by the construction of the wind farm, we investigated the differences in property value changes between the treatment group and the control group.

The results obtained indicate that the two most commonly used measures to estimate the impact of wind farms on property prices have significantly different results. Further analyses are necessary to estimate which of these two instruments might better capture the effects considered, as they possess rather different characteristics. According to our results, visibility seems to be a more specific indicator, which enables to single-out a distinct component in the price valuation of a property. Distance variables, on the other hand, are relatively generic means to approximate the local impacts of wind farms, which, according to our findings, remain ambiguous regarding their interpretability.

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Renewable Generation and Capacity Markets

By Peter H. Griffes*

Introduction and Summary

Capacity markets have become an important feature of a restructured electricity industry. They are needed to provide sufficient cost recovery where with energy market prices are restricted from providing sufficiently high signals to induce new generation. Over the last decade, there has also been a significant upswing in the renewable generation designed to replace greenhouse gas producing sources of energy. The introduction of intermittent renewable generation into bid-based restructured markets, especially as these resources achieve higher penetrations, can have a profound impact on the energy revenues to conventional generation, and consequently increase the necessity of capacity payments. As intermittent renewable generation penetration increases in restructured markets, there needs to be a greater reliance on capacity market compensation to ensure viability of conventional generation, needed to maintain reliability.

Capacity Markets are a Fixture of Restructured Electricity Markets

Capacity markets have become a necessary feature of restructured markets[1]. Capacity payments compensate generators for being available to participate in the energy markets. Such capacity markets can take many forms including bilateral contracting with load serving entities as well as centralized auctions operated by system operators who clear the market, invoice load serving entities, and send payments to generators.

Capacity markets are needed to provide revenue sufficiency and assure reliability where sole reliance on energy market revenues may not cover the long-term cost of generation (or short term cost for existing units to stay afloat). Energy prices in such markets are generally set by the bids of marginal generator taking into account transmission availability. However, energy revenues based on competitive prices are often not compensatory to cover longer-term cost of building and operating a new plant. For example, in the California market in 2013, the Department of Market Monitoring estimated that energy market revenues for a new combined cycle plant would be \$296.39/kW-yr. in comparison to the \$256.78/kW-yr. in operating costs and \$175.80/kW-yr. in annualized fixed costs.[2] The remainder of the costs would have to be covered by capacity market revenues.

Consequently, restructured markets have taken on resource adequacy requirements as a means to ensuring there is sufficient capacity to meet the anticipated needs of the system. Capacity markets are a necessary part of a restructured electric industry to produce sufficient revenues to generators.

Renewable Resources have Developed Significantly in Recent Years.

Over the last decade, concerns with climate change have pushed public policy to adopt a greater reliance on renewable resources. There is a wide range of different renewable generation, including hydro, geothermal, wind, biomass, and solar. Some renewable fuel sources are more easily storable than others. For instance, depending on the topology and availability, hydro power can be stored in reservoirs and released at times of greatest value. Biomass fuel is also readily storable, and geothermal is likely only to be tapped at locations where it is readily available. If fuel is able to be stored, then curtailing these resources when not needed, or detrimental to reliability, and then allowing their energy to be produced at other time times may not impact the economics of their operations. Other sources of renewable power are not as easily stored, and if they are compensated based on production, then they would need to generate when fuel is available to allow them to cover the plants development and operation costs. Wind and solar are such sources of renewable energy. If curtailment is not allowed and storage is not an economic option, then intermittent integration into the electrical grid may require more controllable resources to address the intermittence. Further, renewable resources have a different cost structure than conventional generation. Running costs for renewables can be quite low since payments for fuel are not necessary because power is produced through natural means: falling water, blowing wind or shining sun.

Renewable Participation in Bid-based Energy Markets

In restructured electricity markets, the presence of a significant number of renewable generators can have a profound impact on the market. There are three areas where renewables will impact capacity markets: displacement, increase costs and reduction in prices.

First, in bid-based energy market where the dispatch is based on generators' bids, renewable resources can affect which resources are dispatched in the market. In comparison to conventional fossil-fired generation, renewables are likely to have a lower running cost. Consequently, renewable generators can often bid much lower than conventional generation. This will lead to renewable generation being dispatched ahead of conventional plants. Thus, renewable generation

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displaces conventional generation in bid-based markets. This displacement lowers the capacity factor of conventional generators and reduces the time conventional generators are selling in the market. This reduced output reduces energy revenues to conventional generators.

Second, more intermittent renewables require greater flexibility on the part of all generation on the system. More variable output produced by renewable resources requires conventional generation to operate with greater variability to accommodate the increased variation. Significant demands for flexible output, including more starts/stops per day as well as cycling more often from minimum to maximum output, will likely increase the wear and tear on conventional generators and lead to higher operations and maintenance (O&M) costs and the need to schedule more frequent maintenance outages. Increased O&M costs and less availability due to more frequent maintenance will also have a financial impact on the conventional generators, likely cutting into the profitability of the generator. Consequently, conventional generation will be operating less often as well as having to operate in a manner that increases operating costs. These factors work to reduce the net energy revenue earned by conventional generators.

Third, there is an additional impact of renewable generation on energy prices. In bid-based markets, prices are set by the running costs of the marginal plants. Because renewable generators can have low running costs, prices can be quite low in markets where a renewable generator is marginal. Also, social policies to promote renewable generation often provide non-market incentives that influence market outcomes. For example, a production tax credit can produce positive net revenues to a generator even with negative market revenues. Consequently, renewable generators can be willing to pay other market participants to produce, resulting in negative prices for the entire electricity market.

As renewable generation penetration increases, the likelihood that such generation will be on the margin is greater, placing downward pressure on energy market prices. However, conventional generators will still be needed to provide flexibility to address renewable variability. This conventional generation may be subjected to very low energy prices. Therefore, ancillary services should be designed to provide needed flexibility at compensatory rates to conventional generators providing the service. If such ancillary services have not been implemented, there can be a significant impact on conventional generation revenue.

Consequently, the impacts of renewable generation in restructured, bid-based markets place a much greater need for a capacity market. Conventional generators are needed to balance renewable intermittence, but will face lower output, higher O&M costs and lower energy prices. These factors place a premium on enhanced ancillary services products to provide flexibility and greater reliance on capacity market revenues.

Implications for Capacity Markets

From the discussion above, there are empirical implications for capacity markets and reliance of capacity payments with respect to renewable generation as a proportion of a supply portfolio. While these implications are not tested here, general conclusions can be drawn as renewable generation penetration increases.

First, markets with a larger portion of renewable sources as intermittent will have greater need for capacity payments to conventional generation providing flexibility. Thus, markets with more intermittent wind and solar capacity will likely need greater capacity payments than markets with geothermal and controllable hydro resources.

Further, over time, there will be a greater need for the adoption and potentially refinement of capacity market payment streams for conventional generation providing flexibility as the penetration of intermittent renewable resources in a market increases. Thus, some of the moves to enhance existing capacity market structures can be seen in part as a response to increased intermittent renewables. For example, California's move to implement flexible resources requirements in its capacity market structure helps address issues arising from the adoption of an aggressive renewable portfolio standard.

Summary and Conclusion

Development of renewable resources can have a profound impact on revenues for conventional generators, and change the balance of energy and capacity market revenues. There are three causes for this impact on conventional generators. First, intermittent renewable resources reduce conventional generator revenue from quantity of electricity expected to be sold. Second, intermittent renewable resources reduce conventional generator revenue from selling at lower prices or scheduling energy directly into markets regardless of marginal cost. Third, increased flexibility requirements increase costs for conventional generators from more variable operations. These all work to reduce the energy revenues to conventional generators. Consequently, restructured markets with a greater proportion of intermittent renewable generation should have higher capacity payments than those with non-intermittent renewable generation.

See footnotes on page 34

Electricity

Active Distribution System Management: Need to Adapt the Regulation of Electricity DSOs

By Sophia Ruester, Ignacio Pérez-Arriaga, Sebastian Schwenen and Carlos Batlle*

Technological advances are reshaping today's electricity markets. More mature technologies for local renewable generation, joint with national support schemes, led to a significant market penetration of distributed generation in many EU countries. A newly emerging broad range of distributed energy resources (DER), including also local storage, electric vehicles and demand response, are driving significant changes in the operation of power systems.

The market penetration of DER opens possibilities for decentralized trade of energy and allows for new business models, mainly related to the aggregation and marketing of DER. Also distribution system operators (DSOs) can profit from employing local energy resources in their daily tasks of ensuring system functioning and grid investments. However, to exploit the full range of potentials that DER offer, DSOs have to undertake significant upfront investments in grid (and related) infrastructures. For DER to flourish and to enable them to compete with resources connected to the transmission grid, DSOs also have to provide adequate conditions for network access and usage. New business models may potentially even lead to a paradigm shift that can shake up the traditional value chain and cause a radical change of the power market architecture as we know it today, replacing traditional downstream marketing of power by increasing reliance on local sources.

As a consequence, existing regulation needs to be reviewed in its full spectrum, considering the DSO's function as a network operator as well as its function as a market facilitator along the value chain (see Figure 1). Reviewing DSO incentives as a network operator implies revisiting regulatory schemes for allowed remuneration and resulting incentives to invest and innovate, as well as revisiting network tariff design, as the allowed revenue is collected via grid charges and the structure and format of these charges will have an important impact on grid users' behavior. In contrast, reviewing DSO incentives as a key player along the value chain implies revisiting the regulatory base of DSOs both vis-à-vis the transmission system operator and vis-à-vis competitive activities.

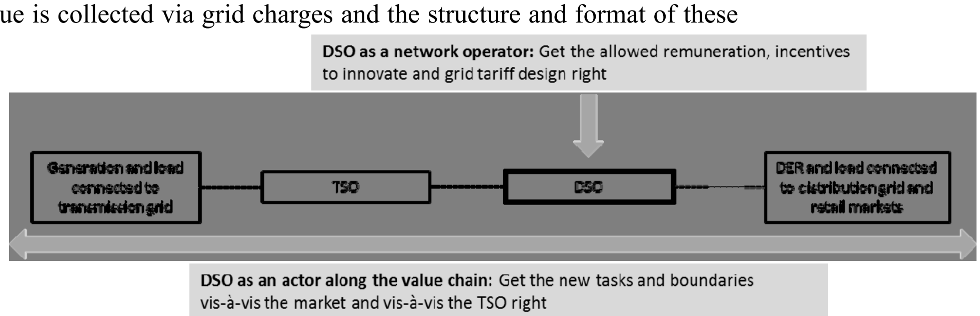

Figure 1: Relevant areas of regulation

The current regulation of DSOs needs updates to allow for welfare-enhancing DER technologies to be adapted efficiently and in a timely fashion. A major challenge is to revisit regulation such that distribution companies are not negatively affected by the development of DER and are incentivized to foster the integration of viable new technologies into the market. Moreover, updates are needed to provide the right regulatory tools to DSOs such that they can benefit from the services DER can offer for system operation and planning. Ultimately, the priority task of regulation is not to try to predict what the future will be, but to design incentives that make possible all welfare-enhancing business models under any future market development.

DSO remuneration: For high amounts of DER connected to distribution systems, the total costs of business-as-usual management of distribution networks (that is, a continued "fit-and-forget" grid management) will likely increase in most systems. Yet, increasing amounts of DER have a twofold impact on DSOs' cost structures: On the one hand, substantial investments are required to connect all new resources, to enable the system to deal with increased volatility of net demand, and to set up ICT infrastructure that empowers DSOs to employ DER for their daily grid operations. On the other hand, DER at the same time offer a new set of instruments for grid operation and thereby a tool for DSOs to perform their tasks of ensuring a reliable, secure and efficient electricity distribution.

Therefore, incentive regulation for DSOs has to allow for overall higher compensation of DSOs, but at the same time set sufficient incentives to invest in ICT

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This article summarizes their paper forthcoming in Utilities Policy.

and grid infrastructures in order to exploit the full potentials that DER offer for system services. Future regulation has to take account of i) changing OPEX and CAPEX structures, ii) the optimal choice among both, and of iii) how to incentivize DSOs to deploy innovative solutions.

Distribution grid tariff design: The present design of network tariffs does not provide a level-playing field among all agents that use the distribution network. With an increasing penetration of DER, business models exploiting, for instance, inefficient arbitrage possibilities caused by differentiated treatments of different DER technologies, or of certain types of producers and consumers, might flourish in the absence of sound tarification procedures. Moreover, grid users are becoming complex, sophisticated agents, which can have very diverse consumption and production patterns. The current paradigm, exclusively designed for pure consuming agents and where distributed generation was considered a minor exception, does not hold anymore.

Therefore, grid tariffs, on top of guaranteeing full cost recovery, should be able to convey efficient economic signals to the entire diversity of agents that may connect to the distribution grid. Tariffs should reflect the true costs (or benefits) of different types of load and generation for the distribution system, which will depend on an agent's geographic location in the system as well as on the profile of injection/withdrawal from the connection point. Any hidden subsidies should be removed and replaced by sufficient but direct subsidies that do not turn into inefficient signals.

DSO boundary vis-à-vis the market: There are a number of areas in the newly emerging market environment where there is no consensus about whether the respective tasks should be under the responsibility of the DSO or not. Different proposed (regulated as well as liberalized) models for e.g. the ownership and management of metering equipment, or data handling, all have their advantages and disadvantages. For all new infrastructure services it holds that when regulators opt for implementing these new tasks via DSOs, possible repercussions on energy and power markets have to be ruled out. With an increasing penetration of DER and the accompanying advent of new market actors and business relations, the negative effects of limited unbundling might become aggravated. When mandatory ownership unbundling is politically not enforceable, or is economically counterproductive for the customers' choice (through a drastic reduction of suppliers on the market) or for the customers' bill (through duplication of costs in separated entities or loss of synergy with other local utility functions), stricter implementation of unbundling requirements and market transparency measures should be mandated as more responsibilities are given to DSOs.

DSO boundary vis-à-vis the transmission system operator (TSO): When moving from 'passive distribution networks' towards 'active distribution system management', DSOs become agents that manage local markets for network services or directly purchase services with commercial value from other agents, and their role and organization will have an important impact on (retail) market functioning. Some of the products which DER can offer are relevant for either the TSO or the DSO, whereas other types of services might be of interest for both types of network operators. Hence, coordination and information exchange between TSOs and DSOs, from planning stage to operation, will play a particular role as the amount of DER increases and as DSOs become more active and exploit DER services closer to real-time delivery.

In the European context, regulation has to be in line with the three EU energy policy pillars and be kept at minimum level, respecting the principle of subsidiarity. Accordingly, we see neither the need nor a solid justification for an EU-wide comprehensive harmonization of the regulation of DSOs, although we recommend setting clear minimum requirements in a few key regulatory aspects, as well as the publication of EU guidelines to spread, encourage, and monitor good regulatory practices in some of the critical areas that have been identified in our paper.

Manipulation of Day-ahead Electricity Prices through Virtual Bidding in the U.S.

By Chiara Lo Prete and William W. Hogan*

Enforcement actions of the Federal Energy Regulatory Commission (FERC) in regard to allegations of price manipulation in electricity markets have been the source of a great deal of controversy in recent years. In several of these cases, the agency has accused banks, energy trading firms and other participants in physical and financial electricity markets of taking uneconomic positions in the physical market to reap gains in related financial positions. Most pending investigations and proceedings have ended with settlement agreements, which typically contain no admission of wrongdoing and no analysis of the underlying claims. Between October 1, 2012 and September 30, 2013, the Commission's approved settlements levied roughly $445 million in civil penalties and disgorgement against six companies. JP Morgan's $410 million penalty, the largest one handed down by the Commission so far, is well below the $488 million proposed for Barclays Bank and four of its former traders for allegedly manipulating electricity prices in California between 2006 and 2008. The tendency to resolve enforcement cases via settlement has raised concerns among market participants and analysts: settlement agreements provide little information about the details of the alleged violations, and thus offer limited insights about FERC's interpretation of its fraud-based anti-manipulation rule.

Real-time physical markets are vulnerable to manipulation, and extensive monitoring and mitigation rules are in place to prevent such manipulation. Absent control over real-time markets, the special nature of electricity cash settlement rules makes day-ahead manipulation more difficult than with storable commodities. So-called virtual trades are day-ahead financial transactions that mimic physical bids and offers, but are settled at the real-time energy price. Financial Transmission Rights (FTRs) are financial instruments that entitle the holders to receive a share of the congestion rents created when the network is constrained in the day-ahead energy market, and provide a hedge against variations in nodal prices and associated congestion charges.

In this article, our focus is on one particular type of market manipulation strategy considered by FERC: placing virtual bids that are unprofitable on a stand-alone basis, but are intended to move day-ahead electricity prices in a direction that enhances the value of related FTR positions. Ledgerwood and Pfeifenberger (2013) show how, given the positions of other market participants, an energy trader would have an incentive to submit an excessive number of uneconomic virtual demand bids at a node representing the sink of its FTR position. Because the FTR pays the holder, for each megawatt awarded, the difference between the day-ahead congestion price at the sink and at the source of the contract, cleared virtual load at the sink could increase the value of the financial position. However, the situation described by Ledgerwood and Pfeifenberger cannot represent an economic equilibrium. By placing uneconomic virtual demand bids at a node, the trader would create a divergence between day-ahead and expected real-time prices. This should promote competition for arbitrage opportunities, in turn leading to price convergence and making manipulation of day-ahead electricity prices impossible to sustain.

How could an energy trader affect day-ahead electricity prices, but avoid allowing other market participants to profit from arbitrage opportunities created by uneconomic virtual bidding? Although this issue presents relevant implications for the design of electricity markets, an economic framework for the analysis of electricity market manipulation through virtual bidding has not been presented. Such a framework may help identify market features that implicate manipulation, as well as conditions that would need to be observed for empirical analysis. Our goal is to adapt an equilibrium model of day-ahead market manipulation, when real-time price manipulation is not possible.

The focus is on the case of an energy trader who does not control real-time power output nor serve load, and does not collude with other market participants. We refer to the extensive literature on price manipulation in equity and other financial markets, and construct examples of equilibrium manipulation in the context of Kumar and Seppi (1992), which in turn draws on the classical work by Kyle (1985).

Kumar and Seppi's equilibrium model allows a trader without superior information on market fundamentals to successfully manipulate the spot settlement price of a stock futures contract. Spot sales are subsequently cash-settled on the delivery date: importantly, there is no manipulation of the cash settlement for spot transactions. Thus, their framework is analogous to the case of day-ahead electricity price manipulation, when the real-time price is assumed not to be subject to manipulation. We begin by considering a single electricity node, where an FTR forward market is followed by a two-settlement, day-ahead and

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real-time, energy market. An informed trader participates in the day-ahead energy market, while noise traders and an uninformed trader participate in both the FTR and the day-ahead markets. All market participants are risk neutral and place virtual bids on the day-ahead market. In particular, the uninformed trader establishes its FTR position, and then submits its virtual demand or supply position to maximize expected profits, given the total quantity cleared in the FTR market and subject to an FTR position limit. In each market, orders are batched and the market-clearing price is set based on the aggregate order flow.

Following Kyle and assuming linear pricing rules and trading strategies, we obtain the unique equilibrium via backwards induction. The uninformed trader successfully manipulates the market and earns positive expected profits by going long (or short) in the FTR market with equal probability, and then buying (or selling) in the day-ahead market, so as to raise (or depress) the day-ahead price, because its trades are confused with those of the informed trader. If its FTR position is larger than the expected day-ahead position, the manipulator will recoup, on average, the losses in the day-ahead energy market through the profits in the FTR market.

The application of the Kumar and Seppi framework yields insights with regard to the possible empirical implications of day-ahead price manipulation through virtual bidding. First, randomization of the manipulator's confidential FTR positions is a critical feature of this equilibrium model. Although necessarily hidden from other market participants, the FTR positions should be fairly easy for FERC to observe. Moreover, in this setting the manipulator does not create a persistent divergence between day-ahead and expected real-time prices: from the perspective of market participants other than the manipulator, the expected day-ahead price is equal to the expected real-time price. Finally, in Kumar and Seppi's framework the efficiency of the day-ahead market is neither raised nor lowered as a result of the manipulation, since the variance of the day-ahead price is the same, relative to the case in which no manipulation occurs. The principal effect of the manipulation is to redistribute trading profits among the day-ahead market participants.

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Kyle, A. 1985. Continuous auctions and insider trading. Econometrica 53, 1315-1335.

Costs and Benefits of U.S. Renewables Portfolio Standards *(continued from page 20)*

Footnotes

[1] The full report (Heeter et al. 2014) is publically available at http://emp.lbl.gov/publications and http://www.nrel.gov/publications/.

[2] In states with restructured markets, the traditional electric utility monopoly—where the utility provides generation, transmission, and distribution—has been split. Customers in restructured states can choose which electric service company will supply their generation. In traditionally regulated states, vertically integrated utilities provide generation, transmission, and distribution service to a captive market (i.e., franchise service territory).

[3] Most states with restructured markets include an ACP mechanism whereby a load-serving entity (LSE) may alternatively meet its obligations by paying the program administrator an amount determined by multiplying the LSE's shortfall by a specified ACP price (e.g., $50/MWh). ACP prices serve, more or less, as a cap on REC prices, because LSEs generally would not pay more than the ACP rate for RECs.

[4] CT—Connecticut, DC—Washington DC, DE—Delaware, IL—Illinois, MA—Massachusetts, MD—Maryland, ME—Maine, NH—New Hampshire, NJ—New Jersey, NY—New York, OH—Ohio, PA—Pennsylvania, RI—Rhode Island, TX—Texas, AZ—Arizona, CA—California, CO—Colorado, MI—Michigan, MN—Minnesota, MO—Missouri, NC—North Carolina, NM—New Mexico, OR—Oregon, WA—Washington, WI—Wisconsin

National Policies for Renewable Electricity are an Obstacle to Market Integration in the European Union

By Thomas P. Tangerås*

Introduction

A cornerstone of energy policy in the European Union (EU) is to create a well-functioning internal market for electricity. Another fundamental objective is to transform the EU into an economy based upon a reliable and environmentally sustainable supply of energy.

To facilitate the transformation into a greener economy, the EU has imposed national targets for the renewable share of energy consumption, but delegates to the individual member states how to fulfil them (Directive 2009/28/EC). Electricity makes up a significant share of final energy consumption; the EU average is roughly 20 per cent. To achieve the renewable targets, many EU member states have thus implemented policies to promote the production of electricity from renewable energy sources, RES-E.

RES-E support mechanisms are now main drivers of investments in new generation capacity in many countries and thereby exercise a substantial influence over electricity prices. Price changes affect not only generation investment and consumption, but also the profitability of cross-border interconnections through the congestion rent network owners earn from buying electricity in one country and selling it more expensively in another. The cross-border interconnection capacity in turn determines the degree of market integration by restricting the volume of electricity trade between countries. Market integration, as measured by the volume of trade, and RES-E support mechanisms are therefore linked through the electricity market.

The Objectives of Increased RES-E Production and Market Integration are Mutually Inconsistent

A problem with implementing the desired EU energy policy is that the twin goals of increased RES-E production and market integration may oppose one another when implementation is decentralized to the individual member states.

Governments can choose between a host of instruments to promote investments in renewable electricity: green certificates (also known as renewable portfolio standards), feed-in tariffs, investment support and taxes on electricity production from non-renewable energy sources, to name a few. This menu of instruments leaves ample room for national policy makers to pursue additional objectives unrelated to the official goal of increasing renewable electricity production.

National policy makers can increase surplus in an electricity importing country by introducing certificates or feed-in-tariffs which serve to reduce the import price of electricity. A corresponding production tax on non-renewable electricity production increases the export price of electricity and thereby domestic surplus in an electricity exporting country. A unilateral pursuit of such domestic RES-E policies decreases cross-border price differences, with negative consequences for congestion rent, transmission investment and thereby market integration.[1]

The Historical Adoption of RES-E Policies Among EU Member States

In light of the above arguments one might expect electricity importing countries to have been keener on renewable portfolio standards and feed-in-tariffs than electricity exporting countries and therefore introduced them at an earlier stage.

Table 1 partitions 27 EU member states (Croatia is not in the sample) into early adopters and late adopters depending on whether they introduced a RES-E policy prior to or later than 2002, the median year of enacting a RES-E policy in the sample. The table also characterizes the sample according to trade flows. A member state is defined an electricity importing (exporting) country if its average annual net import (export) volume of electricity was statistically significant at the 10% level over the period 1990-95. A balanced country had an average annual net trade insignificant from zero.[2]

	Import	Balanced	Export
Early adopters	GR, IT, LU, PT	AT, DE, DK, ES	FR
Late adopters	FI, GB, HU, LV, NL, RO, SK	BE, BG, CY, IE, MT, SE	CZ, EE, LT, PL, SI

The data seem consistent with the hypothesis of early adoption and trade flows. Four of the early adopters (Greece, Italy, Luxembourg and Portugal) were

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See footnotes at end of text.

net importers of electricity, whereas all net exporters except for one (France introduced a RES-E policy in 2001) were late adopters. Three of the early adopters, Denmark, Germany and Spain, were import countries on average, although not in a statistically significant sense. These findings should be interpreted with caution because they could have other explanations. Still, they are indicative that trade flows could have an impact on the adoption of RES-E policies.

What are the Policy Implications?

Governments can use RES-E schemes as substitute policies when trade agreements prevent them from using tariffs and export subsidies directly. Trade policy concerns speak in favour of prohibiting RES-E mechanisms. But environmental or other externalities, such as spill-over effects from R&D investments in renewable technologies, sometimes justify RES-E support policies on welfare economic grounds.

A possibility would be to coordinate investments at a centralized level. This would require of the central authority that it knew the distribution of costs and benefits of renewable electricity throughout the economy. More plausible is the assumption that a central planner would be incompletely informed about relevant aspects of the member states' economies. This renders some decentralization desirable.

A harmonization of and reduction in the number of policy instruments would reduce the risk of distortions under decentralized policy making by limiting the scope for pursuing ulterior motives. A particular promising strategy would be to follow the lead of Sweden and Norway and create an integrated market for green certificates. Trade in certificates increases efficiency by reallocating renewable investments to their most socially beneficial location.

Harmonization may be incapable of fully eliminating all distortions arising from decentralized policy making. If so, the observed differences in electricity prices across countries are likely to underestimate the marginal social benefit of cross-border interconnections. In this case, subsidies to transmission investment at the central level are one way of increasing market integration and efficiency.

Energy Policy in the EU Beyond 2020

The European Commission has recently presented its proposals for an energy policy posterior to 2020. It is now up to Parliament and the member states to reach an agreement. This process provides an opportunity to reassess the EU energy policy and possibly modify it along the lines discussed above.

A future harmonization may in fact be unavoidable. In a recent Opinion, Advocate-General Yves Bot at the European Court of Justice came to the conclusion that Article 3.3 of Directive 2009/28/EC is void insofar as it allows member states to limit producers' in other member states access to domestic RES-E mechanisms. This would represent a quantitative restriction on imports and thus be in violation of Article 34 of the EU Treaty. If the court accepts this Opinion, it will become impossible to uphold national support systems. One solution is an EU-wide mechanism which provides equal access to all producers of renewable electricity. A properly designed integrated support system would furthermore increase the efficiency of electricity supply in the EU.

Footnotes

[1] The EU seems to have recognized the potential for member countries to use national policies for trade policy reasons. Directive 2001/77/EC, which lays the foundation for RES-E policy in the EU, states that "the Commission shall evaluate … mechanisms used in Member States according to which a producer of electricity … receives direct or indirect support, and which could have the effect of restricting trade."

[2] The data on RES-E policy are from Jenner, S., Chan, G., Frankenberger, R. and Gabel, M. (2012) 'What drives states to support renewable energy?' Energy Journal 33 (2), 1-12. The trade flow data are from Eurostat.

Renewable Generation and Capacity Markets *(continued from page 28)*

Footnotes

[1] The nature of capacity markets has been well documented and summarized in the literature; see Symposium on 'Capacity Markets,' *Economics of Energy and Environmental Policy*, Vol. 2, Issue 2, September 2013.

[2] P. 55-56, *2013 Annual Report on Market Issues & Performance*, California ISO Department of Market Monitoring, April 2014.

On the Future of Electricity Supply. Competitive Markets or Planned Economies?

By Reinhard Haas, Hans Auer and Michael Hartner*

Introduction

In recent years increasing shares of electricity generation from intermittent renewable energy sources (RES-E) like wind and photovoltaics (PV) in Germany have started to change the usual pattern of electricity markets in Western Europe fundamentally. The fact that these "must run" capacities are offered at Zero or even negative costs over a large time per year has led to the situation that mainly natural gas power plants became economically less attractive because of lower fullload hours per year and to a call for "capacity" markets (CM) in addition to the "energy-only" markets. Currently, also the EC is looking for a new or revised electricity market design (Koch (2012)). The core objective of this paper is to discuss the relevance and the effects of CM and the alternatives.

Our method of approach is based on the basic principle that prices equal marginal costs. This principle prevails since the start of liberalization. Because at that time considerable excess capacities existed in Europe the expectation was that prices will (always) reflect short-term marginal costs (STMC) see Stoft (2002). Because of lower fulload hours this principle is now questioned.

How Intermittent Renewables Impact Prices in Electricity Markets

The core issue is, how electricity prices will evolve in future if larger amounts of intermittent RES-E mainly from wind and PV are generated. An example is shown in Figure 1 where a hypothetical scenario with high levels of generation from intermittent RES-E over a week in summer is depicted. The graph shows significant volatilities in electricity market prices with total costs charged for conventional capacities – black solid line – ranging from zero to 14 cents/kWh within very short time intervals. Note, that intermittent renewables will also influence the costs at which fossil generation – especially natural gas – are offered. The reason is that they wcould lead to much lower fullloadhours, e.g. only 1000 instead of 6000 h/yr before. Yet, the revenues earned from these hours must cover both the fixed and variable costs, see also Haas 2013. This leads to the figure of 14 cents/kWh in Figure 1.

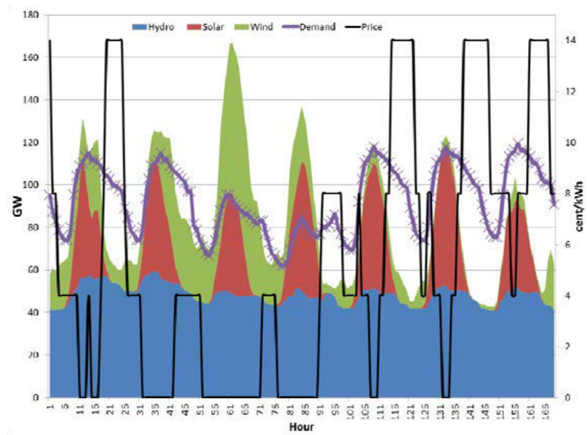

Figure 1. Development of intermittent RES-E over a week in comparison to demand and resulting electricity market prices with total costs charged for conventional capacities.

In practice, of course, the prices may not just go to zero but also below. Given the price pattern in Figure 1 we are convinced that it would be attractive for (some but sufficient) power plants operators to stay in the market or even to construct a very efficient new plant! This would lead to a revised energy-only market.

Capacity Payments and Corresponding Problems

If these temporaily high prices are not accepted CM could be a proper solution. Yet, the first major reason for the call for CM is to retain supply security in the electricity system. The historical (anachronistic) definition of supply security is: At every point-of-time every demand has to be met regardless of the costs! The major reason for this is that in times of regulated monopolies every demand could be met due to significant excess capacities and in the liberalized markets still excess capacities remained. In the context of the discussion of market design this historical view of supply security plus CM would lead to a new market design in the sense of a centrally planned economy.

The major CM models currently discussed are (see e.g. Cramton et al 2012): (i) a Comprehensive CM model which treats existing and new capacities jointly; (ii) a Focused CM approach which differs between existing and new capacities. In both of these market models – as in the classic EOM – the price should equal the STMC. The major open questions regarding CM are: (i) Which quantity of capacity should get payments and where? (ii) How to split in existing and new capacity? (iii) How to tune with grid extention?; (iv) Who plans? On national or international level?

Based on these open questions an important aspect is the international dimen-

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sion. In recent years a remarkable convergence of prices has taken place even in Western continental Europe. That is to say that any measure in one country will affect the market structure in others. The discussion in Europe starts with the request for CM on national level. Yet, because the Western European electricity markets is strongly integrated the national planning activities has at least to some extent to consider the international dimension. Transboundary grid extentions and storage availability are some important aspects. This leads after some time undoubtedly to international planning of CM. The next logical step is to think about an international joint concept for financing. And this would lead very soon to central European planning, Figure 2.

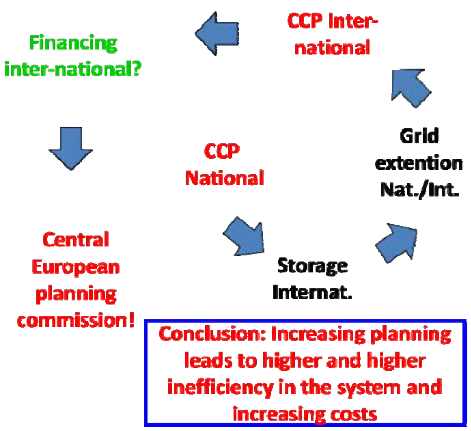

Figure 2. The international planning spiral in the implementation of capacity markets.

A Market-based Approach

On contrary to this central planning approach a market-based one would take into account customers WTP and the equilibrium between demand and supply would come about at lower capacities. Note, that where WTP is lowest the MC of providing capacity are highest, see Figure 3. A market approach will consider also other options on the supply- and demand-side as there are, see Figure 4 and Praktiknjo 2013:

- DSM (technical): Measures conducted by utilities like cycling, control of demand, e.g. of cooling systems)
- Demand response due to price signals: Response of mainly large customers to price changes
- Transmission grid extention: if the grid is extended there is in principle always more capacity available in the system and the volatility of RES a well as demand evens out;
- Smart grids: They allow variations in frequency (upwards and downwards regulation) and switch of voltage levels and contribute in this context to a load balancing
- Storages: short-term and long-term storages – batteries, hydro storages, or chemical storages like hydrogen or methane – can help to balance significant volatilities of RES generation.

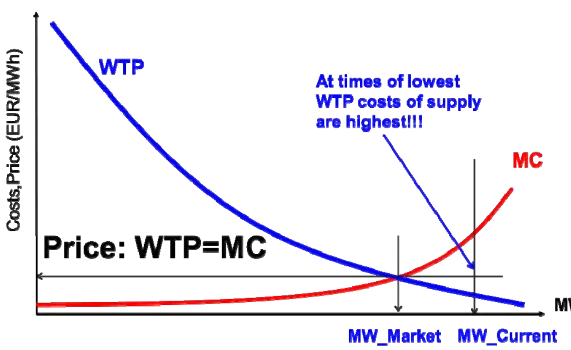

Figure 3. A market-based approach to supply security

A core problem is that so far the demand-side has been fully neglected with respect to contributing to an equilibrium of demand and supply in an electricity market. No culture of integration of demand has so far been developed. This aspect – to develop the impact of demand-side and customers willingness-to-pay (WTP) – is essentially for a real electricity market and it is actually regardless of the aspect of an integration of larger shares of RES.

Hence, a major component of the revised EOM-model described above is to include demand-side contracts. In this category fits also the idea of Erdmann (2012) who suggests that the balancing groups should be responsible for providing capacities.

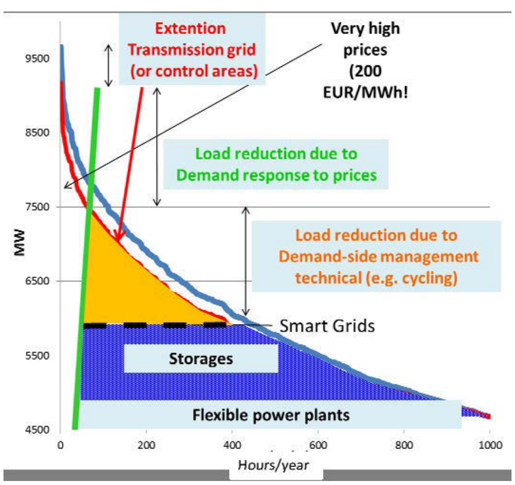

Figure 4. Options for coping with peak residual load in electricity markets

Conclusions

The major conclusion of our analysis is that capacity markets are a step back to a planned economy with – all in all – much higher costs for society. The only "negative" aspect of a market without capacity component will be that – at least in the short run –temporarily higher costs than the short-term marginal costs will occur. However, after some time the market will learn to benefit from these higher costs and also from the very low costs at times when RES are abundant. A reasonable price spread will come about that provides incentives for different market participants to benefit from these spreads. In total we think that in addition to pure power generation capacities other elements like Smart grids, technical and economic demand-side management, short-term storage options will even out a large part of the residual load profile (the difference between demand and supply from RES).

The most important conclusion is that the evolution of such a creative system of integration of RES in Western Europe may also serve as a role model for largely RES-based electricity supply systems in other countries world-wide. So there is especially NOW no need for CCP. If all our arguments would turn out to be wrong it would still be sufficient to introduce such a model and to abolish the electricity markets.

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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				
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				
February 23-24	8th NAEE/IAEE International Conference *Future Energy Options: Assessment, Formulation and Implementation*	Ibadan, Nigeria	NAEE/IAEE	Adeola Adenikinju *adeolaadenikinju@yahoo.com*
March 15-18	5th ELAEE Conference *Energy Outlook in Latin America and Caribbean: Challenges, Constraints and Opportunities*	Medellin, Colombia	ALADEE/IAEE	Isaac Dyner *idyner@yahoo.com*
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*
October 25-28	33rd USAEE/IAEE North American Conference *The Dynamic Energy Landscape*	Pittsburgh, PA, USA	3RAEE/USAEE	David Williams *usaee@usaee.org*
2016				
February 18-19	9th NAEE/IAEE International Conference *Theme to be Announced*	Abuja, Nigeria	NAEE NAEE/IAEE	Adeola Adenikinju *adeolaadenikinju@yahoo.com*
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*

Residential Electricity Demand in Chile

By Claudio A. Agostini, Cecilia Plottier and Eduardo Saavedra*

Introduction

Since early 90s the electricity demand in Chile has steadily grown (at an average rate of 8% during the period 1990-2007 and an average of 5.7% during 2008-2012). In the past, the increase in demand was follow by increases in supply, even though there were some shortage periods mostly due to droughts. During these periods of shortage consumers were rationed and there were even some blackouts periods for some type of consumers.

In general, government policy in cases of electricity shortages has been to try to reduce consumption using non-pricing mechanisms. In the case of residential electricity different policies have tried to reduce consumption through incentivizing energy efficiency (use of efficient light bulbs for example) and reducing voltage. The implicit assumption behind these policies (and an explicit assumption in the regulation) is that electricity demand is inelastic to prices. If this assumption is incorrect and the price elasticity is different from zero, then there are pricing policies that can be a better option to deal with supply shortages.

Now Chile faces more complex energy challenges, as the approval of new power generation plants have become increasingly difficult due to environmental restrictions and the supply of energy is not growing at the same pace as demand. Therefore, in a context of growing demand and stochastic energy supply in Chile, it becomes relevant to have a better knowledge of the determinants of the demand of electricity for household use- price elasticity in particular- in order to reduce possible energy deficits through flexible pricing mechanisms. This paper estimates the demand for residential electricity using data from the National Survey of Socioeconomic Characterization (CASEN) 2006, being innovative over previous studies by using disaggregated data per household as previous studies have used aggregated data (Benavente et al. (2005) and Marshall (2010)). The results are consistent with some previous studies, showing a price elasticity between -0.38 and -0.40 for residential consumption, a cross- elasticity between 0.14 and 0.16 with respect to the price of liquefied gas, and an income elasticity of between 0.11 and 0.12, depending on whether it was evaluated on the median or mean of the independent variables. In conclusion, the results show the feasibility of demand management as part of an energy efficiency policy and thus cope with negative shocks of electricity supply in Chile.

Electricity Demand

The residential demand for electricity is a derived demand from the use of appliances and illumination. Therefore, the demand for electricity depends on the stock of durable goods (appliances) in the household, their energy requirements, and their intensity o fuse by household members. Based on this, we theoretically derived a demand for electricity from a household maximization problem (Filippini (1999) models energy demand in a similar way). Then, using data from a survey of 34,072 households in Chile in 2006 and data on energy prices for each region of the country, we estimate a residential electricity demand. The data includes information on household consumption of electricity, natural gas, liquefied gas, and wood (mostly for heating purposes and in some rural areas probably for cooking too). Additionally, the survey reports each appliance in the household (washer, dryer, refrigerator, boiler, computer, TV), main housing characteristics (type of roof, type of walls, number of bedrooms, number of bathrooms) and several demographic characteristics (income, education level, number of people in the household, number of children in the household). We also include in the estimation several geographic variables (average temperature, amount of rain). The demand is estimated using Non Linear Least Squares with Heteroskedasticity correction and also considering a potential selection bias because it is non-random the access that different households have to liquefied gas.

One the most relevant results is that demand elasticity is around -0.4, which implies that an automatic price adjustment in case of shortage would allow a reduction in electricity consumption that could prevent blackouts. The magnitude of the elasticity is similar to what other studies have found for other countries (Reiss and White (2005) for California (de –0,39) and Halvorsen and Larsen (2001) for Norway), and shows that assuming a completely inelastic demand might be incorrect and prevent the implementation of better energy policies.

The estimated cross-price elasticity of electricity with respect to liquefied gas is around 0.16, showing some degree of substitution between the two energy sources. This is an additional contribution o this paper as there are few studies

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in the literature estimating this elasticity (Dubin and McFadden (1984) estimate an elasticity of 0.39 for U.S. households).

Finally, the income elasticity is quite small, with a magnitude around 0.1, which is a relevant parameter for the purpose of estimating demand growth in the future as Chile's income per capita grows.

Conclusions and Future Research

In Chile there exists increasing concerns about potential future shortages of energy, as demand have been increasing faster than supply. As a result, several energy policies have been considered and implemented with the goal of reduce electricity consumption. Most of them are related to energy efficiency, but when facing serious risks of blackouts the government has opted for rationing consumers and reducing voltage.

The evidence presented in this paper allows to consider the substitution patterns of households in terms of energy for the purpose of designing and implementing better policies. Particularly, a demand that is not completely inelastic allows the use of a price mechanism to reduce consumption instead of a rationing mechanism.

As future research, the knowledge of price and income elasticities allows a more precise estimation of the potential effects, in terms of revenue and efficiency, of the use of taxes that consider negative externalities of energy consumption on global warming (Azevedo et al. (2011)).

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Energy Modeling

Beyond National Economy-wide Rebound Effects

By Simon Koesler, Kim Swales, and Karen Turner*

Introduction

The potential for rebound effects in energy consumption to erode anticipated energy savings from increases in energy efficiency are the subject of much academic debate and increasing policy concern. Rebound occurs where the potential energy savings from efficiency-enhancing innovations are partially (or perhaps even wholly) offset by a variety of economic responses. For example, cost-effective energy efficiency improvements in industrial energy use lowers the marginal cost of energy services, thus encouraging increased use of those services, as well as lowering output prices, boosting economic productivity and competiveness (both in the sector where efficiency improves and down-stream) and thereby triggering a general economic expansion in the region/country where the efficiency improvement takes place. The energy use associated with this expansion gives what is referred to as the economy-wide rebound effect. However, expansion may be limited, with crowding out in some sectors where supply constraints exist, and with potential contraction in energy supply activity where there is a net decrease in energy demand as a result of the efficiency improvement. Therefore, economy-wide rebound may be expected to consist of a mix of positive and negative pressures on energy use across the economy in question (see the corresponding author's recent review in The Energy Journal 1).

Here we argue that the common national focus of energy rebound should be extended to an international context. Specifically, given the global nature of today's goods and factor markets generally, and energy supply in particular, national actions to reduce domestic energy use through efficiency improvements may impact energy use in other regions. This is an important issue particularly in the context of multiregional policy frameworks such as the European Union's 20-20-20 package, as it implies that national targets and actions cannot be considered independently.2

Energy Efficiency Spillover Channels

We identify three broad channels through which rebound effects from increased efficiency in industrial energy use (the nature of international spillover effects and rebound pressures may differ to some extent where efficiency increases in residential energy use) may spread from one country to its trade partners.

First, consider general demand channels. When technical efficiency increases in productive energy use this equates to a positive supply-side shock in the nation where the improvement takes place, leading to falling prices and increased competitiveness. The most basic impact will be a general expansion in activity on both the production and final consumption sides of the domestic economy. Where producers and final consumers use a combination of domestic and imported goods and services, positive income and multiplier effects will stimulate both foreign and domestic production, allowing the benefits of the expansion to spread to the wider global economy. This would underlie concerns that rebound in energy use will grow as the boundaries under consideration expand. However, where there are any constraints in factor supply conditions in different regions, there will be opposing upward pressure on prices, which will in turn put downward pressure on economy-wide rebound, although increased factor returns will general positive income effects. Thus, this channel generates a mix of positive and negative pressures on rebound in global energy use.

Second, we identify a related competitiveness channel. An increase in the energy input efficiency in a target sector/country causes a shift in comparative advantage of this sector relative to its counterparts in other regions. Moreover, the benefits enjoyed by the targeted sector will spread to other (domestic and external) sectors that use the targeted sector's outputs as intermediate inputs. However, the nature and strength of international spillover effects will depend on contraction in external sectors whose competitiveness is reduced relative to the targeted sector, and any negative impacts on related supply chains and factor returns.

Third, we consider energy market channels. Changing demands for the outputs of energy supply sectors may result in three types of effects. First, any reduction in energy demand will ultimately reduce the overall amount of produced energy. Because energy supplying sectors are generally relatively energy intensive, this by itself will curb energy use in the energy supply chain, both at home and abroad. The extent to which this will decrease local and/or foreign rebound depends crucially of the location of the main energy supply of sector and wider economy

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See footnotes at end of text.

where the efficiency improvement takes place. However, the initial decrease in energy demand as efficiency improves will generate downward pressure on domestic and – if energy markets are sufficiently integrated – also external energy prices. Where energy prices are depressed due to excess capacity, this will trigger additional energy demand and put upward pressure on rebound in the respective regions. On the other hand, if revenues and returns to capital fall, over time the incentive to maintain/invest in energy supply capacity will be negatively affected. As energy supply conditions tighten, market prices for energy are likely to rise, thereby offsetting positive demand pressure driving rebound.

Preliminary Results for the Case Study of Increased Efficiency in German Industrial Energy Use

Quantitatively, the influence of each of these channels on overall 'global economy-wide rebound' effect will vary depending on the structure of existing trade linkages between regions that have and have not directly benefited from increased energy efficiency. We close with some results from an initial case study for Germany, where we use a static multi-sector, multi-region interregional computable general equilibrium modelling (CGE) framework to simulate a costless and permanent 10% improvement in energy efficiency that is first applied to all German production sectors and then limited to the composite manufacturing sector. In the results reported below we assume that total supplies of labour and capital are fixed at the national level. We identify four levels of rebound effect that incorporate all economy-wide impacts (as determined in a general equilibrium context) but with attention focused on: (1) the targeted sector; (2) on all industrial/productive energy use – where (1) and (2) coincide where all production sectors are targeted with the efficiency improvement – (3) on all domestic (industrial and final consumption) in the home economy; and (4) energy use in the global economy, first considering energy use within the EU before total world energy use.

Table 1. General equilibrium rebound effects from a 10% increase in industrial energy efficiency

	Own sector	Own-country production	Own-country total	Global	
				EU	World
(a) Increased efficiency in all German produciton					
Rebound (%)		46.60	50.18	47.28	46.58
Percentage point change			3.58	-2.90	-0.70
(b) Increased efficiency in German manufacturing					
Rebound (%)	56.44	47.63	51.31	50.22	48.11
Percentage point change		-8.81	3.68	-1.09	-2.11

Table 1 reflects our findings (reported in detail in the full conference paper) that in the case of a general efficiency improvement across all German production sectors, positive effects on external production and energy use via the general demand channels are offset due to a relative reduction in foreign competitiveness. On the other hand, where only German manufacturing is targeted with the efficiency improvement, non-competing external sectors are positively affected. However, negative impacts on external manufacturing through the competitiveness channel are sufficiently strong to be the main determinant of the observed contraction in economy-wide rebound in moving first from German to EU-wide then the global level. Moreover, with fixed factor supply, other German production is also crowded out, causing the contraction (8.8 percentage points) in own-country economy-wide rebound as we move from the sectoral to total production level.

In terms of the third spillover channel identified, the energy market channel, contractions in both domestic and external energy supply chain activity resulting from the initial demand reduction as efficiency improves dominate the results in Table 1. These are found to have the strongest negating impact on rebound (at all spatial levels), and this is more so the larger the efficiency improvement (i.e. where the efficiency improvement is applied to all German sectors). When we limit the efficiency improvement to German manufacturing, which has a relatively low energy-intensity to begin with, positive demand effects in energy supply from boosted activity in household consumption in all regions, and in other European and Non-European production sectors, lessens the negating impact of the energy market channel on rebound at all levels.

Conclusions

This preliminary study suggests that increases in energy efficiency in one nation are likely to impact energy use in others through several channels. The key finding reported here is that changes in relative competitiveness and energy supply conditions will potentially act to dampen economy-wide rebound as the boundaries of the economy are expanded. However, the sectoral and spatial distribution of positive and negative effects will depend on the nature of the efficiency improvement and factor supply conditions, both of which merit further investigation.

Footnotes

[1] Turner, K. (2013) Rebound effects from increased energy efficiency: A time to pause and reflect, The Energy Journal, 34(4), 25-42.

[2] For more information on the European Union's 20-20-20 package please see: http://ec.europa.eu/clima/policies/package/index_en.htm

Increased Electricity Demand Flexibility Enabled by Smart Grid: Impacts on Prices, Security of Supply and Revenues in Northern Europe

By Torjus Folsland Bolkesjø, Åsa Grytli Tveten and Iliana Ilieva*

Background

The challenges related to regulation and balancing of energy systems with a high share of renewable intermittent power are well known (e.g. Georgilakis (2008), Franco and Salza (2011), Perez-Arriaga and Batlle (2012)). Increased flexibility on the demand side, in the form of moving electricity consumption from peak to off-peak periods, is seen as one of the options for handling varying power generation from RE sources in future energy systems with high RE shares. Currently, however, this type of short-term flexibility on the demand side, i.e. a consumption pattern with less difference between off-peak and peak periods and that may adjust on an hourly basis to variations in supply, is limited. There are two main reasons for the current lack of demand flexibility: First, most consumers are not exposed to real-time pricing (RTP), implying that they have no incentives to move consumption to periods with low prices. Second, technical solutions for automatic adjustment of consumption are today limited, meaning that flexible - or smart - energy usage requires user's action. Notwithstanding, there are reasons to expect that these obstacles may become less important in the future, due to technical development and restructuring of electricity markets. In this regard, it is of interest to analyze how a development towards more active use of demand side management will affect the power system in terms of need for peak power capacity, technology mix in electricity production, electricity prices and system costs.

Scenarios Analysed

In the current study, we apply country-specific estimates from IEA on potential short term (within day) demand flexibility that are used to define four scenarios regarding future demand flexibility in the North European power market (the Nordic countries, Germany, the Netherlands and the UK). The electricity market impacts of the different demand flexibility levels are then analyzed applying an power market model that has an hourly time resolution, a fine spatial resolution. The power market model applied is based on the Balmorel model structure which is a convex and linear partial equilibrium model simulating generation, transmission and consumption of electricity under the assumption of competitive markets (see e.g. Ravn (2001), Ravn, Hindsberger et al. (2001)). The current model version covers the Nordic countries, Germany, the Netherlands and the UK and is calibrated with updated 2012 power system data for all model countries. The model, which is deterministic in a one year (or one week in the short-term mode) time frame, calculates the electricity production per technology, time unit and region, minimizing total system costs for a given electricity demand and under certain capacity constraints regarding production and transmission.

Three different demand response scenarios are developed and compared to a Baseline scenario where today's level of demand flexibility is assumed: i) a Moderate demand response scenario, where a 50 % realization of the maximum potential found in the IEA publications is assumed, ii) a Full demand response scenario where the maximum potential found in the literature is assumed implemented, and iii) a High demand response scenario, where we assume that strong policy measures combined with a technological development such that the demand response potential is doubled relative to the Full flexibility scenario.

Findings

Results from model simuilation are shown in Table 1 and Figure 1.Table 1 shows average annual production levels for different technologies in the different scenarios while Figure 1 shows the average changes in production mix in the full flexibility scenario relative to the base scenario, at an hourly level.

The model simulation results show that the need for peak power technologies (natural gas, reservoir hydropower and pumped storage) and balancing reserves decreases substantially when demand flexibility increases. At the same time, revenues of all the intermittent renewable energy sources (wind, run-of river and solar power) are found to increase, indicating opportunities for improved utilization of the renewable energy resources if systems for increased short term demand side management are introduced. Coal power

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	Baseline scenario (total production in TWh)	Demand flexibility scenarios (change in GWh)		
		Moderate	Full	High
CHP, biomass and nuclear	417	-3	-40	-121
Natural gas	41	-1996	-3775	-6941
Solids	402	+1328	+2533	+4747
Reservoir hydro and pumped storage	146	-613	-1162	-2079
Run-off river hydro	104	+44	+67	+97
Wind	252	+217	+501	+995
Solar	56	+85	+101	+131

Table 1. Average production levels in the Baseline scenario (GW), and change in production for the different demand response scenarios, all model countries summarized.

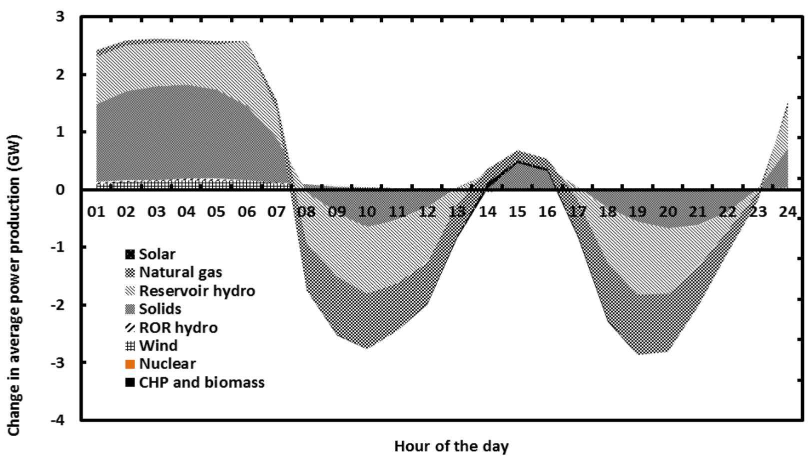

Figure 1. Change in the hourly North European production mix (GWh/h) caused by the increase in demand response, "full" flexibility scenario (all model countries, all-year average)

revenues are found to decrease with increasing demand flexibility, but total coal power production is found to increase significantly. As a consequnece, increased short term demand flexibility caused an increase in greenhouse gas emissions from electricity production . In this study area, increased demand flexibility will in general cause higher night consumption and lower day consumption in the northern, hydro dominated parts. This shift will, in general, also take place in the southern parts (Denmark, Germany, the Netherlands) in the winter season, but variations in wind power generation do to some degree alter the night versus day pattern. In summer months, there is, in the southern parts, a tendency of increasing consumption during day hours in the high flexibility scenarios, due to high levels of solar PV generation. Prices in off-peak hours will as expected increase for increasing short term demand flexibility, while the price in peak hours decrease. The change in average prices is found to be limited, but the change in the daily price profiles is found to be considerable, with a 11-18% reduction in price variation, and the consumption weighted price decreases with increasing demand flexibility.

The North European energy system is in rapid change, with increasing levels of intermittent energy sources entering the market. Increased demand flexibility is likely to play a vital role for realizing system balancing and increased security of supply in energy systems with large shares of intermittent renewable energy. Our results show rather clearly that the system benefits, in terms of reduced residual demand levels, reduced need for peak capacity and increased security of supply, are larger than the economic benefits for the consumers. Therefore, policies stimulating to increased flexibility on the consumer side are likely needed to fully utilize the potential system benefits from increased demand flexibility.

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Negative Bidding by Wind: A Unit Commitment Analysis of Cost and Emission Impacts

By Lin Deng, Benjamin F. Hobbs, and Piet Renson*

In order to meet renewable energy targets, various renewable energy policies and incentive mechanisms have been adopted by many countries. Spain, for example, has set up a Renewable Action Plan (REP) 2011-2020, in order to meet the EU 2020 targets. In Spain, and the EU, feed-in tariffs are generally prevalent, which pay a guaranteed amount per MWh for renewable production. Meanwhile, most U.S. states have adopted renewable portfolio standards in which renewable generation creates credits that can be sold, while the U.S. government has a production tax credit (PTC) amounting to ~$26/MWh produced. U.S. wind power generation has experienced rapid growth in the last 20 years from 1,500 megawatts (MW) total installed capacity in 1992 to more than 50,000 MW in August of 2012. Wind power provided more than 4% of total U.S. electricity generation in 2013, according to the Energy Information Administration (EIA). Two primary policies provide market and financial incentives that support the wind indus-try and have contributed to U.S. wind power growth: (1) production tax credit (PTC)—a federal tax in-centive amounting to ~$26/MWh, and (2) renewable portfolio standards (RPS)—state-level policies that encourage renewable power by requiring that either a certain percentage of electricity be generated by renewable energy sources or a certain amount of qualified renewable electricity capacity be installed.

Negative Bidding by Renewable Producers and Its Impact

In European and U.S. power markets, excess generation conditions are occurring more frequently when heavy wind and light load conditions coincide, and increasingly in the middle of the day during the times of highest solar production. Negative energy prices are a useful tool for encouraging generators to volun-tarily curtail operation during such conditions, and to incent consumers to buy more power. Negative prices occur, for example, when traditional generators would rather stay on line rather than shut down and have to incur start-up costs again soon thereafter. Figure 1, based on USEPA data for a Texas coal-fired generator, shows the significant amount of fuel that is required for that plant's lengthy start-up period.

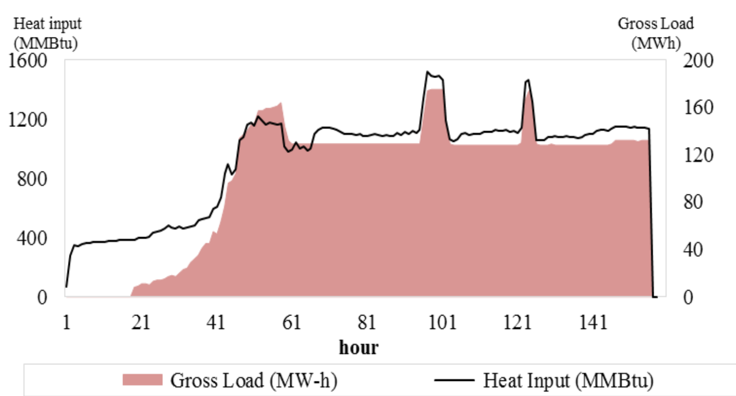

Figure 1: Power output (MW) and fuel use (millions of BTUs) of an example coal generator over time.
Source: USEPA Continuous Emissions Monitoring System data

However, since renewable plant owners usually receive substantial subsidies per unit of energy production, they would also prefer to pay in order to produce power even if prices are negative, as long the mag-nitude of the subsidies exceed the magnitude of the negative energy price. This mutual unwillingness on the part of thermal and renewable producers to turn down drives prices even lower.

Negative prices can also occur in markets just prior to ramping up of net loads in the morning or evening. This is because if loads were higher just before the ramp occurs, it would then be possible to avoid at least some of the cost of turning on peaking plants (such as combustion turbines) to meet steep ramps that online thermal generation cannot keep up with. Steep net load ramps are also occurring increasingly frequently due to renewable variations (e.g., Figure 2 which shows how Texas wind power can soar up and down dramatically). Growing concern about those ramps has lead the California and Mid-Continent ISOs in the U.S. to institute an explicit constraint for the amount of rampable capacity online (called "flexiramp" in California), which results in payments to generators that can provide that ramp.

Negative prices are, of course, welcomed by consumers, and negative prices can be an efficient means of determining which plants stay on and which turn off--if the costs that each generator incurs in order to turn down are real societal costs. However, the subsidy payments to wind producers are transfer pay-ments from ratepayers or tax payers, at least in the short run, and not real costs. Conse-

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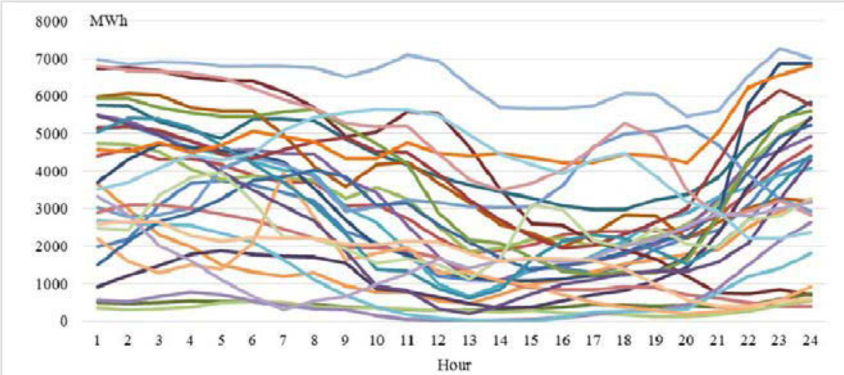

Figure 2: The wind curves of September 2012, ERCOT
Source: Electric Reliability Council of Texas.

quently, if renew-able generation stay during periods of negative prices and force thermal generators to turn off, the result can be higher social costs and also higher emissions from the additional start-ups and shut-downs. In our analysis we focus on these short-term effects, and argue that a fine tuned policy that maintains the subsidy even if wind is curtailed would improve short-run market efficiency. Our study can also be viewed as an examination of the short-run cost and emissions impacts of rules in some countries of the EU that require that wind production be taken by the system operator unless system reliability is endangered. Under such a requirement, an operator may be forced to incur fuel costs to stop and start units, with the resulting costs and emissions possibly more than offsetting the fuel and emissions savings from using more wind power.

Possible long-term effects were on the mind of Public Utilities Commission of Texas Chairman Donna Nelson on September 6, 2012 when she the cautioned policymakers against further subsidies, arguing that the wind production tax credit had undermined generation capacity adequacy in the state:

> "Federal incentives for renewable energy… have distorted the competitive wholesale market in ERCOT. Wind has been supported by a federal production tax credit that provides $22 per MWH of energy generated by a wind resource. With this substantial incentive, wind resources can actually bid negative prices into the market and still make a profit. We've seen a number of days with a negative clearing price in the west zone of ERCOT where most of the wind resources are in-stalled….The market distortions caused by renewable energy incentives are one of the primary causes I believe of our current resource adequacy issue… [T]his distortion makes it difficult for other generation types to recover their cost and discourages investment in new generation."[1]

Impacts of Negative Bids on Short-Run Costs and Emissions Depends on the Characteristics of the Systems

We used a standard industry model of power system operations called a unit commitment model to exam-ine the impact of negative bidding by wind plants. The model decided which generating units to commit in which hours, and the amount of generation from each (including wind plants) over a week-long period. Constraints that have to be met include energy balance (total generation = total load) and individual gen-erator operating constraints, such as ramp limits. We did not model transmission. We considered systems with about 1/3 wind power and 2/3 non-renewable sources, consistent with California's 2020 goals and what Denmark has now. We then modeled different levels of negative bids by wind and examined how system costs and emissions were affected. The largest negative bid (-$300/MWh) can also be viewed as a simulation of the EU policy of absolute priority of wind in system dispatch.

The analysis shows that the impacts of negative wind bidding strategies have on total system cost and CO_2 emission depend strongly on the generation mix. We consider four systems: high nuclear and coal (NUCL), high coal (COAL), high combined cycle (CCGT), and high steam gas (SGAS). These represent a range of actual conditions; e.g., the CAISO, Spanish and Texas systems have, respectively, a low, medium and high share of coal-fired generators. Sensitivity analyses considered different sizes of systems and alternative CO_2 prices.

The least flexible system is NUCL because the nuclear unit always operates at its full capacity of 1000 MW. Consequently, it has the least amount of rampable capacity and the highest minimum production. Our main conclusions are the following. First, wind curtailment is greater when the overall generation mix is inflexible, as measured by total rampable capacity and total minimum run levels. Second, larger negative energy bids for wind force the system to accept more wind generation even though energy prices are negative. As a result, system costs unambiguously increase (disregarding penalties for curtailing wind). It is possible to show, by contradiction, that these costs must increase under negative wind bidding. Third, such bids leads to more starts and stops for generators and associated CO_2 emissions, which partially and, in some cases, more than fully offsets emissions reductions due to decreased thermal gen-eration. In some of our runs, total system emissions for the week were almost 2% higher under a minus $300/MWh bid for wind than under a $0/MWh bid.

We show the results for two of the four systems here as illustrations. The first plot in Figure 3 shows the cost and CO_2 emissions increases as a result of larger negative wind bids for the nuclear system. The system costs exclude penalties for curtailing wind which, as we argued above, are merely transfer pay-ments. For small negative bids (through -\$30/MWh, about the magnitude of the U.S. federal wind produc-tion tax credit), the impacts are very small, but they grow rapidly thereafter as the system's coal capacity is subjected to additional starts and stops. If we calculate the ratio of the incremental costs and incre-mental emissions to the increased wind production (comparing the \$0 and -\$300/MWh solutions), we find that the cost of taking that wind power is \$18/MWh (in added fuel costs) and the additional emissions are 0.84 tons CO_2/MWh. Thus, this incremental coal power, in this case, is effectively as dirty as coal-fired generation (generally around 1 ton/MWh). For the gas dominated system, however, additional starts and stops occur mainly in combined cycle capacity, which involves fewer BTUs to start-up, and has lower emissions per BTU. As a result, although costs also go up in the CCGT case (at a rate of \$88/MWh of increased wind output), emissions are relatively unchanged (0.21 tons CO_2/MWh of increased wind). In a few of other cases we considered, the emissions actually decreased.

Thus, the precise cost and environmental effects of allowing negative bids, or requiring that all wind be taken subject to reliability constraints, depend on the particular system. Furthermore, transmission, demand response, hydro generation, and energy storage could have a large impact on the flexibility of a power system and the impact of wind injections during negative price periods; we did not consider those complications, and they could significantly alter the results shown in Figure 3. We can conclude that policies that encourage wind to bid flexibly (i.e., zero or low negative bids) will improve short-run system cost performance and in many cases emissions as well. This will help society to reap the full economic and, often, environmental benefits of wind power integration. Such policies might include, for instance, renewable energy credit or tax credit systems that provide credits even for curtailed wind, based on statis-tical estimates of how much wind would have been provided in the absence of curtailment.

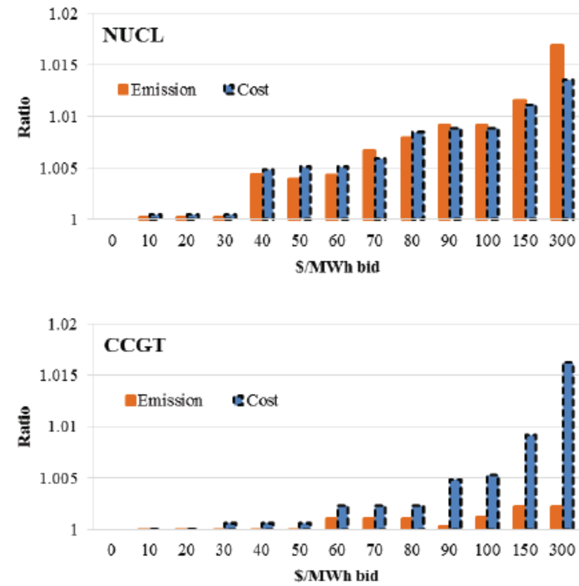

Figure 3: Changes in total system cost (excluding wind bids) and total CO_2 emissions as the magnitude of negative \$/MWh bids by wind increases (ratios are respect to \$0/MWh bid solutions) for the nuclear- and combined-cycle-dominated systems

Footnote

[1] Chairman Donna Nelson testimony before the Texas Senate Natural Resources Subcommittee (Septem-ber 6, 2012), transcribed from http://www.senate.state.tx.us/avarchive/, quoted by Frank Huntowski, Aaron Patterson, and Michael Schnitzer in "Negative Electricity Prices and the Production Tax Credit", http://graphics8.nytimes.com/news/business/exelon.pdf

Efficient Storage Capacity in a System with High Photovoltaic Penetration

By Benjamin Böcker and Christoph Weber*

Many countries aim to reduce carbon emissions and, consequently, implement policies to foster power generation from renewable energy sources (RES). Besides wind power, photovoltaic systems (PV) are the major technology used for that purpose, with large capacities being connected to the grid every year. Given its intermittent nature, RES cannot be controlled to follow the system load. Today, primarily conventional power plants are used to compensate these fluctuations in order to ensure availability of electricity when needed. Considering the foreseen path of massive expansion of renewable energy, this is no longer sufficient.

Storage systems can be used to store energy in time of high RES feed-in and to provide the needed energy just in time. With pumped-hydro storage (PHS) an efficient and proven technology is available. Most of the other storage technologies are characterized by high but declining investment costs, so that a widespread rollout could be expected within the next 20 years.

In future power systems, storages will be part of the efficient technology portfolio. Because of typical storage characteristics (volume limitations, charging and discharging cycles), storage capacity is not always available. The typical setup of PHS in lower mountain ranges allows several hours of full-load operation, which complements the day-night-pattern of PV systems. In comparison to that, battery systems (e. g. Li-Ion) are characterized by flexibility and high power supply during a short period of time.

In this analysis, we apply an extended capacity planning model for storages (cf. Böcker & Weber, 2014) to specifically investigate the efficient use of pumped-storage and battery systems to complement PV systems. In light of the political objectives to reduce carbon emissions and other major scenario assumptions, the efficient capacity of storages will be derived for several case studies.

Storages in a System Perspective (Model)

Various technologies may be used for power generation and their operation typically is determined by their position in the merit order. The efficient portfolio is obtained by considering the long-term capacity planning problem (also known as peak-load-pricing problem), which is an extension of the merit-order model taking into account both investment and operational costs and load restrictions. Storages can also be attributed a position in the merit order and thus can be a part of the efficient portfolio. If storage volume restrictions are neglected, they can be treated almost like conventional technologies (Steffen & Weber, 2013).

Yet, the storage volume is a major restriction implying two effects on the efficient portfolio. First, the amount of energy which can be shifted from high supply to high demand is limited. Second, the required capacity of technologies ranked to the right of the storage technology in the merit order may be increased in comparison to the case of unlimited storage volume (Böcker & Weber, 2014).

	Unit	**Lignite**	**Coal**	**CCGT**	**OCGT**	**Wind**	**Wind**	**PV**	**PHS**	**Li-Ion**
								Offs.	**Ons.**	
Capacity costs	k€/MW	1,500	1,200	700	400	1,600	1,200	800	840	100
Volume costs	k€/MWh	0	0	0	0	0	0	0	20	150
Technical lifetime	years	40	40	30	25	20	20	25	50	20
Efficiency	- - -	49%	51%	62%	41%	100%	100%	100%	80%	90%
Operational costs	EUR/MWh	8.2	23.9	50.5	76.3	0	0	0	0	0

Table 1: Main Input Parameter
Based on data by IEA (2013), ISE (2013), RWTH Aachen (2013/2014), own analyses

In the present analysis, the cost-optimal combination of storage volume and storage filling/withdrawal capacity is determined together with the optimal operation from a system perspective. In this context, an appropriate storage operation strategy will notably minimize the needed peak capacities. It is thereby also taken into account that most RES have marginal costs of nearly zero so that they are dispatched with priority given their natural availability.

Key technology characteristics used for the analysis are summarized in Table 1. These correspond to expected technology developments until 2040. For this year, current generation capacities only play a minor role. Therefore, a greenfield

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approach is applied. Load and RES feed-in profiles are based on German data for 2011. Moreover the following German policy objectives are included: 1) CO_2 emissions at 20 % of the 1990 level, 2) 65 % share of renewables in electricity generation.

Efficient Portfolio and Sensitivities

The optimal sizing of storages and capacities of generation plants in a long-term economic equilibrium is given for the reference case in Table 2. Investments in wind offshore are limited to the realistic sites along the German coast leading to a maximum installed capacity of 54 GW (IWES, 2013). The resulting CO_2 price is almost 75 €/tCO_2.

Efficient Portfolio	Capacity	Volume
Lignite	3 GW	---
Coal	0 GW	---
CCGT	46 GW	---
OCGT	14 GW	---
Wind Off.	54 GW	---
Wind On.	61 GW	---
PV	66 GW	---
PHS	15 GW	371 GWh
Li-Ion	4 GW	14 GWh

Table 2: Results reference case

Sensitivities of the efficient Li-Ion capacity and volume with respect to key input parameters (± 50% of the reference value) are given in Figure 1. The installed storage quantities turn out to be strongly dependent on the investment costs, notably the storage volume related costs. Also reduced investment costs for PV increase the amount of Li-Ion batteries, showing that these are complementary technologies. CO_2 emissions targets above the reference case do not influence the efficient storage capacity and volume, because the target share for renewables is then binding in the analyzed setting. This changes and the role of storages increases significantly, if the target is strengthened by 25 % or more. Then lignite plants are out of the efficient portfolio and further emission reductions are achieved through increased renewable penetration. In the extreme case (10 % of 1990 emissions), the efficient Li-Ion capacity declines again. More long term storage using PHS is required and PHS partly substitutes Li-Ion batteries. This is also true if the requirement on the RES share is tightened. In the most extreme cases no Li-Ion capacities are installed, instead RES fluctuations are solely flattened through the use of PHS. Efficient storage capacity and volume are less sensitive to operational costs (less than 5 % variation), their installation is mainly driven by RES fluctuations.

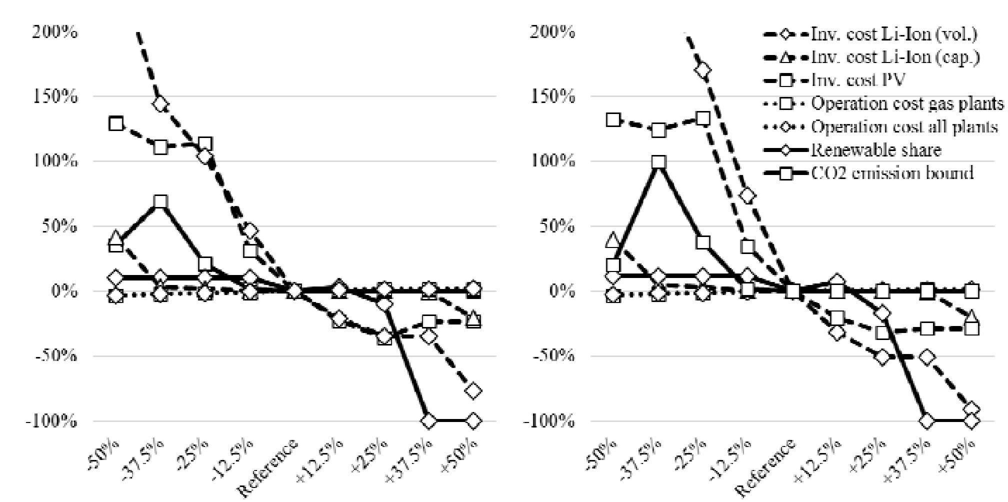

Figure 1: Sensitivities of efficient Capacity (left) and Volume (right) of Li-Ion Battery

The model provides insights into the optimality of storage expansion in power systems with large shares of renewables and especially PV feed-in. It therefore complements large-scale optimization models allowing a detailed assessment of specific scenarios by indicating the main driving forces and impediments for the implementation of storages in a competitive environment.

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A Regional Demand Forecasting Study for Transportation Fuels in Turkey

By Özlem Atalay and Gürkan Kumbaroğlu*

Fuel demand in the transportation sector has received considerable attention for the last decades. Population growth and economic development in the past few decades have caused a growing demand for fuel in transportation sector in Turkey. However, gasoline consumption has been constantly decreasing in Turkey since 2006, whereas diesel consumption reached record levels in the same period. The demand for LPG (Liquefied Petroleum Gas) remained rather stable. Model projections indicate in all regions in Turkey a shift away from gasoline-fueled vehicles towards diesel-fueled ones.

The main objectives of this study are to analyze past Gasoline, Diesel and LPG consumption in Turkey's transportation sector and to identify the main factors affecting future demand. To achieve these objectives, six different categories of models are developed based on 11-year historical data include Multi Linear Regression Models, Moving Average (MA), Double Moving Average (DMA), Simple Exponential Smoothing (SES), Double Exponential Smoothing (DES), Time series models Holt–Winters' model. The results indicate that Multiple Regression Analysis provides relatively better solutions for explaining the fuel demand. The growth of fuel consumption creates trending data, therefore the most reliable forecast methods would be the ones which take trend into account. So it is not a surprise that Regression and DES perform better than the others. With the help of these models, it is possible to perform sales forecasts in terms of different fuel types, sectors and geographical regions. Figure 1 shows that these regions in Turkey can be categorized in twelve categories according to TUIK (Turkish Statistical Institute). In addition to that, the regional shares of gasoline, diesel and LPG consumptions in 2013 are shown in Figure 1.

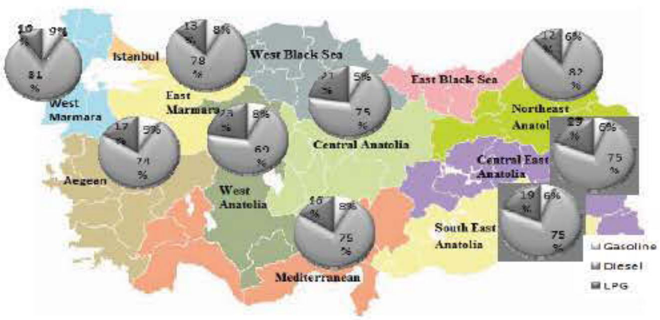

Figure 1. TUIK Regions Used in the Analyses [7], [8]

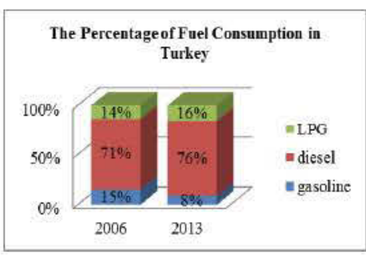

Figure 2. LPG, Diesel and Gasoline Shares in Turkey[7]

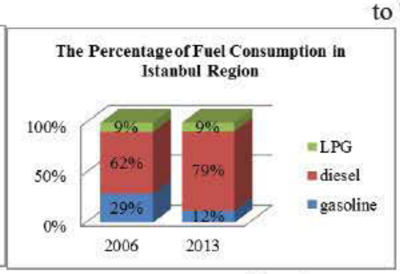

Figure 3. LPG, Diesel and Gasoline Shares in Istanbul[7]

Gasoline demand decreased linearly between the years 2006 and 2012 in, whereas diesel consumption reached to record levels in the same period. There is not a dramatic change in the consumption of LPG. In Figure 2, the shares of types of fuel consumptions are displayed for the years 2006 and 2013.

Figure 3 presents the shares of types of fuel consumptions in Istanbul region for the for the years 2006 and 2013. The gasoline consumption in 2006 is 17% larger than in 2013. The difference in diesel consumption between the years 2006 and 2013 is significant, about 17%. As a result, Turkey's dependence on diesel could reach to precarious levels in the next decade.

In addition to the forecasting of fuel demand, several independent variables of the regression models were projected including population, gross value added of the transport sector, fuel prices, vehicle stock and utilization rates etc. All projections have been calculated with different methods so as to make use of the most reliable forecasts. Gross Value Added (GVA) is the key economic metric used to measure all economic activity within a geographical area over a given period. Understanding GVA and its calculation is essential when trying to measure economic impact. 2013 forecast value for GVA is calculated with the help of Moving Average Method. The objective is to use past to data to develop a forecasting model for future periods. For the fuel prices there is a small improvement within consecutive years. Therefore taking the average of small periods is expected to give more reliable results as a consequence. In addition to that, the selling price of LPG has an upward trend. For that reason regression analysis is considered to be an alternative method for Moving Average Method. The Vehicle Fuel Usage Indicator is an independent variable for the Multiple Regression Analysis. During the creation of the Vehicle Fuel Usage Indicator Population, GVA, the Vehicle Fuel Usage Indicator which belongs to past years independent variables have been tested. In general, the rate of GVA and Population, and the Vehicle Fuel Usage Indicator from the previous

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years have been effective in these Multiple Regression Model. However, the rate of GVA and Population is not an independent variable for some regions. For example, the Regression Analysis for West Marmara Region, East Black Sea Region, and Northeast Anatolia Region shows that the rate of GVA and Population do not affect the Vehicle Fuel Usage Indicator. Vehicle fuel usage indicator defines the number of road motor vehicles by kind of fuel used. Multiple Regression Analysis is performed to achieve long-term projection of demand forecasting in this study. The data of GVA, fuel prices, vehicle fuel usage indicator, types of fuel, and population have been used. In order to compare the various forecasting methods and check model accuracy, MSE (Mean Squared Error), MAD (Mean Absolute Deviation) and MAPE (Mean Absolute Percentage Error) are analyzed. For the fuel demand the best result can be derived by regression analysis. Assumptions of normality and independence of errors are validated for each region. Table 1 shows the percentage changes compared to previous year's gasoline, diesel and LPG demand together with the best performing methods.

Regions	The Best Performing Method	2013	2014	Regions	The Best Performing Method	2013	2014
Istanbul Region	Regression (G)	26%	29%	Central Anatolia Region	Regression (G)	4%	6%
	MA=3 (D)	7%	2%		Regression (D)	-7%	-5%
	Regression (LPG)	-1%	-1%		Regression (LPG)	-9%	-9%
West Marmara Region	Regression (G)	-2%	6%	West Black Sea Region	Regression (G)	-1%	1%
	Regression (D)	-6%	-8%		Regression (D)	-2%	1%
	Regression (LPG)	-10%	-10%		DES (LPG)	-10%	-18%
Aegean Region Region	Regression (G)	-0,37%	3%	East Black Sea Region	Regression (G)	0,95%	3%
	Regression (D)	-3%	-5%		Regression (D)	-5%	-12%
	DES (LPG)	-10%	-19%		DES (LPG)	-10%	-18%
East Marmara Region	Regression (G)	3%	6%	Northeast Anatolia Region	Regression (G)	4%	8%
	DMA=2 (D)	-8%	-14%		Regression (D)	-4%	-3%
	Regression (LPG)	-2%	-1%		Regression (LPG)	14%	10%
West Anatolia Region	Regression (G)	6%	9%	Central East Anatolia Region	MA=3 (G)	-0,24%	0,48%
	Regression (D)	-4%	-4%		Regression (D)	-5%	-10%
	DES (LPG)	-8%	-15%		Regression (LPG)	-10%	-19%
Mediterranean Region	SES (G)	11%	13%	South East Anatolia Region	SES (G)	-10%	-11%
	Regression (D)	8%	-7%		Regression (D)	-11%	-9%
	DES (LPG)	-11%	-20%		Regression (LPG)	-7%	-9%

G: Gasoline, D: Diesel, LPG: Liquefied Petroleum Gas

Table 1. Best Performing Methods and Percent Change Projections for Fuel Demand

Turkey has the highest gasoline price among all the OECD (Organisation for Economic Co-operation and Development) member states due to the high taxes that are reflected at the level of retail price. As gasoline prices increase dramatically, consumers are shifting to diesel and LPG in Turkey [2]. Taxis run almost exclusively on diesel or LPG. Since the late 1990s, the European diesel car market boomed whereas diesel vehicles were phased out of the Japanese market and remained at a negligibly small level in the United States while gaining popularity recently. Registrations for diesel cars and sport utility vehicles rose 24 percent in the United States from 2010 through 2012 [3]. The main reason for the attractiveness of diesel cars is fuel efficiency, as diesel engines are 20 percent to 40 percent more fuel efficient than equivalent gasoline engines. However, diesel fuel contains about 15% more carbon per litre reducing the CO_2 emission advantage by favourable fuel efficiency. It is expected that increasingly stringent emissions regulations and the high cost of new anti-pollution technology will make diesel engines much more expensive [4]. Criticism of diesel vehicles has recently increased and expectations changed such that diesel automobiles will see a downward trend (e.g. [5], [6]). Results of this study indicate that this will not be the case in Turkey in the short term unless there is a new environmental tax policy or standard to discourage the use of diesel fuel.

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Market instruments for energy efficiency
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Participants	before July 15	after July 15
Speaker/Chair IAEE Member	€ 525	€ 575
Speaker/Chair Non-Member	€ 600	€ 650
IAEE Member	€ 690	€ 740
Non-Member	€ 790	€ 840
Student IAEE Member	€ 330	€ 380
Student Non-Member	€ 370	€ 420
Accompanying person	€ 330	€ 380

The concurrent sessions will be organized from accepted abstracts. Authors may be encouraged by the Programme Committee to organize specific sessions. Submitted abstracts should be of one or two pages in length, comprising (1) overview, (2) methods, (3) results and (4) conclusions.

We welcome you in Rome!

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The **LUISS independent university** is placed in one of the city´s most beautiful areas close to Rome´s historic centre.
The conference rooms are modern and provided with all the technical devices.
The Venue's facilities include also a space for the Information and Registration Desk where the participants will have at their disposal throughout the conference computers with Internet access, free wireless connection and a catering area for the coffee breaks and lunches.

THE GALA DINNER

On **Wednesday, October 29, 2014** a gala dinner will be offered at the **Caffarelli Terrace**, a magnificent place with a view to the Piazza del Campidoglio designed by Michelangelo, with the equestrian statue of Marcus Aurelio in its center.

Before the gala dinner a special session and the **Awards Ceremony** will be organized in the prestigious Protomoteca room in the City Hall of Rome.

THE CONFERENCE DINNER

On **Thursday, October 30 2014** a conference dinner will be offered to the participants in the charming and elegant **Hall of Columns of the LUISS University.**

THE CONFERENCE PROGRAMME

Tuesday 28/10	
12.00 – 18.00	**Registration**
12.15 – 17.00	IAEE European PhD - students Day
17.00 – 18.00	IAEE European Affiliate Leaders meeting
18.00	*Welcome Reception*
20.30 – 22.00	Students Happy Hour
20.30 – 22.00	IAEE European Affiliate Leaders Dinner

Wednesday 29/10	
08.00 – 18.00	**Registration**
08.00 – 09.00	Breakfast Meetings
09.30 – 10.30	**Opening Plenary Session**
10.30 – 11.00	*Coffee Break*
11.00 – 12.30	**Dual Plenary Sessions**
12.30 – 14.00	*Lunch*
14.00 – 15.30	Concurrent Sessions
15.30 – 17.00	Concurrent Sessions
18.00 – 19.30	***The Awards Ceremony*** (*Protomoteca Hall*)
20.00 – 22.30	***Gala Dinner*** (*Caffarelli Terrace*)

Thursday30/10	
08.00 – 18.00	**Registration**
08.00 – 09.00	Breakfast Meetings
09.00 – 10.30	**Dual Plenary Sessions**
10.30 – 11.00	*Coffee Break*
11.00 – 12.30	Concurrent Sessions
12.30 – 14.00	*Lunch*
14.00 – 15.30	**Dual Plenary Sessions**
15.30 – 16.00	*Coffee Break*
16.00 – 17.30	Concurrent Sessions
20.00 – 22.30	***Conference Dinner***

Friday 31/10	
08.00 – 09.00	Breakfast Meetings
09.00 – 10.30	Concurrent Sessions
10.30 – 11.00	*Coffee Break*
11.00 – 12.30	Concurrent Sessions
12.30 – 13.30	**Closing Session**

STUDENTS

students are especially encouraged to partecipate and may attend the conference at the reduced student registration rate.
In addition students may submit a paper for consideration in the *IAEE Best Paper award Competition* (cash prises plus waiver of conference registration fee). Students are also welcome to partecipate in the *Student Poster Session.*

(http://www.iaee2014europe.it/pages/student_events.html; http://www.iaee2014europe.it/pages/student_awards.html)

REGISTRATION AND HOTEL ACCOMMODATION INFORMATION

Ageements were made for special rates/night (from 80 to 150 Euro) in various hotels, close to the conference venue.

Welcome New Members

The following individuals joined IAEE from 4/1/14 to 5/31/14

Mirar Acar
TURKEY

Justin Adder
US DOE NETL
USA

Yemi Adetunji
NNPC
NIGERIA

Kardelen Adsal
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TURKEY

Hamid Aghaie
AIT Austrian Inst. of Technology
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Saudi Aramco
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Hussain Al Nimr
Saudi Aramco
SAUDI ARABIA

Ahmad Alaseeri
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De Pardieu Brocas maffei
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Majid Aljasir
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38TH IAEE INTERNATIONAL CONFERENCE

ECONOMIC, ENVIRONMENTAL, TECHNOLOGICAL AND SECURITY CHALLENGES FOR ENERGY

MAY 25-27, 2015 | GLORIA GOLF RESORT | ANTALYA, TURKEY

CONFERENCE OVERVIEW

It is my great pleasure to announce the 38th IAEE International Conference and invite you to a beautiful resort in Belek, Antalya.

Turkey's unique location straddling the continents of Europe and Asia at the ultimate crossroads of the world's largest oil & gas deposits in the Middle East and consumption centers in Europe, offers an exclusive hub for the exchange of research, policy, practice and ideas to overcome global energy challenges.

The conference program is being prepared by an International Program Committee (IPC) with outstanding prominent members so as to ensure that critical issues of vital concern and importance to governments and industries are presented, considered and discussed from all perspectives. In this context, many exiting plenary and dual plenary sessions on key current energy issues, featuring internationally established speakers and lively discussions, will be organized.

With its informal social functions, the conference will provide a unique opportunity for networking and enhancing communication amongst energy concerned professionals from business, government, academia and other circles worldwide. The rich social program will include unique arrangements like pre-conference tournaments and a beach party on the Mediterranean shore.

I and my colleagues, an experienced and enthusiastic team of outstanding prominent energy professionals in Turkey, are determined to make this conference a professionally most enriching and socially most memorable event – as we did in Istanbul in 2008. Please visit our website for all details and latest updates about the conference.

On behalf of the organizing committee I wish you all a very warm welcome to Antalya and an exciting conference at a time when spring leads into summer.

Gürkan Kumbaroğlu
General Conference Chair

Topics to be Addressed in Concurrent Sessions

- Carbon trading and taxation
- Climate change and energy industry
- Coal in CO_2-constrained world
- Consumer and self-generation
- Design of energy markets
- Distributed generation issues
- Electricity prices and uncertainties
- Energy access and poverty
- Energy consumer behavior
- Energy efficiency challenges
- Energy policy under 2030 emissions target
- Energy finance
- Energy markets and regulation
- Geopolitics of oil and natural gas
- Green energy and economic growth
- Hydropower issues
- Integration of intermittent power sources
- Economics and prospects of clean energy technologies
- Intelligent grids and demand response
- Investment issues in liberalized markets
- Low carbon energy economics
- Market power issues
- Oil and gas transportation and pipelines
- Oil and gas reserves and production
- Promotion of renewable energy
- Prospects of CCS and CCU technologies
- Prospects for nuclear power
- Alternative transportation fuels and vehicles
- Power and gas trade under volatile prices
- Regulation and regulation uncertainties
- Renewable energy technologies and markets
- Resilience of complex energy systems
- Role of new energy services
- Security of supply issues
- Unconventional oil and gas
- Risk and quality management issues in the energy sector

Zero Emission Conference

HOSTED BY

TURKISH ASSOCIATION for ENERGY ECONOMICS

38TH IAEE INTERNATIONAL CONFERENCE CALL FOR PAPERS

It is our pleasure to announce the Call for Papers for the 38th IAEE International Conference, *Economic, Environmental, Technological and Security Challenges for Energy*, to be held May 25 through 27, 2015, at Gloria Golf Resort, Antalya, TURKEY.



Concurrent Sessions

The concurrent sessions will be organized as Regular, Invited, Discussant or Collaborative Conversation sessions. The Regular sessions will be composed of contributed papers, whose submitted abstracts will be refereed and the accepted ones carefully allocated into coherent groups by the IPC. The topics and functioning of the other types of concurrent sessions will be proposed by their organizing chairs, to be approved by the IPC. Speakers invited to participate in such concurrent sessions (by the organizing chairs) will still be required to submit abstracts to be considered by the IPC. Each concurrent session may accommodate 3-5 speakers, while lasting 80-100 minutes.

Poster Session

A poster session, featuring around 25 poster presentations, all relevant to the Conference theme, and which will run throughout the Conference, is to be held in the main lounge of the conference facility. Poster authors are to be collected into a concurrent session, where each author will have an opportunity to explain/describe his/her poster within a matter of 15-20 minutes.

Concurrent and Poster Sessions Abstract Format and Submission

Authors wishing to make concurrent session presentations must submit an abstract that briefly describes the material to be presented by the abstract submission deadline, December 19, 2014. The abstract must be no more than two pages in length and must include the following sections: i) Overview of the topic including its background and potential significance; ii) Methodology: how the matter was addressed, what techniques were used; iii) Results: key and ancillary findings; iv) Conclusions: lessons learned, implications, next steps; v) References (if any).

Abstracts for the poster session must be submitted by the regular abstract deadline. The abstract format for the Poster Session is identical to that for the Concurrent Sessions. Additionally, such an abstract should clearly indicate that it is intended for the Poster Session.

Please visit the conference website (http://www.iaee2015.org) to download an abstract template. All abstracts must conform to the format structure outlined in the template. Abstracts must be submitted online through the conference website. Abstracts submitted by e-mail or in hard copy will not be processed.

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 to 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. 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.

Optionally, authors whose abstracts are accepted may submit their final papers or posters for publication in the online conference proceedings. Please visit the conference website (http://www.iaee2015.org) to download a paper template. All such submitted papers must conform to the format structure outlined in the template. Regarding posters to be published in the online conference proceedings, poster presenters should submit a final version of the poster electronically (in pdf format).

Registration Fees	Received on or before March 20, 2015	Received on or before April 17, 2015	Received after April 17, 2015
Speakers/Chairmen (Members)	750 USD	850 USD	950 USD
Speakers/Chairmen (Nonmembers)	900 USD	1,000 USD	1,100 USD
Members	950 USD	1,000 USD	1,050 USD
Nonmembers (including membership)	1,100 USD	1,150 USD	1,200 USD
Full-time Students (Members)	400 USD	450 USD	500 USD
Full-time Students (Nonmembers, including membership)	450 USD	500 USD	550 USD
Spouse/Accompanying Persons	200 USD	250 USD	300 USD

Key Dates and Deadlines

- Receipt of abstracts: *December 19, 2014*
- Notification of acceptance: *February 4, 2015*
- Full paper submission: *March 20, 2015*

Pre-Conference Workshop

A pre-conference workshop entitled "Shale Gas in North America: Resources, Deliverability, Demand and Global Implications" will be held on May 24th 2015. The workshop will be given by Gürcan Gülen and Svetlana Ikonnikova from the Bureau of Economic Geology, The University of Texas at Austin. Registration fee is 100 USD.

Pre-conference Golf Tournament

Gloria Golf Resort is known for its excellent golf courses, attracting golfers from all over the world. In order to offer IAEE golfers an opportunity to meet and enjoy the Gloria golf courses, a pre-conference golf tournament will be organized on Sunday, May 24. The maximum number of participants is 24 (first come first serve) and the fee is 120 USD. Information about the golf tournament will be posted on the conference website. Players are welcome to contact Lars Bergman (lars.bergman@hhs.se) for more detail.

Awards

- Best Student Paper Award
- Best Poster Award
- Energy Development, Growth and Sustainability Award

Contact Information

Host Organization:
Turkish Association for
Energy Economics (EED)
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Tel: +90-212-3597544

For the latest updates about the conference;
Official website: http://www.iaee2015.org
Official Twitter account: @IAEE15
Official Facebook Page: IAEE15
e-mail: info@iaee2015.org

IAEE INTERNATIONAL ASSOCIATION *for* ENERGY ECONOMICS
WWW.IAEE.ORG

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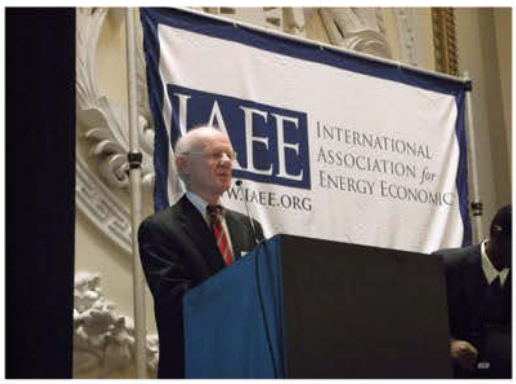
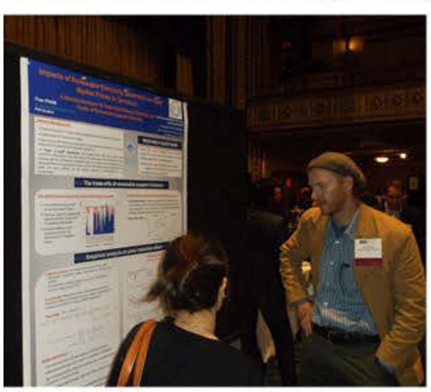
TURKISH ASSOCIATION for ENERGY ECONOMICS

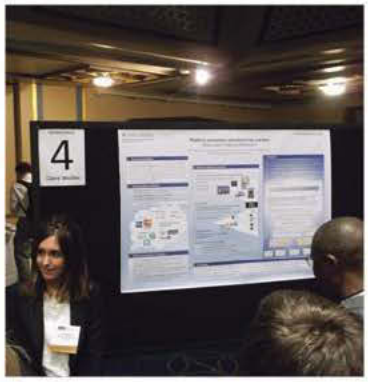
Scenes From the 37th IAEE International Conference June 15-18, 2014







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IAEE


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ASSOCIATION for
ENERGY ECONOMICS



SPECIAL OFID/IAEE SUPPORT FUND FOR STUDENTS FROM DEVELOPING COUNTRIES

IAEE is pleased to announce the continuation of a special program offering conference support to IAEE student members from developing countries (for a list of qualifying countries please visit http://www.iaee.org/documents/LIC.pdf). Your country of origin must be on this list for support to be considered. The program covers eight of the Association's conferences in 2014 & 2015. This program is generously underwritten by the OPEC Fund for International Development (OFID) and the International Association for Energy Economics. The program covers transportation and lodging reimbursement up to $1750.00 plus waiver of conference registration fees for a limited number of qualifying students. Note: you must be (1) from a qualifying country, (2) a current IAEE member, (3) registered as a full-time student in a program of study and (4) be enrolled in full-time PhD academic coursework during the application stage as well as during the conference to be attended. It is further strongly suggested that you submit a paper for presentation at the conference you wish to attend and receive this support and be in the process of obtaining your PhD. The conferences included in the program are the 7th NAEE/IAEE International Conference in Abuja, Nigeria, February 17-18, 2014, the 37th IAEE International Conference in New York City, USA, June 15-18, 2014, the 4th IAEE Asian Conference in Beijing, China, September 19-21, 2014, the 14th IAEE European Conference in Rome, Italy, October 28-31, 2014, the 8th NAEE/IAEE International Conference in Ibadan, Nigeria, February 23-24, 2015, the 5th ELAEE Conference in Medellin, Colombia, March 15-18, 2015, the 38th IAEE International Conference in Antalya, Turkey, May 24-27, 2015, and the 34th USAEE/IAEE North American Conference in Pittsburgh, PA, October 25-28, 2015.

Application deadlines for these conferences are as follows: Abuja Conference – application cut-off date, November 15, 2013; New York City Conference – application cut-off date, March 13, 2014; Beijing Conference – application cut-off date, June 17, 2014; Rome Conference – application cut-off date, July 14, 2014; Ibadan Conference – application cut-off date, November 24, 2014; Medellin Conference – application cut-off date, December 31, 2014; Antalya Conference – application cut-off date, February 18, 2015; Pittsburgh Conference – application cut-off date, July 20, 2015.

Please submit the following information in one succinct email (e.g., all below materials sent in the same email – including your professor's letter of recommendation) electronically to iaee@iaee.org to have your request for support considered. Make the subject line of your email read "Application to OFID/IAEE Support Fund (mention the conference you wish to attend)."

- Full name, mailing address, phone/fax/email, country of origin and educational degree pursuing.
- A letter stating you are a full-time graduate/college student during the application stage as well as during the time of the conference you wish to attend, a brief description of your course work and energy interests, and the professional benefit you anticipate from attending the conference. The letter should also provide the name and contact information of your main faculty supervisor or your department chair, and should include a copy of your student identification card.
- Indication of whether or not you have submitted an abstract to the conference you wish to receive OFID/IAEE Support to attend.
- A letter from your academic faculty, preferably your faculty supervisor, recommending you for this support and highlighting some of your academic research and achievements, and your academic progress.
- A cost estimate of your travel/lodging expenses to participate in your conference of choice.

Please note that students may apply for this support at only one of the above conferences. Multiple requests will not be considered. If you are awarded support and are unable to attend the conference this support is not transferrable to another conference. Further note that you must be a student member of IAEE to be considered for this support. Membership information can be found by visiting https://www.iaee.org/en/membership/application.aspx

Applicants will be notified whether their application has been approved approximately 21 days after the applicable application cut-off date, above. After the applicant has received IAEE approval, it will be his/her responsibility to make their own travel (air/ground, etc.) and hotel accommodations to participate in the conference. Reimbursement up to $1750.00 will be made upon receipt of itemized expenses and after the conference is held. The reimbursement will only cover transportation and lodging expenses. No other expenses will be covered (e.g., paying for Visa's/Passports, meals outside the conference provided meal functions); no more than three nights lodging will be covered.

For further information regarding the IAEE support fund for students from developing countries to participate in our conferences in 2014 & 2015, please do not hesitate to contact David Williams at 216-464-5365 or via e-mail at: iaee@iaee.org

For a list of qualifying countries please visit http://www.iaee.org/documents/LIC.pdf If your country of origin is not on this list your application for support will not be considered.

The Italian Energy Sector in 2013 and Prospects for 2014

Every year, the AIEE organizes an important conference to analyze the energy trends in the past year and the prospects of what appears to be the outlook for the current year, which allows to have a thorough past, present and future view of the national energy sector against the anticipated evolution of the worldwide energy situation.

This event has become "a key appointment" which is now at its 6th edition. It is one of the most anticipated events of the year with a large participation not only of institutions but also of academics and experts of the energy sector.

The main objective of this conference is to provide a context for discussion, debate, communication and exchange among energy professionals. This is a platform for dialogue, an appointment that the AIEE members will never miss and also involves a large number of non-member institutions, companies, academics and experts working in the energy field.

This year, the conference took place on April 9, in the beautiful historical palace of the American Cultural Center, in Rome, and had as special guests the IAEE representatives Dave Williams and Gurkan Kumbaroglu, who opened the conference welcoming the participants and presenting them the IAEE mission, organization, structure, publications and activities, and inviting them to participate in the next important event IAEE organizes in Rome, the 14th European conference on "Sustainable Energy Policy and Strategies for Europe".

The AIEE Honorary President Edgardo Curcio then introduced the speakers who reported for their respective areas of expertise.

The first speaker, Ciro Rapacciuolo, from the Study Centre of the Confederation of the Italian Industry, presented the general frame of the Italian economy against which the energy sector and its possible evolution in 2014 should be examined. In the fourth quarter of 2013, overall a black year for the Italian economy, we can identify some weak signs of recovery (of the order of +0.1 % in some key indices) that is struggling against some persisting obstacles, such as the difficult access to credit and exchange rates above average levels that have strongly affected the export of Italian companies. In spite of these negative elements, in 2014 we begin to catch a glimpse of some signs of recovery as the reduction of the sovereign's interest rates and a positive trend of the world trade with a good influence also on the Italian export and an improvement of the public finances. The forecast for the current year is moderately optimistic and provide a growth of GDP in 2014 (+0.7 %), which is expected to grow further in 2015 (+1.2%). Household consumption trends should return to positive in 2014 as well as imports of goods and services (+3.4%) and the related exports. Consumer prices are expected to remain stable (+1.3 %), while unemployment will remain high and would not yet show signs of reversal.

The next speaker, *Rita Pistacchio* from the Italian Association of Oil Companies, presented the oil market situation in 2013, which in Italy was strongly affected by the crisis but was not so disastrous as in some other countries. For the United States 2013 was a wonderful year thanks to the huge contribution of non conventional crude oil and gas. The U.S. is experiencing a turning point in their energy system and are relaunching their economy.

In Italy, the energy consumption has decreased from 170 Mtoe in 2012 to 164 Mtoe in 2013 (-3.7%) , particularly oil which last year fell by 5.3%, with a contraction of 2.6% of the domestic production of crude oil, which confirmed the high degree of dependence on oil imports from abroad (91%).

The reduction of crude oil consumption recorded this year is lower than that of last year (-5.3 % vs. -9.6 %) , nevertheless the oil is the source that most reflected the impact of recession (-28 % -23 million tons); the contraction of the natural gas that is being recorded now is linked both to the crisis and to the reduction of electricity demand as a side effect of the increased development of renewable energy .

On the contrary to what happens in our country, there is a growth of the world GDP as well as of the oil demand (+1.6 % in 2013). The oil bill stood at 30.5 billion euro in 2013 as compared to 33.9 in the previous year, registering a saving of € 3.4 billion (-10%) due to the dollar decreasing value (-2.2%), the euro strengthening (+3.4 %) and the decline in consumer spending (-5.3%), The energy bill stood at about 55.8 billion against € 64.9 billion last year, registering a saving of € 9 billion (-14 %).

The year 2013 as compared to 2012 marked a sharp reduction of supply from the Middle East especially from Saudi Arabia and Iraq and from Africa due to the lower production in Libya which is experiencing internal political tensions. These declines were covered by the increase of supply from the former USSR.

The production of the Italian plants has fallen by 12% , reaching 71.4 million tons. Over the last decade, 2003 - 2013, around 32.2 million tons were lost in terms of lower fuel consumption , a value decidedly worrying considering that it exceeds the value of the second oil shock (17.9 million tons between 1980-1985). As regards the oil products there is a decreasing trend that has seen a loss of about 3.4 million tons, from 64.2 million tons in 2012 to 60.8 million tons in 2013.

Turning to prices, the gasoline sold at an average of 1.749 € /liter in 2013 as compared to 1,787 € / liter of 2012, due to the lower raw material cost and the strengthening of the euro, while excise duties continue to represent a significant amount. The same for diesel fuel: there has been a decline in the price in 2013 at 1,659 € / liter, as compared to 1,705 € / liter in 2012 for the same reasons as for gasoline. The system is suffering not only due to the decline of domestic consumption, but also for the “unfair” competition of the refiners from the countries that have no EU legislation constraints and burdens. This means that unless action is taken with targeted interventions Italy risks to permanently lose an important slice of its industrial system .

The analysis of the oil industry was followed by the overview on the electricity sector presented by *Andrea Lupi* from Terna. The balance shows a temporary decrease of the electrical demand of 3.4% which thus reached 317.1 TWh. Net production recorded a decrease of 3.6% , linked to the contraction of thermoelectric production (-24.8 TWh compared to 2012), while there is a growth of all renewable sources (photovoltaic production +18.8% , wind +11.6% and hydro +21.4%). The thermal production which represents about 66 % of national production is of 182.5 TWh.

Imports of electricity also decreased from 43.1 TWh in 2012 to 42.1 TWh in 2013 (-2.2%). The installed capacity in 2013 increased by 0.1 GW , mostly related to photovoltaic plants , whose capacity has grown of 1.9 GW compensating, together with the new wind capacity , the lower capacity of thermal power plants.

Final electricity consumption in 2013 was reduced of 10,470 GWh as compared to 2012 (-3.4%) , which have thus reached a value of 296.7 TWh.

This is mostly derived from the contraction of industrial consumption from 130.8 TWh in 2012 to 124.7 TWh in 2013 (-4.7% compared to 2012). The household electricity consumption reached 66 TWh (-3 TWh compared to 2012) and the tertiary sector 99.8 TWh compared with 101 TWh in 2012 (-1.2%) .

The point of view of the Renewable Energy and Energy Efficiency Association (FREE) was presented by *G.B. Zorzoli.* The renewable energy sector, in Italy, in 2013, had a slight decrease in the volume of investment as compared to the previous year and to the world general raising trend which amounts to 214 billion dollars. At the global level, there is a growth of the installed wind power equal to 318.1 GW in 2013 (+35 GW compared to 2012) and of the installed capacity of the photovoltaic for a total of 132 GW in 2013 (+31% compared to 2012). In Italy, there are also interesting new developments for the renewable energy sources. In 2013 the national production satisfied 19% of the total consumption. The renewable energy sources contribution represented of 11% as compared to 8.5% of the traditional sources. In terms of electricity generation the year 2013 has offered a big surprise: the strong growth of the wood biomass that reached 8.5 Mtoe.

The representative of the Ministry of Economic Development *Andrea D’Elia* presented the situation of the natural gas which is consistent with that of the other energy sectors. The natural gas consumption decreased of 6.5 %, from 74.9 to 70.1 billion cubic meters . Consumption was mainly covered by imports, which compared to 2012 have declined of 8,5%, representing 88% of the gas supply in Italy.

The gas consumption is mainly related to the residential and tertiary sector (44%), thermal (30%) and industry (21%). The supply takes place mostly through pipelines, while the use of LNG is still marginal. The imports, lower than in 2012, are mainly related to the flow from Tarvisio that corresponds to the imports of Russian gas.

A look at the international markets was illustrated by *Vittorio D'Ermo*, Director of the AIEE Energy Forecast Service. In 2014 the world GDP is expected to increase by more than 3 % as compared to just 1% of the Eurozone's, with higher values for the emerging countries although with lower rates than those of recent years.

The global oil demand will be mostly covered by OPEC, with a contribution of around 35.9 million barrels/day, below the level of 2013 that amounted to 36.3, while the OECD production due to increased production in the United States will reach 24.9 million b/d, improving the flexibility of the world's oil system. The attitude of Saudi Arabia and other Gulf countries is expected to remain essentially cooperative with the aim to fight price increases out of control. The geopolitical factors will influence prices also in 2014 but they will no longer be confined to the areas of the Middle East but also in Libya , Egypt, Syria , Nigeria and even Europe. The average Brent price is expected around 108 $ / barrel, slightly down compared to 2013. The international coal market , however, showed further reductions in 2013 that pushed prices below the peak levels of 2011; the general outlook points to a modest increase in line with the recovery of the international economy.

The change in the international gas market, thanks to the American shale gas, has now consolidated the separation of the gas price from the Brent price with a progressive reduction of the gas price that is expected to continue also in 2014. The Italian system is in a difficult situation, but the outlook for GDP in 2014 is positive with a balance of trade that is expected to grow as well as the index of industrial production (+2.4% in 2014). In the private consumption a modest growth is expected (+0.4% in 2014 compared to 2013). The 2014 promises to be a year of change but not of return to the past, with the Italian energy system that has begun a new path based on efficiency and an increased role of the renewable energy.

Edgardo Curcio, the AIEE Honorary President outlined the main elements of 2013 illustrated by the previous speakers saying that the crisis of all the productive sectors particularly the refining sector, the power generation and gas sector led to the closure of some factories and to the sale of majority stakes by some Italian companies to foreign companies, Russian in particular, a situation that could be extended also to other energy sectors in crisis, thus leading to a "colonization" of our productive sector. In the early months of 2014 the energy demand in Italy decreased of 6.4% in almost all sectors. The demand for natural gas has fallen by almost 16 %, also due to the mild weather, while the fall of the oil products has stopped at -4%.

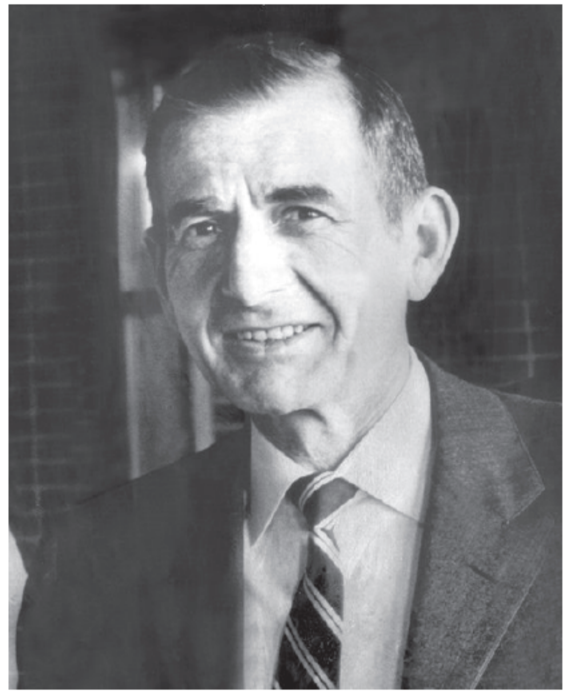
On the international front, to the already very critical geopolitical situation in the Middle East and North Africa, that in 2013 disrupted the flows of gas and oil to Italy, has now added the crisis in Ukraine - Russia that threatens to disrupt or at least weaken gas imports from Russia , which are vital for Italy. On the political level the most important event was the establishment of the Government Renzi, who has set a goal in the field of two important goals. The first reduction of 10% in energy costs , especially for small and medium-sized businesses who pay about 25% more than their European competitors. The second objective is the reform of the Fifth Amendment of the Constitution which had attributed to the Regions concurrent legislation in some important fields, such as energy and networks, creating over the past few years a strong litigation and delay in decisions on new power plants building and new transmission networks of gas and electricity.

Carlo Di Primio , AIEE CEO brought up the problem of competitiveness and of the high cost of energy in Italy that constitutes an obstacle to the development and competitiveness of the economy making it more expensive than that of other countries with which we compete in international markets .

The industry has already made extensive efforts in reducing energy consumption.

The high cost of energy in our country is due to internal factors but also to external factors of the energy system. One of the internal factors is the energy mix itself, based on the most expensive and vulnerable sources (gas and oil) compared to the cheaper ones (coal and nuclear), and a slow system of energy infrastructures inflexible to changes. Among the external factors the most relevant is the high taxation for all the needs of the state. In 2012 the revenue from environmental taxes reached 47.2 billion euro, of which 77 % came from taxes on energy, compared with 75% of the European average. Besides the excises, which represent the prevalent component of the energy taxes, we should also mention the "Robin Hood Tax", an Italian anomaly inserted in 2008 as additional tax paid by oil and electric companies and extended to gas and renewables companies with a lowering of the income threshold for the application. The amount of this tax in 2012 was 52 million euro. What is really needed is an efficient energy policy to achieve of a lower energy price.

Morrie Adelman



Morris Albert Adelman was born in New York City on May 31, 1917, and graduated from the City College of New York in 1938 with the intention of becoming a science teacher. After working as an economist for the government, he joined the Navy, serving as an ensign in the Pacific during World War II commanding a landing ship. After the war, he earned a Ph.D. in economics from Harvard and was hired by the MIT economics department in 1949.

His early work was in industrial organization and he moved to studying the petroleum industry, combining theoretical work with empirical analysis. His first major publication, "The Supply and Price of Natural Gas," in 1959, began a long line of academic articles and books on the economics of the petroleum industry. The World Petroleum Market, with intensive data gathering and analysis, demonstrated that the cost of extraction was quite low, and led him to suggest that prices could remain low for some time.

When they soared, he was always in the forefront of the debate over the cause, pointing to producer policies of restricting production in the short-term and investment in the long-term, which kept prices above competitive levels. This began a long-term debate with others inside, but mostly outside, the profession, who tried to explain higher prices as due to natural economic law or resource scarcity. His position seemed to be undermined when the 1979 Iranian Revolution tripled oil prices again, but when prices collapsed in 1986, despite many predictions to the contrary, his reasoning was validated.

He also made a number of important research contributions including:, writing the equations that defined cost of production including the impact of decline rates; demonstrating that large resource owners would likely have high, not low, discount rates; showing how high user costs would lead to production sooner rather than later; and especially exposing the flaw in those who argued that Harold Hotelling's work meant resource prices would rise exponentially. Carol Dahl provides an excellent summary of his math in International Energy Markets (2004).

The IAEE was founded to function as a forum where energy issues, and particularly those extremely politicized issues involving oil and gas economics and government policy, could be discussed in a serious, non-political way, among government, university and industry analysts. The first IAEE meeting was held in June of 1979 with a number of important government, industry and university participants, during a time that sorely needed such a forum. The founders of the organization discussed who might become the third President of the IAEE and give it the increased credibility it needed for it to succeed. Morris Adelman was the unanimous choice; Mike Telson, who had been his student, was asked to speak with him and see if he would be willing to become its President to help the fledgling IAEE establish itself at a most critical stage. Professor Adelman readily agreed to do so and helped turn the-then barely existent IAEE into the important organization it is today. The IAEE has become successful, in great part, due to the efforts of many, including its first two Presidents, Sam Schurr and Jim Plummer. As its third President, Morris Adelman lent the IAEE his imprimatur which meant a great deal at the time; his contribution to the IAEE is recognized, in part, by naming its most important award after him.

Mike Lynch
Mike Telson

2016 International Conference to be in Bergen, Norway

The 2016 International Conference of IAEE will be in Bergen, at Norwegian School of Economics, NHH. IAEE representatives David Williams and Gurkan Kumbaroglu visited NHH early April to take part in preparations. "Refreshing and comforting to know we will be on campus and have seen the facilities," says Dave" and we met with rector, hotels and the conference team, headed by former IAEE president Einar Hope. The overall theme of the conferece is *Energy: Expectations and Uncertainty, Challenges for Analysis, Decisions and Policy.*

"Bergen being wedged between a century old hydroelectric energy journey, a half-century old petroleum adventure, and a future fueled by a pretty impressive oil fund, we are pretty excited", says Gurkan.

The Grieg Hall – Bergen is also culturally and touristically ambitious – will be the venue for the Gala Dinner, and the city is welcoming the conference delegates to a reception at the Haakon's Hall, where King Haakon Haakonsen dined and threw parties three quarters of a millennium ago.

Energy economists will be excited to hear that themes of policy analysis, expectations and risk will be highlighted at the conference, in addition to themes such as resources, environment, technology and climate change.

Corporate sponsors from electricity sectors as well as petroleum – Statkraft, Statoil and others - are helping make the conference possible, and will also ensure interesting content and technical tours.

So mark your calendars now with the dates of June 19-22, 2016.

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Remarks by James D. Hamilton on Receiving the *IAEE Outstanding Contribution to the Profession Award* at the 2014 IAEE Awards Banquet

In 1980 this organization was three years old and I was in my third year in the economics Ph.D. program at Berkeley. There was a lot of interest in what was going on in energy markets at that time. The oil embargo by the Organization of Arab Petroleum Exporting Countries in 1973-74 and the Iranian revolution in 1978-79 were both associated with significant disruptions in world oil production and big spikes in energy prices. Many of us were persuaded that these events made a contribution to the two economic recessions that followed the two oil supply disruptions.

I was supposed to write a third-year empirical paper at Berkeley. As I was looking into these events I was surprised to find that this wasn't the first time something like this had happened. The Suez Crisis of 1956-57 resulted in a significant disruption in the flow of oil, and that had also been followed by an economic recession. There were quite dramatic increases in oil prices in 1947-48, and these were followed by the first of the postwar U.S. recessions. In fact, as of 1980, we'd seen seven recessions in the United States since World War II, and six of those had been preceded by a spike in oil prices. I thought, ok, maybe I should use this for my third-year paper.

As I was working on this topic, Iraq invaded Iran, knocking out even more global oil production, and sending oil prices to all-time highs. The National Bureau of Economic Research declared that the U.S. entered an eighth recession just 12 months after we got out of recession number seven. I thought, ok, maybe I should use this for my dissertation.

And so I did. I was resolved that once I finished the dissertation I was going to move on to other areas of research. But world events kept dragging me back. In 1990, after eight years of falling oil prices, and eight years without an economic recession, Iraq invaded Kuwait, knocking out two of the world's biggest oil producers. Oil prices rocketed back up, and it was déjà vu all over again as the U.S. fell into postwar recession number nine. There was another dramatic move up in oil prices prior to the 2001 recession. And you're all very familiar with the spectacular oil price spike of 2007-2008, which was as big in magnitude as any of these other episodes, and which was followed by what we have now come to refer to as the Great Recession. So the count is now up to 10 out of 11 postwar recessions were preceded by a spike in oil prices. I think there's something to this.

But what could account for this apparent relation? It's easy to write down a model in which energy shouldn't be all that important for the economy. In a frictionless neoclassical model, the key parameter is the dollar share of energy out of total spending, and this is a relatively small number. According to neoclassical theory, equilibrium prices persuade firms and consumers to reduce their energy consumption in response to an exogenous disruption in supply, and any economic costs associated with voluntary reductions in energy use should be smaller than had the users decided just to pay the higher price and go on using energy the way they had been. The total economic loss should be less than the dollar cost of the lost energy.

But a frictionless neoclassical model won't get you very far in understanding economic recessions no matter what kind of shocks you're looking at. Most of us are persuaded that there are important inefficiencies associated with recessions, as labor and capital become underutilized relative to the efficient frontier. Once you start thinking along these lines, it's easy to see how an energy shock could make a contribution. For example, we often see consumers suddenly stop buying the larger, less fuel-efficient vehicles that have historically been key to U.S. auto industry profits. Loss of income and layoffs in the auto sector then become a separate factor contributing to the overall decline in economic activity.

Certainly many of the economic developments in 2007 and early 2008 were consistent with the patterns in earlier oil shocks. Sales of larger vehicles plunged, and consumer sentiment and overall consumer spending responded to higher gasoline prices in much the same way we had seen them do in previous episodes.

But there was one important difference. Many of the historical oil shocks that I mentioned were associated with dramatic geopolitical events such as wars in the Middle East. But there were none of these in 2007-8. Instead what happened was global oil production stagnated even as demand from the emerging economies continued to surge, and this produced the dramatic spike in oil prices.

I think it's clear today that this episode marked the beginning of a new era in which it has been hard for oil production to keep up with growing demand without big increases in oil prices. Since 2005, field production of crude oil has increased very little worldwide, with U.S. shale oil production accounting for more than 100% of the increase—in the absence of these new sources of supply, global production today would be lower than it was in 2005. Add to this the challenges of dealing with the consequences for the world's climate of our fossil fuel consumption, and also add this week's news coming out of Iraq, and it seems pretty clear that it is extremely important to study what is going on in energy markets right now, just as it was in 1980. So I think all of you are in the right place at the right time. The right place being the International Association for Energy Economics, the right time being June 2014. The world is in real need of the insights that each of you can bring to these challenges.

Thank you very much for this great honor.

Calendar

14-15 July 2014, 2014 EIA Energy Conference at Washington DC, JW Marriott, USA. Contact: Kelsey Brasher, Government Relations Specialist , U.S. Energy Information Administration, 0. Phone: 202-586-2935, Email:Kelsey.Brasher@eia.gov, URL: http://www.fbcinc.com/e/eia/?src=home-b6,

21-22 July 2014, Shale and Tight Gas Fundamentals at Informa Australia, King William Street, Adelaide SA, 5000, Australia. Contact: Informa Australia, Informa Australia, King William Street, Adelaide, SA, 5000, Australia. Email: Info@informa.com.au, URL: http://atnd.it/6457-0,

21-21 July 2014, LNG Awareness at Perth, Australia. Contact: Informa Australia, LNG Awareness, Informa, St Georges Terrace, Perth, Western Australia, 6000, Australia. Phone: 61 2 9080 4050, Email:Info@informa.com.au, URL: http://atnd.it/6533-0,

21-22 July 2014, 5th Annual Mozambique Coal Conference at Radisson Blu Hotel, 141 Av. da Marginal, Maputo, 1100, Mozambique. Contact: Informa, Australia, Informa, Level 2, 120 Sussex St, Sydney, NSW, 2000, Australia. Email: info@informa.com.au, URL: http://atnd.it/6305-0,

22-24 July 2014, LNG Fundamentals at Informa Australia, St Georges Terrace, Perth, WA, 6000, Australia. Contact: Informa Australia, Informa, Australia. Phone: 02 9080 4307, Email: info@informa.com.au, URL:http://atnd.it/6477-0,

23-24 July 2014, Shale and Tight Gas Fundamentals at Informa Australia, St Georges Terrace, Perth WA, 6000, Australia. Contact: Informa, Australia, Informa, 2/120 Sussex St, Sydney, 2000, Australia. Phone: +61 2 9080 4307, Email: Info@informa.com.au, URL: http://atnd.it/6505-0,

25-25 July 2014, Hydraulic Fracturing Basics for CSG and Shale - Perth at Informa Australia, St Georges Terrace, Perth, 6000, Australia. Contact: Informa Australia, Informa Australia, Level 6, 120 Sussex Street, Sydney, 2000, Australia. Phone: +61 2 9080 4050, Email: Info@informa.com.au, URL: http://atnd.it/6463-0,

28-28 July 2014, Hydraulic Fracturing Basics for CSG & Shale - Sydney at Informa Australia, 120 Sussex St, Sydney, 2000, Australia. Contact: Informa Australia, Informa, Level 6, 120 Sussex Street, Sydney, 2000, Australia. Phone: +61 2 9080 4050, Email: Info@informa.com.au, URL: http://atnd.it/6465-0,

29-30 July 2014, Coal Industry and Market Fundamentals Masterclass at Informa Australia, George Street, Brisbane QLD, 4000, Australia. Contact: Informa, Australia, Informa, 2/120 Sussex St, Sydney, 2000, Australia. Phone: +61 2 9080 4307, Email: Info@informa.com.au, URL: http://atnd.it/6501-0,

29-31 July 2014, Mine Ventilation 2014 at Royal on the Park, Cnr Alice & Albert Streets, Brisbane, QLD, 4000, Australia. Contact: Mining IQ, The, IQPC, 0. Phone: 02 9229 1000, Email: enquire@iqpc.com.au, URL:http://atnd.it/9527-0,

01-01 August 2014, Hydraulic Fracturing Basics for CSG & Shale - Brisbane at Informa Australia, George Street, Brisbane QLD, 4000, Australia. Contact: Informa Australia , Informa, Level 6, 120 Sussex Street, Sydney, NSW, 2000, Australia. Phone: 61 2 9080 4050, Email: Info@informa.com.au, URL: http://atnd.it/6464-0,

03-08 August 2014, The World Renewable Energy Congress - 25th Anniversary at London, UK. Contact: Conference Secretariat, WREC XIII, United Kingdom. URL: www.wrenuk.co.uk ,

05-06 August 2014, Asian Utility Week 2014 at Renaissance Kuala Lumpur Hotel at Corner of Jalan Sultan Ismail and Jalan Ampang, Kuala Lumpur 50450, Malaysia. Contact: Clarion, Events, Clarion Events, 78 Shenton Way, No20-03, Singapore, 079120, Singapore. Phone: +65 6590 3970, Email:info@clarionevents.asia, URL: http://atnd.it/8179-0,

11-14 August 2014, The Cybersecurity for Oil, Gas and Petrochemicals at IQPC Asia, 3 Jalan Stesen Sentral, Kuala Lumpur, 50470, Malaysia. Contact: Susy Angryany, IQPC, 129 Wilton Road, London, London, SW1V 1JZ, United Kingdom. Phone: 6567229465, Email: Susy.Angryany@iqpc.com.sg, URL:http://atnd.it/9332-0,

19-21 August 2014, South East Asia Australia Offshore & Onshore Conference 2014 at Darwin Convention Centre, Stokes Hill Road, Darwin, NT 0800, Australia. Contact: Informa Australia, Informa Australia, Level 2, 120 Sussex St, Sydney, NSW, 2000, Australia. Phone: +61 2 9080 4300, Email: info@informa.com.au, URL:http://atnd.it/5281-0,

20-22 August 2014, 3rd International Conference Offshore Wind Power Substations 2014 at Swissotel Bremen, Hillmannplatz 20, Bremen, 28195, Germany. Contact: IQPC Germany, IQPC, Friedrichstrasse 94, Berlin, 10117, Germany. Phone: +49 (0)30 20 91 3274, Email: eq@iqpc.de, URL: http://atnd.it/11449-0,

25-27 August 2014, Oil and Gas Offshore Vessels Summit at New Orleans, LA, USA. Contact: Dionne Mariavaz, 0. Email: enquiryiqpc@iqpc.com, URL: http://www.offshoresupportvessels.com/,

25-27 August 2014, Offshore Modular Construction Summit at Houston, Texas, USA. Contact: Dionne Mariavaz, 0. Phone: 1-800-822-8684, Email: enquiryiqpc@iqpc.com, URL:http://www.offshoremodularconstruction.com/,

26-28 August 2014, 3rd International Conference Advances in Wind Turbine Towers 2014 at Swissotel Bremen, Hillmannplatz 20, Bremen, 28195, Germany. Contact: IQPC, Germany, IQPC, Friedrichstrasse 94, 10117, Berlin, Berlin, Germany. Phone: +49 (0)30 20 91 3274, Email: eq@iqpc.de, URL: http://atnd.it/11450-0,

26-27 August 2014, 10th International Energy Conference at Iran Energy Institute. Contact: M.Reza Taqavi, Mr., National Energy Committee Member, Dadman Blvd. Shahrak-e-Gharb, Tehran, 1468936311, Iran (Islamic Republic of). Phone: +982142917000, Fax: +982142917100, Email: irannec@irannec.com, URL:www.irannec.com ,

01-03 September 2014, 20th Latin Oil Week Upstream 2014 at Copacabana Palace, Avenida Atlantica, 1702, Rio de Janeiro, 22021-001, Brazil. Contact: Babette van, Gessel, Global Pacific and Partners, Av. Almirante Barroso, 91- sl, Rio de Janeiro, 1112, Brazil. Phone: +31.70.324.6154, Email: babette@glopac-partners.com, URL: http://atnd.it/12739-0,

02-02 September 2014, Gas Industry & Market Fundamentals - Brisbane at Informa Australia, George Street, Brisbane, 4000, Australia. Contact: Informa Australia, Informa, Level 6, 120 Sussex Street, Sydney, 2000, Australia. Phone: 61 2 9080 4050, Email: Info@informa.com.au, URL: http://atnd.it/6461-0,

03-04 September 2014, Coal Industry and Market Fundamentals Masterclass at Informa Australia, 120 Sussex St, Sydney, 2000, Australia . Contact: Informa Australia, Informa, 120 Sussex Street, Sydney, New South Wales, 2000, Australia. Email: Info@informa.com.au, URL: http://atnd.it/6502-0 ,

04-04 September 2014, Iron Ore Beneficiation & Processing Fundamentals - Perth at Informa Australia, St Georges Terrace, Perth, 6000, Australia. Contact: Informa Australia, Informa, Level 6, 120 Sussex Street, Sydney, 2000, Australia. Phone: +61 2 9080 4050, Email: Info@informa.com.au, URL: http://atnd.it/6499-0,

09-10 September 2014, The Essential Techno Commercial Introduction to CSG at Informa Australia, George Street, Brisbane, QLD, 4000, Australia. Contact: 02 9080 4307, Australia. Email: info@informa.com.au, URL:http://atnd.it/6487-0,

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