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

IAEE Energy Forum

Second Quarter 2009 International Association for Energy Economics

President's Message

The world financial and economic crisis has reached the core of the energy industry. Energy demand is shrinking, energy prices are falling on a broad front, energy investments are being cancelled, and energy technology manufacturers are reducing production and closing facilities. Even the prospects for clean renewable technologies such as wind power, photovoltaics, biofuels, and geothermal energy are being darkened.

The global energy economy is in a situation typical after a crash. Not yet 12 months ago we saw record high energy demand and energy price increases, and some serious experts assumed that this trend would continue. So why not simply argue today that global energy market conditions have just normalized. Remember that during the first half of this decennium a crude price of 40 to 50 USD per barrel would allow energy companies to do a rather good businesses.

But this doesn't correspond to the psychological sentiment of the market. Today the glass is not half full but half empty. Economic growth rates are truly disastrous, perhaps with the exception of some countries in Asia and Latin-America. Politicians all over the world allocate gigantic rescue programs to the financial sector and initiate Keynesian type expenditure plans with financial volumes the world has never seen before. Still the effect of all these political activities does not show much impact yet. Perhaps the mere size of the government expenditures is prohibiting the return of the most important resource to overcome the crisis – business confidence. Or the programs have other shortcomings that hinder them from being effective. We can observe, for example, that governments use large shares of their business recovery programmes to satisfy lobbying interests without carefully checking the implications for economic growth. In the present situation of easy government spending it would be stupid not to queue for government money. It may compensate for the increased tax burden which quite likely will be imposed one day in order to stabilize the public budgets and to amortize public debt.

We have to fear a more serious problem: the return of global protectionism. As energy economists we are used to considering the energy industry as the most completely organized global market. The oil market takes the lead here, followed by the natural gas industry. But other energy markets have caught up. Today, the manufacturers of conventional or renewable power generation equipment represent a truly global industry. The world trade share of biofuels is on the rise. Even the "most local" form of energy, electricity, is moving towards international markets, particularly in Europe.

Many people in energy importing countries, and even serious experts, argue today that governments should reduce energy import dependency and increase the domestic share of energy production. This would not only improve energy supply security but also create domestic jobs that are so urgently needed in order to sustain social balance and stability.

Economists know that this theory is wrong and dangerous. If cheap energy imports are replaced by expensive domestic energy sources, welfare is decreased. In addition, a vicious circle could emerge. As an example, if Europeans would reduce natural gas imports from Russia and produce more biogas at home, Russia would be less able to import manufactured goods and services from European countries. If the USA would not import cheap Brazilian ethanol but produce expensive ethanol at home, Brasilia would import less airplanes or software products from U.S. manufacturers. It is obvious that energy protectionism will be harmful to all.

(continued on page 2)

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

CONTENTS

Editor: David L. Williams

PRESIDENT'S MESSAGE *(continued from page 1)*

In order to reduce the impact of climate change, the world has to use fossil fuels much more efficiently than in the past. There are hopes that the Copenhagen Climate Conference later this year will contribute to a global greenhouse gas agreement. If power plants, houses, vehicles and appliances become more energy efficient, and if renewable technologies become increasingly competitive, it will ultimately reduce the global volume of traded energies. This would result in reduced greenhouse gas emissions, but has nothing to do with energy protectionism: Energy protectionism means to support domestic energy production at costs above world market prices in order to generate jobs and stimulate domestic businesses.

In time of need, politicians may increasingly look for new initiatives and amendments to currently only marginally successful business recovery programs, particularly if they do not execute another burden to the public budgets. In this situation the likelihood is growing that politicians follow protectionist ideas of interest groups and develop protectionist initiatives. Fortunately, major international leaders are striking against such a misguided and harmful energy policy. I believe that the IAEE, its affiliates and members can have an important supporting role to play in these efforts.

There is series of important international meetings ahead of us where we will exchange ideas and proposals around these important issues. From June 21-24, 2009, we will meet at the 32nd IAEE International Conference in the beautiful city of San Francisco. Under the leadership of the United States Association for Energy Economics, USAEE, a great program with important international speakers has been arranged that you should not miss. The Austrian Association for Energy Economics invites all of us to the 10th IAEE European Conference in Vienna. This meeting will take place from 7 to 10 September 2009 in a rather exiting location, the former residence of the Austrian emperors Hofburg. I would like to thank very much all IAEE members who are involved in preparing these two events and invite you to attend them.

I have more good news on IAEE and its affiliates. Last month we had the 2nd Latin American Meeting on Energy Economists in Santiago Chile. This was a break through of the IAEE mission in South America. Please take notice of the conference review in this issue of the IAEE *Energy Forum*. As a result of the Santiago meeting, many energy experts joined the association and decided to establish a Chilenian IAEE affiliate. I warmly welcome the many new members from Chile and from other parts of the world. The next IAEE conferences in South America will be the 2010, 33rd IAEE International Conference in Rio de Janeiro (Brasilia) and the 2011, 3re ELAEE in Argentinia. For those colleagues that will not be able to travel so far – in 2010 IAEE and its affiliates are preparing conferences in Africa, Asia, Europe, and North America.

Georg Erdmann

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 Note

This issue we begin a series of articles on renewable energy. We will continue the series in the third quarter issue and quite likely in the fourth quarter issue as well. Our call for papers on the subject has been particularly bountiful.

Ross McCracken notes that the omens for wind power are very good, and there is cause to believe that the EU's 2020 targets in this area will be exceeded. But as capacity grows, it may be wind's impact on price that presents the most immediate problem. Wind's intermittency can be ameliorated by interconnection and storage options, but the development of this infrastructure is lagging the installation of wind power itself.

Mamdouh Salameh outlines the components of a sustainable hydrogen economy and argues that the vision of a hydrogen economy could become a reality within the next four to five decades with Iceland already leading the way to become the world's first fully-operational hydrogen economy. By that time, hydrogen production costs will be lower, the basic components of a hydrogen storage and distribution network will be in place, and hydrogen-powered fuel cells, engines and turbines will be mature technologies that are mass produced.

Gary Beckett describes how a Seattle company hopes to harness energy from ocean waves, tides and wind to generate electricity using offshore platforms that would resemble oil rigs. The company is one of dozens developing wave and tidal energy-generation systems.

Fritz van Oostvoorn and Adriaan van der Welleare discuss the importance of large scale DER and DG integration as a means of meeting the 2020 EU policy objectives for RES. They note the barriers and discuss some solutions to the increasing use of DER and DG and how the costs of integrating more intermittent RES and DG might be addressed.

Mary Hutzler analyzes the Pickens Plan noting that he proposes that wind and natural gas usage be reconfigured to replace imported oil. Yet consumers and taxpayers will be asked to rely on an intermittent technology to generate more than 20 percent of U.S. electricity and convert transportation to a fuel that is imported on net.

Andrea Bollino discusses the role of Gestore dei Servizi Elettrici (GSE) in the support of the Italian Renewable Electricity System. The company has a single shareholder, the Ministry of Economy and Finance. This ministry, together with the Ministry of Economic Development, provides the guidelines for GSEs operations.

Paolo Polinori notes that the new "20-20-20" EU goals are for 20% of total energy resources to come from RES by the year 2020, together with a 20% energy savings; the annual cost necessary to reach this goal is estimated at 5.2 billion €. He reports that research findings support the view that, in Italy, there is some consensus on the development of RES but that surveys indicate a willingness to cover less than 20% of the total subsidy required.

DLW

Conference Objectives

Recent developments in energy markets suggest that we may be entering a new phase, with demand increasing more rapidly than supply, putting continued upward pressure on prices. Although technological advances continue to extend our capabilities, additional constraints – most notably global climate challenge – are complicating the picture and adding to uncertainties. And while low-carbon approaches including renewable energy technologies, biofuels, nuclear energy and carbon capture and sequestration offer significant promise, they also pose new challenges for policymakers.

The 32nd Annual IAEE conference will assemble prominent scholars and experts from around the world to explore, discuss and debate the challenges facing the global energy sector and offer solutions. The conference aims to bring into focus a host of topics that are of interest both to energy consumers and producers, be it oil, natural gas, transportation fuels, or electricity.

This timely and topical conference, to be held in **San Francisco 21-24 June 2009**, is designed to bring together energy practitioners, industry professionals, regulators, policymakers, researchers and scholars engaged in all aspects of the energy sector to exchange views, network and collaborate. This conference promises to be as big as its theme, "***Energy, Economy, Environment: The Global View***."

Plenary Sessions

The plenary sessions will explore several major issues affecting energy markets today. The question of how energy markets will respond to various climate policies is one of the most important questions currently faced. Climate concerns have spurred rapid developments in renewable energy technologies and nuclear power, each of which has a role in ensuring that growing energy needs can be met without increasing CO_2 emissions while facilitating broader goals of energy security.

Increasing rhetoric on energy security was spurred by the unprecedented heights that oil prices reached in 2008. However, the concept of energy security can mean different things to different countries, which can affect the policy actions taken by both suppliers and demanders. This and its implications for future global energy markets will be addressed.

The various factors responsible for the record oil prices witnessed in 2008, and how those factors may affect the future, will be also discussed. There will also be a discussion of the rapid emergence of unconventional oil and gas resources, which by most accounts could dramatically influence the global energy balance. Ensuring an appropriate level of investment to accomplish adequate energy supply can be a challenge in the face of the economic and political uncertainty inherent in today's energy markets. So, the many dimensions of uncertainty and its effect on investment planning will also be explored.

HOSTED BY: USAEE United States Association for Energy Economics

Conference Keynote & Plenary Sessions

Keynote Speakers

David O'Reilly
Chairman and Chief Executive Officer, Chevron

Michael R. Peevey
President, California Public Utilities

Christof Ruehl
Chief Economist, BP International Ltd.

George P. Shultz
Thomas W. & Susan B. Ford Distinguished Fellow, Hoover Institute

Climate Change Policy – Views from Academia, Government, and the Corporate Sector

James L. Sweeney *(Presiding)*
Director Precourt Institution for Energy Efficiency, Stanford University

Speakers TBA

Drivers of Oil Price and the Outlook for the Future

Samuel A. Van Vactor *(Presiding)*
President, Economic Insight Inc

Jeff Currie
Head of Commodities Research, Goldman Sachs

Ivan Sandrea
Vice President, Strategy for International Exploration & Production, StatoilHydro

Shane Streifel
Senior Energy Economist, World Bank

The Future of Renewables

Gary Stern *(Presiding)*
Director of Market Monitoring and Analysis, Southern California Edison

Ryan Pletka
Project Manager, Renewable Technologies, Black & Veatch Corporation

Robert M. Margolis
Senior Energy Analysis, National Renewable Energy Laboratory

Todd P. Strauss
Senior Director, Energy Policy, Planning, and Analysis, Pacific Gas and Electric Company

Energy Market Developments in the Pacific Basin

Kenichi Matsui *(Presiding)*
Councilor Energy Data Modeling Ctr, Institute of Energy Economics

James P. Dorian
International Energy Economist

Makoto Takada
Senior Researcher, Institute of Energy Economics

Michael Lynch
President, Strategic Energy & Economic Research

Unconventional Resources: Impacts and Issues

Andre Plourde *(Presiding)*
Professor, Dept of Economics, University of Alberta

Bob A. Hardage
Senior Research Scientist, University of Texas

John Wimer
Director, Systems Analysis Division, U.S. DOE/NETL

Frits Eulderink
VP Unconventional Oil, Shell Exploration & Production Company

Energy Markets and Policy: Developments Around The Globe

Kenneth B. Medlock *(Presiding)*
Energy Fellow, Rice University

Mark K. Jaccard
Professor, Simon Fraser University

Carlo Andrea Bollino
Chairman, GSE SpA

Paul Tempest
CEO and Director, Windsor Energy Group

Energy Market Integration – Developments in LNG

Glen E. Sweetnam
Director, International, Economic and Greenhouse Gases Division, U.S. Energy Information Administration

Christian von Hirschhausen
Professor, Technische Universitat Dresden

William J. Pepper
Senior Fellow, ICF International

Betting on the Crystal Ball – Private Energy Investment In Uncertain Times

William J. Kemp *(Presiding)*
Managing Director, Black & Veatch Corporation

Mark Burkhart
Sempra

International Trends in Nuclear Power

Fereidoon P. Sioshansi *(Presiding)*
President, Menlo Energy Economics

Ana Palacio
Senior Vice President of International Affairs and Marketing, AREVA

Tom O'Neill
Vice President, New Plant Development, Exelon Nuclear

Jean-Pierre Benque
Executive Vice President, EDF Development, Inc.

Achieving Energy Security – What it Means for Different Players

Mine K. Yucel *(Presiding)*
Vice President & Sr Economist, Federal Reserve Bank of Dallas

Paul Leiby
Distinguished Research Scientist and Energy Analysis Team Leader, Oak Ridge National Laboratory

Guy F. Caruso
Senior Advisor, CSIS Energy and National Security Program

Pierre Noel
Research Fellow, EPRG University of Cambridge

Questions/ Comments? Please contact:

David L. Williams
USAEE/IAEE
28790 Chagrin Blvd. Ste. 350
Cleveland, OH 44122 USA

usaee@usaee.org

Visit our conference website at:
http://www.usaee.org/usaee2009/

All of these factors – climate, energy security, and uncertainty – have significant importance for developments both regionally and globally, as well as for growing energy commodity markets such as that for LNG. Accordingly, regional development in the Pacific basin and global perspectives on the direction of energy policy in various regions around the world will be addressed. Finally, recent and expected future developments in global natural gas markets, and how those developments affect the interconnectedness of regional gas markets in the coming years will be addressed.

Please refer to http://www.usaee.org/usaee2009/program.aspx for more information on the plenary sessions.

Student Participation

Students are encouraged to submit papers for consideration of the USAEE Student Paper Awards, which include cash prizes plus waiver of conference registration fee. Students may also inquire about scholarships for conference attendance. Visit http://www.usaee.org/usaee2009/paperawards.html for full details.

Travel Documents

International delegates are urged to contact their respective consulate, embassy or travel agent regarding the necessity of obtaining a visa for entry into the U.S. If you need a letter of invitation to attend the conference, contact USAEE with an email request to usaee@usaee.org. We recommend ample time for processing documents.

About San Francisco

If you have not been there already, you don't know what you've been missing. For those who have already been to San Francisco, it looks more beautiful than you remember it. With world-class shopping, dining, historical and cultural sights and within easy reach to many top sightseeing spots in California, San Francisco is consistently ranked among the most popular destinations in the US – and the world.

Conference Venue and Accommodations

The conference venue is the **Grand Hyatt** on Union Square, conveniently located at the heart of the city within short walking distance to wonderful shopping, eating, entertainment and cultural sights. We encourage early reservations as the hotel venue is likely to sell out.

SPONSORED BY

How to Get to San Francisco

San Francisco is primarily served by San Francisco International Airport (SFO) offering frequent direct flights to the rest of the US as well as many Asian and European cities. The Oakland (OAK) and San Jose (SJC) Airports also serve the city. San Francisco is served by BART, a mass transit system connecting the SFO airport to downtown and other points of interest.

Technical & Social Tours

A number of technical and social tours have been organized and are available to conference participants. Please visit https://www.usaee.org/usaee2009/specialevents.html to see currently scheduled events.

What San Francisco Has to Offer

The beautiful San Francisco Bay, Golden Gate Bridge, the world-renowned wineries of Napa and Sonoma and quaint Monterey Bay are within a short drive. To visit Yosemite National Park, Lake Tahoe and much more, you should allow extra time before and after the conference for a memorable experience.

A number of half-day, full-day and multi-day sightseeing and cultural options are recommended, including the following:

- Full or half day cultural city tour
- Full day tour of Napa/Sonoma Wine country
- Full day tour of Monterey Bay and Carmel-by-the-Sea
- Full day tour of Yosemite National Park
- Full day bay cruise plus lunch and sightseeing in Sausalito
- Half day San Francisco Bay Cruise & Alcatraz Island
- Tour of Hearst Castle, Santa Barbara, Lake Tahoe & regions beyond San Francisco

Program Committee

GENERAL CONFERENCE CHAIR
Joe Dukert, *Energy Analyst*

CONFERENCE PROGRAM CO-CHAIRS
Fereidoon P. Sioshansi, *Menlo Energy Economics*

Mine K. Yucel, *Federal Reserve Bank of Dallas*

HONORARY PROGRAM CHAIRMAN
James Sweeney, *Stanford University*

PLENARY SESSION COORDINATOR
Ken Medlock, *Rice University*

CONCURRENT SESSION CHAIR
Omowumi Iledare, *LSU Center for Energy Studies*

STUDENT PARTICIPATION
Pedram Mokrian, *Stanford University*

PROGRAM COMMITTEE
Charles Greer Rossmann, *Southern Company*
Lars Bergman, *Stockholm School of Economics*
Georg Erdmann, *Berlin University of Technology*
Jose Antonio Scaramucci, *UNICAMP, Brazil*
William Kemp, *Black & Veatch*
Carlo Andrea Bollino, *Università di Perugia*
Arnie Baker, *Sandia National Laboratories*
Hoesung Lee, *Keimyung University*
Jean-Michel Glachant, *Universite Paris*
Sam Van Vactor, *Economic Insight Inc.*
Kenichi Matsui, *Institute of Energy Economics*
Jay Zarnikau, *Frontier Associates & University of Texas at Austin*
Reinhard Haas, *Technical University, Vienna*
Fereidun Fesharaki, *FACTS Global Energy*
Peter R. Hartley, *Rice University*

The Unbearable Lightness of Wind

By Ross McCracken*

There are few renewable energy policies that do not depend heavily on wind power and wind is certainly at the heart of the most ambitious, the EU's binding target of sourcing 20% of final energy consumption from renewable resources by 2020. As the EU's target for transport is half that for energy consumption as a whole, it follows that the power sector will be required to source a proportion of energy from renewables that is much higher than 20%. According to the European Wind Energy Association, the figure is 35%.

Within that, wind will be the largest contributor, accounting for just over one-third of 'green' electricity, suggesting that between 11.6-14.3% of the EU's power will be supplied by wind by 2020, according to the EWEA. This would mean the installation of 180 GW of wind power by 2020, up from 56.535 GW installed in the EU-27 at end-2007, producing about 477 TWh of power. The transport element of the EU plan is also dependent on future scientific advances, for example, that second generation biofuels become commercially available. This uncertainty will put more pressure to achieve in areas that are already within technological reach.

But if these targets seem ambitious, it is also evident that wind capacity is being installed at much higher rates than previously forecast by bodies such as the International Energy Agency. According to Stefan Gsänger, secretary-general of the World Wind Energy Association, worldwide wind capacity had risen to about 120,000 GW by end-2008, an increase of 30% on 2007. According to Platts Power in Europe, wind additions in Europe for the first time in 2008 accounted for more new capacity than any other power source. A study carried out by the Deutsches Windenergie-Institut in 2008 estimated that the annual worldwide installation capacity of the industry would have risen above 100 GW by 2017.

Experience in Europe shows that with the right policy framework, wind capacity can rise fast. And while the 'binding' nature of the EU's targets means little in practice, it is a serious statement of intent. Renewable energy also promises new jobs, making it an attractive sector for policy makers on a counter-recessionary spending spree. Wind would appear to tick all the right boxes in terms of both energy and industrial policy, suggesting, as some non-governmental pressure groups do, that the EU's targets for wind are in fact not that ambitious and could well be exceeded.

The Desirability of Wind

But just because you can, doesn't mean you should. Wind power has its critics and they feel that their reservations have been overridden by policy makers whose imaginations have been captured by a green agenda that downplays wind's limitations. Wind's intermittency cannot be ignored just because it is the most readily available and domestically attractive technology to hand, they argue.

Any electricity system needs a mix of baseload generation power -- which tends to be relatively inflexible in terms of switching on and off – and peaking plants, which are more flexible and, as their name suggests, designed to take advantage of high electricity prices at times of peak demand. Wind falls into neither of these categories because it is essentially unreliable.

Proponents of wind power dislike the negative connotations of the word 'unreliable', pointing out that on average the amount of power supplied by a given capacity of wind turbines is reasonably predictable. But, according to the EWEA, wind turbines produce no electricity at all between 15% and 30% of the time. And, on average, the load factor for onshore turbines is about 30%. This means that over 24 hours, 1 MW of wind capacity would provide about 7.2 MWh of power, but there's no knowing exactly how much or when until the last minute.

As wind provides neither baseload nor peaking plant it has no impact on reserve capacity. There will always be the possibility that, at some point, no power will be produced at all. This threat falls as more wind capacity is added; some analyses suggest 26 GW of back-up is needed for 100 GW of wind, others that back-up needs range from 60-95%, depending on the make-up and size of the system. But wind's intermittency ultimately means that a system reserve must remain in place. The system must be set up to accommodate wind, but also to work as if it did not exist.

Wind Surges

But if wind turbines add little or no reserve capacity, they do produce power. And the impact they have depends on a range of factors, including when the power is produced, the ability of the system to add and withdraw non-wind capacity and how power is priced.

* Ross McCracken is a Senior Editor with Platts, based in the United Kingdom., He may be reached at ross_mccracken@platts.com

Imagine two scenarios; peak and trough demand. During lower demand periods, the system is at its least flexible, with power supplied by baseload plants. A surge of wind power may simply result in surplus power production, sending prices towards zero. In effect, it is as if the system has too much baseload generation plant that cannot be turned off quickly enough, either for technical or economic reasons.

The ability to export might provide a key safety valve, but would depend on; first, the physical infrastructure being in place; second, prices falling below the external system's baseload prices; and, third, the lack of a similar wind surge in the external market, either as a result of different weather patterns or of less wind capacity in that system.

At times of peak demand, the system is at its most flexible because the maximum amount of the most flexible power generation capacity is in use. A wind surge would look as if the system had in effect much more flexible plant that it really does. Prices would be shaved, but underpinned by a greater ability to withdraw peaking capacity.

So, in the low demand period, the impact on peaking plant is negligible – they are not producing power anyway. The impact on baseload plant is principally in terms of price rather than generation displacement and, therefore, would not necessarily result in carbon emissions being avoided. Prices react as the ability to withdraw capacity is low.

In the high demand period, baseload plants again suffer from lower prices when the wind blows. Peaking plants experience either lower prices or generate for shorter periods. This suggests that the principle result would be for wind to displace peaking plant, i.e., gas rather than more carbon-intensive coal or low-carbon nuclear.

The thorny issue of subsidies aside, adding an intermittent energy source would act to reduce prices overall as wind adds power but does not add reserve capacity. In so doing, it increases redundancy in peaking plant and reduces the profits of baseload generation; potentially good for consumers but bad for investment in non-intermittent sources of power, and presenting the risk of a decline in reserve capacity.

Back-up Not Required

The EWEA argues that "because of the way the electricity network is planned, there is no need to back up every megawatt of wind energy with a megawatt of fossil fuel or other power. All networks have enough spare capacity available to deal with disconnections, breakdowns and sudden surges in demand."

That argument is fine, but only because it assumes that sufficient reserve capacity and flexibility already exists from non-intermittent sources. However, if wind energy is built to meet growth in energy demand it implies a decline in reserve capacity. Wind can be added to a system if demand growth is static or if non-intermittent sources also grow with demand. The amount of 'back-up' capacity is related to demand growth not to the amount of wind added to the system.

Take the argument to its extreme. In a system with no wind power, adequate reserve capacity and no demand growth, any proportion of wind can be introduced with no need for any additional fossil fuel powered generation. At 100% wind penetration, the non-wind plant would still be needed for low or zero wind days. However, peaking plant would be used much less and baseload plant would see sustained periods of potentially below cost prices – a particular nightmare for the nuclear industry.

As such, the proportion of wind that can be incorporated into a system is both an engineering challenge and an economic one. The conundrum that wind poses is not just technical, i.e., organizing the electricity grid in such a way as to cope with increasingly large rises and falls in supply from multiple and decentralized sources, although this too is a significant challenge. It lies in the fact that wind does not directly displace fossil fuel generating capacity, but will make this capacity less profitable to maintain.

Mitigating Intermittency

There are a number of ways in which wind's intermittency might be mitigated. The organization of electricity systems is being rethought to incorporate decentralized, diffused and intermittent sources of energy. Demand response programs are aimed at shaving off peaks in demand, but also might be seen as tools in responding to sudden losses of wind power. Any innovation that increases flexibility within the system should enable the accommodation of higher proportions of intermittent power sources.

The problem of wind producing surplus power when it is not wanted may find a solution in the form of electric cars. The idea, being pioneered in Copenhagen, is that surplus wind power generated at night would be used to power electric plug-in cars for urban transport. Copenhagen is the perfect place to try this, given Denmark's 20% penetration of wind in the electricity system, the highest in the world, the inflexibility of its baseload coal-fired CHP systems, and the fact that it is very flat.

It is also a move that could be very bankable in terms of meeting the EU's renewable energy targets. In the EU's renewable energy package, it says "the amount of renewable electricity used by electric road vehicles is to be considered to be 2.5 times the energy content of the renewable electricity input, in recognition of their greater efficiency." It is not clear what measure of efficiency is being used here (perhaps an accounting one).

However, the use of plug-in electric vehicles would create a relatively constant and inelastic demand load within a specific time period, to be satisfied by an intermittent supply. In practice, although it would clearly displace transport fuels, it would mean increased coal and gas burn at night when the wind wasn't blowing, or vehicle owners would find themselves with a flat battery in the morning.

Proponents also argue that if the power wasn't used by the car, it could be returned to the grid at peak demand times. This suggests that plug-in electric vehicle manufacturers have found the holy grail of the electricity industry – the efficient storage and retrieval of power. It is more likely that they have not and that the renewable energy returnable to the grid after having being transmitted from wind turbine to car battery is not substantial. However, the displacement of transport fuel with electricity otherwise priced close to zero would be significant.

Efficient storage is a technological advance that could transform wind's contribution to an electricity system by ironing out the troughs and peaks of power production, effectively neutralizing its intermittency. It could turn wind from an intermittent power source into peaking power plant that makes a real contribution to reserve capacity. There are many experiments taking place in this field, some of which are promising, but (with the exception of pump storage hydro) commercially viable projects on a large-scale do not appear to be on the immediate horizon. But as wind capacity increases, the impetus to make this breakthrough will rise, and the future impact it would have, if it occurs, will be all the greater.

Interconnections

As mentioned, exports could prove a major safety value for intermittent power sources, enabling them to find new sources of demand when there is a surplus of power and acting as additional reserve capacity when the wind fails. Denmark's capacity to import and export power as a proportion of total system capacity is just as impressive as the world-beating penetration of wind power within its system. But even so, it has its limitations in that excess power occurs when demand is low in external markets, markets that as yet do not have the same level of wind penetration as Denmark.

In the 2nd Strategic Review of the EU's Energy Security and Solidarity Action Plan, great emphasis was placed on major infrastructural plans that would benefit wind integration. These include the Baltic interconnection plan, completion of a Mediterranean energy ring, the development of North-South electricity interconnections within Central and South-East Europe, and most significantly the development of a blueprint for a North Sea offshore grid, interconnecting national electricity grids and plugging in planned offshore wind projects.

All of these are major projects, requiring a high degree of international cooperation, planning and capital. And international interconnectors are notoriously difficult to get built; it may well be to the North Sea offshore grid's advantage that it is indeed offshore. But assuming (optimistically) that they get built within the required timeframe, they should promote competition and improve security of supply, as any available capacity on one national system can be put at the disposal of another, subject to the restrictions of the interconnection.

But the North Sea offshore grid goes a step further than an international interconnection because it implies multiple connections with an added common power source through linked offshore wind farms, potentially serving the UK, French, Dutch, Belgian, German, Danish and Nordic markets. The grid would encompass a wide geographical area and would be more likely to produce some power all of the time. According to the UK Meteorological Office all areas of the North Sea are usually affected by the same weather systems, typically Atlantic depressions drifting in from the west, but it is fairly rare for calm to descend across the whole of the North Sea at any one time because it is such a large expanse of open water.

That suggests that offshore wind capacity tied into a North Sea grid would start to provide power than could be depended upon, albeit never quite with 100% certainty. However, that 'dependable' power would only be a fraction of the capacity of the total offshore system, and would be split between all the markets the grid would serve. Moreover, raising each national markets' exposure to wind might negate the advantages of the export/import facility. The most common experience could well be that they all experience similar patterns of rises and falls in wind power.

Hydro Option

Another more tried and tested form of storage might prove more reliable. According to Swiss parliamentarian and economist Dr. Rudolph Rechsteiner, hydropower can provide the vital storage element. Rechsteiner says that Swiss hydro reservoirs are already being adapted to create a system that provides an active storage capacity that can be monetized through exporting power at times of peak demand in neighboring markets. Interconnectors and storage are the key.

Swiss hydro has historically been developed on the basis of huge storage volumes released in one season to meet peak seasonal demand. Investment is now taking place to install pump storage so that transfers can take place once a week rather than once a year. The flexibility to absorb power at any time and release it at peak demand is good news for an intermittent power source.

Swiss hydro resources are huge and Rechsteiner estimates they could provide sufficient storage to manage the whole of Switzerland and Germany's power. He says there are at least two dozen sites where pump storage could be developed in the Swiss Alps alone with a further 12 in Germany. At the moment, pump storage systems in Switzerland are absorbing excess baseload nuclear power, releasing the power at peak times through interconnectors to the German market.

Retaining Reserve Capacity

The potential problems of a high penetration of wind power are being downplayed by European policy makers grateful for a domestically-produced renewable technology that exists in the here and now. Although the target 2020 proportion for wind as a percentage of total electricity generation is not that large -- 12% -- this average is likely to see large differences between EU states. And while wind's intermittency is likely to be ameliorated over time by future scientific and infrastructural advances, the impact on prices of a growing proportion of wind in the EU energy system may prove more immediately challenging than the technical difficulties that a higher penetration of wind poses.

The issue for the producers of power from fossil fuels (and nuclear) and for policy makers is that as the penetration of wind rises, they are likely to see a price effect that starts to have a material impact, while wind turbine income is protected by feed-in tariffs and the like. This is a commercial problem for power generators, but also for the wider system, as in all likelihood fossil fuel plant will still be needed for reserve capacity. It appears that the installation of wind capacity is racing ahead of investment in the infrastructure required to manage that capacity reliably. Taken to its logical long-term conclusion, in this scenario, the only companies able commercially to manage such infrequently used reserve assets, will be the wind producers (or aggregators) themselves.

How Viable is the Hydrogen Economy? The Case of Iceland

By Mamdouh G. Salameh*

Introduction

The vision of a hydrogen economy could become a reality within the next four to five decades with Iceland already leading the way to become the world's first fully-operational hydrogen economy (see Figure 1). Iceland even cherishes the dream of becoming the "Kuwait of the North", a major source of energy in a world where all nations follow Iceland's path. Icelanders even dream of exporting hydrogen and creating a booming new industry (though first they will have to figure out a way to get it there).

A hydrogen economy is a hypothetical economy in which the energy needed for transport or electricity is derived from reacting hydrogen with oxygen. While the primary purpose is to eliminate the use of fossil fuels and thus reduce carbon dioxide emissions, a secondary goal is to provide an energy carrier to replace dwindling supplies of crude oil.

The vision of a hydrogen economy in Iceland as spelled out by Professor Bragi Arnason, also known as Professor Hydrogen, is to take all of Iceland's cars and fishing trawlers and gradually replace their gas combustion engines with electric motors run on hydrogen-fuel cells just like American space shuttles. Meanwhile, harness Iceland's abundant geothermal and hydro-energy resources to begin producing hydrogen gas on a mass scale.[1]

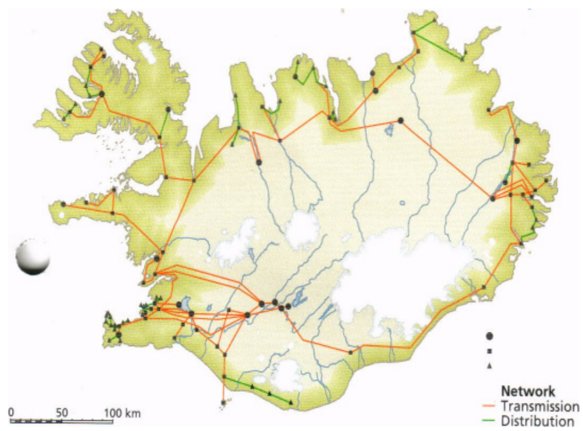


Figure 1. Iceland
Source: Energy Statistics, Iceland

Iceland is a model in the making. With a population of only 290,000 people and with its abundant hydro-energy and its huge geothermal energy, Iceland has already started the transformation into a hydrogen economy. For a number of years, public transport buses in Reykjavik, the capital, have been running on hydrogen-powered fuel cells. The next step is the introduction of hydrogen fuel cell cars for private transport. Eventually the entire Icelandic fishing fleet will be gradually powered by hydrogen fuel cells. The question is when and at what cost. Shell Hydrogen figures it would cost at least $19 bn to build hydrogen plants and stations in the United States, $1.5 bn in the UK and $6 bn in Japan compared with a few millions in Iceland.[2]

Most hydrogen on Earth is bonded to oxygen in water. Hydrogen is presently most economically produced using fossil fuels. More expensively it can also be produced via electrolysis using electricity and water, consuming approximately 50 kilowatt hours of electricity per kilogram of hydrogen produced. Nuclear power can provide the energy for hydrogen production by a variety of means but its wide-scale deployment is opposed in some Western economies while it is embraced in others. Renewable energy is being used to produce hydrogen in Denmark and Iceland.

In the context of a hydrogen economy, hydrogen is an energy storage medium, not a primary energy source. Nevertheless, controversy over the usefulness of a hydrogen economy has been confused by issues of energy sourcing, including fossil fuel use, global warming and sustainable energy generation. These are all separate issues, although the hydrogen economy impacts them all.

Proponents of a hydrogen economy suggest that hydrogen is an environmentally cleaner source of energy to end-users, particularly in transportation applications, without release of pollutants (such as particulate matter) or greenhouse gases at the point of end use. Analysts have concluded that "most of the hydrogen supply chain pathways would release significantly less carbon dioxide into the atmosphere than would gasoline used in hybrid electric vehicles" and that significant reductions in carbon dioxide emissions would be possible if carbon sequestration methods are utilized at the site of energy or hydrogen production.[3] The roster of experts who see hydrogen as the most likely replacement for oil when the wells run dry now includes the oilmen of the Bush Administration and the futurists at General Motors and Ford. Iceland's plan is now backed by DaimlerChrysler, Shell and the European Union.

Critics of a hydrogen economy argue that for the many planned applications

* Mamdouh G. Salameh is an international oil economist and consultant. He is Director of the Oil Market Consultancy Service in the UK and a member of both the International Institute for Strategic Studies (IISS) in London and the Royal Institute of International Affairs. He is also a member of the Energy Institute in London.
A PowerPoint presentation of this paper was given at the 28th USAEE/IAEE North American Energy Conference in New Orleans 3-5 December 2008.
See footnotes at end of text.

of hydrogen, direct distribution and use of energy in the form of electricity, or alternate means of storage such as chemical batteries, fuel cells, or production of liquid synthetic fuels from CO_2 (methanol economy), might accomplish many of the same net goals of a hydrogen economy while requiring only a fraction of the investment in new infrastructure. Hydrogen has been called the least efficient and most expensive possible replacement for gasoline. A comprehensive study of hydrogen in transportation applications has found that "there are major hurdles on the path to achieving the vision of hydrogen economy; the path will not be simple or straightforward."

One hurdle is that hydrogen fuel cells, seen as a way to provide electricity in homes as well as vehicles, rely on precious-metal catalysts like platinum. A conventional automotive fuel-cell stack contains up to 100 grams of platinum, which could cost more than $3,000 at today's prices. For the hydrogen economy to happen, the amount of platinum used in fuel cells has to come down, and soon. This will not be a problem. Car makers will be able to slash the amount of platinum needed to just 20 grams per car by the time the technology is commercialized probably in the middle of the next decade. Moreover, the platinum can be recycled. Yet the numbers still look daunting.[4]

Global car production in 2007 was just over 71 million. If only 12 million fuel-cell cars were produced a year starting the middle of the next decade and with only 20 grams of platinum per car, the quantity of platinum used will amount to 240 tonnes. This is bigger than the current annual global platinum production of 237 tonnes. At that rate the world's resources of platinum-group metals would be gone in 70 years. And this calculation makes no allowance for any growth in fuel-cell car production, or for the use of fuel cells at home. Therefore, hydrogen could only be a partial solution until an alternative to platinum is found.

Elements of the Hydrogen Economy

In the current economy, transport is fuelled primarily by crude oil refined into gasoline and diesel, and natural gas. However, the burning of these hydrocarbon fuels causes the emissions of greenhouse gases and other pollutants. Furthermore, the supply of hydrocarbon resources in the world is limited and the demand for hydrocarbon fuels is increasing, particularly in China, India and other developing countries.

In a hydrogen economy, hydrogen fuel would be manufactured from some primary energy source and used as a replacement for hydrocarbon-based fuels for transport. The hydrogen would be utilized either by direct combustion in internal combustion engines or in proton exchange membrane (PEM) fuel cells (see Figure 2).

The primary energy source can then become a stationary plant which can use renewable, nuclear or coal-fired energy sources, easing pressure on finite liquid and gas hydrocarbon resources. There is no carbon dioxide emission at the point of use. With suitable primary energy sources, greenhouse gas emissions can be reduced or eliminated. Excepting minor NOx generation from hydrogen internal combustion engines, the emissions footprint of a hydrogen economy remains that of the underlying energy generation technology.

In the 1960s NASA developed fuel cells that replaced liquid electrolytes like potassium hydroxide solution with PEMs, and the technology was applied to electrolysis too. However, the membranes were acidic, and an acidic membrane needs a platinum catalyst. What's more, the membranes themselves remain hugely expensive. Now a small British company, ITM Power, claims to have developed a membrane that can be made alkaline so nickel can replace platinum. Using half a dozen commonly available hydrocarbons, it has developed a solid but flexible polymer gel that is three times as conductive as existing PEMs. Thanks to its simplicity and the fact that it is made from readily available materials, it should also be massively cheaper. The company claims that with mass production its membrane would cost just $5 per square metre, compared to $500 for existing PEMs. As a result, ITM Power says the electrolyser would cost $164 per kilowatt of capacity, against a current average of $2,000 per kilowatt.[5] Hydrogen has a high energy density by weight. The fuel cell is

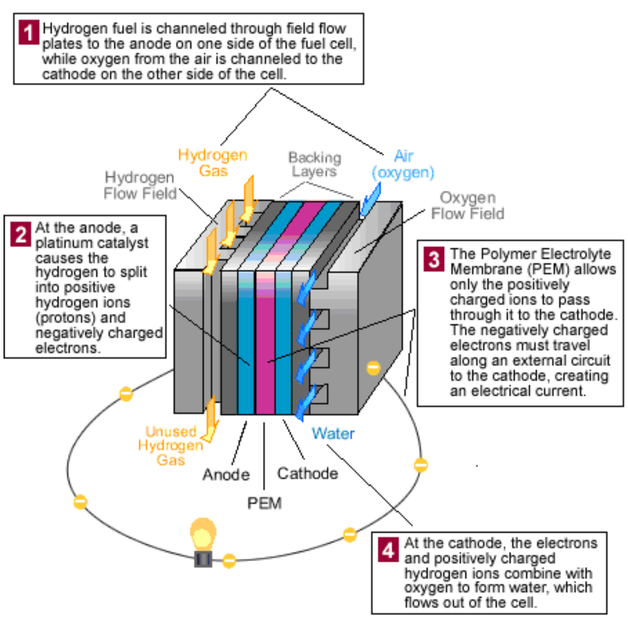


Figure 2. The Proton Exchange Membrane Fuel Cell (PEM)
Source: Courtesy of Wikipedia, the Free Encyclopedia

also more efficient than an internal combustion engine (ICE). The ICE is said to be 20%-30% efficient, while the fuel cell is 35%-45% efficient (some even higher).

Current Hydrogen Market

Hydrogen production is a large and growing industry. Globally, an estimated 67 million metric tons (mmt) of hydrogen (equivalent to 4.58 million barrels a day), were produced in 2007. The growth rate is around 10% per year. Within the United States, 2007 production was about 14.64 mmt, an average power flow of 64 gigawatts. For comparison, electricity production in 2007 was estimated at 490 gigawatts. As of 2007, the economic value of all hydrogen produced worldwide was estimated at $150 bn per year.

Because both the world population and the intensive agriculture used to support it are growing, demand for ammonia is growing. The other half of current hydrogen production is used for hydrocracking, the process by which heavy crude oil resources are converted into lighter fractions suitable for use as fuels. Hydrocracking represents an even larger growth area, since rising crude oil prices encourage oil companies to extract poorer source material such as tar sands, extra heavy oil and oil shale. The economies of scale inherent in oil refining and fertilizer manufacture make possible on-site production and "captive" use. Smaller quantities of hydrogen are manufactured and delivered to end users as well.

If energy for hydrogen production were available from wind, solar or nuclear power, use of hydrogen for hydrocarbon synfuel production could expand its captive use by a factor of 5 to10. Present use of hydrogen for hydrocracking in the U.S. is roughly 4 mmt/yr. It is estimated that 38 mmt/yr of hydrogen would be sufficient to convert enough domestic coal to liquid fuels to significantly reduce U.S. dependence on foreign oil imports.

Currently, global hydrogen production is 48% from natural gas, 30% from oil, and 18% from coal; water electrolysis accounts for only 4%. The distribution of production reflects the effects of thermodynamic constraints on economic choices: of the four methods of obtaining hydrogen, partial combustion of natural gas in a natural gas combined cycle (NGCC) power plant offers the most efficient chemical pathway and the greatest off-take of usable heat energy.

One key feature of a hydrogen economy is that in mobile applications (primarily vehicular transport) energy generation and use are decoupled. The primary energy source need no longer to travel with the vehicle as it currently does with hydrocarbon fuels. Instead of tailpipes creating dispersed emissions, the energy and pollution can be generated from point sources such as large-scale centralized facilities with improved efficiency. This allows the possibility of technologies such as carbon sequestration, which are otherwise impossible for mobile applications. Alternatively small scale hydrogen stations could be used.

Methods of Production

Hydrogen is presently most economically produced using fossil fuels. More expensively it can also be produced via electrolysis using electricity and water, consuming approximately 50 kilowatt hours of electricity per kilogram of hydrogen produced. Nuclear power can provide the energy for hydrogen production, but its wide-scale deployment is opposed in some Western economies while it is embraced in others. Renewable energy is being used to produce hydrogen in Denmark and Iceland.

Different production methods have differing associated investment and marginal costs. The energy and feedstock could originate from a multitude of sources, i.e., natural gas, nuclear, solar, wind, biomass, coal, other fossil fuels and geothermal. Some facts and figures are shown in Table 1.

While hydrogen (the element) is abundant on earth, manufacturing hydrogen does require the consumption of a hydrogen carrier such as a fossil fuel or water. The former consumes the fossil resource and produces carbon dioxide, but often requires no further energy input beyond the fossil fuel. Decomposing water requires electrical or heat input, generated from some primary energy sources (fossil fuel, nuclear power or renewable energy). The economic and environmental impact of any implementation of a future economy will largely be determined by future energy development.

Energy Sources	Annual production of Hydrogen (mmt)	Investment Required	Cost per Gallon of Gasoline Equivalent (GGE)
Natural gas	150	$1000 bn	$3.0/GGE
Nuclear	provides energy for electrolysis	$ 840 bn	$2.5/GGE
Solar	provides energy for electrolysis	$ 22000 bn	$9.5/GGE
Wind	provides energy for electolysis	$ 3000 bn	$3.0/GGE
Coal	provides energy for electrolysis	$ 500 bn	$1.0/GGE
Biomass	provides energy for electrolysis	$ 565 bn	$1.9/GGE

Table 1
Different Production Methods, Investment & Marginal Costs

Source: *Popular Mechanics* Magazine, November 2006.

For the hydrogen economy to happen, industry must also come up with clean ways of producing it. Most hydrogen is currently made in refineries by heating natural gas with steam in the presence of a catalyst, but this usually relies on energy from fossil fuels and can generate carbon dioxide as a by-product. Because of this, the climate benefits of fuel-cell vehicles are scarcely better than those of petrol hybrids according to a 2003 study led by Malcolm Weiss at the Massachusetts Institute of Technology (MIT). To make hydrogen cleanly and in bulk will almost certainly mean using renewable energy to electrolyze water, though this process is costly and energy-intensive.

Current Energy Consumption of the World & Future Outlook

Today the world's primary energy consumption is about 11099 million tonnes oil equivalent (mtoe), whereof 88% comes from fossil fuels, 5.6% from nuclear and 6.4% from renewable energy sources (hydro, biomass, wind, geothermal). Crude oil accounts for 36% of global primary energy consumption and 40% of fossil fuels consumption.[6] There are indications that global conventional oil production has peaked and that we are heading towards an energy crisis in the very near future.

A good example to demonstrate the increasing need for energy in the near future and the eventual consequences if this is met by harnessing coal, is China. The ultimate potential of the Three Gorges Project, on the Yangtze, 18,000 MW, will still only supply a small fraction of China's needs over the next twenty years. It has been estimated that China will require an additional 600,000 MW over the next twenty years. This raises the question of what would happen to our planet if China approached the per capita electricity consumption of America and Europe and generated it from coal.[7]

With the expected decline in the global production of oil together with increasing demand, renewable energy sources like biomass, hydropower, wind, wave energy, tidal energy, geothermal energy and solar radiation are going to become increasingly important. In the long-term solar energy is likely to become the major energy source for humankind. Also ecological aspects such as the need to reduce greenhouse gas emission, as well as other polluting components like sulphur and nitrogen oxides are likely to promote increasing use of renewables.

As is the case of solar energy when harnessed, other renewable energy sources and nuclear energy in most cases will be converted into electricity. Whenever possible the electricity will be used directly, but there will always be a need for energy storage medium, like fuel to power land, sea and air transport. Obviously the number one candidate fuel is hydrogen. In principle any available energy source could be used to produce hydrogen.

The Case of Iceland

Iceland does not have to wait until harnessing of solar energy becomes economic. With its abundant hydro-energy and its geothermal energy, Iceland has already started the transformation into a hydrogen economy. This makes Iceland an attractive pilot country to participate in developing and improving the necessary hydrogen technology and to demonstrate the transformation into the hydrogen economy.

By the end of the 20th century Icelanders had already performed two major transitions in energy sources: to hydroelectric and geothermal. With the advent of the 21st century, Icelanders expect the third major transition. This century will also see a transition from conventional combustion engines to fuel cells. Hydrogen produced with electric energy from hydropower and geothermal heat is expected now to become the main fuel in the Icelandic transport and fishing sectors. In this way Iceland would be almost entirely free from imported fossil fuel and its greenhouse gas emission would be reduced below 50% of the present level.

The economically harnessable hydroelectric energy in Iceland has been estimated at 30 TWh/year and that of geothermal energy at 200 TWh/year of heat.[8] With present technology, 200 TWh/year of geothermal heat can be used to produce 20 TWh/year of electricity. Thus the total energy potential is 50 TWh/year. Of these 50 TWh/year only 8 TWh/year have been harnessed up to now (see Table 2).

Oil	Natural Gas	Coal	Nuclear Energy	Hydro electricity	Total
1.0	-	0.1	-	1.9	3.0

Table 2
Iceland's Primary Energy Consumption, 2006 (mtoe)
Source: BP Statistical Review of World Energy, June 2008.

If all imported fossil fuel were to be replaced by hydrogen produced from electric energy from domestic sources, an additional 5 TWh/year would be needed. Thus Iceland is in a rather unusual situation. Although only a small fraction of its domestic energy sources has been harnessed so far, one third of the energy used in the country comes from imported fossil fuel. This has inspired a study of the possibility of replacing imported fossil fuel by some synthetic fuel produced from domestic sources.

In the beginning, various alternatives were considered such as synthetic gasoline, methanol, ammonia and hydrogen, but over the past 15 years, especially after the breakthrough of the PEM fuel cell in 1993, the research work has concentrated on hydrogen. Because of the advantage that very high energy efficiency of the fuel can be achieved, it is believed that fuel cells will become increasingly important as engines in the 21st century.

Assuming for example a 100 MW plant and an electricity price of 0.02 US $/kWh, which is the estimated cost of electricity from power plants built in the near future, hydrogen produced in this way would be 2-3 times more expensive than presently imported gasoline when calculated on the basis of energy content.

In the case, however, where hydrogen is used to power PEM fuel cells currently in rapid development, the energy efficiency is 2-3 times higher than in conventional internal combustion engines. The reason for this is that in internal combustion engines the chemical energy of the fuel is converted into heat with a low efficiency because of thermodynamics limitations. In fuel cells, on the other hand, the chemical energy is converted into electric energy with a high efficiency. Fuel cells are free energy engines not Carnot engines.

Thus if both hydrogen production cost and energy efficiency are taken into account, the utilization of hydrogen produced from hydro-energy or geothermal energy in the Icelandic transport and fishing sectors could be almost competitive with present fuels.

Hydrogen Storage

The storage of hydrogen is a critical limiting factor promoting the use of hydrogen to power the transport and fishing sectors in Iceland. Hydrogen can be stored in numerous ways such as hydrogen gas, liquid hydrogen, hydrogen bound in metalhydrides and bound in liquid hydrides like methanol. Because of the large amount of energy needed to liquefy hydrogen, liquid hydrogen is about two times more expensive than hydrogen gas.

In a city bus fleet powered by PEM fuel cells hydrogen can be easily stored onboard as pressurized gas in sufficient quantity to operate the buses throughout the day (see Figure 3).The fuelling time is less than 7 minutes. A city bus fleet also can be operated from one fuelling station which makes no need for complicated infrastructure for the distribution of the fuel.

Storing hydrogen in private cars is not as simple as storing it in city buses. In prototype cars built until now, hydrogen has been stored onboard either as a pressurized gas, as liquid, in metalhydrides or bound in methanol. Private cars storing pressurized hydrogen onboard have only been able to run a short distance compared to gasoline powered cars. That, however, might change. Last year the Japanese company Honda presented a car, storing pressurized hydrogen on board, that can run 350 km on each filling. Three alternatives of storing hydrogen onboard are being considered: pressurized hydrogen, hydrogen bound in metalhydrides and hydrogen bound in methanol.

There are onging debates about whether fuel cells should be powered by hydrogen in a gaseous or liquefied state. The former is more energy efficient but also more difficult to handle. The latter is more amenable to mass consumption, but requires an impractically large storage tank. German automaker BMW is forging ahead with fuel tanks for liquid hydrogen, while most others have decided to use gaseous hydrogen.

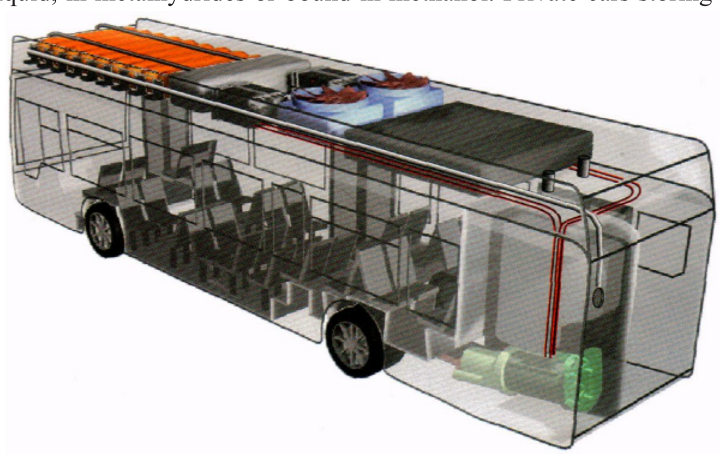


Figure 3
A Daimler-Chrysler Bus Powered by Hydrogen Fuel Cell in Reykjavick, Capital of Iceland

Source: Courtesy of Prof. Thorsteinn I. Sigfusson, Science Institute, University of Iceland.

As for powering the large Icelandic fishing vessels there are in principle no obstacles provided that fuel cells in the megawatt range become commercially available. These fishing vessels are at sea for up to six weeks and, therefore, need to store onboard large amounts of fuel. Consequently we can rule out the storage of pressurized hydrogen gas. Liquid hydrogen is a possibility, but as mentioned before, liquid hydrogen is very expensive and so is the technology needed to handle it. Therefore, the only possible near term solution for storing a sufficient amount of hydrogen onboard large fishing vessels seems to be to store it bound in methanol. Technically it is possible to produce sufficient methanol in Iceland to power the entire fishing fleet, by combining electrolytically-produced hydrogen and carbon dioxides currently emitted from the metals industry in Iceland. This could reduce the greenhouse gas emission from the fishing sector to about 45% of the current level.

Price may also be prohibitive in the early stages. The DaimlerChrysler buses introduced in Reykjavik carry a price tag of about $1.1 million each, equal to the price of four to five traditional diesel buses. Increased hydrogen production will inevitably lower these prices, but this economic barrier has prevented larger countries and regions from embarking on a full "hydrogenization" of their own. Iceland's government has done its share to offset costs: The parliament passed a bill exempting zero-emission vehicles from road taxes.

In 1997 a research team at the University of Iceland devised a roadmap to reach a hydrogen economy in Iceland. The following 5-phase scenario was suggested:

- PEM cell bus demonstration project. Up to three buses in public transport in Reykjavik.
- Gradual replacement of the Reykjavik city bus fleet and possibly other bus fleets by PEM fuel cell buses.
- Introduction of hydrogen-powered PEM fuel cell cars for private transport.
- PEM fuel cell vessel demonstration project. One research vessel with hydrogen stored onboard bound in methanol.
- Gradual replacement of the present fishing fleet by PEM fuel cell powered vessels.

The above scenario interested three big European companies, which in 1998 led to the establishment of Icelandic New Energy, a University of Iceland spin-off corporation created to promote hydrogen economy in Iceland. Icelandic New Energy anticipates 50 years of development towards the goal of replacing fossil fuels in the transport and fishing sectors. The company estimates that about 4.3 TWh/year of energy will be needed to complete the change using 81,000 tonnes/year of hydrogen .[9]

Iceland: Pioneering the Hydrogen Economy

Iceland had already undergone two energy revolutions in the 20th century. First the country's immense hydroelectric resources were tapped to produce electricity. Then, in the 1940s, geothermal water supplies were appropriated to provide the heating needs for all of the homes of Reykjavick as well as to produce a significant portion of the country's electricity (see Table 3). Hydrogen could spark the third energy revolution in Iceland's recent history.

Why hydrogen? In a word, unlike petroleum, hydrogen is a clean and unlimited fuel. And Iceland can use its already-developed and practically pollution-free hydro-electric and geothermal energy resources to produce it.

Most outside observers agree that Iceland is a uniquely well-qualified contender for this hydrogen experiment. The country has a relatively small population (290,000) – mostly concentrated in the southwest of the country around the capital – that is well educated (100-percent literacy). Also Iceland has higher per capita car ownership than any other country in the world.[10] Moreover, Icelanders are typically very environmentally conscious as the country's successful recycling programmes and clean air and water suggest. All these elements combine to help Iceland advance its reputation as the "Kuwait of the North".

	2005		2006	
	GWh	**% of total**	**GWh**	**% of Total**
Hydropower	7,014	80.8	7,289	73.4
Geothermal	1,658	19.1	2,631	26.5
Fuel	8	0.1	5	0.1
Total	8,680	100.0	9,925	100.0

Table 3
Electricity Generation in Iceland, 2005-2006
Source: Energy Statistics in Iceland, 2007.

Figure 4
The World's First Commercial Hydrogen Filling Station Reykjavic, Iceland
Source: Courtesy of Professor Thorsteinn I. Sigfusson, Science Institute, University of Iceland.

Iceland has designed an impressive plan to convert every personal vehicle in the country – of which there are currently over 180,000 – to hydrogen. The plan does not stop there, however. In the fall of 2003, the first three hydrogen buses began their scheduled routes on the streets of Reykjavic. They fill up at the world's first commercial hydrogen station, which opened on April 24, 2003 (see Figure 4).

By 2006, the first demonstration project for a fuel cell-powered ocean vessel was completed with current plans calling for a complete conversion to hydrogen of Iceland's 2,500-ship fishing fleet, beginning in 2015. These are ambitious goals and correspondingly difficult to meet, but the opportunity for future benefits has attracted major players in the energy industry to come to Iceland's aid. Among them carmaker, Daimler Chrysler, Royal Dutch Shell and Norway's leading hydroelectric company, Norsk Hydro. The European Union is also actively involved.

Moving to a hydrogen economy is not without problems. Iceland has been producing hydrogen for decades to use in fertilizers, so the technique is well known by the energy industry. Capacity rather than knowledge presents the most serious challenge: hydrogen production will have to be increased at least 30-fold to meet the expected demand a hydrogen economy would create. The preferred method, electrolysis, is a highly energy-intensive process, which makes hydrogen about three times more expensive by energy content compared to fossil fuel imports. But the PEM fuel cells that Iceland would use are up to three times as efficient as internal combustion engines, which will probably make hydrogen competitively priced.

Worldwide Interest

As Iceland moves forward with its hydrogen plans, other countries have taken a keen interest in the small island nation. Hydrogen stations have recently been opened in Tokyo, Hamburg and major cities in the Netherlands, Spain, Britain, Belgium and Sweden. Canada – like Iceland, abundant in hydroelectric energy – has also expressed a strong interest in the new energy process.

The United States is slowly acknowledging the benefits of hydrogen. The U.S. Department of Energy projects that by 2010 about 12 trillion kilowatt-hours will be replaced by hydrogen. By 2030, DOE aims to replace 10% of current U.S. energy consumption with hydrogen power.

Iceland is in a way serving as the model of the society of the future – the society which is environmentally sound; which is based on renewable energy and on a way of life which does not destroy the life or the atmosphere or the bio-system that we have. There is a lot at stake.

Conclusions

Iceland's gradual transformation into a hydrogen economy is a viable proposition given its abundant hydro-power and geothermal energy. Iceland, like Brazil vis-a-vis the ethanol production, could be a great success story since it fulfils the two essential conditions to make a hydrogen economy viable, namely vast hydroelectric and geothermal resources. Countries like Canada and Norway also meet the critieria for a successful hydrogen economy.

But such a transformation can't be replicated anywhere else yet without the massive use of fossil fuels, something that the hydrogen economy is trying to leave behind. However, with steady progress and a few significant technology breakthroughs, the world will start to make a committed switch to a hydrogen economy – over the next several decades a confluence of events will mark a steep increase in hydrogen energy development. By that time, hydrogen production costs will be lower, the basic components of a hydrogen storage and distribution network will be in place, and hydrogen-powered fuel cells, engines, and turbines will be mature technologies that are mass produced.

A hydrogen economy is destined to become a reality sometime during the twenty-first century and that hydrogen will become the "fuel of choice" and will be available for every end-use energy need in the economy, including transportation, power generation and portable power systems. At the time the vision for a hydrogen economy becomes a reality, several decades from now, hydrogen will still be produced not only from fossil fuels, but also from biomass and water using thermal, electric and photolytic processes. Hydrogen produced from water will be a cost competitive alternative to hydrogen made from hydrocarbons.

<u>Footnotes</u>

[1] Adam Piore, *Hydrogen Economy*, Newsweek April8/April 15, 2002, p. 62.

[2] Ibid., p.64.

3 Wikipedia, the Free Encyclopedia, p. 1.

[4] David Strahan, *Hydrogen's Long Road to Nowhere*, NewScientist, 29 November 2008, p. 41.

[5] Ibid., p. 42.

[6] BP Statistical Review of World Energy, June 2008, p. 41.

[7] Bragi Arnason, *The Road from a Fossil Fuel to a Sustainable Energy Economy: The Strategy in Iceland* (a paper to be Published soon), p.1.

[8] Ibid., pp.3-4.

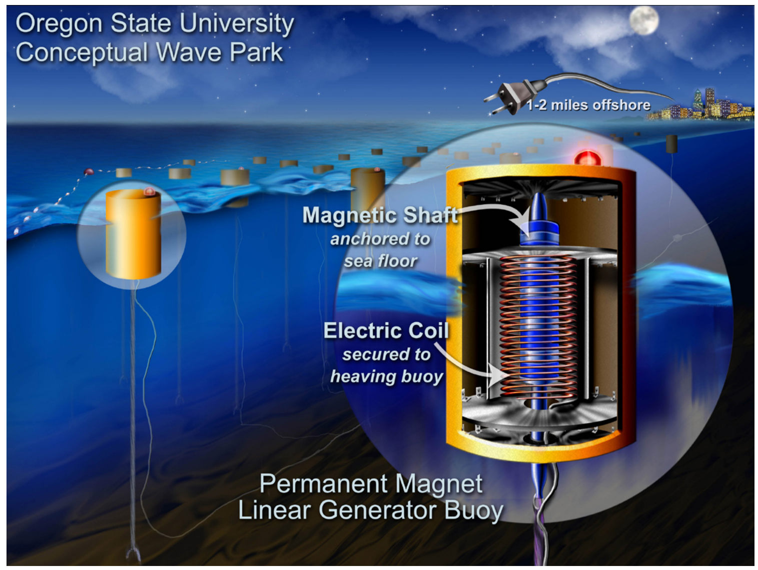
[9] Ibid., pp. 4-5.

[10] Asgeir Sigfusson, *Iceland: Pioneering the Hydrogen Economy*, Foreign Service Journal, December 2003, pp. 62-65.

Wind And Waves To Generate Juice*

By Gary Beckett

In what is being described as one of the largest green-energy projects in the country, a Seattle company hopes to harness energy from ocean waves, tides, and wind to generate electricity using offshore platforms that would resemble oil rigs. In December 2008, Grays Harbor Ocean Energy had applied to the Federal Energy Regulatory Commission (FERC) to develop seven offshore ocean-energy systems, in California, Hawaii, Massachusetts, New Jersey, New York, and Rhode Island waters. The company is one of dozens developing wave and tidal energy-generation systems but Grays Harbor wants to add wind power to the mix.



Systems vary, but all use wave motion and tidal flow to generate electricity. Some capture water in a floating tube or buoy and use it to turn a conventional water turbine to generate electricity. In others, the buoy contains a magnetic shaft and electric coil. As the buoy bobs in the water, the shaft slides through the coil to generate electricity. The Grays Harbor system also would add wind turbines on top of the platforms. The company estimates that the power generated from one of its "wave farms" — made up of about 100 platforms grouped in a 100-square-mile area approximately 10-15 miles offshore, should supply electricity for 300,000 homes.

Wave-energy systems come with environmental considerations. A recent report to California's Ocean Protection Council and the state energy commission questioned if such systems might disturb normal wave patterns and harm some marine life. Projects also could diminish energy from waves, interfering with shoaling and beach building, which could adversely affect species living in the high-tide line out to the continental shelf.

Last November FERC set a 60-day comment period on the Grays Harbor application as the first step in what is expected to be a lengthy review process. A proposed site off the Rhode Island coast is in the most advanced stage of application development.

"There, if everything went well, I think it could start making power around 2015 or 2016," said Grays Harbor president Burton Hamner. Other proposed sites could be producing electricity not long after, he added. Rhode Island has been the most aggressive state at promoting offshore renewable energy. In December 2007, the state signed an agreement with an Australian wave-energy developer to build a generation system off its coast. The program is part of an overall mission by Governor Donald Carcieri of obtaining at least 20 percent of the state's energy from renewable sources by 2011. Grays Harbor in August 2008 also received a FERC permit to study a site off the Washington coast.

Several wave-energy systems, constructed by competing companies, are in operation already, one off the coast of Portugal. One system reportedly generates about 2.25 megawatts of power, enough to power around 1,500 homes. Hamner said wave energy systems are expensive to build, averaging around $4 million per megawatt. Projects must generate at least 1,000 megawatts of power to be cost-effective. Sites need to be at least 100 square miles to be viable, Hamner said. Given their cost, wave/wind energy projects of the type Grays Harbor would build must be located in larger markets and in states offering sizable incentives to developers.

* Reprinted from *BoatU.S. Magazine*, March 2009, a publication of the Boat Owners Association of The United States. Gary Beckett is a free-lance writer.

Changes in Policy and Market and Network Regulation to Increase Power Generation by Renewables and DG in the EU

By Frits van Oostvoorn and Adriaan van der Welle*

Background

Recently the importance of "Large scale DER integration" has increased as means to meet the ambitious 2020 EU policy objectives and targets for RES, emissions reductions and energy efficiency. Increasing the role of RES & DG (DER) in supply is also highly beneficial for reducing EU dependency on gas and oil imports. In this EU context, it is important to review the current barriers, support policies and network regulation for integration of more DG, RES and small scale CHP in the power systems.

Several studies conducted for the EU and led by the ECN reveal that currently, in some, mainly new, Member States, the contribution of RES & DG is still very low. However, in coming decades the share of variable RES-E sources should become much larger in many EU countries. See Figure 1. Note that 20% RES in a country in 2020 implies a share of electricity supply by RES of about 30% or more. Currently countries like Denmark and Spain, already experience such a large contribution of (mostly intermittent type) renewables and this is already negatively impacting power system costs. Now the question arises can we increase the contribution of RES to the power supply beyond 20-30% without raising system inefficiency and what changes in system conditions and market and network regulation are necessary to efficiently absorb large volumes of so called intermittent RES supply resources.

Based on findings from several large EU projects promoting the role of RES & DG in the power supply, we discuss and present the different barriers and solutions that should facilitate meeting the ambitious EU policy targets for RES in 2020. See Figure 1.

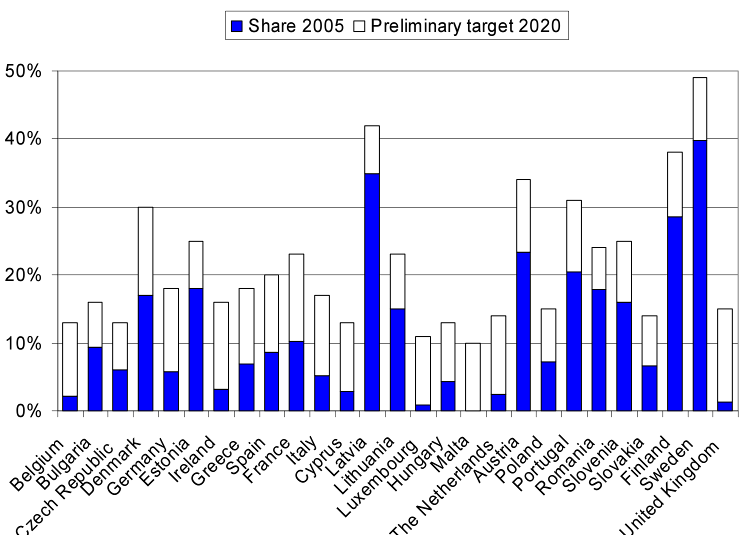


Figure 1 Shares of RES in Final Consumption, EU Countries
Source: EC

Current Policy Drivers and Support in EU

In the last decade, electricity markets in EU have been liberalized, meaning the vertical power supply chain has been unbundled in most countries and transmission and distribution networks are regulated businesses.

In that context decentralization of power generation through connecting Distributed Energy Resource (DER), including generation options such as small scale CHP and wind turbines, were promoted in many countries. According to the EU Electricity Directive, distributed generation includes all power plants connected to the distribution system. Each different type of distributed generation has, however, its own technical and commercial characteristics.

In fact, the connection of DER technologies for generating electricity has been promoted by several EU countries for environmental and industrial policy reasons. In countries like Spain, Germany, Denmark and Netherlands this type of power generation has received much extra policy support through favorable (compared with conventional fossil fuel fired plants) tax exemptions, subsidies and price interventions. In fact, over the last decade, different types of production support schemes have been set up and implemented in all EU member states. Feed-in support schemes have been very effective in increasing wind and PV generation in Germany, Spain and Denmark. However, for meeting the recently formulated policy targets of the EU for RES and climate change, large wind parks connected to the transmission network are also becoming a key option. Clearly meeting the ambitious EU target for RES electricity supply requires a complete redesign of the power systems in many EU countries.

However, a first step in that process should be to look critically at current support schemes in so far as these still serve their initial purpose (i.e., getting RES

* Frits van Oostvoorn and Adriaan van der Welle are with the Energy Research Centre of the Netherlands. van Ostvoorn may be reached at oostvoorn@ecn.nl
See footnotes at end of text, www.solid-der.org and references

& DG off the ground) and see if these support schemes can be modified into more economic and market based systems and thus can be more efficient instruments for promoting RES & DG. The success of the favorable (for the DER investor) subsidies has led to high shares of PV and wind technologies without considering the costs to society of these support schemes and their implications for other players in the power system, networks, capacity reserves, etc. System cost burdens can be reduced by the development of alternative instruments such as RPS & Green Trade Certificates.

Feed-in tariffs and direct investment subsidies for power generation by DG and RES that have led to a high penetration of a less flexible and less controllable power supply with increasing system costs, should be replaced by feed-in premiums, including market power prices. Additionaly, for cross border trade in RES, power supply harmonization among the various country support instruments requires urgent EU action.

Clearly balancing the increasing costs of support with the declining efficiency of the overall power system needs to be addressed soon in those countries that were most successful in enhancing the share of DG and renewables in electricity supply. A fair sharing of both the costs and benefits between producers, networks and consumers and the introduction of more market based incentives into the support schemes is necessary. If support schemes like renewable portfolio standard with tradable green certificates or feed-in premiums are implemented, DER is (partially) subject to market and system conditions (like wholesale and balancing markets), see M ten Donkelaar et al. (2008).

Barriers and Solutions for Take-off

First it should be realized that the contribution shares of DG & RES power generation differs greatly among EU countries, consequently barriers and recommendations to improve the system for stimulating more RES & DG vary by country. For simplicity, the situation of all EU countries is grouped into two stages of RES & DG development in supply, i.e, a situation of a very small contribution (at the take-off) of RES & DG and another with already a large share of RES & DG for the power supply.

In the first group of countries having an almost zero role of DG & RES in supply the main network connection barrier seems to be the lack of streamlining of rules and the compliance with rules by all parties. Clearly heavy and very complicated administrative and legal procedures hamper new connections, e.g., Poland, Czech Republic, making grid access of new DER time-consuming and costly. Lack of standardization of network access regulation increases this effect. Finally we should mention that network access by DG & RES is also often obstructed by insufficient unbundling of production and supply networks. While the networks are generally legally unbundled, in practice incumbent power producers are still able to (tacitly) influence the DSO network access policy through affiliated companies (see also Frias et al., 2008).

Network access of DG & RES is also often obstructed by insufficient unbundling of production and supply networks. However, more advanced forms of unbundling are likely to be implemented due to a forthcoming guideline of the European Commission. This might somewhat diminish the chance of incumbent power producers to (tacitly) influence the DSO network access policy through affiliated companies. It is an open question; whether this form of unbundling is strong enough too enable connection of DER owned by independent companies (non-DSOs) to the grid.

Generally, if energy companies are no longer, or only to a small extent, state-owned, more competition between generators gradually diminishes large plant margins (overcapacity). So if countries are moving gradually to more market liberalization, putting in place support schemes for RES & DG has a positive impact on investments in DG & RES. But the many administrative barriers and lack of transparency in rules and procedures should be reduced. In this case investment permits should be handled via a so called one shop-stop procedure.

Network access of DG & RES is also often obstructed by insufficient unbundling of production and supply networks. However, more advanced forms of unbundling are likely to be implemented due to a forthcoming guideline of the European Commission. This might somewhat diminish the chance of incumbent power producers to (tacitly) influence the DSO network access policy through affiliated companies. It is an open question; whether this form of unbundling is strong enough too enable connection of DER owned by independent companies (non-DSOs) to the grid.

Increasing System Costs by More Intermittent RES & DG Based Power Supply

The current architecture and functioning of electricity networks have mainly been developed in the last three decades and was designed for supporting the connection of large-scale centralized generation to higher voltage levels during the last fifty years. Therefore, the power flow goes largely through transmission and then to distribution networks, and then on to the final consumers via a series of voltage transformations, i.e., in a unidirectional mode. DER (DG & RES) generators are currently mainly connected to lower voltaic levels, with PV units mainly connected to the LV distribution network, while onshore wind turbines and biomass units are connected to either MV or HV distribution networks. Figure 2 shows the changes in the power flows and network architecture in the power system as whole as much larger volumes of power supply are generated by RES & DG.

Consequently in this second phase of integrating more and more DG & RES, particularly if by intermittent type technologies, there are substantial technical and economic impacts on the functioning of a power system designed in the past. In the group of countries with already or soon expecting large shares of (mainly intermittent type) RES and DG electricity generation, an increasing negative impact on system costs caused by all kinds of measures securing the safety and supply security (extra need for flexible generation and balancing markets, etc.) build up new thresholds for increasing further integration of RES & DG now and in the future. See Figure 3 with an overview of system costs impacts.

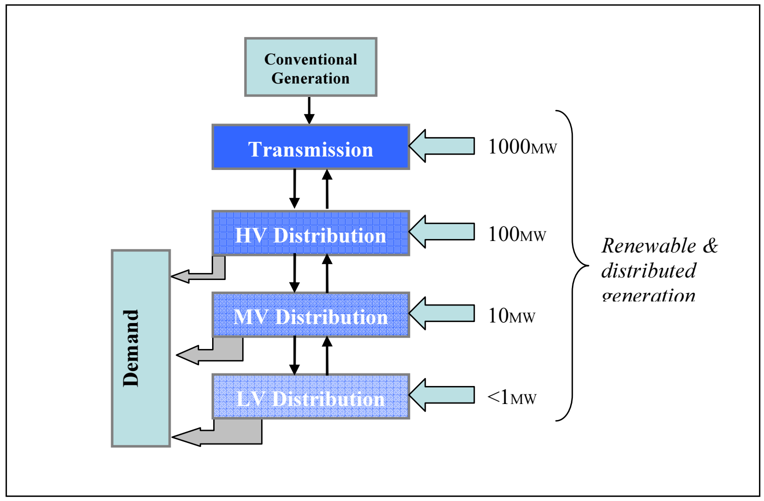


Figure 2. Connection of various forms and sizes of distributed generation to distribution networks (HV: High Voltage; MV: Medium Voltage; LV: Low Voltage).

Source: RESPOND, www.respond-project.eu.

As became clear from experiences in Denmark, Spain, and Germany and from different (EU and IEA) studies in recent years, the rapid growth of RES and DG, if rising above certain shares of generation capacity in a country, causes impacts that will gradually increase overall system costs. This challenges the feasibility of meeting the EU RES targets for 2020 and, therefore, needs to be resolved soon. Measures and options identified and observed in these EU countries generally concern an additional need for market and balancing market flexibility and network controllability.

Demand for more flexibility in the system drives up peak prices and gives generators the opportunity to achieve a higher rate of return by deploying more flexible generation technologies like hydro and gas based generators in the generation mix. An alternative for enhancing generation flexibility is the option of interconnection contracting. The benefits of interconnection depend on price differentials between markets.

Also the options that are able to mitigate (part of) the increase of the demand for balancing (by the increasing variable RES-E supply by wind turbines and PV) are possible if using demand response, provision of balancing services by DER, improvement of wind power prediction models and extension of (available) interconnection capacity. The Demand response is a concept that seeks to lower demand during specific, limited time periods, by temporally curtailing electricity usage, shifting usage to other time periods, or substituting another resource for delivered electricity (such as self-generation), focusing on when energy is used and its cost at that time. With application of demand response the increased demand of DER for balancing can be met without endangering system operation.

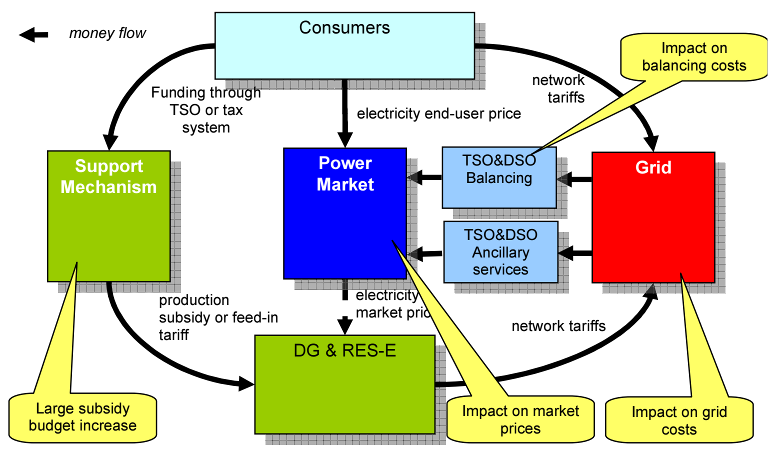


Figure 3 Increase of system costs by large scale connection of RES & DG

Diminishing forecast errors of wind supply by prediction methods and models decreases the need for balancing and is already practiced in Spain and Denmark. Improved wind power output forecasting accuracy also implies that less interconnection capacity has to be reserved to absorb unexpected wind power flows and resulting loop flows. Finally reduced network controllability in lower voltage networks may, in the long run, be solved by implementing active network management and (related) options like flexible deployment of DER, demand response and storage by DSOs. In summary, all compensating measures increase, or will increase in the future, overall system costs. The question is how to minimize these while maintaining an economic power system.

Summary of Recommended Policy and Regulatory Measures

All recommended measures both on support policies, system rules and regulation are focused on creating new or other system conditions that promote the efficient economic development of sufficient market, balancing and generation flexibility and network control.

For increasing generation and market flexibility member country support schemes for renewable production needs to be harmonised among the states, at least to some extent, to insure that RES, i.e., wind turbines are deployed optimally across Europe. Also the introduction of a single European market for tradable guarantees of origin is of utmost importance for steering investments in an efficient way to countries with the highest resources or potentials to meet the EU renewable targets for 2020. While capacity allocation can be enhanced by using market based mechanisms like implicit and explicit auctions for cross-border trading, improved coordination between TSOs is also needed. For the day-ahead and intraday time frames implicit auctions are most efficient and, therefore, have to be encouraged.

To increase balancing market functioning the introduction of balancing responsible parties (BRP) is advised. This should limit the size of the imbalance between scheduled and real production and demand, and result in the TSO having less power to dispose of to fulfil his system balancing task. Also DER balancing responsibilities should be given to the TSOs. Furthermore use demand response as a balancing mechanism. Adding balancing services by DER through VPP is already in use in some member states (Germany, The Netherlands) and expected to be a valuable option for other countries in the near future. However, the required minimum size for provision of balancing services varies a lot, country to country.

Improvement of wind power predictions can be furthered by BRP as well as by shortening the gate closure time (GCT) of the day-ahead market. Through implementation of balancing responsible parties, generators and suppliers receive an incentive to improve their wind power predictions and limit their imbalance exposure. Reducing the gate closure time of the day-ahead market is also strongly advised to limit the demand for balancing services due to intermittent generation.

Measures to increase network controllability for distribution networks (DSOs) include active network management, i.e., a higher visibility of distribution network components, generation and load. A consequent steering of distribution network flows will reduce system integration costs of DG in most cases. In the short term, in most countries monitoring and controlling of a part of distributed generation and load seems to be enough to reduce system integration costs. Implementation of regulatory rules enabling DSOs to be indifferent between new investments and deployment of DG for network planning is advised. This should take into account the impact of unbundling on the development of other flexibility enhancing options like storage for flexible network operation, when separating networks from commercial activities. Rationalize the different congestion management methods for allocation of cross-border capacity currently applied across Europe. Create more coordination between TSOs for cross-border congestion management in order to increase the efficiency of the allocation and foster the integration of RES generators. Legal provisions need to be implemented on a European level. Apply time-of-use network pricing for both large generators and load is advised for maximising the use of the existent network capacity, thereby limiting the system integration costs of renewables.

Footnotes

[1] See reports SOLID-DER, website www.solid-der.org.

[2] Part of the country-specific impacts are derived from Blazic et al. (2008)

References

Blažič, B., Pfajfar, T. and Papič, I. (2008) - 'Techniques for DER integration and Active Network Management', SOLID-DER.

Cobelo, I., Rodríguez, R. and Díaz, A. (2008) - 'Demand response and demand side management', SOLID-DER.

Donkelaar, M. ten, and Jacobsen H. (2008), 'Role of National support policy in large scale integration of DER in electricity supply', SOLID-DER.

Frías, P. et al. (2008), 'Regulatory recommendations for large-scale integration of DER into the European electricity market', SOLID-DER.

Oostvoorn, F van et al (2008), Overview of progress, barriers and solutions for more DER integration into electricity supply systems", SOLID-DER.

The Pickens Plan: Is It the Answer to Our Energy Needs?

By Mary J. Hutzler*

T. Boone Pickens is calling for wind and natural gas to be used to replace imported oil, providing a transition to new "alternative" technology developments that are supposed to meet future U.S. energy requirements. In particular, his plan calls for wind to replace natural gas in the electric-generation sector and for natural gas to replace petroleum in the transportation sector, thereby displacing 30–50 percent of U.S. foreign-oil imports over the next 10 years. His plan is fraught with problems, however, including its reliance on an intermittent technology (wind) to generate more than 20 percent of our electricity needs and its goal of converting our transportation fleet to a fuel that the United States already imports (natural gas). Yet the plan is virtually risk free for T. Boone Pickens, who can probably make a 25 percent return at the expense of taxpayers and electric customers, owing to federal and state energy and tax subsidies.

Problems with Wind

Wind power is an intermittent producer of electricity, dependent on when the wind blows to turn the turbine blades. It represents about 1 percent of our electricity generation and 0.3 percent of our energy demand,[1] with an average capacity factor of only 25 percent,[2] and, in the best areas, a capacity factor of 35 to 40 percent.[3] In contrast, most of the natural-gas fired capacity added since the late 1980s has been combined-cycle technology with much higher capacity factors and availability of 88 percent.[4] Natural gas currently provides 21 percent of our electricity generation and 23 percent of our energy demand,[5] and is usually regarded as the technology that backs up wind generation when the wind doesn't blow.

A recent report by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), entitled "20% Wind Energy by 2030,"[6] envisions wind production on the order that Pickens is advocating, but at a slower pace of development. According to the DOE, 293 gigawatts of new wind capacity would be required,[7] or more than 13 gigawatts each and every year, a yearly increase almost equal to the 2007 level of installed wind capacity in the United States.[8] This growth in wind turbine capacity would require siting wind units on publicly owned lands (where a large percentage of the development sites are located), continued taxpayer-funded subsidies, the building of power lines from the remote areas where wind turbines are located, and the public's acceptance of noise and other wind-related effects.[9] The "not-in-my-back-yard" syndrome, the cost of construction, and the technological expertise needed will likely combine to prevent the level of increase projected by the Pickens plan. For evidence, consider Cape Wind, a proposed wind farm off the coast of Nantucket that has been subjected to years of costly delays by opponents of the project.[10]

Wind facilities are often hundreds of miles away from consumers and require a massive investment in transmission lines to deliver electricity from the facility to the power grid. Texas officials, for example, recently approved a $4.9 billion wind power project that will add more than 2,000 miles of heavy duty transmission lines from wind centers in West Texas to major population hubs in Austin, Dallas/Fort Worth, and Houston, among other areas. This project will result in a $4-a-month increase in the electricity bills of Texas consumers.[11] As this example shows, additional costs will have to be levied on consumers to pay for the transmission lines needed for Pickens's massive undertaking. And with line losses of power close to 10 percent, the electricity available to the consumer will be further reduced.

Problems with Natural-Gas Vehicles

But it is not just the wind component of Pickens's plan that is troubling. The cost of changing America's fleet of vehicles to natural gas will also mean expenses for consumers, either to buy a new vehicle or to convert an existing one. Honda's price for a new natural gas-fueled Civic is 62 percent higher than its price for a standard gasoline-fueled model ($9,685 higher).[12] And the costs of converting an existing automobile to natural gas range between $6000 and $20,000. Add to this, the money needed to purchase and install a home refueling station—about $5,000—and the 20 hours needed to fill it—all of this yielding a range of only 250 miles per tankful.[13] To get consumers to switch fuels, government mandates will probably be needed, requiring manufacturers to produce and sell mostly natural gas–fueled vehicles. Since less than 1 percent of the current retail service stations have natural gas facilities,[14] consumers will also need to pay the infrastructure costs of converting current retail service stations to natural gas. Plus, consumers will need to give up half their vehicle's trunk space for the tank that holds the natural gas.[15]

Another issue is the cost and availability of the energy to fuel the vehicle. The United States already relies on other countries for 20 percent of its natural

*Mary Hutzler is a Distinguished Senior Fellow at the Institute for Energy Research. She may be reached at maryh8@netzero.net
See footnotes at end of text.

gas supplies,[16] importing natural gas from Canada via pipeline and from other countries via liquefied natural gas (LNG). [17] More LNG facilities are currently being built,[18] reflecting the expectation of more imported natural gas. Unfortunately, because natural gas is increasingly part of a global market, the stability of its future price can be affected by other countries. The countries with the largest reserves of natural gas are Russia, Iran, and Qatar, which together hold almost 60 percent of the world's total.[19] They have, in the past, discussed the formation of a natural gas cartel.[20] Thus, the result of the Pickens plan could be that the United States becomes dependent on foreign sources of natural gas, transitioning the United States from an oil-cartel customer to a natural gas–cartel customer.

Options and Benefits

While all of the above issues exist for the American taxpayers and consumers, the plan is virtually risk-free for T. Boone Pickens, owing to federal and state tax incentives and subsidies. These incentives include a federal Wind Production Tax Credit of $0.02 cents per kilowatt-hour for electricity produced during the first ten years of operation; a federal income tax incentive consisting of a five-year, double declining balance accelerated depreciation; a Texas franchise break allowing a corporation to deduct the cost of a wind facility from its franchise tax; Texas's Renewable Energy Credits and its Renewable Portfolio Standard, which require a growing amount of electricity sold in Texas to come from renewable energy; and a Texas mandate that requires transmission capacity to be built and the cost to be borne by electric customers.[21] Without these subsidies, Pickens's investment in a 4,000-megawatt wind facility would probably not generate a 25-percent return.

So, what is the alternative? The National Petroleum Council's report "Hard Truths"[22] indicated that the United States needs all fuel types—renewables, nuclear, and fossil fuels. The United States has massive resources of coal (more than 200 years' worth at current consumption rates),[23] which can continue to supply base-load electricity at or above its current 50-percent level of electricity generation.[24] Coal power can be supplemented by generation from nuclear, natural gas, hydroelectric, and renewable sources such as wind, solar, and biomass. The country just needs to allow the construction of generating facilities from non-renewable as well as renewable sources.

Biofuels are already supplementing our transportation fuels, and they will supply an increasing amount in order to meet the targets in the Renewable Fuel Standard (RFS). World reserves of oil total 1.3 trillion barrels, the highest level in history.[25] The Energy Information Administration's Annual Energy Outlook 2009[26]—which incorporates in its forecast the RFS, the new Corporate Average Fuel Efficiency Standards for transportation vehicles, and offshore drilling—indicates that our net dependence on oil imports could be reduced from its current level of 58 percent to 41 percent by 2030.[27] If the Alaskan Natural Wildlife Refuge were opened to drilling, another 1 million barrels of production would be available, reducing net oil imports to 36 percent. This reduction in oil imports is about equivalent to our current level of imports from OPEC countries.[28] The United States also has 2 trillion barrels of shale oil (the most in the world), with 800 billion barrels estimated to be recoverable[29] and available to further reduce our imports of oil.

This alternative does not require the infrastructure and life-style changes that could result from the Pickens plan. It just requires the government to allow the federal lands on which these resources are located to be leased and developed. While Pickens needs the government to subsidize, mandate, and in other ways support a plan that would result in consumers and taxpayers paying more for their energy, the government could instead allow access and use of its domestic energy resources, resulting in increased energy security, revenues from resource development, and the use of existing delivery systems.

Footnotes

1 Energy Information Administration (EIA), Monthly Energy Review (MER), Table 1.2, http://www.eia.doe.gov/emeu/mer/pdf/pages/sec1_5.pdf

2 Energy Information Administration, Annual Energy Review 2007, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_8.pdf and http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_42.pdf

3 http://instituteforenergyresearch.org/2008/07/10/pitfalls-in-the-pickens-plan/

4 North American Electric Reliability Council, http://www.nerc.com/page.php?cid=4|43|47.

5 Energy Information Administration, Annual Energy Review 2007, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec1_9.pdf and http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_8.pdf

6 DOE, EERE, "20% Wind Energy by 2030," May 2008, http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf

7 This level of wind production is significantly more than the generation level that the Energy Information

Administration is projecting in their Annual Energy Outlook 2009 assuming current tax incentives and mandates by both Federal and State governments. See http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf

[8] Energy Information Administration, Annual Energy Review 2007, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_42.pdf

[9] "U.S. DOE Report '20% Wind Energy by 2030" Presents Implausible Scenario,'" http://www.windaction.org/releases/16239 .

[10] http://washingtontimes.com/news/2009/jan/17/interior-issues-drilling-proposal/?page=2 and http://www.ee-news.net/climatewire/2008/12/19/archive/5?terms=wind

[11] http://www.statesman.com/news/content/news/stories/local/07/18/0718wind.html

[12] http://automobiles.honda.com/civic/

[13] Reece Epstein and David A. Ridenour, "The Pickens Plan: Questions Unanswered," http://www.nationalcenter.org/NPA574.html

[14] Department of Energy, http://www.eere.energy.gov/afdc/fuels/sztations_counts.html

[15] http://automobiles.honda.com/images/2008/civic-sedan/downloads/2008-civic-sedan-factsheet.pdf and http://automobiles.honda.com/images/2008/civic-gx/downloads/2008-civic-gx-factsheet.pdf

[16] Energy Information Administration, Annual Energy Review 2007, Table 6.1, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec6_5.pdf.

[17] Energy Information Administration, Annual Energy Review 2007, Table 6.3, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec6_9.pdf

[18] Federal regulators approve Baltimore LNG facility, refuse rehearings on 2 others, http://www.eenews.net/eenewspm/2009/01/15/8

[19] Energy Information Administration, International Energy Outlook 2008, Table 6, http://www.eia.doe.gov/oiaf/ieo/nat_gas.html

[20] Russia, Iran and Qatar announce cartel that will control 60% of world's gas supplies, October 22, 2008, http://www.guardian.co.uk/business/2008/oct/22/gas-russia-gazprom-iran-qatar

[21] http://www.instituteforenergyresearch.org/2008/09/26/financial-incentives-behind-the-pickens-plan/

[22] http://www.npchardtruthsreport.org/

[23] http://www.instituteforenergyresearch.org/energy-overview/coal/

[24] Energy Information Administration, Annual Energy Review 2007, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_8.pdf

[25] Energy Information Administration, Annual Enery Review 2007, Table 11.4, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec11_9.pdf and http://www.instituteforenergyresearch.org/2008/08/26/has-oil-reached-its-peak/

[26] Energy Information Administration, Annual Energy Outlook 2009, http://www.eia.doe.gov/oiaf/aeo/index.html

[27] Energy information Administration, Annual Energy Outlook 2009, http://www.eia.doe.gov/oiaf/aeo/aeo2009_presentation.html

[28] Energy Information Administration, Annual Energy Review 2007, Table 5.4, http://www.eia.doe.gov/emeu/aer/pdf/pages/sec5_11.pdf

[29] http://www.instituteforenergyresearch.org/oil-shale/

Careers, Energy Education and Scholarships Online Databases

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

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

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

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

We look forward to your participation in these new initiatives.

GSE's Role in the Italian Renewable Electricity System

By Carlo Andrea Bollino*

In accordance with the Italian and the relevant international legislation, Gestore dei Servizi Elettrici—GSE Spa—supports the development of renewable electricity, by granting incentives to power plants, and conducting awareness campaigns for fostering environmentally-sustainable uses of electricity.

The company has a single shareholder: the Ministry of Economy and Finance, which, together with the Ministry of Economic Development, gives it operation guidelines. GSE is also the holding of the Single Buyer and the Market Operator, the company responsible for the management of the Italian electricity exchange. By managing the support schemes to electricity generation, as well as the related financial flows, GSE plays a key role in the Italian power system.

In particular, GSE carries out all the activities related to the renewable energy certificates (REC) system. This system is Italy's major policy for the deployment of renewable energies (in operation since 2001), and is based on mandatory targets. Italian energy suppliers producing or importing more than 100 GWh per year from conventional sources are obliged to ensure that a percentage of their annual electricity supply for the domestic market comes from entitled renewable energy plants. For those plants, audited in advance by GSE, the total amount of REC is differentiated according to technology. Each MWh produced, before getting REC, is, therefore, multiplied by a special ratio. GSE also checks the compliance of market players.

Since 2005 GSE has also managed the new feed–in tariff for photovoltaic plants; and 2008 it also became responsible for the new feed–in mechanism for all renewable plants smaller than 1 MW.

Furthermore, GSE manages voluntary renewable certifications in accordance with the EU. In that respect it issues the Guarantee of Origin (GO) to renewable electricity. As requested by European directive 2001/77/CE, it participates in the international certificate trading platform managed by AIB (Association of Issuing Bodies) and issues RECS (Renewable Energy Certificates System) certificates.

The strengthening of its role in Italian RES energy policy, also increases the participation of GSE at the international level. During 2008 GSE joined both the IEA (International Energy Agency) Working Party on Renewable Energy Technology as the alternate of the Ministry of Economic Development and the OME (Observatoire Méditerranéen de l'Énergie) Renewable Energy and Sustainable Development Committee.

A new challenge for GSE is represented by the climate change package discussed at EU level. The ambitious targets need, in fact, a good analysis and GSE can be an active party supporting the job of the Italian government.

* Carlo Andrea Bollino is President of GSE Spa and a past presdent of the IAEE. He may be reached at carloadrea.bollino@gsel.it

Italians, Renewable Energy Sources and EU "Climate Vision"

By Paolo Polinori*

Changes in Italy's political and institutional set up have brought with them new aims to comply with EU directives regarding energy. In line with the European Union Directive 2001/77/EC on renewable sources, the Italian aim is to achieve a 22% share in renewable energy source (RES) electricity production by 2010; the annual cost necessary to reach this aim is estimated at 2 billion €.

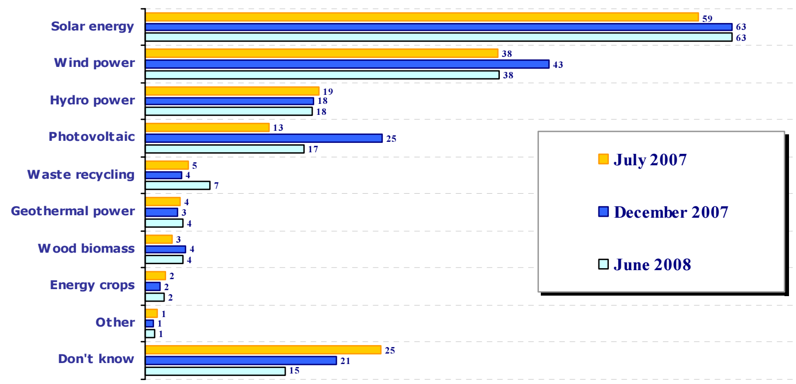


Figure 1. Knowledge of RES (%; 1600 obs. each survey)

Even in early 2007, new EU goals, i.e., 20-20-20, were aiming for 20% of total energy resources by the year 2020, together with a goal of 20% energy saving; the annual cost necessary to reach this aim is estimated at 5.2 billion €. With this background, it has now become crucial to explore Italian consumers' willingness to pay (WTP) in order to use "green energy" in electricity production. We did this using various methods.

In order to derive estimates of WTP, three national surveys, with 1600 interviews each, were carried out in July 2007, December 2007 and June 2008. The stratified samples are highly representative of the 46.8 million individuals' resident in Italy. The surveys were conducted by CATI and CAWI methods, by Istituto Piepoli. These surveys were not performed ad hoc but we were able to interact with survey staff in order to define the language of the questionnaires. The full raw data-sets were given to the authors for processing, so in theory no hidden non-stochastic distortion (such as recording mistakes) should affect results.

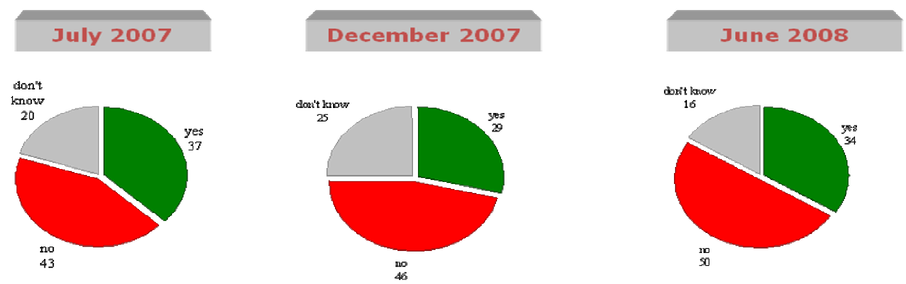


Figure 2. "Are you willing to pay extra for your electricity in order to use green energy in electricity production?" (%; 1600 obs. each survey)

Do Italians Know About RES?

In the surveys each respondent was questioned on: i) RES and their potential development; ii) the Italian Energy System; iii) amounts of money (bids) in order to support RES development in Italy. Figure 1 shows the statistics of "Knowledge variables", i.e., whether respondents have or do not have good knowledge of RES.

79% of the total respondents answered that they know about RES. The best known sources are solar power, hydro and wind power, whereas biomass, energy crops and geothermal power are little known. These results show that Italian people have a good knowledge of RES.

Are Italians Willing to Pay for RES?

One very interesting result concerns the respondents' favorable attitude to RES (Figure 2): more than 30% of the respondents declared a positive WTP in order to increase RES use in energy production, while 20% were undecided.

In the last section of each survey questionnaire consumers' WTP was elicited by different formats (payment card, bidding game, contingent evaluation) but here we present aggregate results (Figure 3). Among respondents with a positive WTP, the average amount respondents are willing to pay constantly increases with time. Another important result is that 80% of them, on average, are willing to pay from 0.1€ to 10€ , while only 5%, on average, is willing to pay 20€ or more.

* Paolo Polinori is a professor in the Department of Economics, Finance and Statistics at the University of Perugia, Italy. He may be reached at polpa@unipg.it

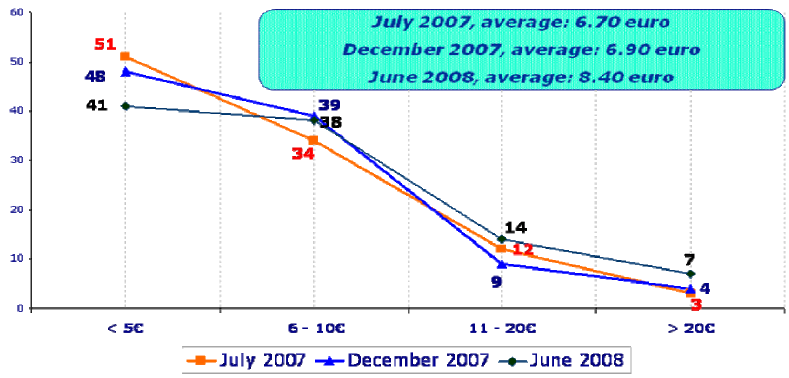


Figure 3

Econometric results confirm these WTP amounts, the highest mean WTP amount obtained is 9.39€ with a confidence interval of [9.24€ – 9.50€], while the lowest is 3.74€ with a confidence interval of [3.45€ – 3.91€].

Is Italian WTP Sufficient to Reach EU Goals?

The main question is whether Italian WTP is sufficient in order to achieve EU goals. We found that consumers were quite willing to cover the cost of the goals partially. Table 1 shows that with the old goal (European Union Directive 2001/77/EC), the capacity to cover costs lies between 44% and 55% and this is an encouragingly high percentage in the context of EU policy; unfortunately with respect to the new goal "20-20-20" the capacity is much lower, between 17% and 21%.

	Mean WTP (€)	Annual electricity bill (No.)	Households (No.)	Total annual WTP (€)	Annual subsidy cost (€) 22%	Annual subsidy cost (€) 20-20-20	Market sustainability (%) 22%	Market sustainability (%) 20-20-20
July 2007	6.70			876,789,175			43.84%	16.75%
December 2007	6.90	6	21,810,676	902,961,986	2,000,000,000	5,234,562,240	45.15%	17.25%
June 2008	8.40			1,099,258,070			54.96%	21.00%

Table 1

The above findings support the view that, in Italy, there is some consensus on the development of RES. In monetary value this consensus to cover the cost is estimated as less than 20% of the total subsidy cost under the new EU "Environmental Regime", while under the old one it was, on average, 50%. Regrettably, the increasing EU expectations on energy efficiency and CO_2 emission reduction will tend to reduce the market sustainability of the EU' s climate vision.

Report from the Spanish Affiliate

The Fourth Conference of the Spanish Association for Energy Economics took place in January 22-24, 2009 in Seville, at the IPTS (JRC-European Commission) headquarters, and was considered by all participants a large success. The Conference was able to draw together more than 60 representatives from academia, energy companies, and Spanish and international institutions (including regulators, public bodies, and NGOs), which presented their research on Energy Economics, and which participated actively in the plenary session (given by Dolf Gielen, from the IEA) and the round tables (on biofuels; and on the impact of the economic crisis on the energy sector). The presentations will be available shortly at www.aeee.es. The organizers of the Conference (IPTS and U. Pablo de Olavide) were widely praised for their good management of the events, and the significant degree of attendance and participation. The Conference ended with a visit to one of the first solar thermal power plants being built currently in Spain. The Conference was sponsored by the Andalusian Energy Agency, Endesa and IPTS.

Welcome New Members!

The following individuals joined IAEE from 1/1/09 to 3/31/09

Mohammed Amin Adam
United Kingdom

F Gerard Adams
USA

Esther Agboyitor
University of Dundee
United Kingdom

Christophe Agogue
GDF Suez GrDF
France

Luis Agosti
LECG
Spain

Nana Akua Agyei
University of Dundee
United Kingdom

Joseph Ahmed
Balfour Beatty
United Kingdom

Khadijat Akranbi
Nigerian Electricity Regulatory Com
Nigeria

Mohamed Al Marchohi
University of Antwerp
Belgium

Abdulmuhsin Alakkas
Saudi Arabia

Fareed Alasaly
Saudi Aramco
Saudi Arabia

Barjas Albarjas
Saudi Aramco
Saudi Arabia

Khaled Albinali
King Fahd Univ of Petrol and Min
Saudi Arabia

Vicente Alcantara Escolano
Universitat Autonoma de Barcelona
Spain

Ahmed Al-Ghamdi
Saudi Aramco
Saudi Arabia

Sham-un Said Alhassan
University of Cape Coast
Ghana

Nabeel AlMojil
Saudi Aramco
Saudi Arabia

Tatiana Alonso Gispert
BBVA
Spain

Khalid Al-Qhatani
Saudi Aramco
Saudi Arabia

Mohammed Al-Sahlawi
Saudi Arabia

Anton Altman
GW University
USA

Fuad Al-Zayer
OPEC
Austria

Ercole Amato
Italy

Francisco J andre Garcia
Universidad Pablo de Olavide
Spain

Jose Adres Martinez
Prado en Energia y Medio Ambiente
Spain

Luigi Apicella
Soluzioni Energetiche
Italy

Cemal Araalan
Cemal Cursel Cad Gursel
Turkey

Snnamaria Arcudi
Plurigas SPA
Italy

Maria-Soledad Arellano
Universidad Adolfo Ibanez
Chile

Manel Avella Fluvia
Columbia University
USA

Simona Balzano
Italy

Justine Barden
USA

Hubertus Bardt
Inst der Deutschen Wirtschaft Koln
Germany

Gaelle Barrot
GDF Suez
France

Lucia Bartocci
Ideadata Srl
Italy

Bernard Beaudreau
Universite Laval
Canada

Etienne Beeker
EDF BC DMS
France

Velio Bellini
NA Met Srl
Italy

Luc Belzile
Canada

Chris Bement
EnCana Oil & Gas Inc
USA

Ariel Bergmann
Napier University
United Kingdom

Gabriele Bertholet
Assoutility
Italy

Robert Bessette
Council of Industrial Boiler Owners
USA

Riccardo Biagetti
Italy

Nedo Biancani
Italy

Gennaro Bianchi
Italy

Ilaria Bientinesi
Italy

Kjetil Bjornsen
StatOil Hydro
Norway

Andrew Bochman
DOD Energy Blog
USA

Stanislav Bogomolov
Switzerland

Darcy Bonner
Houlihan Smith & Co
USA

Rita Borgo
Deutsche Bank Spa
Italy

Jorn alte Borsheim
Petoro
Norway

Hafedh Bouakez
Canada

Fanny Bouthillier
CEROG et CREID CIFRE a la dr
France

Courtenay Brammar
United Kingdom

Zbynek Brettscheider
ORGREZ as
Czech Republic

Matteo Briganti
Italy

Quirino Brindisi
Italy

Giorgia Bronzetti
Italy

Isabella Bruno
Italy

Michael Burn
University of Colorado at Denver
USA

Steven Butler
University of California
USA

Daniel Camos Daurella
Paris School of Economics
France

Antonio Cannella
Italy

Cristina Cantasano
Italy

Giuseppe Carcasi
Italy

Amanda Carlos
Getulio Vargas Foundation
Brazil

Andrea Casile
Italy

Franco Ceresa
Italy

Qimin Chai
Tsinghua University
USA

Emile Chappin
Delft University of Technology
Netherlands

Claudio Chiste
Intesa Sanpaolo
United Kingdom

Youngsung Cho
Korea University
South Korea

Maurizio Ciampi
Italy

Michele Ciaramella
Italy

Antonio Coccia
Italy

Bruno Coppolino
Italy

David Corderi Novoa
Spain

Ingrid Correa Sanchez
Universidad Complutense
Spain

Stefanie Croyle
TRC Solutions
USA

Michael Cruciani
CGEMP
France

Eva Daaske
Olje og Energi dep
Norway

Bulent Dagdelen
Turkey

Hans Jorgen Dahl
Norway

Benjamin Davis
USA

Daniele De Sanctis
Italy

Sergio De Sanctis
Sapio Produzione Idrogeno Oss Srl
Italy

Pablo Del rio Gonzalez
CSIC
Spain

Francesco Del Signore
Italy

Francesco Di Fillipoantonio
Italy

Davide Di Giuseppe
Italy

Mauricio Di Stefano
Italy

Evelyn Dietsche
CEPMLP
United Kingdom

Wadjamsse Beaudelaire Djezou
University of Cocody
Cote d'Ivoire

Otto Doering III
Purdue University
USA

Anthony Dols
Avantis43 DMCC
United Arab Emirates

Cristiano D'Ortenzio
DRT Operations
Italy

Seymour Douglas
Cox Enterprises
USA

Bogumil Druciarek
Warsaw School of Economics
Poland

Pauline Dugat
United Kingdom

Julie Edwards
Argus Media Inc
USA

Effom Effiong
Nigerian Electricity Regulatory Com
Nigeria

David Eikelberg
US DOE
USA

Ozgur Emre Sivrikaya
Hurriyet Mah Spor Cad Akasya Sk Emr
Turkey

Richard Agbor Enow
EurOil Limited
Cameroon

Imad Erdogan
Turkey

Korhan Erdon
Germany

Ruhollah Eskandari
Inst for International Energy Stud
Iran

Joseph Essandoh-yeddu
Energy Commission
Ghana

Jin Fan
Jiangsu Administration Inst
China

Tijun Fan
East China Univ of Science and Tech
China

Ying Fan
CEEP
China

Marco Ferrando
IPM Energy Italia
Italy

Roberto Ferreira da Cunha
Univ Federal do Rio de Janeiro
Brazil

Marcela Ferreira Ramos
Getulio Vargas Foundation
Brazil

Aurelio Fetz
ATEL
Switzerland
Federico Fische
USA
Brian Fisher
Concept Economics
Australia
Massimo Fornari
Italy
Julien Fouquau
ESC Rouen
France
Terry Freeman
Public Eyes Risk Group
USA
Shawn Freitas
University of Alaska
USA
Patricia Fuentes Saguar
Universidad Pablo de Olavide
Spain
Norberto Fueyo Diaz
Cateoratico de Universidad
Spain
Luis Galárraga
Occidental ME Development Co
United Arab Emirates
Christian Geist
Lic Oec Pub
Germany
Liliana Gelebert
Spain
Abbas Ghandi
USA
Udoy Ghose
University of Potsdam
Germany
Salvatore Giacomarra
Italy
Stefania Giannitelli
Italy
Dario Giardi
Italy
Bernard Gindroz
ADEME
France
Rafaele Graziano
Pricewaterhousecoopers
Italy
Steven Greenberg
The Bridge View Resources
USA
Matthias Gysler
BFE
Switzerland
Reza Haidari
Point Carbon
USA
Julie Hale
Hudson Partners LLC
USA
Zhiyong Han
CEEP
China
Lakshmikanth Hari
Natl Inst of Industrial Engineering
India
Erik Haugom
Norway
Ling-Yun He
China Agricultural University
China
Edle Heigre
StatOilHydro
Norway
Johannes Henkel
Berlin University of Technology
Germany
Serena Hesmondhaigh
The Brattle Group
United Kingdom
Jean Phillippe Hiegel
Total
France
Mi Hong
Zhejiang University
China
Elizabeth Hooper
University of East Anglia
United Kingdom
Jianchao Hou
China
Matthias Huber
Germany
Mohamed Hussan Sayed
University of Surrey
United Kingdom
Masaru Ichihashi
Hiroshima University
Japan
Guillermo Iglesias Gomez
Universidade da Coruna
Spain
Otonye Igoni
United Kingdom
Mohammed Imam
Nigeria Electricity Reg Commission
Nigeria
Hazuki Ishida
Japan
Stacy Jackson
University of California Berkeley
USA
Tom James
Buschco International Fzco
United Arab Emirates
Andrew Jarvis
GHK Consultancy
United Kingdom
Trono Jensen
Statnett
Norway
Amy Jordan
USA
Moses Kabanda
United Kingdom
Wisam Kakish
Parsons Brinckerhoff Middle East
Jordan
Antony Karembu
CEPMLP
United Kingdom
Sercan Kayalar
Entek Elektrik Uretimi AS
Turkey
Jourdain Kengne Ouabo
IFP
France
Martin Kleinelanghorst
Singapore
Melinda Kokorovic
University in Tuzla
USA
Miroslav Konecny
OSC as
Czech Republic
Ozan Korkmaz
Istanbul Technical University
Turkey
Barnett Koven
World Information Transfer UN
USA
Mehmet Kucukbeycan
METU
Turkey
Praveen Kumar
University of Houston
USA
Rajiv Kumar
MF Global Middle East DMCC
United Arab Emirates
Theodore Kury
Public Utility Research Center
USA
Erling Kvadsheim
Econ Poyry
Norway
Jesus Lacasta Clemente
Facultad Ciencias Economicas
UNED
Spain
Becky Lafrancois
Syracuse University
USA
Richard Lattanzio
USA
Maiella Leano
BP
USA
Kelly Lear Nordby
LECG LLC
USA
Ulrike Gabriele Lehr
GWS mbH
Germany
Thomas Lin Ao
Sky Global SPA
Italy
Lan-Cui Liu
China
Andrea Lupi
Italy
Sonja Luthi
IWO HSG
Switzerland
Xiao Wei Ma
CEEP IPM Chinese Academy of Sci
China
Carmelo Macaluso
Italy
Arthur J Madden
Mid Missouri Energy Inc
USA
Diptiranjan Mahapatra
Indian Inst of Mgt Ahmedabad
India
Laura Malaguzzi Valeri
ESRI
Ireland
Andrea Mangoni
Aceaelectrabel Energia
Italy
Sylvain Marcoux
SNC-Lavalin Environment Inc
Canada
Vitor Marques
Portugal
Gianluca Marras
Italy
Dorrit Marti
Ernst Basler and Partner Ltd
Switzerland
Rafael Martinez
Commodity Futures Trading Comm
USA
Paolo Andrea Mascagni
Italy
Massimilliano Maxci
Italy
Elena Maspoli
Banca IMI
Italy
Abdukarim Mayere
United Kingdom
Pamela McKinnon
Canada
Graham Meekes
Combined Heat and Power
United Kingdom
Paolo Melandri
Italy
Merrill Miller
USA
Hassan Mohammadi
Illinois State University
USA
Mattia Molfetta
Ergyca Bio
Italy
Marc Montalvo
ISO New England
USA
Milan Moravec
EGU CB as
Czech Republic
Pasquale Morelli
Italy
Mathew Morey
Christensen Assoc Energy Cons
LLC
USA
Giuseppe Moro
Convert Italia
Italy
Maria Pilar Munoz Gracia
Universitat Politecnica de Cataluny
Spain
Rosa Maria Mura
Italy
Eugenio Murano
Italy
Ian Myslivec
USA
Samer A Najm
Invensys Middle East
United Arab Emirates
Sophie Nappert
3VB
United Kingdom
Fatemeh Nazifi
Macquarie University
Australia
Alessandra Nobili
Certificati Verdi Green Card SPA
Italy
Grace Nyajro
Shell Nigeria E and P Co
Nigeria
Martin Obermaier
Fed Univ of Rio de Janeiro
Brazil
Juliet Obi
EO Collins Investment Ltd
Nigeria
Gerald OConnell
USA
Bernt Arne Odegaard
Univ of Stavanger
Norway
Monica Ognissanto
Italy
Bolaji Okanlawon
Pan Ocean Oil Corp
Nigeria
Ekpen Omonobude
Commonwealth Secretariat
United Kingdom
Stephen Oodo
Inst of Power Electronics
China
Gideon Opoku Kesse
Premier Charter Travels
Ghana
Osman Or
Kultur Mah Hoca Ahmet Yesevi sk
Turkey
Innocent Oriaku
CEPMLP
United Kingdom
Tomilayo Owodunni
Schlumberger
United Kingdom
Tom Palmer
AEA Energy and Env
United Kingdom
Eleni Papadopoulou
Centrica Plc
United Kingdom
Lorenzo Parola
Allen Overy Studiolegale Assoc
Italy
Jaroslav Pejcoch
T-Soft spol sro
Czech Republic
Sara Pelacchi
Italy
William Pepper
ICF International
USA
Thomas G Petersen
Danish Metalworkers Union
Denmark
Finn Erik L Pettersen
Norges Vassdrags og Energoi Dir
Norway
Antonio Picolo
Italy
Alberto G Pincherle
Italy
Alessia Pinti
Italy
Josef Pokorny
Colsys-Automatik as
Czech Republic
Kevin Pollard
GlobalSolve Management Services
USA
Nathalie Popiolek
CEA/DEN/DANS
France
Praboudh Pourouchottamin
EDF R&D
France
Andreas Mauricio Qunitero
Italy
Hasina Rasata
HEC Montreal
Canada
Charles Raux
France
Prabodh Regmi
University of Alberta
Canada
Roberto Renda
Italy
Brunett Reto
Azienda Elettrica Ticinese
Switzerland
Marco Ricci
Italy
David Riviere
Horvath and Partners
Switzerland
Francesca Rizzo
Verivox GMBH
Germany
Aaron Rodehorst
Bonneville Power Administration
USA
Patrick Rodey
USA

New Members (continued)

Kristin Helen Roll
University of Stavanger
Norway

Sebastian Rothe
University of Hamburg
Germany

Olivier Roy
Total
France

Diego Rufo
Italy

Serena Rugiero
IRES
Italy

Thomas Rutherford
ETH Zurich CEPE
Switzerland

Samir Y Salama
Saudi Aramco
USA

Daniele Salerno
Italy

David Sam
USA

T P Sankar
The Energy and Resources Inst
India

Feza Sanli
IBS Research and Consultancy
Turkey

John Sargeant
Consultant
United Kingdom

Antonio Seminara
Italy

Urmi Sen
USA

Ozlem Sencan
Istanbul Technical University
Turkey

Dereje Azemraw Senshaw
Germany

Steve Shankle
USA

Graham Shuttleworth
NERA
United Kingdom

Marius Sikveland
Norway

Chirstopher Silkie
USA

Giuseppe Siniscalchi
Italy

Martin Skach
ORGREZ as
Czech Republic

Lucas Skoufa
The University of Queensland
Australia

Athanasios Skoulikidis
Greece

Colin Smart
USA

David Sodade
University of Dundee
United Kingdom

Antonio Sorbera
Italy

Gianluca Sorsoli
Italy

Thierno Sow
Minerals Management Service
USA

Adolfo Spaziani
Federutility
Italy

Aubry Springuel
CESMAP CEROG
France

Jevgenijs Steinbuks
University of Cambridge
United Kingdom

Jeb Stenhouse
USA

David Stern
Australian National University
Australia

Peter Stewart
PEL Market Services
United Kingdom

Roman Studer
Oxford University
Switzerland

Sonja Studer
Swissmem
Switzerland

Zhongfu Tan
Professor
China

Althina Tellidou
Switzerland

Philippe Thalmann
EPFL ENAC REME
Switzerland

Brinda Thomas
Carnegie Mellon University
USA

Mark A Thompson
Augusta State University
USA

Lixin Tian
Jiangsu University
China

Bob Tippee
Oil & Gas Journal
USA

Beatriz Tobar de la Fe
Universidad las Palmas
Spain

Barbara Torres
Italy

Marco Tortora
Italy

Mark Tremblay
HQ Energy Services US
USA

Gizem Tulun
Hamidiye Mahallesi Fatih Caddesi
Turkey

Marco Tumolo
Electrade
Italy

Erginbay Ugurlu
Gazi University
Turkey

Kemal Uzun
Bogazici University
Turkey

Domenico Valastro
Italy

Antonio F Valero Capilla
Fundacion CIRCE
Spain

Robert H van Ligten
Vanell Associates
Switzerland

Celine Varenio
LEPII
France

Francesco Vasciarelli
Italy

Elisabetta Volpato
Italy

James Vopelius
USA

Corey Walrod
USA

Yu Wang
The Tsinghua University
China

Michael Wartmann
Carnegie Mellon University
USA

Yi Ming Wei
School of Mgt Beijing Inst of Tech
China

Tracey Wilkinson
IHS Global Insight
United Kingdom

Gang Wu
CEEP IPM Chinese Academy of Sci
China

Yasin Yanik
Turkey

Josef Zadnik
Czech Republic

Jinsuo Zhang
Xian Univ of Science and Tech
China

Xinya Zhang
USA

Yue-Jin Zhang
China

Jing Zhao
College of Humanities and Soc Sci
China

Virginia Zhelyazkova
Eurobank EFG Bulgaria AD
Bulgaria

Dequn Zhou
Nanhang University
China

Peng Zhou
Nanjing Univeristy
China

Lele Zou
CEEP IPM Chinese Acad of Sci
China

SPECIAL OFID/IAEE SUPPORT FUND FOR STUDENTS FROM DEVELOPING COUNTRIES

IAEE is pleased to announce the continuation of a special program which offers support to students from developing countries to participate in two of the Association's conferences in 2009. This program is generously underwritten by the OPEC Fund for International Development (OFID) and the International Association for Energy Economics. The support will consist of a cash stipend of up to $1500.00 plus waiver of conference registration fees for a limited number of eligible students, who are citizens of developing countries (who can be registered as full-time students in programs of study anywhere in the world), to attend either the 32nd IAEE International Conference in San Francisco, California, USA, June 21-24, 2009, or the 10th IAEE European Conference in Vienna, Austria, September 7-10, 2009.

Application deadlines for these conferences are as follows: San Francisco Conference – application cut-off date, April 7, 2009; Vienna Conference – application cut-off date, June 23, 2009.

Please submit the following information 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."

- 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, a brief description of your coursework 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.
- 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 one of the above conferences.

Please note that students may apply for this support at only one of the above conferences. Multiple requests will not be considered. 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 14 days past the application cut-off date above. After the applicant has received IAEE approval, it will be their responsibility to make their own travel (air/ground, etc.) and hotel accommodations, etc. to participate in the conference. Reimbursement up to $1500.00 will be made upon receipt of itemized expenses.

For further information regarding the IAEE support fund for students from developing countries to participate in our conferences in 2009, please do not hesitate to contact David Williams at 216-464-5365 or via e-mail at: iaee@iaee.org

World Natural Gas Markets and Trade: A Multi-Modeling Perspective

Edited by Hillard Huntington

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

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

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

Order online at: http://www.iaee.org/en/publications/specialorder.aspx
ISSN Number 0195-6574

ORDER FORM • Special Issue from the IAEE

World Natural Gas Markets and Trade: A Multi-Modeling Perspective

☐ Domestic Shipment $135.00 each (includes postage and handling)
☐ International Shipment $150.00 (includes postage and handling)

Total enclosed_________________
Make check payable to IAEE in U.S. dollars with checks drawn on a U.S. bank
Credit Card ☐ Visa or ☐ Mastercard

Card No.______________________________________Exp. Date_______________

Signature____not valid without signature

NAME: ____

TITLE: ____

COMPANY: ____

ADDRESS: ____

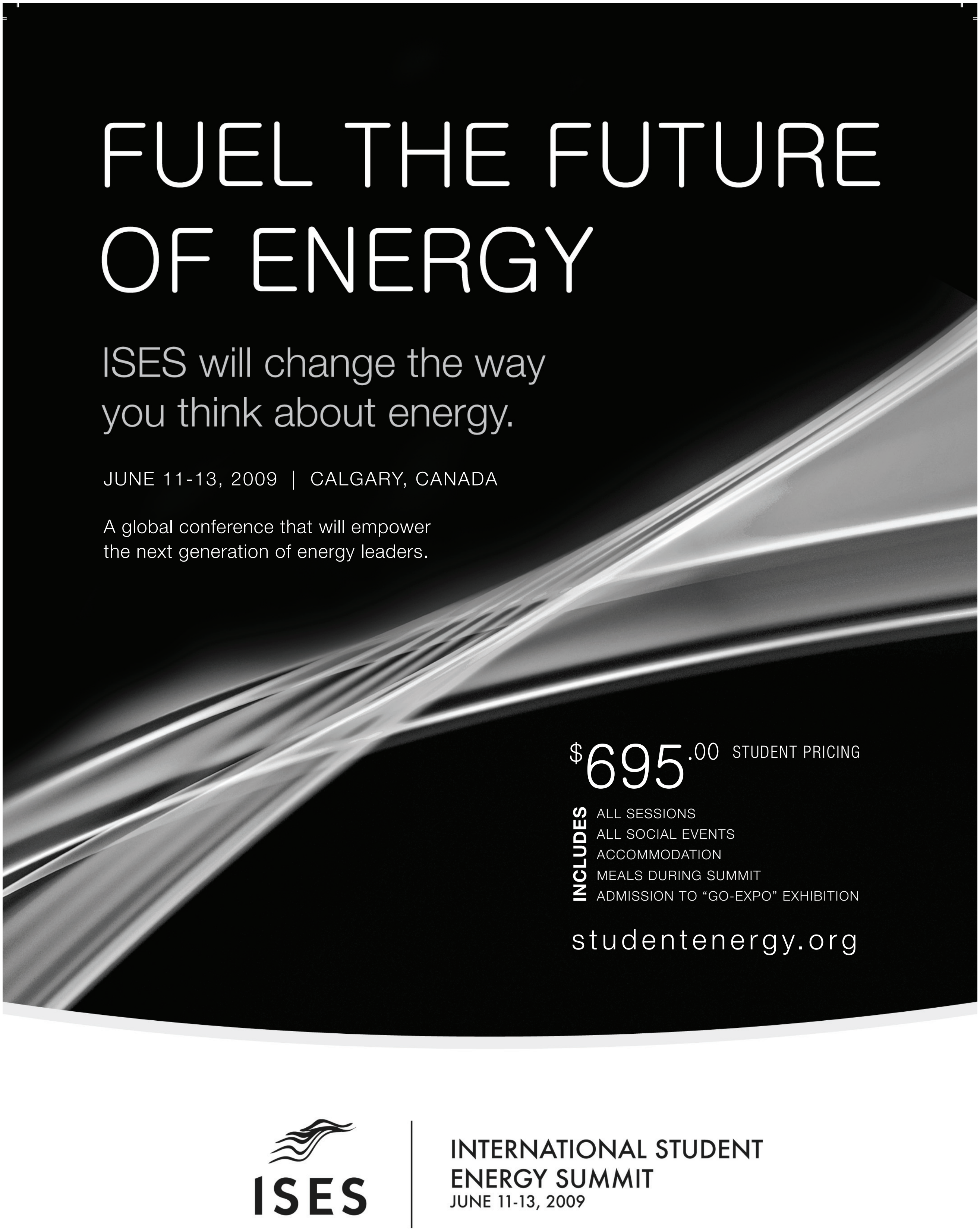
CITY,STATE,MAIL CODE: ____

COUNTRY: ____

Send order form along with payment to: International Association for Energy Economics, 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122 USA
Phone: 216-464-5365 - Fax: 216-464-2737 - E-mail: iaee@iaee.org • Website: www.iaee.org

CONTENTS

IAEE
WWW.IAEE.ORG
International Association for Energy Economics


FUEL THE FUTURE OF ENERGY
ISES will change the way you think about energy.
JUNE 11-13, 2009 | CALGARY, CANADA
A global conference that will empower the next generation of energy leaders.
$695.00 STUDENT PRICING
INCLUDES
ALL SESSIONS
ALL SOCIAL EVENTS
ACCOMMODATION
MEALS DURING SUMMIT
ADMISSION TO “GO-EXPO” EXHIBITION
studentenergy.org
ISES
INTERNATIONAL STUDENT ENERGY SUMMIT
JUNE 11-13, 2009

FIRST ANNOUNCEMENT AND CALL FOR PAPERS

Dramatic events of last few years: very fast energy demand growth in developing countries, artificially stimulated economics in developed countries and related with that banking crisis, the largest energy price shock in modern history and following global recession, growing evidence of global warming and looming difficulties in production of primary energy resources presents a unique environment for activities and businesses of energy economists and policy makers. All of that creates a vast medium of thoughts for researchers active in energy economics and great challenges for politicians responsible for energy policies.

The 11th IAEE European Conference "Energy Economy, Policies and Supply Security: Surviving the Global Economic Crisis" will provide excellent opportunity to present and discuss the results of newest studies preformed in such exceptional circumstances. The conference will bring together wide spectrum of scientists, policy makers, professionals from all energy sectors, governmental and public institutions. This conference for the first time will take place in Vilnius - the capital of Lithuania, at the year when Lithuania will celebrate 20th anniversary of regained independence.

That opens good opportunity for participants of the conference to learn more about the specifics and problems of energy sector's development in the Baltic States and the wider region around them. The problems of the integration of that region to the future PanEuropean energy market should be one of most important topics of Vilnius conference.

We are looking forward seeing you in Vilnius.

Prof. Jurgis Vilemas
General Conference Chair

Conference topics

- Energy supply security (political, economical and technical)
- Sustainability of energy systems, mitigation of global warming
- Role of renewable energy sources and biofules
- Energy demand forecasting
- Energy sector analysis and modeling
- Energy policy
- Geopolitics of energy supply (gas, oil, nuclear and etc.). Price of security
- Road map for energy efficiency
- Market integration and liberalization
- Energy sector risk analysis
- Specific energy sector problems of CEE countries
- Nuclear energy: hopes and realities
- Environment

Call for Papers

Abstract Submission Deadline: 9 April 2010

We are pleased to announce the Call for Papers for the 11th IAEE European Conference to be held on 25-28 August 2010. You are cordially invited to submit proposals for presentations at the concurrent sessions on a range of topics highlighted but not limit to above.

Please submit abstracts of maximum two pages in length, comprising: overview, methods, results, conclusions. Please attach a short CV too. The lead author submitting the abstract must provide complete contact details: mailing address, phone, fax, e-mail etc. Accepted abstracts will be published in the printed abstract volume. At least one author for each accepted paper must pay a registration fee and attend the conference.

Authors will be notified by 9 May 2010 of their paper status. Authors, whose abstracts are accepted, will have to submit their full-length papers (up to 10-12 pages limit suggested) by 9 July 2010 for publication in CDROM conference proceedings. While multiple submissions by individual or groups of authors are welcome, the abstract selection process will seek to ensure as broad participation as possible: each speaker delivers only one presentation in the conference. If multiple submissions are accepted, then a different co-author will be required to pay the speaker registration fee and present the paper.

Abstracts must be submitted electronically as a text document (doc; NO pdf) via the following link: http://www.iaee2010.org

Conference Venue

Vilnius is the capital of Lithuania since 1323. About 554 000 people of various nationalities and different religions are living there. Despite wars, occupations and destruction, the architectural ensemble of Vilnius remains unique. It is the largest Baroque city in North-East Europe. Nearly all styles of European architecture from Gothic to Classicism are present in Vilnius.

Contemporary Vilnius is a modern, forward looking and dynamic city, which attracts people and charms them.

For long ages the picturesque Old Town and National Museum of Lithuania could tell a lot about honorable past of this city and the whole country, which in 2009 celebrates solid 1000 years anniversary of being for the first time mentioned in historical annals. Because of its unique and openness the Old Tow of Vilnius is enrolled into the list of UNESCO World's Cultural Heritage.

The conference venue is Reval Hotel Lietuva, Konstitucijos av. 20, located at the administrative center of the city within walking distance to Old Town, major museums, other cultural sights, restaurants and many hotels.

Program Outline

Wednesday, 25 August 2010

8:00 – 16:00	IAEE Council & Strategy Meeting
16:30 – 17:30	IAEE European Affiliate Leadership Meeting
18:00 - 20:00	Welcome Reception

Thursday, 26 August 2010

7:30 - 18:00	Registration
7:30 - 8:30	Student Breakfast (with invitations only)
7:30 - 8:30	IAEE/European Affiliate Planning Meeting
9:30 - 10:30	Opening Plenary Session
10:30 - 11:00	Coffee Break
11:00 - 12:30	Plenary Session
12:30 - 14:00	Lunch
14:00 - 15:30	Concurrent Sessions
15:30 - 16:00	Coffee Break
16:00 - 17:30	Concurrent Sessions
19:00 – 22.30	**Cultural Event & Gala Dinner**

Friday, 27 August 2010

7:30 - 18:00	Registration
7:30 - 8:30	Energy Journal Board of Editors Meeting
7:30 - 8:30	2011 Conference Planning Meeting
9:00 - 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
17:00 – 22:30	Dinner

Saturday, 28 August 2010

7:30 - 14:00	Registration
7:30 - 8:30	Planning and Strategy Meeting
7:30 - 8:30	2012 Conference Planning Meeting
8:30 - 10:00	Concurrent Sessions
10:00 - 10:30	Coffee Break
10:30 - 12:00	Concurrent Sessions
12:00 - 13:30	Dual Plenary Sessions
13:30 - 14:30	Closing Reception

Registation Feels

Participants	**Early registration EURO**	**Late registration EURO**
Speakers/Chairpersons	450	475
IAEE members	500	550
Non-members	650	700
Students	250	275
Accompaning persons	225	250

Cancellation/Refund policy: A refund (less 100 EUR administration fee) is available until 19 July 2010. From 19 July, there will be no refund given, but a delegate from the same organisation may be substituted.

Register online at http://www.iaee2010.org

IAEE International Conference Student Program

As part of the IAEE International Conference Student Program, the IAEE offers the IAEE Student Paper Award and IAEE Internatrional Conference Student Scholarships. Detailed information for application is available at: iaee@iaee.org

Program Committee

Andersen Frits	Haas Reinhard	Miškinis Vaclovas
Bergman Lars	Hope Einar	Rutkauskas Aleksandras
Bollino Carlo Andrea	Jankauskas Vidmantas	Sauhats Antans
Capros Pantelis	Klevas Valentinas	Štreimikienė Dalia
Erdmann Georg	Larsen Anders	Vilemas Jurgis
Filippini Massimo	Lundberg Gunnar	Williams David L.
Green David	Martinaitis Vytautas	

Organizing by:

Hybrid Modeling of Energy-Environment Policies: Reconciling Bottom-up and Top-down

Guest Editors: Jean-Charles Hourcade, Mark Jaccard, Chris Bataille and Frédéric Ghersi

Over the last two decades, energy-economy modelers of all stripes have begun to realize that energy and climate change policy cannot be approached solely with either a financially denominated macroeconomic 'top-down' approach, be it CGE or otherwise, or a purely technologically denominated 'bottom-up' approach. Large scale shifts in the energy system, like those that effective climate policy may require, will involve similarly large changes in technology and the micro- and macrostructure of the economy, demanding realistic modeling of all these dynamics.

This is the 'hybridization' challenge, to bring technological explicitness and micro- and macroeconomic realism together in one integrated policy analysis package, and it has given rise to several distinct hybrid modeling approaches. Yet, while individual publications over the past decade have described efforts at hybrid modeling, there has not yet been a systematic assessment of their prospects and challenges. To this end, several research teams held a workshop in Paris on April 20, 2005 to compare and share their hybrid modeling strategies and techniques.

This 177-page special issue, edited by Jean-Charles Hourcade, Mark Jaccard, Chris Bataille and Frédéric Ghersi, is composed of an introductory editorial, which summarizes the various modeling approaches represented in the issue and speculates on future methodological advances, and detailed articles from each of the participating modeling teams (WITCH, IMACLIM-S/POLES, ObjECTS MINICAM, CIMS, E3MG, an MCP CGE, AMIGA, and EPPA-MARKAL). By presenting the state of the hybridization art in one easily accessible package, this issue is a unique and useful tool to the wider modeling community grappling with the world's energy and environmental policy issues.

Order online at http://www.iaee.org/en/publications/specialorder.aspx
ISSN Number 0195-6574

ORDER FORM | Special Issue from the IAEE
Hybrid Modeling of Energy-Environment Policies: Reconciling Bottom-Up and Top-Down

❑ Domestic Shipment $75.00 each (includes postage and handling)
❑ International Shipment $85.00 each (includes postage and handling)

Total enclosed $____________________.
❑ Check made payable to *IAEE* in U.S. dollars with checks drawn on a U.S. bank.
❑ Visa or ❑ Mastercard
Card No. ____ Exp. Date __________

Signature ____ *not valid without signature*

NAME: ____

TITLE: ____

COMPANY: ____

ADDRESS: ____

CITY, STATE, MAIL CODE: ____

COUNTRY: ____

Send order form along with payment to: International Association for Energy Economics, 28790 Chagrin Blvd., Suite 350, Cleveland, OH 44122 USA
Phone: 216/464-5365 | Fax: 216/464-2737 | E-mail: iaee@iaee.org | Website: www.iaee.org

CONTENTS

Vienna Conference Best Student Paper Award

IAEE is pleased to continue the IAEE Student Paper Award programme for student papers on energy economics.

Description

Up to 5 Student Paper Awards may be given, each consisting of a $400 cash prize plus a waiver of conference registration fees (a value of EUR 250) for the 10th IAEE European Conference, 7-10 September 2009.

The award recipients will also be invited to present their papers at the Best Student Paper Competition on the first day of the conference. A panel of judges at the student paper session will select one of the papers to receive the Best Student Paper Award.

The winner of the Best Student Paper Award will receive a further $500 cash prize, for a total of $900. An award ceremony later in the conference will recognize all recipients of a Student Paper Award.

Application Guidelines

To be eligible for consideration, the applicant must

- be a full-time student as of the application deadline (or have completed degree within the past 12 months and not be employed full-time);
- be a member of IAEE in good standing. Membership information may be found at https://www.iaee.org/en/membership/application.aspx

The paper must

- be original work completed by the student;
- not be co-authored by a faculty member or other non-student (papers co-authored by students are ok).

Application materials consist of

- Paper abstract (may be same as abstract submitted to conference, in case one has been submitted);
- Paper – double-spaced; A4 or 8.5 by 11 inch page setup; 30 pages maximum (any paper that exceeds the page limitation will be subject to disqualification);
- Letter from applicant stating that applicant meets qualifications listed above (include photocopy of student ID);
- Letter from applicant's advisor or another faculty member familiar with applicant's research confirming that paper meets qualifications listed above and recommending it for consideration.

The application deadline is 1 June 2009. Please submit all materials electronically in pdf format to iaee@iaee.org, with "Submission for Vienna Best Student Paper Award" in the subject line.

Additional Information

Please note: in order to receive the award, students must attend the conference and present their papers. All travel and accommodation costs associated with attending the conference are the responsibility of the award recipients.

For further questions regarding the IAEE Student Paper Award, please contact David Williams at iaee@iaee.org.

Publications

Ending Dependency: How is Oil Revenues Effectively Used in Azerbaijan? (2009). Contact: Ms. Turkan Asgarova, PR Manager, CESD, Shirin Mirzeyev 76 a/33, Baku Az1002, Azerbaijan. Phone: 99412-4954248. Fax: 99412-4373240. Email: cesd@aztelekom.net URL: www.cesd.az

Calendar

11-19 May 2009, 9th Annual Spring Executive Program: New Era in Oil, Gas & Power Value Creation at Houston, TX. Contact: Center for Energy Economics, Conference Secretariat, CEE, USA. Phone: 713-654-5400. Fax: 713-654-5405 Email: energyecon@beg.utexas.edu URL: www.beg.utexas.edu/energyecon/new-era

11-15 May 2009, Achema 2009 at Frankfurt, Germany. Contact: Conference Coordinator, Dechema e.V., PO Box 15 01 04, Frankfurt am Main, 60061, Germany. Phone: 49-0-69-7564-0. Fax: 49-0-69-7564-201 Email: achema@dechema.de URL: www.achema.de

12-15 May 2009, Pipeline Simulation Interest Group at Moody Gardens Hotel, Galveston, Texas, USA. Contact: Mike Goodman, USA. Phone: 713-420-5885. Fax: 713-445-8959 Email: Mike.Goodman@elpaso.com URL: http://www.psig.org

12-14 May 2009, Electric Power: Unmatched Buying Power at Rosemont, IL. Contact: Conference Coordinator, TradeFair Group. Phone: 832-242-1969. Fax: 832-242-1971 Email: info@electricpowerexpo.com URL: www.electricpowerexpo.com

14-14 May 2009, Transform through Innovative Business Models - An Energy Conference at Hyatt Regency, Calgary, Alberta, Canada. Contact: Connie Drossos, CORE Administrator, Centre for Outsourcing Research & Education (CORE), Toronto, Ontario, Canada. Phone: 1-866-993-CORE Email: administrator@core-outsourcing.org URL: http://www.core-outsourcing.org/about/conferences/evteTqNLsOdYA.php

21-22 May 2009, IPED's Financing Solar Energy at Alexandria, VA. Contact: April Stephen, Executive Director, IPED Inc., 401 9th Street, NW - Suite 900, Washington, DC, 20004, USA. Phone: 202.585.8514 Email: astephen@ipedinc.net URL: www.

San Francisco International Conference Registration Fee Scholarships

The San Francisco conference organizers are offering a limited number of registration fee scholarships to offset the conference registration costs for students ($355 value). All travel and accommodation costs associated with attending the conference are the responsibility of the recipient.

Fee scholarships are awarded on a rolling basis (first-come, first-served) until funds run out, so early applications are encouraged. No applications will be accepted after May 22, 2009.

To be eligible for consideration, you must:

- be a full-time student as of the application deadline (or have completed degree within the past 6 months and not be employed full-time);
- be a member of IAEE in good standing. Membership information may be found at https://www.iaee.org/en/membership/application.aspx

Application materials consist of

- Letter from applicant (see details below);
- Letter from applicant's advisor or another faculty member familiar with your research (see details below).

The letter from applicant should

- state that you meet qualifications listed above (include photocopy of student ID);
- briefly describe your energy interests and what you hope to accomplish by attending the conference;
- provide the name and contact information for the faculty member who will be writing a letter on your behalf.

The letter from applicant's advisor or another faculty member familiar with your research should

- briefly describe your research interests, the nature of your academic program, and your academic progress;
- state whether he or she recommends that you be awarded the conference fee scholarship.

Please submit all materials electronically in pdf format to iaee@iaee.org, with "Application for Registration Fee Scholarship" in the subject line.

Students who do not wish to apply for a fee scholarship may still attend the conference at the reduced student registration rate. In order to qualify for the student rate, please submit a letter stating that you are a full-time student and are not employed full-time. The letter should provide the name and contact information for your main faculty advisor or your department chair and a copy of your student identification card. IAEE reserves the right to verify student status.

For further questions regarding the Registration Fee Scholarship, please contact David Williams at iaee@iaee.org

For information regarding our Best Student Paper Award program, please visit http://www.usaee.org/usaee2009/paperawards.html

---

ipedinc.net

7-9 June 2009, Collective Approach in the New Paradigm at Kuala Lumpur, Malaysia. Contact: The Conference Connection Inc., The Conference Connection Inc.. Phone: 65-6338-0064. Fax: 65-6338-4090 Email: info@ccgroupevents.com URL: www.cconnection.org/AOGCHHome.htm

9-10 June 2009, 3rd International Symposium on Natural Gas at Istanbul, Turkey. Contact: Gurkan Kumbaroglu, Chair, International Program Committee, Bogazici University, Turkey Email: gurkank@boun.edu.tr URL: www.ingas2009.com

11-13 June 2009, International Student Energy Summit at Calgary, Alberta Canada. Contact: Janice Tran, Vice Chair, Calgary, Alberta, Canada Email: info@studentenergy.org URL: http://www.studentenergy.org

11-13 June 2009, International Student Energy Summit (ISES) at Calgary, Alberta Canada. Contact: Janice Tran, Vice Chair, International Student Energy Summit, 199B Scurfield Hall - University of Calgary, 2500 University Drive NW, Calgary, Alberta, T2N 1N4, Canada. Phone: 403.220.2921 Email: info@studentenergy.org URL: http://www.studentenergy.org

11-11 June 2009, Conference: The Search for Wise Energy Policy at The Mayflower Hotel, Washington, D.C. Contact: Carla Cowden, Event Planner, Indiana University School of Public and Environmental Affairs, Bloomington, IN, USA. Phone: 812-856-0509 Email: ccowden@indiana.edu

15-16 June 2009, Euroelectric 2009: Electricity Markets 2050 - Smart, Integrated, Carbon-Neutral at Bucharest, Romania. Contact: Conference Secretariat, Eurelectric, Blvd de l'Imperatrice 66, Brussels, B-1000, Belgium. Phone: 32-2-515-10-62. Fax: 32-2-515-10-69 Email: eoleary@eurelectric.org URL: www.eurelectric.org

21-24 June 2009, 32nd IAEE International Conference: Energy, Economy, Environment:: The Global View at San Francisco, CA. Contact: David Williams, Executive Director, USAEE, 28790 Chagrin Blvd Ste 350, Cleveland, OH, 44122, USA. Phone: 216-464-2785. Fax: 216-464-2768 Email: usaee@usaee.org URL: www.usaee.org

June 29, 2009 - July 3, 2009, 84th Annual Conference: Western Economic Association International at Vancouver, BC, Canada. Contact: Conference Administrator, WEAI, 18837 Brookhurst St, Ste 304, Fountain Valley, CA, 92708, USA. Phone: 714-965-8800. Fax: 714-965-8829 URL: www.weai.org

June 29, 2009 - July 3, 2009, 17th European Biomass Conference and Exhibition - From Research to Industry and Markets at CCH - Congress Centre Hamburg, Germany. Contact: Anna Andretta. Phone: +39 055 5002280 Email: biomass.conference@etaflorence.it URL: www.etaflorence.it

14-15 July 2009, Biomass '09: Power, Fuels, and Chemicals Workshop at Grand Forks, ND. Contact: Derek A. Walters, Communications Manager, EERC, 15 North 23rd St Stop 9018, Grand Forks, ND, 58202, USA. Phone: 701-777-5113 URL: www.undeerc.org

28-31 July 2009, ACEEE Summer Study on Energy Efficiency in Industry at Niagara Falls, NY. Con-

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

IAEE ENERGY FORUM

Volume 18, Second Quarter, 2009

The IAEE *Energy Forum* is published quarterly in February, May, August and November, by the Energy Economics Education Foundation for the IAEE membership. Items for publication and editorial inquiries should be addressed to the Editor at 28790 Chagrin Boulevard, Suite 350, Cleveland, OH 44122 USA. Phone: 216-464-5365; Fax: 216-464-2737. Deadline for copy is the 1st of March, June, September and December. The Association assumes no responsibility for the content of articles contained herein. Articles represent the views of authors and not necessarily those of the Association.

Advertisements: The IAEE *Energy Forum*, which is received quarterly by over 3400 energy practitioners, accepts advertisements. For information regarding rates, design and deadlines, contact the IAEE Headquarters at the address below.

Membership and Subscription Matters: Contact the International Association for Energy Economics, 28790 Chagrin Boulevard, Suite 350, Cleveland, OH 44122, USA. Telephone: 216-464-5365; Fax: 216-464-2737; e-mail: IAEE@IAEE.org; Homepage: http://www.iaee@iaee.org

IAEE *Energy Forum*
Energy Economics Education Foundation, Inc.
28790 Chagrin Boulevard, Suite 350
Cleveland, OH 44122 USA

PRSRT STD
U.S. POSTAGE
PAID
Richfield, OH
Permit No. 82