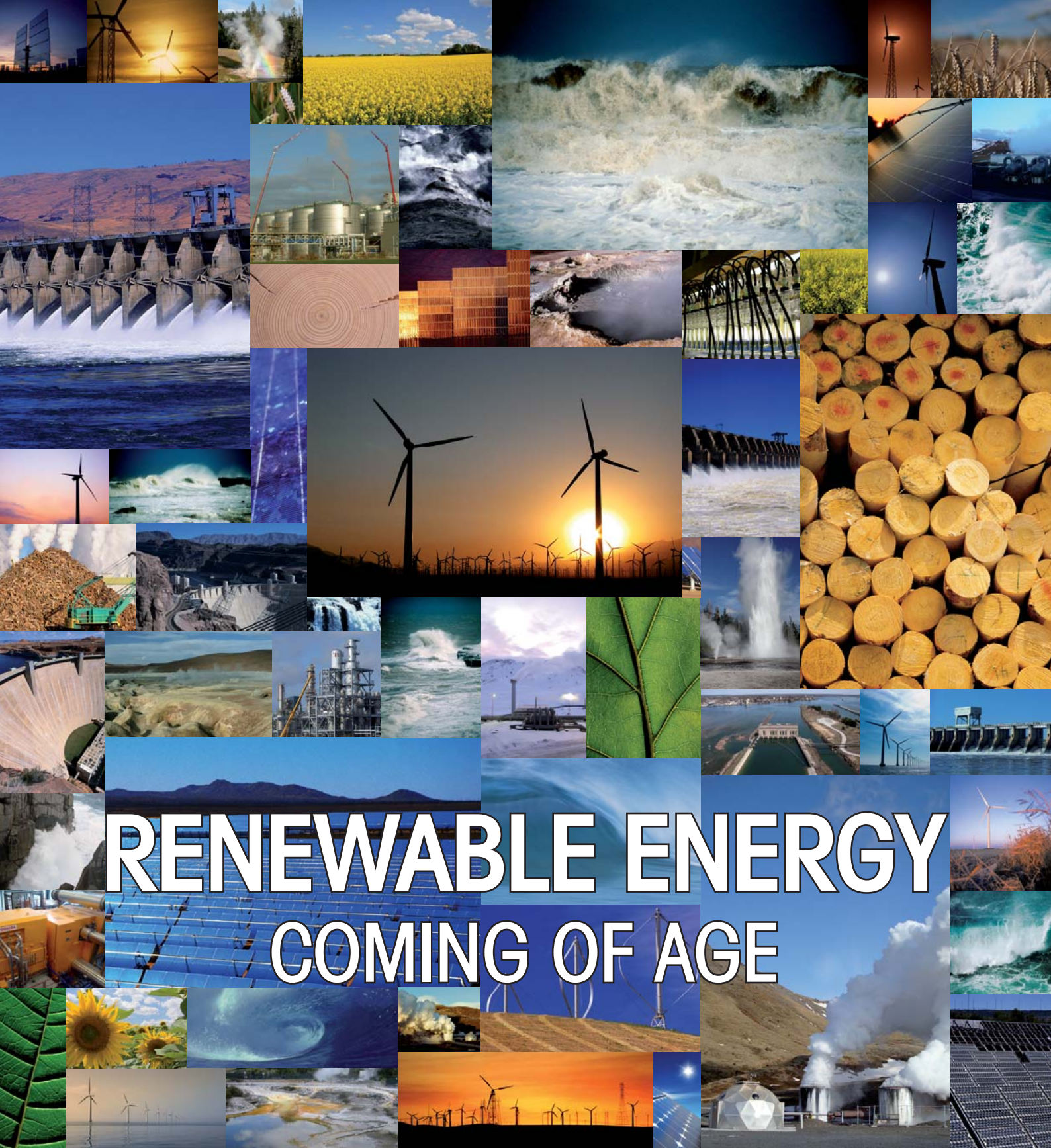


The Journal of the International Energy Agency

iea energy

Issue 2 – Spring 2012



**RENEWABLE ENERGY
COMING OF AGE**

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
- Improve transparency of international markets through collection and analysis of energy data.
 - Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
 - Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

IEA member countries:

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International
Energy Agency

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The European Commission also participates in the work of the IEA.

A BUSY, PRODUCTIVE, CHALLENGING TIME

Just under seven months have passed since I started at the International Energy Agency, but it has been a busy, productive and challenging time. At my first Governing Board meeting, in September, we ended the Libya Collective Action that brought extra supply onto the markets to buttress energy security during the fighting in Libya. In October, we organised a successful Ministerial meeting with unprecedented attendance of a record number of key partner countries, from China to South Africa to Brazil.


In November, we launched the *World Energy Outlook 2011 (WEO)* in London to a standing-room-only crowd of journalists. That was the start of a month-long whirlwind tour that covered five continents and introduced me to how important and effective Agency analysis is, especially as the *WEO* and IEA Chief Economist Fatih Birol advanced the case for how we are running out of options for limiting global temperature increase. In December, we contributed this important message to the COP17 meeting in Durban while further strengthening ties with South Africa.

This year shows no sign of slowing down. In January, we signed an agreement with the International Renewable Energy Agency (IRENA) which will strengthen cooperation. In February, I travelled to Mexico – another important partner country – to speak about the future of energy. And in March, the IEA played an important role in the International Energy Forum Ministerial in Kuwait, which brought together the major consumer and producer countries for dialogue on pressing energy matters.

And even while most of us were relocated from our usual offices for two and a half months because of unexpected maintenance work, the Agency still managed to produce two *Oil Market Reports*, a technology roadmap on carbon capture and storage, two authoritative books on renewable energy and the Agency's first *Medium-Term Coal Market Report*. Other achievements during my first months included a *WEO* excerpt on energy poverty, a China wind technology report, a green growth study prepared jointly with the OECD and *In-Depth Policy Reviews* of Greece, Denmark and the Slovak Republic. The IEA also trained scores of energy statisticians from countries ranging from Indonesia to Mozambique to Venezuela, adding to the more than 600 trained since the Training and Capacity Building Programme started in 2010.

All of this since my arrival last September!

During my brief tenure, I have been impressed by the professionalism and expertise of my colleagues at the IEA. Without them, none of these accomplishments would have been possible. I also salute the member countries, whose governments and officials have worked to build consensus for energy security, sustainability and innovation through their support of the IEA. I have appreciated everyone's hard work, creativity and motivation.

Looking forward to the second half of my first year, there are already many important energy events on the calendar, not to mention political, economic, environmental and budget challenges for us to tackle. The rest of 2012 will be busy and productive as well, I have no doubt, and the IEA is ever hard at work. It is an honour to be among those furthering the goals of the Agency, its member countries and the world at large. 



By Maria van der Hoeven

Maria van der Hoeven took over as Executive Director of the International Energy Agency on 1 September 2011. She previously served as Dutch Minister of Economic Affairs from February 2007 to October 2010, during which time she demonstrated leadership on energy policy at the national, regional and global levels. She is a fierce supporter of market principles, promoting transparency and establishing a level playing field in administrative affairs.

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Delaying climate action until 2015 is an expensive proposition



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IEA ON RENEWABLES
AN EXPERT VIEW:
PAOLO FRANKL

The IEA is more than fossil fuels: it is fully involved in the pursuit of new energy technologies, perhaps none more than renewables. IEA experts, especially in the Renewable Energy Division led by Paolo Frankl, contribute to developing analysis and policy recommendations to foster low-carbon alternatives. In the cover story interview, Frankl emphasises how renewables are key to increasing energy security.



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WORLDWIDE

SPOTLIGHT

Hopes for modern, reliable energy service for more Sub-Saharan Africans

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TRAINING ACTIVITIES

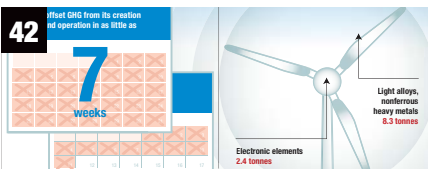
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IEA IN ACTION



Fatih Birol launching the *WEO* excerpt "Energy for All"
Oslo, Norway



Executive Director Maria van der Hoeven on IRENA panel
Bonn, Germany



Deputy Executive Director Richard Jones
COP17, Durban, South Africa



Energy Ministers, including South Africa's Dipuo Peters
IEA Ministerial meeting, Paris, France



WEO team with Deputy Prime Minister Hussain al-Shahrstani
Baghdad, Iraq



Gao Hu, China Energy Research Institute
IEA headquarters, Paris, France

"Energy for All" WEO excerpt launch: © Norwegian Ministry of Foreign Affairs, photo by Kilian Munch; IRENA panel discussion: Photo courtesy of IRENA; COP: © OECD/IEA, 2011; IEA Ministerial meeting: © OECD/IEA, 2011, photo by Benjamin Renout; Iraq visit: Photo courtesy of the Iraqi Deputy Prime Minister's Office, all rights reserved; China talk at IEA: © OECD/IEA, 2012

WHAT DO YOU THINK?

What do you see as the biggest obstacle to wider use of renewable energy?

*One respondent chosen at random will win a free copy of the **Medium-Term Renewables Market Report**.*

Share your thoughts and submit your raffle entry by 1 June 2012 at: <http://svy.mk/ieaEnergySurvey>

FROM OUR LAST ISSUE:

List the priorities for Energy Ministers meeting in the 2011 IEA Ministerial.

WOULD HAVE PREFERRED TO RANK EVERYTHING WITH A TOP PRIORITY.

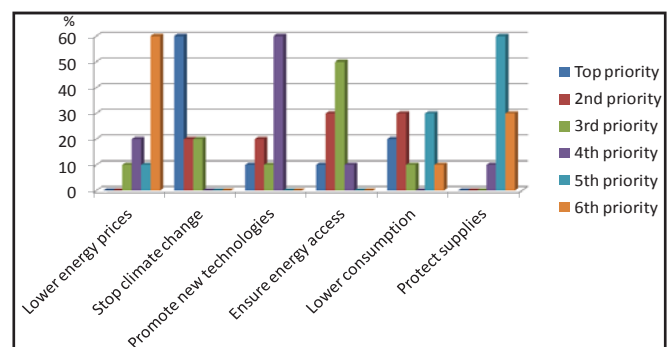
UWE T. | Berlin

An important step would be to increase the amount of work that the IEA does in the area of comparing programmes that seek to promote energy technology innovation. In other words, what has been demonstrated to work well at different stages of the innovation continuum (*i.e.* for research, development, demonstration and deployment). Such benchmarking would help countries design their programmes to give the best possible return on investment and also provide support for the need to take a longer-term view in such programmes.

JOHN S. | Canberra

OFFER MEMBERSHIP TO CHINA AND INDIA TO BETTER INFLUENCE THEIR ENERGY/ENVIRONMENTAL POLICIES.

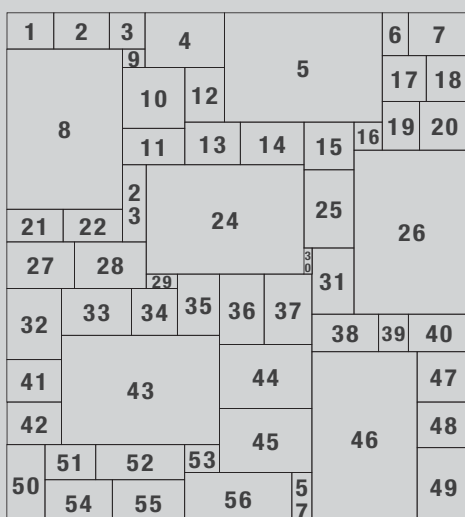
ALAN K. | Amman



On behalf of young generations, avoid, to the extent achievable, future social unrest by achieving the opportunities that entail access to energy while maintaining international stability with degraded Earth capacities due to climate change.

JULIO A. V. | Santiago

The winner of the previous raffle for a copy of the World Energy Outlook 2011 is Lorcan Lyons of Bio Intelligence Service, Paris



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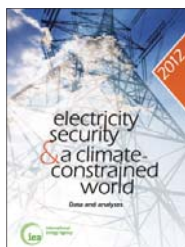
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ENERGETIC READING

ELECTRICITY SECURITY AND A CLIMATE-CONSTRAINED WORLD

Language: English; Release: June 2012



Using authoritative regional and global data on the evolution of the electricity sector, *Electricity Security and a Climate-Constrained World* offers a comprehensive view of the electricity sector, the largest and fastest-growing source of CO₂ but also the sector that holds many of the solutions to a more efficient, less carbon-intensive economy. Featuring a host of charts and tables, it provides original analyses on how policy and technology can

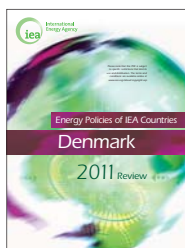
address necessary changes in the sector.

Electricity Security and a Climate-Constrained World focuses decision makers and the whole range of stakeholders on timely, pressing issues in the electricity sector and encourages the bottom-up actions necessary to place the world firmly on a path towards a secure and low-carbon energy system.

ENERGY POLICIES OF IEA COUNTRIES – DENMARK

Language: English; Release: Available now

Pages: 154; Price: €75; ISBN: 978-92-64-09820-6



Denmark is a leader among OECD member countries in terms of its well-designed policies for renewable energy, energy efficiency and climate change.

The country is a forthright voice in international fora for climate policy and a strong advocate of tougher measures for mitigation of climate change. A long history of consensus-based policy making and political stability has been leveraged to develop

Denmark's far-reaching and comprehensive energy policies.

Energy Policies of IEA Countries – Denmark analyses the energy-policy challenges facing the country as it develops and implements its ambitious policies, providing critiques and recommendations for further policy improvements in particular sectors. The intent of the review is to assist Danish policy makers as they move towards a sustainable, low-carbon energy future.

MEDIUM-TERM GAS MARKET REPORT

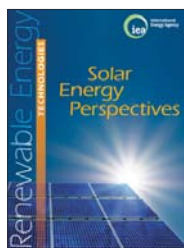
Language: English; Release: June 2012

The new IEA *Medium-Term Gas Market Report* reviews how gas markets managed the difficult 2011, from the consequences of the Fukushima incident to the unrest in the Arab world to a further deteriorating economy, and gives detailed supply, demand and trade forecasts up to 2017 while investigating many of today's crucial questions. Will regional gas markets diverge further or is the shale gas revolution to spread worldwide? Will North America become a significant LNG exporter? Will natural gas replace nuclear energy in key OECD member countries? Can China meet its goal of doubling gas consumption in four years? Amid a fragile economy and widely diverging regional gas prices, the report provides an in-depth view of future changes in trade patterns as markets absorb a second wave of LNG supply, testing the upper limit of gas demand in America, analysing European gas consumption's struggle to recover, and assessing the potentials of new suppliers.

SOLAR ENERGY PERSPECTIVES

Language: English; Release: Available now

Pages: 234; Price: €100; ISBN: 978-92-64-12457-8



In 90 minutes, enough sunlight strikes the earth to provide the entire planet's energy needs for one year. While solar energy is abundant, it represents a tiny fraction of the current energy mix. But driven by global action to improve energy access and supply security and to mitigate climate change, countries and companies are investing in solar generation capacity on an unprecedented scale, and, as a consequence, costs continue to

fall and technologies improve. *Solar Energy Perspectives* gives an authoritative view of these technologies and market trends, while providing examples of the best and most advanced practices. It also provides a unique guide for all concerned stakeholders on how best to use, combine and successfully promote the major categories of solar energy: solar heating and cooling, photovoltaic and solar thermal electricity as well as solar fuels.

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or email: books@iea.org

CALENDAR

April

- 20-22 Pacific Energy Summit:
Hanoi. www.nbr.org/research/activity.aspx?id=166
- 23-24 Asia Gas Partnership
Summit: New Delhi.
www.ficci-agps.in

- 25-26 Clean Energy Ministerial:
London. www.cleanenergyministerial.org/events/cem3

May

- 6-8 Middle East Petroleum &
Gas conference: Bahrain.
connection.org/conference/MPGC/2011/MPGCHome.html

- 13-16 Australian Petroleum
Production and Exploration
Association Conference:
Adelaide. www.appea.com.au/events/appea-annual-conference-a-exhibition.html
- 29 Debut of *World Energy Outlook 2012* excerpt "Golden Rules for Gas": London.
www.worldenergyoutlook.org

June

- 4-8 World Gas Conference: Kuala Lumpur. www.wgc2012.com
- 18-19 G-20 Summit: Los Cabos, Mexico. www.g20.org
- 20-22 Rio Earth Summit.
www.earthsummit2012.org
- 21-23 St. Petersburg International Economic Forum.
www.forumspb.com

IEA ENERGY FEATURE PAPERS

SPREADING THE NET: THE MULTIPLE BENEFITS OF ENERGY EFFICIENCY IMPROVEMENTS

Authors: Lisa Ryan and Nina Campbell



Energy efficiency provides significant non-energy benefits for economies and societies through broad gains to welfare. For instance, improved efficiency has been associated with higher GDP, huge public health benefits, better public budget balance, increased productivity, job creation, and a rise in consumer surplus, in addition to its role in reducing greenhouse gas and pollutant emissions and improving energy security.

Despite increasing proof of efficiency policies' economic and social gains, the benefits often are significantly underestimated because the programmes are evaluated simply on the basis of reduced energy use, ignoring the broader gains. Some of these benefits have a cost in energy consumption; this "rebound effect" must be managed in achieving energy savings, but it can be seen as a positive result when multiple benefits are taken into account.

Addressing the gap between traditional "energy saving" programmes and the actual benefits to national and global well-being must be addressed for efficiency policy to reach its full potential. Quantifying and monetising the less obvious benefits of efficiency requires robust evaluation with involvement of experts from outside the traditional sphere of energy specialists.

Spreading the Net: The Multiple Benefits of Energy Efficiency Improvements identifies and details 15 benefits beyond pure energy savings. Affecting economies at the individual, household and enterprise levels and all the way to the international stage, these outcomes have multiplier effects which show the full socioeconomic value of efficiency programmes. The IEA report investigates the impact of different benefits and addresses how to contextualise the rebound effect. Finally, it highlights the gaps in knowledge and evidence, noting where more work is needed. While energy saving remains the central goal of energy efficiency policy, a broader knowledge of its multiple benefits can result in better prioritisation and optimisation of efficiency policy design.

CCS RETROFIT: ANALYSIS OF THE GLOBALLY INSTALLED COAL-FIRED POWER PLANT FLEET

Authors: Matthias Finkenrath, Julian Smith and Dennis Volk



The many coal-fired power plants in operation around the globe account for more than 8.5 Gigatonnes of CO₂ emissions each year, or roughly one-quarter of the world's anthropogenic CO₂ emissions. Without further action to mitigate the effects of growing unabated coal-fired power generation capacity, this situation represents a massive threat to the global climate.

Significant progress has been made toward understanding the importance of different aspects relevant for assessing carbon capture and storage (CCS) retrofitting, but the realistic global potential is unclear. The new IEA report *CCS Retrofit – Analysis of the Globally Installed Coal-Fired Power Plant Fleet* illustrates the size and regional distribution of the globally installed coal-fired power plant fleet that is potentially relevant for retrofitting.

While global energy scenarios suggest that CCS retrofit is necessary for deep CO₂ emission cuts (in addition to constructing new power plants with CCS), the undertaking will be costly in terms of expense and efficiency.

The Information Paper divides existing infrastructure into three groups based on size and age and then assesses the situation country by country. The result is a quantification of the share of comparably young, efficient and large power plants in the current fleet, providing an important first cut of those coal-fired power plants particularly attractive for CCS retrofitting.

China in particular has strong potential for retrofit, with no other country having as young an operating coal-fired power generation fleet. Japan and Korea also deserve special attention, because their coal-fired power plant fleets are rather young and based on many units with large capacities.



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By Adnan Z. Amin

Adnan Z. Amin was elected the Director General of the International Renewable Energy Agency (IRENA) in April 2011. He is responsible for establishing a sound institutional management structure and clear strategic vision for the implementation of the Agency's mandate to promote the deployment of renewable energy worldwide. He brought to the position more than 20 years of experience in international environment and sustainable development policy.

"IRENA AND THE IEA: NATURAL PARTNERS"

Among the dramatic events that shaped the world in 2011 was the devastating impact of the earthquake and tsunami that hit Japan in March. The crisis at the Fukushima nuclear power plant transformed the public perception of national energy systems globally. Additionally, events in North Africa and the Middle East have increased tensions in oil markets and intensified price volatility. Observable trends of climate change continue to cause serious concerns worldwide. Significantly, the global uptake of renewable energy is rapidly accelerating. In 2010, renewable energy supplied about 16% of global final energy consumption and accounted for about 50% of total additions to power generation capacity. Preliminary data for 2011 confirm the same trend. Renewable energy is increasingly seen as an essential contribution to a robust energy mix while creating new economic opportunities.


Despite the challenging circumstances in the global economy, growth continues in the developing world. Out of the ten fastest-growing economies around the globe, six are in sub-Saharan Africa. Meeting the energy needs of these and other developing countries all over the world will require substantial growth in the global energy sector. Renewable energy can play an essential role in improving the livelihoods of millions while contributing to energy security and climate change mitigation.

It is in this context that the global role of the International Renewable Energy Agency (IRENA) should be considered. IRENA is the world's newest inter-governmental organisation and counts 158 countries to date. Its mission is to promote the widespread use and increased adoption of all forms of renewable energy globally. Acting at the behest of its members, its mandate is to serve as a global hub of knowledge and information on renewable energy, bringing all stakeholders to the global policy dialogue.

IRENA and the IEA are natural partners in the global quest to increase the deployment of renewable energy. Although the agencies have collaborated since IRENA's founding in January 2009, they formalised their agreement in January 2012 and launched a number of joint initiatives, including a global joint database on renewable energy policies and measures; complementary work on data, in particular on renewable energy technology costs; and close cooperation on technology and innovation, including within the framework of IEA multilateral technology initiatives, also known as Implementing Agreements.

Our organisations can mutually reinforce each other in the area of global renewable energy statistics, which are often fragmented and incomplete. Because of the multiplicity of technologies and applications, market trends and the impact of policy instruments can be difficult to monitor and interpret.

The laborious collection of capacity data, in particular for off-grid systems in rural areas in non-OECD countries, can be quite challenging. Accurate and timely data are critical to building a consistent business case and rationale for renewable energy. The IEA has more than 30 years of experience in statistics, and IRENA, through its universal membership, has the country engagement necessary to gather this data.

2012 marks the International Year of Sustainable Energy for All as well as the Rio+20 Sustainable Development Conference to be held in June. With the global population projected to reach 10 billion by 2050, and some 1.3 billion people currently lacking access to electricity, renewable sources worldwide can make a significant contribution to meeting the growing demand for energy and improved quality of life. Monitoring progress towards doubling the share of renewables in the global energy mix by 2030 gives our organisations a strong mandate to join forces towards a safer, cleaner and more sustainable global energy system. 



IEA Executive Director Van der Hoeven at the accord signing with Director General Amin.



IEA ON RENEWABLES AN EXPERT VIEW

THE IEA IS MORE THAN JUST FOSSIL FUELS: IT IS THOROUGHLY INVOLVED IN THE PURSUIT OF NEW ENERGY TECHNOLOGIES, PERHAPS NONE MORE THAN RENEWABLE ENERGY. IEA EXPERTS, ESPECIALLY FROM THE RENEWABLE ENERGY DIVISION LED BY PAOLO FRANKL, CONTRIBUTE TO THE DEVELOPMENT OF ANALYSIS AND POLICY RECOMMENDATIONS TO FOSTER LOW-CARBON ALTERNATIVES. MANY FORMS OF RENEWABLES ARE EVER MORE VIABLE IN VARIOUS PARTS OF THE WORLD, FRANKL EMPHASISES IN THESE INTERVIEW EXCERPTS, AND THEY ARE NOT JUST A MEANS TO MITIGATE CLIMATE CHANGE: THEY ALSO PROMOTE ENERGY SECURITY, THE ORIGINAL AND MAIN MISSION OF THE AGENCY.

Why have renewables emerged so strongly?

Apart from rapid technological improvement, the strength of renewables lies in the diversity and the richness of their technology options and applications, as well as their widespread availability. Every country in the world has at least one renewable energy source that is significant. Some have many.

Renewables offer a large portfolio of different sources and technologies. The IEA is in favour of energy diversification because this, as a first order of effect, increases energy security.

As a matter of fact, it is clear from our analysis that those countries that have deployed renewables so far were driven by climate-change mitigation, but also by energy diversification, and the reduction of fossil-fuel imports. Other drivers have been economic-growth aspects such as job creation and, last but not least, mitigation of other, local pollution.

What are the greatest possible stimuli and barriers to renewables' growth?

Renewables are a family of very different technologies at very different stages of technological and market maturity. So, depending on that, different stimuli are needed, and there are different threats.

One major issue among OECD [member] countries today is that policies need to address, from the very beginning, issues related to system integration of variable renewables. This is feasible through accurate planning of flexibility resources.

Flexibility resources have four dimensions: other flexible supply, e.g. gas and hydro; storage; larger interconnections between adjacent markets, because larger balancing areas have less variability problems and allow for trade of excess power; and, last but not least, demand-side management empowered through intelligent energy networks including, for instance, smart grids.

Weather is crucial with respect to variable renewables such as wind and solar and partly hydro. Of course these system constraints are also a new threat to energy security. While current energy threats are rather of a geopolitical nature, we will have new ones created by nature, by the availability of resources and by some extraordinary events, such as droughts.

[But] cost competitiveness remains the most important barrier for new renewables today. Not for hydro or biomass, but wind is [only] at the very edge of becoming competitive, while the others [e.g. solar, geothermal] still need some incentives. We think incentives are justified to compensate for market failures. But they should be transitional and decrease over time.

How should incentives be decreased?

As I said, economic incentives, justified today, should be transitional in nature, designed to accompany emerging technologies and let them become competitive in a level playing field. This also means making sure that future market design takes into account the full internalisation of external costs, including an appropriate price for carbon.



Solar energy is rich in technological options and applications as well as potentially available in many regions of the world.

This is true for all incentives: over time they need to go down. And if there is a situation where unforeseen developments bring about rapidly increasing [total policy] costs, government and society should have the right to, and should, limit that through appropriate means, introducing transitory caps or other measures that make the deployment of renewables more sustainable and avoid boom-and-bust cycles.

When does the IEA see wind energy being fully competitive, factoring in external costs, with other power technologies?

Under specific market circumstances, wind is already competitive, as shown in the latest auctions in Brazil.

In the *World Energy Outlook [WEO] 2011 New Policies Scenario*, wind is going to be competitive in the European Union by 2020 and in China by 2030. In the [WEO] 450 Scenario, which assumes stronger agreements [for climate change mitigation] worldwide – and of course more deployment of renewables and therefore more technology learning – wind will become competitive before [those dates]. In the United States, the situation is more complex, because of the competition with shale gas.

How soon before solar energy affects the lives of most humans, on- and off-grid?

For off-grid systems, in many cases, solar is the most competitive solution today. But there are barriers to exploiting that potential more broadly. One, the lack of information and awareness. Second, the absence of business and financing models, because people lack the money to buy a PV [photovoltaic] system. What you need is a kind of business model, e.g. soft loans or small tariffs over time that people can repay in order to install a PV system. Third, some kind of policy failure. The fact that currently there are very attractive incentives for on-grid PV in many countries has a simple consequence: most PV systems are installed there [in those countries], and the industry tends to forget markets where PVs are already competitive. Of course, this will change over time – it is just a transitional problem.

In on-grid situations, I want to stress that the cost of solar is going down very fast, in particular for PV. The competitiveness of solar systems will depend very much on what they are competing with. If solar is applied in the right places – in sunny places – it can supply energy when there is the maximum of peak demand, i.e. when electricity is sold at the highest price.

In some countries, notably Italy, PV systems are very close to the retail electricity price. This still implies a hidden incentive, because someone else pays the retail electricity distribution costs. But when hundreds of thousands, even millions, of people realise that if they buy a PV system they will pay less than their electricity bill, this is an enormous trigger for investment. In the next five to ten years in many countries, we will probably see an avalanche effect as solar gains adherents.

What is the greatest impediment to solar?

Today, it's still economics, aside from off-grid situations and those few countries that have high electricity prices and where the grid parity is close. Technology is not an impediment. Variability? Not today, but it will become an important

issue for solar PV at higher shares of penetration. In that respect, I want to make the point that concentrated solar power [CSP] with integrated thermal energy storage has an advantage with respect to PV and should be developed in parallel, wherever possible. Footprint? Not really. We have done some calculations of an extreme deployment of solar and still there is no surface problem. For PV, many thousands of square kilometres of building roofs and facades are available. For CSP, many square kilometres of desert are available in many regions of the world. Footprint in terms of materials and of energy consumption? The solar industry has made life-cycle-assessment studies from the very beginning and has ambitious recycling programmes for modules.

But solar power's lower energy density and inferior transportability are two clear disadvantages compared with fossil fuels.

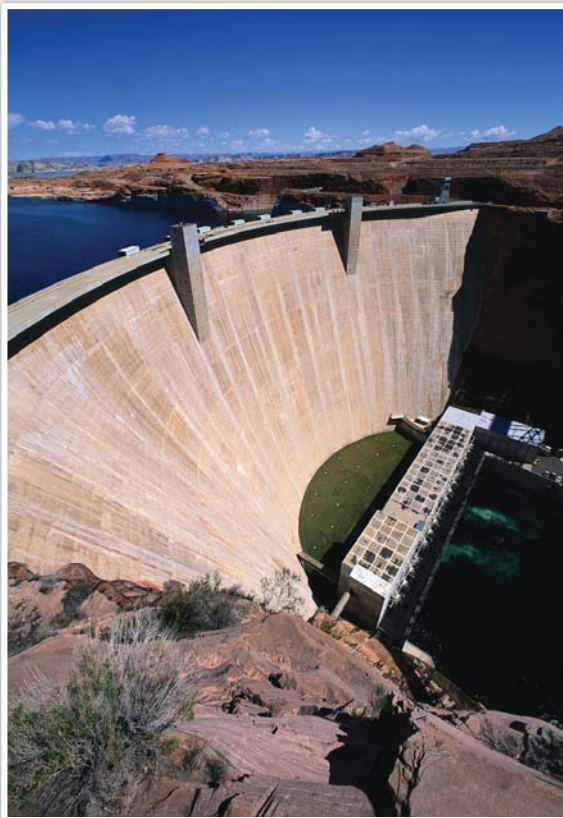
Is there one type of renewable energy that will play the most critical role in attaining a sustainable energy future?

In general, we need a portfolio of [energy] technologies and a portfolio of renewables. Wind energy has made good progress. Of course, if I look at the very, very long term, there is one technology which clearly emerges today with a huge potential: solar. But two other technologies are also interesting, although at the lower level of deployment. One is ocean energy, and the second, enhanced geothermal systems. These technologies promise potentials of exploitation which are tens, hundreds, thousands of times greater than [current global] energy demand. Basically, there is no clear answer on who will win this technology race at the moment. The more technology competition there is, the better.

What led to IEA involvement in renewables?

In the past, the work of the IEA on renewables mainly focused on monitoring and supporting technology development and R&D, notably through the IEA technology collaboration network [Implementing Agreements], overseen by the Renewable Energy Working Party. More recently, the work expanded into scenario modelling, assessment of policies and analysis of market integration issues.

As for energy modelling, before 2005 the IEA had no mandate to look at alternative, climate-friendly, sustainable scenarios.



Hoover Dam: weather may replace geopolitics as top energy-security issue.



Ocean power is one of two energies – with geothermal – that hold similar promise to solar but lag behind in deployment.


In 2005, the Gleneagles Group of 8 summit gave that mandate, and since then the *Energy Technology Perspectives* and the *WEO* introduced low-carbon scenarios

where renewables immediately jumped up in share. The 2007 4th IPCC [Intergovernmental Panel on Climate Change] assessment report – once again, stronger than ever –

pointed to the gravity of climate change. Since then, IEA scenarios have radically changed to focus on a low-carbon future.

What is an example of such change?

[Under] the 450 Scenario of the *WEO 2011*, in the electricity sector, renewables will almost have 50% of the mix by 2035, which is a huge amount. If you see it in absolute terms and not just in share, the increase is even clearer. Today, renewables, including hydro, produce roughly 3 700 terawatt-hours (TWh) in the world; by 2035 in the 450 Scenario it's 15 000 [TWh]. In the scenario biofuels reach 27% of total transport energy demand [by 2035]. The 450 Scenario is a very renewables-friendly scenario.

Having said this, remember that scenarios are not forecasts, and the actual implementation of a scenario depends on a set of very strong assumptions, in particular the sustained design and implementation of policies. 

RENEWABLES MARKET REPORT

This July, the IEA will be introducing the first *Medium-Term Renewable Energy Market Report*, an annual analysis that will include five-year projections for global renewable energy electricity capacity and generation that expands upon the Agency's expertise in long-term scenarios.

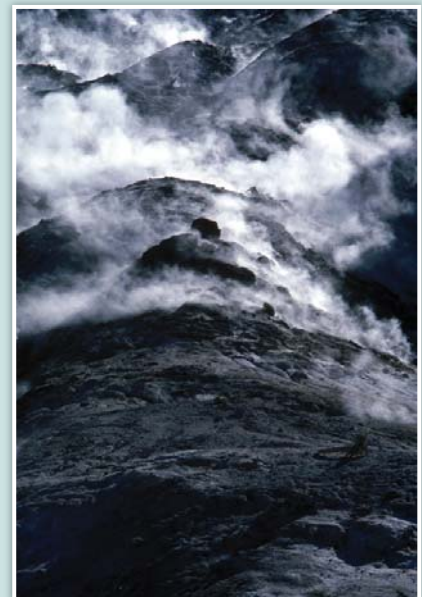
This publication on renewable energy – which is now the fastest-growing sector of the energy mix and accounts for around a fifth of all electricity produced worldwide – will join the Agency's established annual medium-term reports on oil, gas and coal. It will provide an important benchmark to policy makers and the wider market for measuring developments of renewable energy.

"A portfolio of renewable energy technologies is becoming competitive in an increasing range of circumstances and countries," IEA Executive Director Maria van der Hoeven said in the announcement of the *Medium-Term Renewable Energy Market Report*, but she also stressed that "significant policy effort, combined with continued economic incentives, is still needed to push a large portfolio of these technologies towards full competitiveness".

The report will consist of market analysis at the country level, an outlook for renewable energy technologies and manufacturing of equipment, and an examination of global renewable energy finance. In-depth country analysis is being undertaken of key markets and technology-specific drivers and barriers, including economic issues, such as costs compared with fossil fuels, and non-economic topics.

Besides using data that is internally generated and sent from government departments, the IEA is in contact with more than 100 companies and organisations which are helping produce detailed market, cost and performance insights on renewable energy technologies.

Paolo Frankl, head of the IEA Renewable Energy Division, said, "In the short and medium term, the situation of renewables is complex because the newer technologies still need some kind of policy support, particularly in a market framework that does not yet include all external costs, be they related to climate change or to other kinds of pollution. So basically the outlook for renewables in different countries is dependent on a number of factors. These include the stability, predictability and long-term orientation of policy; whether a country has a good renewable resource whose availability coincides with peaks in energy demand; how local



Geothermal and other renewables get their own outlook.

prices for renewables compare with those for fossil fuels; and how easily variable renewable sources can be integrated into local grids.

"What readers can expect will be a thorough discussion of these factors, both enablers and barriers for renewables, in each selected country. And then our conclusion in two scenarios – one more conservative and one more positive."

– IEA Energy

RENEWABLES' ROLE IN AIDING ELECTRICITY SECURITY

Greater use of renewables to produce power raises security questions, none of which bar deployment but all of which must be addressed.

The authoritarian government of a major oil producer is facing a wave of strikes and demonstrations culminating in a revolution. Unfortunately, the main opposition force is interested in promoting its own extremist ideology rather than establishing democracy, and it launches a series of attacks against oil installations.

This is not a headline today, but describes the Russian Empire in 1905-07, with the insurgent leader eventually having a remarkable career under his new name, Stalin. Yet a century later the base scenario for an energy crisis remains the same: a geopolitical event leading to an oil production disruption.

Today, the rallying cry for electricity security is "keeping the lights on", and the most powerful media image of an electricity crisis is a major city in blackout, such as New York in 2003.

The two situations have very little to do with each other. Oil provides only 5% of world power generation, the bulk of it in the Middle East, which is an oil exporter anyway. The New York



A network collapse caused New York City's 2003 blackout.

blackout affected a country that bases its electricity generation on coal and gas and is self-sufficient in both, and it was not caused by any geopolitical event.

It is possible but rare for an interruption of primary fuel supply to trigger an electricity crisis. (A close call was the January 2009 gas crisis in Europe, which might have spread had it not taken place during a deep recession.) Whereas oil is dominant in the transport sector, technology as well as government policies usually result in diversification of electricity generation sources among coal, gas, nuclear and various renewables, including hydropower.

Supply risks to power generation

Coal is usually regarded as a "safe fuel", although China did face coal-supply difficulties recently because of weather-related disruptions in rail transportation. Gas in Europe and the Asia-Pacific region certainly has some of the geopolitical dangers of oil: not only oil but also liquefied natural gas tankers pass through the Strait of Hormuz, and the conflict in Libya affected gas exports as well as oil. However, countries that have a high share of gas in power generation tend to be either self-sufficient or have a well-diversified supply structure. Nuclear plants routinely stockpile several months' worth of fuel rods, and while hydro, wind and solar have weather-related volatility, they are relatively predictable and largely independent of geopolitical issues.

A more probable crisis is inadequate power generation capacity, where the system is not able to transform enough primary energy into electricity to meet demand. One current example is South Africa: if the country burned just a fraction of its coal exports in domestic power plants, it would eliminate the power shortages plaguing it. But there are simply not enough power plants in South Africa to burn that coal.

Given that electricity demand growth is reasonably predictable from macroeconomic and demographic trends and that building a power



By Laszlo Varro

Laszlo Varro joined the IEA in 2011 as the Head of the Gas, Coal and Power Division, which undertakes the analysis of gas, coal and electricity markets and policy developments. He previously was Director for Strategy Development at MOL Group.

plant takes years, a generation capacity shortage is a medium-term, slow-moving crisis. The response is to build more power plants. But in order to build a power plant, someone has to deploy capital. That someone can either be a cash-rich state entity that then can give away electricity for whatever price – as in the Middle East, where power is heavily cross-subsidised from oil revenues – or preferably a company, which will recover its investment from selling power. The most usual cause of a long-term generation crisis is a bad investment environment, usually a regulated price below the cost recovery level.

But some of the famous electricity crises, including New York and Italy the same year, were not caused by inadequate generation capacity but rather by a cascading network collapse. The 2003 regional blackout that darkened New York was caused by too much rather than not enough power in the system, while the Italian one took place during a time of low demand. This brings up the special characteristics of the electricity grid. With oil, consumers can decide to fill up today or tomorrow for use the day after, but electricity systems require real-time balancing of supply and demand. The equivalent of many vehicles waiting at a filling station causes the collapse of the electricity system. The system needs to be able to deliver power from production to consumers consistently despite rapid changes in output and demand. The reliability, robustness and flexibility of the electricity system are the key components of its security.

New challenges in shift to renewables

The major tests and some of the high-profile failures of reliability took place around the turn of the century. The IEA at that time published a book, *Learning from the Blackouts*, and the world did. But beyond keeping the lights on, concerns about climate are generating strategies that generally involve a rapid decarbonisation of the power sector, creating completely new challenges for electricity security.

For starters, there is a need for deployment of low-carbon electricity sources on a

mind-boggling scale. The biggest incremental, or new, production to a decarbonising electricity system is coming from renewables, especially wind and solar power. Under the *World Energy Outlook's* 450 Scenario, to limit the rise in global temperature to no more than 2° from pre-industrial levels, the combined combination of wind and solar grows by 2050 by a factor of 20, and that share of incremental generation is one and a half times the total of gas-fired power generation today. This raises a host of electricity-security questions, none of which precludes a rapid growth of renewables but all of which require careful considerations and thus will form a measurable part of upcoming IEA work.

Take adequacy first. The bulk of wind and solar investment today is based on feed-in tariffs. The government picks a technology, determines a numerical target and sets the price it will pay for use of that new technology. In a well functioning market, if demand growth or the decommissioning of existing power plants tighten capacity balance, rising prices will bring new investment. But this market model is undermined if a higher and higher proportion of new supply is based on feed-in tariffs rather than market incentives.

Of course wind and solar depend on the weather. This is not a problem specific to renewables: from coal trains blocked by snow to the effect of a heat wave on nuclear plants' cooling water, weather has long had an impact on the power system. Nevertheless, the volatility will increase, requiring back-up capacity

as well as a rising ramp rate, or the time it takes to ramp up from zero or low generation to higher levels of production. In the first week of January 2012, British wind production went from its maximum level to almost zero in three hours as a gale forced the safety stop of turbines. A modern power system can integrate substantial variable renewables – as Britain's did, for London did not go dark – by mobilising its flexibility.

THE SWITCH FROM FOSSIL FUELS TO TECHNOLOGIES THAT CONVERT DIRECTLY TO ELECTRICITY WILL REQUIRE MASSIVE INVESTMENTS IN TRANSMISSION.


Conventional power plants are and will remain a major flexibility source, but their operation will be exactly as volatile as wind and solar. In this new system, conventional plants' capacity will be needed for dark, windless hours, but they will operate at a very low and unpredictable utilisation.

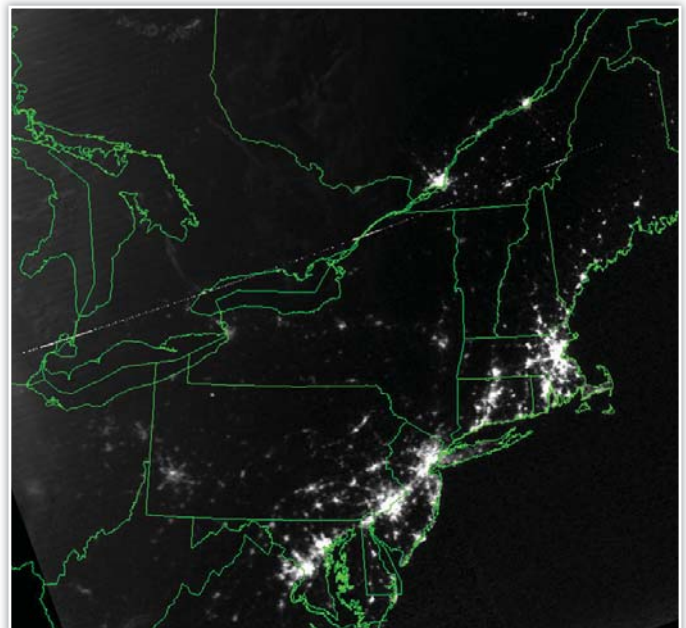
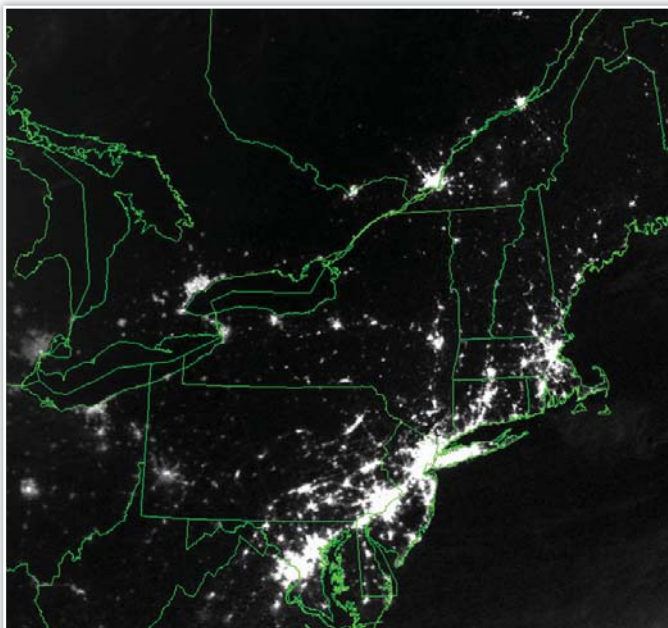
This new use of conventional plants severely strains the current business model of financing investment from the price difference between gas and coal and their resulting power. But if the bulk of electricity production will be renewable, such plants' capacity is necessary for ramping supply up and down: in the 450 Scenario, European gas-fired generation falls to a third of its current level even as the

capacity of gas power plants grows by half. This new business model is very likely to need a new market design.

A secure pure-electricity network

Last but not least is the network. When we move energy today, we mainly move it in the form of high-density primary energy: oil, gas or coal. As a result, in most major energy systems (Europe, North America, Russia) the capacity of the gas pipeline network exceeds the capacity of the power network by a large margin: If Nord Stream gas was burned in Russia, transporting the resulting power to Germany would require 20 undersea cables similar to the NorNed submarine power cable that links Norway and the Netherlands. As a result, the switch from fossil fuels to technologies that convert directly to electricity will require massive investments in transmission so that the main consumption centres can get wind power from the North Sea and Nebraska or solar power from the Mediterranean and Arizona.

Even if flexible power plants, interconnections and storage capacities are there, the extent of volatility will be such that the supply side will struggle to accommodate it, unless there is new flexibility on the demand side. A more flexible, market-driven demand side requires both smart grids and metering that transmit market signals and accommodate the consumer response, for which the technology now exists, as well as the much more difficult implementation of smart regulations that can help make flexibility happen. 



North America the night before (left) and then during the blackout: such outages make “keeping the lights on” a rallying cry even as the rise of renewables raises generation challenges.



By Jean-Yves Garnier

Jean-Yves Garnier joined the IEA in 1995, and he heads the Energy Statistics Division. Before joining the IEA, his career spanned over five years in Indonesia, three years in Ivory Coast, two years in Djibouti, two years in Berkeley and the rest in Paris, where he was in charge of National Energy Plans, energy-efficiency policy and building energy information systems.

For more renewables data, read *Renewables Information*, including the article "Understanding Solar Energy Statistics" by Yasmina Abdelilah, which can be downloaded at www.iea.org.


BETTER DATA, PLEASE

If one asks what is the share of renewable energy in total global energy consumption, most people will answer 2%, 3%, maybe 5%. Wrong! It is two or three times that, *around* 13% because biofuels (mainly wood, charcoal and agro-residues) alone *should* account for more than 10%. When talking about renewable energy, one should be careful with the figures because of the extreme difficulty in getting the right numbers; it is important to add caution words such as "around" or "should" when trying to quantify production and consumption of renewables. The non-marketed nature of most renewables explains in part the poor quality of the data. But the limited knowledge about renewables, especially biomass, in some countries could lead to dramatic consequences such as acceleration of desertification. So, the call for an urgent change.

In energy statistics, renewables are generally divided into three categories: hydro; biofuels (and waste); and others (geothermal, wind, solar, etc.). Each category can be disaggregated into various sub-categories; *e.g.* hydro is divided among macro hydro and micro hydro (although the borders separating the two vary from country to country); this is also the case for biofuels, which are broken down into liquid, solid (fuelwood, charcoal, agro-residues) and biogases. Except maybe for macro hydro and liquid biofuels, getting a fair coverage of supply and demand for these categories is far from easy because of the non-marketable aspect of renewables' production and consumption. If assessing information on the electricity production of a nuclear power plant presents no major difficulty, collecting electricity production from solar photovoltaic cells in households is a different story because that production is a tiny fraction of that from a nuclear plant and output is often consumed in situ by the household, so neither transmitted nor sold. As a consequence, energy statisticians must produce estimates based on whatever pieces of information are available. In the case of solar photovoltaics in households, they often make use of sales of PV cells, average insulation, capacity factors, etc. This leads to best estimates which could hide large variability among various sources' numbers. An article in the 2009 edition of the IEA publication *Renewables Information* showed the wide spectrum among sources; it also highlighted the importance of either measuring production and consumption in a systematic way or having well accepted estimation methodologies when targets for renewables become binding, as in the 20% target for European Union countries.

Even less accurate are biomass consumption statistics, especially in many developing countries, and the energy policy implications are far more serious, as biomass can exceed 90% of energy consumption in some nations. In such countries, most fuel wood is not marketed but is instead collected by the people who burn it, and the bulk of the consumption takes place in remote areas or at best in small villages. It is therefore very difficult to have a precise picture of who produces what and who consumes what and how much. The same lack of data leads to vast imprecision in knowledge of the amount of wood needed to produce charcoal as well as on the quantity of charcoal produced. But reliable statistics on fuel wood and charcoal are essential: uncontrolled use of biomass contributes to desertification in many areas. Without knowing with precision how much wood is consumed and where, and the quantity of wood available, policy makers could underestimate the desertification situation and fail to react by taking alternative energy policy measures (substitution of fuel wood by liquid propane gas (LPG), dissemination of improved wood stoves, training and monitoring of charcoal producers, etc.).

Renewables account for a seventh of global energy supply. Far from negligible, this share should increase over time because of policies taken to encourage the deployment of vast wind and solar programmes all around the world. Oil analysts are upset when statistics on the oil market are off by 0.5%; but nobody seems to care about an inaccuracy of more than 20% on data related to renewables. At a time when energy poverty is high on the political agenda, at a time of the Rio+20 Conference, at a time when large renewables projects are being launched, policy makers need to address the lack of resources allocated to the collecting of reliable statistics on renewable energy. Desertification, access to modern energy, compliance to targets are some examples of issues for which the lack of reliable data on biomass, solar or wind energy can have a negative impact.

The IEA is committed to improve the quality and the coverage of its statistics on renewables. But this cannot be done by one organisation alone; there is a clear need for cooperation among key international organisations dealing with renewables, as well as governments and companies working in the field. The IEA therefore calls on other groups, nations and firms to join forces to build a global database on biomass energy to feed the debate and actions on key issues such as access to modern energy, energy poverty and desertification. 

FROM DISRUPTION TO BANALITY VIEWS ON VARIABILITY

As renewables increase their share of the mix, significant changes are coming to infrastructure, consumption of energy, even the landscape.

A world in which, say, a third of electricity is provided by wind and solar power would need to be very different from today's. The tools now available to power system operators are unlikely to be up to the task of managing so much additional variability and uncertainty.

To system operators, wind and solar represent disruption – in both senses of the word. On the one hand, additional management complexity; on the other, a game-changer. And the new game is flexibility.

If there is more variability in the system, the system will need to be more flexible. Only a really complementary portfolio of power sources, ones that can be turned off and on quickly and frequently, can best use clean, variable renewables while ensuring the lights stay on during still nights.

So which new players will emerge to provide for this need? A new generation of gas plants is evolving that can maintain high fuel efficiency even when output is ramping up and down more and more. Other energy sources may become more flexible, too: biomass, coal, geothermal, even nuclear power – if it becomes worth their while to do so.

Flexibility for old and new players

A new game may mean new rules. As plants that once operated round the clock are interrupted to make way for cheaper, cleaner power from wind and solar, they will need some alternative source of revenue to maintain profitability, something other than just the spot market price for their production, perhaps some sort of flexibility premium.

And the new rules must apply to all players. Already, wind plants not only can ramp down when required by conditions, they can also hold themselves below maximum output (at a given wind speed) – in effect keeping themselves in reserve – in order to ramp up later. New energy storage solutions may emerge, from tried-and-tested pumped hydropower stations to exotic

new battery and flywheel technologies, still in the lab. And electric heating and cooling do not require an absolutely constant supply – unlike lighting, for instance – to maintain the service in question, whether it be a warm house or a cold fridge. The charging of large electric vehicle fleets could also be staggered to fit supply.

Indeed, electricity demand will need to reflect supply as well as our instantaneous need for a service. In other words, demand will need to respond to price changes, as with any other commodity.


FOR CHANGEABLE WEATHER TO BE BANAL TO THE SYSTEM OPERATOR, WE NEED TO SEE MASSIVE CHANGE.

And finally, the arena will grow. Power markets are widening and deepening to make gains in competition and reduce electricity costs. This brings important flexibility benefits, too, as resources can be shared over wider areas. In a larger catchment area, there is a greater chance

of complementarity among variable resources, *i.e.* that the wind is blowing or the sun shining at different times in different parts of the area, smoothing the aggregated output of the whole. Of course, this presupposes sufficient transmission to link needs to resources. But the right market design can help here, too – signalling where reinforcements are needed through price differences.

Building an attractive future on many levels

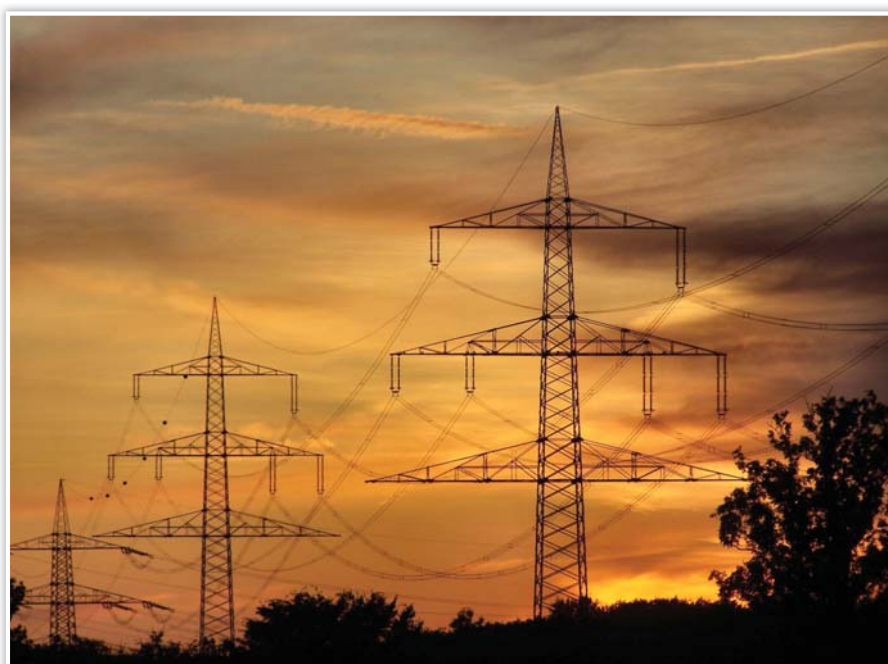
But then a solution will need to be found to the mounting public antipathy to new grid pylons. It's hard to argue with "it's ugly", and for this reason the Danes have already drawn up plans to hide their entire high-voltage grid underground.

So if changeable weather is to become as banal to the system operator as it is to the average Englishman, we need to see massive change: super-flexible power plants filling in the gaps caused by weather; electrification of heat and transport; storage; a demand side that is as elastic as in any other market; and a power market so integrated and deep that to a large extent variability can just be lost in the noise. 



By Hugo Chandler

Hugo Chandler is a Founder and Director of New Resource Partners, a boutique investment advisory specialising in renewable energy. He was with the IEA from 2006 through 2011 and led its Grid Integration of Variable Renewables Project. He can be reached at hugo@newresourcepartners.com.



Growing use of renewables will make it harder to balance infrastructure needs and concerns about the landscape.

Power lines : Photo by dfu via sxc.hu, <http://www.sxc.hu/tx/1license.html>

A BUSINESS LEADER SPEAKS: DITLEV ENGEL

The president and CEO of Vestas, the Danish wind energy company, looks at the industry's growth and future as well as how the IEA helps.

The single most important driver behind wind power's impressive growth in the last ten years has been the significant reduction in costs. Another important factor has been the expanding flexibility of implementing wind energy in large scale into the power supply.

Especially taking into account conventional power sources' many indirect costs to society, such as environmental and health-related costs, wind energy offers citizens and political decision-makers a very competitive value proposition. Wind power is also a local energy source that reduces dependence on imported fuel supplies from sometimes hostile or unstable countries. Finally, our industry's ability to scale up production and at the same time improve quality has been an important factor in the shift in demand for wind energy solutions.

At Vestas we work to reduce the cost of energy from our turbines and improve the business certainty of our product and service. At the same time, the growing demand for fossil fuels from fast-growing economies like China and India is likely to further boost conventional energy prices, which will improve the economic advantages of wind power.

Wind energy is an important element in long-term energy strategies around the world. For instance,

in the National Renewable Energy Action Plans that were launched in 2010 by the 27 European Union countries, wind power is the single largest renewable energy contributor for the European Union power sector by 2020, accounting for almost 20% of total renewable gross energy consumption if the binding plans are executed.

Cost-competitive wind power

Wind is competitive due to its strength both on economic terms, when examining the cost of generating energy, and its many environmental and social benefits.

The average cost of energy for wind has been continually decreasing and will fall further – this is not the case for many conventional energy sources. Bloomberg New Energy Finance has calculated a 14% decrease in cost of energy for every doubling of cumulative onshore capacity installed since the 1980s. This is due to improvements across the board, including declining turbine and balance-of-plant prices, lower operation and maintenance costs, increasing capacity factors (mainly due to more efficient designs, with longer, more aerodynamic blades relative to the same generator output), higher hub heights, economies of scale and better quality and efficiency of manufacturing.

Due to differences in local conditions, there are large cost variations among wind plants. In certain areas, wind projects without subsidies are already cost-competitive with newly built fossil-fuel alternatives. Wind parks are built subsidy-free in New Zealand, which has strong wind resources. In many countries in Latin America and Africa, which rely on imported fuels, the cost of wind energy is lower than wholesale power prices. Of course, these simple comparisons ignore costs associated with the health and environmental damage that accompany fossil-fuel power generation. If these externalities were included, wind energy would already be economically competitive in many more markets. As it continues to mature, wind power will become the most economic option increasingly often and in ever more regions.

Onshore versus offshore turbines

Over the next 10 years, we expect offshore wind to present high growth rates. However from a volume point of view, onshore will still represent the lion's share of the market going forward. Economics still favour onshore despite the progress made for new offshore solutions. Moving wind energy projects closer to the load centres but where the wind resources often are less strong is a challenge to further bringing down the cost of energy at these sites.

We at Vestas see further big potential for improving performance and value of wind energy in the somewhat overlooked area of stability and predictability of wind energy solutions. Our strong focus on Lost Production Factor, to maximise power production by reducing unscheduled downtime, has had a significant positive financial impact on wind projects. Also being better able to predict wind resources in the short term carries a significant value for our customers and the system operators. This is why we have invested a lot of money in modelling and supercomputers to support our customers, to improve their value proposition, from a power system point of view.

From a geographical point of view, there is a lot of growth potential. Europe and the United States are still at penetration levels in low single digits. With the right set-up, wind energy can cover much more of our power need, as some countries have shown. Vestas' home country of Denmark last year sourced almost 30% of its electricity from wind without jeopardising the economy. The new Danish government wants to expand this to 50% by 2020.

Outside of the traditional wind market, we see probably the biggest growth potential in emerging economies, and the need for a stable and sustainable energy supply is a core requirement for



Vestas windmills in Portugal: wind power penetration rates in Europe, like the United States, are at low-single-digit levels.



Ditlev Engel as a panellist during the 2011 IEA Ministerial meeting, part of the ongoing synergy between Vestas and the IEA.

these countries. Wind energy is already gaining a foothold in future plans for expanding the power supply in many developing economies.

Harmonious co-existence with windmills

As wind energy continues to expand, growing numbers of people and communities live and work in closer proximity to wind parks and turbines. So it's natural that some concerns and opposition arise.

Industry can help address many concerns through early and regular consultations in the local communities where wind parks are being developed. It is not uncommon that local concerns are based on lack of knowledge or familiarity with the technology. There are many sources of information available today – some more accurate and credible than others. Industry needs to do its part to ensure that local communities and other stakeholders benefit from the best, most credible information.

Technology can also play an important role. Vestas and others in the industry work hard to develop turbines that are as efficient and as quiet as possible. All mechanical devices produce some sounds, though generally speaking, wind turbines are quiet machines.

Further on the technology front, Vestas uses powerful computing capabilities to help visualise how a wind park will appear in the landscape. Where concerns do exist, wind park developers and local communities can sometimes find sensible solutions that balance the desire for maximum efficiency with minimum visual impact. The wind park just off the Copenhagen coast is a good example – here the turbines were positioned in a gently arcing line rather than a grid formation. This

produces a visually appealing display, with only a modest impact on the park's efficiency.

Overall, it's important to highlight that polling data shows high percentages of populations in big wind markets strongly favour more wind energy. That support, however, tends to be broad and diffuse, whereas the opposition tends to be focused and concentrated. So there is a great opportunity for the industry to convert this broad popular support for more wind energy into pro-wind action at the community and political levels.

How governments can best help

Energy is an area in which governments have always played a central role. As wind power matures, the nature and focus of the support may change, but both financial support and the creation of stable regulatory environments are essential tools in achieving a cost-efficient, green energy future.

Vestas is investing in technology, among others, in order to reduce costs, but we are not able to freely leverage the low cost of energy produced by our turbines.

The existing distribution and transmission infrastructure, which in many markets is relatively antiquated, was not designed to accommodate new technologies like wind. The transition to a system in which large percentages of wind power can be integrated and balanced will require supportive policy from governments, even once the cost of that energy is at, or below, the levels for newly built conventional fossil-fuel plants.

Successful political and regulatory frameworks for wind energy share common aspects. Long-term

HOW THE IEA BENEFITS VESTAS

We at Vestas see the IEA as a very important source for information and analysis on energy issues. Energy is very complex, and Vestas only addresses wind energy. The IEA plays a crucial role by adding to our knowledge of other aspects of the power market. IEA work on unconventional natural gas last year was an important input to the strategy process in Vestas. Vestas has had the honour to be part of the review board for the *World Energy Outlook [WEO]* for a number of years. The interaction with IEA analysts has been a benefit to both organisations. Finally the IEA is hosting many important events such as the IEA Ministerial meeting that I personally participated in last autumn as an Energy Business Council panellist.

At the IEA Ministerial, it was illuminating to learn more and in-depth regarding the trends and shifts in the energy market towards countries outside of Europe, North America and the industrial part of Asia-Pacific. Learning that countries like India, Indonesia, Brazil and in the Middle East will have higher growth rates than China was an eye-opener. It was similarly enlightening to go into details about the trends in fossil-fuel markets, specifically how the age of cheap oil is over but that natural gas will expand further due to non-conventional sources like shale gas. From an electricity systems perspective, natural gas complements wind energy far better than does coal or nuclear, though one does have to consider the potential environmental impacts of non-conventional gas exploration.

Finally, it was revealing to learn that neither the [WEO] New Policy Scenario nor more use of natural gas is going to reduce emissions sufficiently to keep global temperature increases to within 2°. The WEO assessment that "for every dollar of investment avoided in the power sector before 2020 an additional USD 4.30 would need to be spent after 2020 to compensate for the increased emissions" is a powerful warning for the politicians to avoid making expensive short-term decisions that will have otherwise-avoidable long-term consequences.

USING RENEWABLE ELECTRICITY TO BUILD RENEWABLE SOURCES

Vestas is actively sourcing renewable electricity in all parts of the operation where this is possible. To further drive the change towards more renewable electricity, we launched the WindMade initiative in 2011. A shift towards WindMade-compliant electricity internally in Vestas will be our next step.

As part of setting up new plants, energy consumption is carefully considered and renewable energy sources used where possible. An example is the new headquarters building in Aarhus, Denmark, where both solar panels and geothermal heating are applied.

For parts of the organisation, however, it is not possible to source renewable electricity – such as in China and parts of the United States. To balance out the non-renewable part of Vestas's electricity consumption, Vestas seeks to apply the renewable electricity generated from wind power plants owned fully or in partnership with customers. Vestas did not meet the target set for 2011, but the ambition is still pursued.

The WindMade programme

WindMade is the first global consumer label for companies consuming renewable energy. The label will allow consumers to identify companies procuring wind energy as well as products produced with wind energy.

The concept was initially developed by Vestas, but eventually handed over to an independent non-profit organisation supported and endorsed by the World Wildlife Fund and the United Nations Global Compact. The organisation is presently certifying companies and facilities powered with wind energy, supplying the qualifying companies with the WindMade seal of approval. Companies that sign up commit to procuring a minimum of 25% of their electricity consumption from wind energy. A number of global brands have signed up already, including Motorola, Deutsche Bank and Bloomberg. A label for certifying products as WindMade will be made available later this year.



A Vestas wind farm in Norway: offshore growth will surge in the next ten years, but most new sites will still be onshore.

and transparent policies are critical due to the high initial investment and long payback periods for wind projects. Securing stable and transparent policies and consequently stable cash flows for a wind project becomes even more important than short-term returns based upon short-sighted generous support schemes.

We have seen multiple examples of stable long-term support schemes that offer a lower price for power consumers compared with more unstable support schemes. But it is not only a well-designed support scheme that creates a stable environment for wind energy. Coherent policies addressing the full development process of a wind project including planning and grid access, among others, are as important as financial incentives. We see examples of countries where the compensation is quite attractive for wind project developers but where projects are held up in red tape forever.


Lately, the financial crisis has dramatically altered the political focus toward more short-term challenges in some countries. Under-funded support schemes are struggling in several nations. The investor confidence in renewable energy and wind projects is definitely threatened by retro-active changes to support schemes. With most of the cost base locked-in once a wind project is built, such changes threaten investors and lenders as well as development of new projects, even in other countries. This is especially harmful in a situation where politicians and the power sector are looking for new funding sources among institutional investors to carry the huge funding challenge of decarbonising our energy supply.

Finally, trade and local content policies are creating challenges for the wind industry. We at Vestas

normally strive to be in the region for the region: it makes good sense due to the size of our products and transportation costs. But rigid local content policies and trade barriers do tend to raise costs, reduce innovation and slow the uptake of clean-energy technologies. A wind project creates long-term local jobs due to the operational and service part of it. A regional perspective instead of a purely nationalistic approach can secure both jobs and a lower cost of energy.

Outlook for the wind industry

Wind power is a good business to be in. Since the mid-2000s, more and more countries are turning to wind energy to meet their electricity needs. In some cases, China being the most obvious example, the growth in wind power has been extraordinary. The long period of financial and economic turmoil that began in 2008, however, has resulted in slowing energy consumption in some countries as well as increasing pressures on public budgets. This in turn has slowed the growth rates in wind energy at the same time that industry capacity has been increasing. So at a certain level, the intense competition in the industry is a simple matter of supply-and-demand economics.

Some sector analysts and commentators focus a lot on the impact this competition has on turbine prices. This is understandable to a degree but captures only part of the issue. Our customers and their financial partners also know that wind turbines have to perform for 20-plus years, so issues like reliability, cost of energy over the lifetime of the product – *i.e.* the overall business case – certainly are important parts of the equation. An equipment manufacturer's technical and operational track record remains a vital part of the game in wind energy. 



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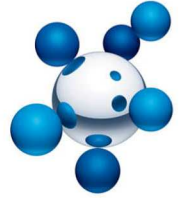
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Can a South African energy company supply alternative fuel to the rest of the world?

Sasol operates in 38 countries and employs about 33 000 people across the globe. In 2010, Sasol celebrated 60 years of operations. Today, Sasol has grown to become South Africa's leading fuel provider and an international player in the energy and chemicals sectors.





Sasol, driven by innovation

Sasol, a technology-driven alternative fuels and chemicals Company, was formed in 1950 in Sasolburg and celebrated 60 years of operations in 2010. Today Sasol has grown to become South Africa's leading fuel provider and an international player in the energy and chemicals sector, operating in 38 countries and employing about 33 000 people across the globe.

Sasol mines coal in South Africa, produces gas in Mozambique and oil in Gabon, and has chemical manufacturing and marketing operations in South Africa, Europe, Asia and the Americas. In South Africa, Sasol refines imported crude oil and markets liquid fuels through its network of retail convenience centres. Sasol also supplies fuels to other distributors in the region and gas to industrial customers in South Africa. Sasol's vision is to grow profitably, sustainably and inclusively, while delivering value to stakeholders through proprietary technology and the talent of their people, in the energy and chemical markets in Southern Africa and worldwide.

With its focus on integrated operations, Sasol uses its proven proprietary gas-to-liquids (GTL) and coal-to-liquids (CTL) technology to produce synthetic transportation fuels and chemicals, providing energy security whilst extracting value from abundant gas and coal reserves.

In partnership with Qatar Petroleum, Sasol started its first international GTL plant, Oryx GTL in 2007, producing ultra-low-sulphur diesel, naphtha and LPG.

Compared to products from conventional crude oil refineries, GTL products have a lower impact on the environment and sell at a premium on world markets.

Oryx GTL has an operating margin of some 44% and a design capacity of 32 400 bbl/d, which the joint venture is looking to expand further.

Sasol is constantly looking to expand its operations into emerging markets by pursuing opportunities that have arisen from a shift in the global energy landscape.

Sasol has a strong, diverse project pipeline across the world ranging from upstream exploration, to establishing additional GTL and CTL facilities, gas-powered and renewable electricity generation and commercialising innovative chemical technologies.

Sasol is driven by one thing, asking questions about tomorrow. To find answers, email sasolltd@sasol.com or visit www.sasol.com

FOCUS

OIL REFINING: A TALE OF TWO MARKETS

Frequently overlooked, the refining sector is the “glue” between the glamorous exploration and production end of the oil business and consumers’ needs for finished oil products at the other. However, no other segment suffers boom and bust like refining. Over-investment in new capacity is followed by low utilisation rates and reduced profitability, which lead to under-investment and renewed surges in profitability, as the whole cycle begins again. Investments are capital intensive, with long lead-times, and are complicated by changing oil products quality specifications and tightening emission standards.

And now, the eastbound shift in oil demand is creating a two-tier market: a tidal wave of refining expansion in Asia, the Middle East and Latin America threatens to submerge smaller, older, less complex capacity in OECD countries that face mature local markets and huge investment requirements to meet ever-tightening environmental norms. IEA projections envisage excess refining capacity persisting for several years, pushing many European and

other OECD refiners to close shop or sell capacity at distressed prices.

Last December’s *Medium-Term Oil and Gas Markets 2011* update highlighted an expected net rise of 8.7 million barrels per day in global crude distillation capacity post-2010, to reach a total of 102 million barrels per day by 2016. This compares with forecast demand growth of less than 7 million barrels per day, even as an increasing share is met by biofuels, gas liquids and condensates supplies, which can bypass the refining system.

CHINA ALONE IS EXPECTED TO ACCOUNT FOR A THIRD OF GLOBAL CAPACITY GROWTH, FOLLOWED BY INDIA, WHILE THE OUTLOOK IS PARTICULARLY BLEAK IN EUROPE.

All the expansion occurs in non-OECD countries, most notably in Asia, and much of it has a competitive advantage embedded from the start – resulting from economies of scale or less onerous environmental norms than in the OECD, or both. New capacity is often built for strategic as much as purely economic rationales, with some consumer countries targeting



By Toril Bosoni

Toril Bosoni joined the IEA in 2001 and is in charge of the refining and product supply analysis in the Agency’s monthly Oil Market Report and the annual Medium-Term Oil Market Report. Before, she

handled oil and gas statistics with extensive work on biofuels and on trade and demand modelling.

greater product self sufficiency, while others are positioning themselves as regional export hubs. At the same time, some erstwhile crude exporters are trying to shift to the exports of higher value-added oil products. Most are driven by a mix of these goals.

China alone is expected to account for a third of global capacity growth, or 3 million barrels per day, largely in line with expected demand growth. While project uncertainty is ever-present, government strategy seems to balance concerns over surplus capacity with those over increased product import dependence.

Led by India, the rest of Asia will add 1.4 million barrels per day, or 16% of global growth, while significant investments are under way in the Middle East and Latin America. Unlike China’s relatively cautious approach, India is expanding its refining industry significantly to establish itself as a major Asian product exporter. India began exporting high-quality products to the United States, Latin America and Europe after Reliance opened its huge Jamnagar export plant in 2009 and is expanding refinery capacity by nearly 1 million barrels per day by 2016.

In the Middle East, Saudi Aramco has revived the ambitious refinery expansion plan it temporarily shelved during the late-2000s recession. Three of the four proposed mega-projects are now likely to come to fruition, with two 400 000 barrel per day projects likely before 2016. The United Arab Emirates plans to start its 400 000 barrel per day Ruwais project in 2014. Latin American expansions are dominated by Brazil, which could add 800 000 barrels per day of capacity by 2016 at several greenfield sites.



Saudi Aramco’s Jubail oil refinery: the company recently revived its ambitious refinery expansion plan.


Refining in the developed world offers a stark contrast to this booming emerging market picture, amid structurally declining OECD oil demand. Since the IEA report last December, further refinery closures in the United States and Europe have been announced, including Hovensa's 350 000 barrel per day plant in the United States Virgin Islands. Depending on the fate of capacity operated by troubled European independent Petroplus (which went into liquidation in January), up to 3.6 million barrels per day of OECD refining capacity may close during 2008-14, equivalent to 8% of 2008 OECD capacity.

The outlook is particularly bleak in Europe, where seven refineries have already closed, and the future of Petroplus' five plants is in question. Furthermore, several plants have lately been sold to cash-rich upstream non-OECD interests (Rosneft, CNPC and Essar, among others).

For OECD countries in the Pacific, the situation is similar, with Japan bearing the brunt. By 2014, Japanese refiners face tough choices of closing capacity or investing heavily in upgrading units, and so far, almost 600 000 barrels per day of capacity is scheduled to close.

A reversal and divergence in the United States

The United States sector is interesting, as the country is transforming into a significant product exporter – a major turnaround from only a few years ago when it imported more than 2 million barrels per day. Diverging markets also exist in the United States, with those enjoying access to relatively cheaper crude from the Midwest at an advantage compared with those in the difficult East Coast market. With lower American gasoline import needs, the gasoline-oriented European refiners face further pressure.

The refining market worldwide is seeing a geographical shift in fortunes already evident in many other spheres of economic life. The story is one of booming Eastern market growth, prompting massive construction of technologically complex, large-scale and competitive plants, versus the contraction or stagnation seen in many OECD markets. Given the troubling short-term economic picture, and the resulting demand uncertainties, OECD refiners may be wise to maximise the flexibility of their capacity and utilisation plans. Unfortunately, not all may weather the economic storm. 

HINTS TODAY ABOUT TOMORROW'S GAS

Forget about straight-line forecasts for natural gas demand and supply. The patterns can suddenly diverge from the conventional view in the most unexpected way. The most obvious example is how the United States, thought on track as recently as 2005 to becoming one of the top importers of liquefied natural gas (LNG) by 2010, is now viewed as a future exporter. Similarly, who would have expected three years ago that Australia could become the largest LNG exporter as soon as 2017? Or that Israel, "the one spot in the Middle East that has no oil", as former Prime Minister Golda Meir put it, would find so much gas offshore that it is now considering exporting it?

We look at the future with knowledge and thoughts of today, making it difficult to diverge from a certain conventional point of view. Natural gas is subject to a greater uncertainty than many other fuels because it is the back-up fuel in many sectors, so demand for it can be disproportionately affected by policy changes or price disparities. While obviously nobody can foresee some events – e.g. the Fukushima incident and its consequences – there can be detectable signs of change to come. Let us see, based on such elements, where less conventional scenarios could lead us.



An LNG tanker arriving in Boston under tight security. The United States has shifted from a gas importer to probable exporter.

In the current context, many people would first think about shale gas developments. What if enough relatively cheap shale gas remains available in North America to support both exports and a substantial domestic demand increase? So far, gas prices have proven resilient to many adverse factors. Gas might then push coal out of the mix because of stricter environmental rules and the price differential. The share of gas in power generation increasing from 24% in




By Anne-Sophie Corbeau

Anne-Sophie Corbeau is an IEA Senior Gas Analyst. She previously worked at Cambridge Energy Research Associates, focusing on European gas markets, and in Peugeot's fuel cell and hydrogen department. She studied engineering in France and Germany.

2010 to 30% would create additional demand of 80 billion cubic metres (bcm) by 2020. Let's stretch our thinking even more: how sustainable is the current system if oil prices don't retreat below USD 100 a barrel while gas holds at the equivalent of USD 20 a barrel? If that price gap remains, what's to stop a shift of most large-vehicles sales to LNG? The technology exists; additional costs would decline with thousands of units sold.

China tends to exceed the most optimistic forecasts. Here again, why couldn't gas demand reach almost 400 bcm by 2020, if the country succeeds in tackling all its challenges: reforming gas prices, developing both shale gas and coalbed methane, and importing Russian gas? By then, China could set global prices and trade, with the creation of a Shanghai-based hub price. To feed gas markets, more supplies will be required. Less traditional exporters could emerge: Mozambique and Tanzania seem to hold sig-

nificant reserves. Their development for export could also provide these two nations with gas for power and industries.

Do all the outlooks foresee growth? No. A deep sustained economic crisis in Europe with still relatively high gas prices would certainly cause gas demand to drop under the pressure of reduced power demand and growth in renewable energy, even if the share of nuclear declines. 

WHY AN IEA COAL MARKET REPORT?

Conventional wisdom suggests that coal is a 19th-century energy, close to disappearing. But coal demand instead keeps on growing. In the last decade, coal has met half of the incremental increase in primary energy demand worldwide, and it remains the main source for electricity generation in OECD member countries as well as many of the fastest-growing emerging economies.

Coal is abundant, relatively cheap, easy to store, geographically widely distributed and largely free from geopolitical tensions. Coal-fired technologies have been well known for decades. That said, coal prices climbed to historical levels in 2008, and after a big dip immediately following the financial crisis, have since been on the rise, doubling their 2009 levels amid increasing volatility. The price gap between higher-quality coking coal and steam coal has hit historical levels in recent years. Indeed, this is moving resources from thermal to “met” (metallurgical) coal. The implications for steam coal investments, access to infrastructure and any future convergence between steam and met coal prices are not clear.

More than 80% of global coal exports come from only six countries, and Queensland in Australia accounts for half of the global trade in coking coal. Nine companies are responsible for more than 40% of total coal exports. This may have implications on energy security concerns. While no political shocks in

exporting countries are expected, weather-related events or infrastructure bottlenecks have caused price and volatility spikes.

A shift in potential sources to meet demand

Reports show huge possibilities in places where coal was unknown just a few years ago. While Mongolia and Mozambique may be more exotic, we should also include new basins in traditional exporting countries, including perhaps the Galilee and Surat basins in Australia or East Kutai or South Sumatra in Indonesia. But developing these areas will require huge financial resources.

China’s predominance in coal is bigger than that of any other country for any other fuel. Roughly half of global coal production and consumption is in China. Given that only around one sixth of all coal is internationally traded, any imbalance in the Chinese supply has a huge impact.

India is another large-scale country in coal consumption, production and imports, and in a few years, it is expected to become the largest importer. These two countries’ economic growth and increase in domestic coal production are pivotal for the global coal trade.

The different coal regions are increasingly integrated. South African, Colombian or Russian coal producers can change their export targets from Europe to Asia (from the Atlantic Basin to the Pacific Basin) depending on who is paying the highest price, and right now it is Chinese utilities that pay that premium. Therefore, policies in Beijing’s Five-Year Plan or rail bottlenecks in the country can increase Chinese imports, lifting prices for traded coal,



By Carlos Fernández Alvarez

Carlos Fernández Alvarez joined the IEA in 2010 with more than 20 years of experience in the energy sector. He began as a consultant for electricity producers,

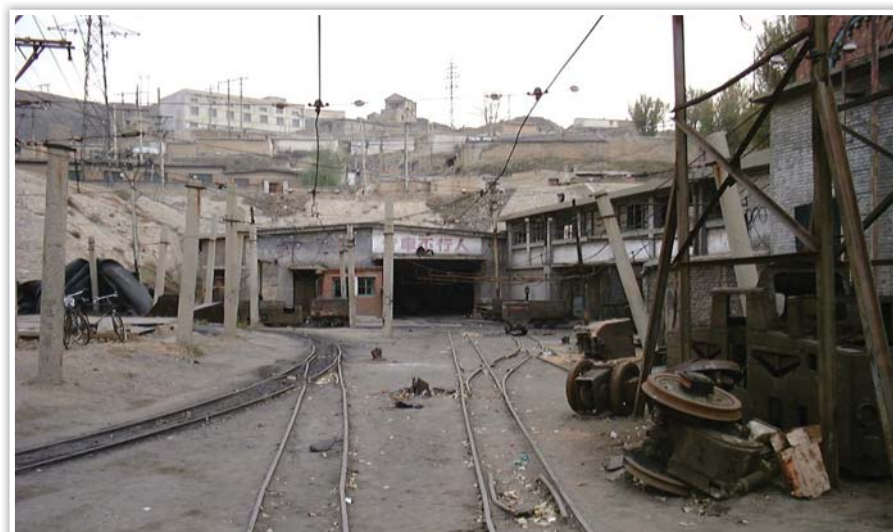
focused on system modelling and nuclear plant safety assessments, before joining the Spanish government.

and therefore, driving up electricity costs in European countries.

Coal trading in Europe has changed dramatically in the last decade. Paper trade based on API 2, the benchmark price reference for imported coal in Northwest Europe and the primary reference for coal trading in Europe, is now more than ten times the value of physical trading. This gives rise to the issue of whether volatility is driven by fundamentals or by financial markets. And this phenomenon is just starting. Last year, the first Indonesian coal derivatives and coking coal derivatives were launched.

Indeed, with climate change a priority in the political agenda, both the public and policy makers need to see that coal use is not declining and is not foreseen to decline in coming years. *Medium-Term Coal Market Report*, an annual series introduced by the IEA late last year, aims to help both audiences understand coal’s critical role in energy supply and security as well as the magnitude of the environmental challenge.

Therefore, the question should not be “Why has the IEA launched a coal market report?” but “Why did it take so long?”



The Lao Ye Temple Mine, China. China’s predominance in coal is bigger than that of any other country for any other fuel.



Medium-Term Coal Market Report cover design: © OECD/IEA, 2011. Photo credit: © Foti Georg Brenner/Partner Media/GraphicObession. Coal mine, photo by LHOON. http://creativecommons.org/licenses/by-sa/2.0/en/gdcode

DEFERRED OR STEADY MENA INVESTMENT?


The greater part of the world's remaining oil and gas resources lie in the Middle East and North Africa (MENA). Relatively low-cost and under-exploited, they could provide much of the oil and gas that energy-importing countries – particularly those in the OECD and emerging Asia – will need in the coming decades.

The synergies therefore seem apparent. In a well-functioning energy market, steady investment in oil and gas production in MENA countries should benefit their economies as well as the global economy. But energy markets do not function perfectly. There has long been uncertainty about the pace at which investment in the region's upstream industry will occur, how quickly production capacity will expand and, given the heavy subsidies that are fuelling rapid growth in domestic energy usage, how much of the expected increase in supply will be available for export. The prospect of new spending priorities and higher perceived risks in the wake of the Arab Spring has heightened this uncertainty, prompting the *World Energy Outlook 2011 (WEO 2011)* to include a special Deferred Investment Case to investigate the implications of a possible investment shortfall.

In the central scenario of the *WEO 2011*, the MENA region contributes more than 90% of the required growth in oil production to 2035. The largest increases in production come from Iraq, adding 5 million barrels per day (mb/d), and Saudi Arabia, adding almost 4 mb/d; following are Kuwait, the United Arab Emirates and Libya. To achieve this growth, upstream investment needs are estimated to average USD 100 billion per year from 2011 to 2020, before rising gradually thereafter. In the Deferred Investment Case, investment over the period of 2011 to 2015 is assumed to be reduced by a third from this level.

Such a shortfall would radically alter the global energy balance. MENA production is 6 mb/d lower in 2020 compared with the central scenario. Consumers face a substantial near-term rise in the oil price to USD 150 per barrel. Higher prices prompt greater investment in resources outside the MENA region, though their higher development costs mean that the shortfall in MENA production is only partially offset. Higher prices also lead to some loss of demand. While MENA countries gain in the short term from more expensive oil, their loss of market share to producers outside the region diminishes their export revenues over the long term.

These results highlight that the timely expansion of MENA's oil and gas resources will benefit both producers and consumers. For consuming countries, the benefits are obvious: economic development cannot be achieved without energy at affordable prices and cannot be sustained unless energy supplies are secure. For producers, oil and gas exports can underpin much-needed growth, stability and prosperity.

I am convinced, therefore, that each of us with a stake in the energy sector should pay close attention over the coming months for signs of whether investments in the MENA region are being deferred or are advancing. The former could have far-reaching implications not only for energy markets but also for the broader economy. 



By Fatih Birol

Fatih Birol is the Chief Economist of the IEA and oversees the annual World Energy Outlook, the Agency's flagship publication. He is also responsible for the IEA Energy Business Council, which provides policy makers with a business perspective on energy market issues. He joined the IEA in 1995 after six years in the Secretariat of the Organization of the Petroleum Exporting Countries (OPEC) in Vienna.

The IEA is preparing an in-depth look at Iraq's energy sector that will be issued in early October as a World Energy Outlook 2012 special report.



The WEO sees the bulk of the growth in oil output coming from the Middle East and North Africa, requiring investment.

MEASURING AND COMPARING ENERGY SECURITY

MOSES assesses IEA member countries' risks of short-term supply disruptions in different energy sources – and their relative resilience.

M OSES does not lay down the law. Instead, this IEA model helps Agency member countries evaluate their short-term energy security by assessing each country according to indicators showing its system's risk of a sudden, temporary supply disruption of a particular energy source. Then it groups countries by their resulting profiles.

MOSES stands for Model of Short-Term Energy Security. It is not a test or ranking model. Instead it helps countries see their security relative to their peers, analysing nine sources – soon to be 11 energy forms in total – in terms of security of supply. The profile helps policy makers recognise their own country's greatest potential weaknesses, allowing for most efficient remedies and prioritisation, by comparison with countries sharing similar strengths and vulnerabilities.

The model does not concentrate on strategic, long-term vulnerabilities. Instead it looks at the kinds of supply disruptions that last days or weeks but can cripple a country and its economy

and citizenry. Some of these risks can double as long-term disruptions, but MOSES looks mainly at the causes of short-term impacts, situations that would force a country to react immediately, and assess how well the country could respond.

The first version of MOSES (*Primary Energy Sources and Secondary Fuels*), published in November 2011, focuses on crude oil, natural gas, coal, biomass and waste, hydropower and nuclear power plus two sets of secondary fuels: oil products and liquid biofuels. For future MOSES reports, the IEA is working to extend the analysis to power generation and end-uses of energy.

Supply risks, and ways to combat them

Disruptions can take many forms. The IEA was formed following the oil shocks of the 1970s, but energy disruptions and crises can come in a broad variety. For instance, weather has affected supplies of biofuels as unseasonal temperatures hurt growing conditions; hydropower, when droughts have reduced river flows; and wind power, through both calms and storms. Natural or



By Aad van Bohemen

Aad van Bohemen, who joined the IEA in 2006 from the Dutch Economic Affairs Ministry, heads the Emergency Policy Division, which ensures that the IEA and member countries stand ready to react to severe supply disruptions and coordinates collective actions during such disruptions.

human problems can block transportation of coal to power stations or shut down a port. Pipelines and power networks are vulnerable to everything from software errors to terrorism.

But MOSES looks at more than just weaknesses. It highlights and evaluates each member country's resilience, its national energy system's means of coping with disruptions. Examples are diversity of suppliers for energy importers, fuel storage capacities, a higher ratio of above-ground coal production relative to riskier underground mines, even variation among nuclear reactor models.

The indicators were developed in consultation with experts inside and outside of the IEA, but data for some useful variables are not available in comparable form for all member countries. In other cases, indicators mean different things for different nations. For instance, while having multiple ports can be a major asset for an importer country's resilience profile, in case of trouble at a critical terminal, the indicator

Group	Countries that:	No. of countries
A	Export crude oil or import ≤15% of their crude oil consumption.	5
B	Import 40%-65% of their crude oil consumption or Import ≥80% of their crude oil consumption and have • ≥5 crude oil ports, high supplier diversity and ≥55 days of crude oil storage.	4
C	Import ≥80% of their crude oil consumption and have: • ≥5 crude oil ports, high supplier diversity, and <50 days of crude oil storage or • 2-4 crude oil ports, high supplier diversity and >20 days of crude oil storage.	9
D	Import ≥80% of their crude oil consumption and have: • 2-4 crude oil ports, high supplier diversity, and ≤15 days of crude oil storage or • 2 crude oil ports or 3 crude oil pipelines, low supplier diversity, and ≥15 days crude oil storage or • 1-2 crude oil pipelines or 1 crude oil port and have either: • medium to high supplier diversity and ≥15 days of crude oil storage or • low supplier diversity and ≥55 days of crude oil storage.	6
E	Import ≥80% of their crude oil consumption and have: • 1-3 crude oil pipelines or 1 crude oil port and ≤15 days of crude oil storage or • 1-2 crude oil pipelines, low supplier diversity and <50 days of crude oil storage.	3

Many factors determine an IEA member country's security profile in the A-to-E groupings for crude oil, with A indicating low risk and high resilience in both internal and external factors.

Table: © OECD/IEA, 2011

matters little for the profile of a country that has a domestic supply.

Each country's profile for each supply source lands the member nation in one of five categories based on external and internal factors for risk and resilience. The categories run from A to E, with A requiring low risk and high resilience in internal as well as external factors.

A look at the grouping for one energy source

Crude oil is the first and primary energy supply assessed for each member nation, for it was the original supply concern when the IEA was formed and remains of critical interest to member countries.

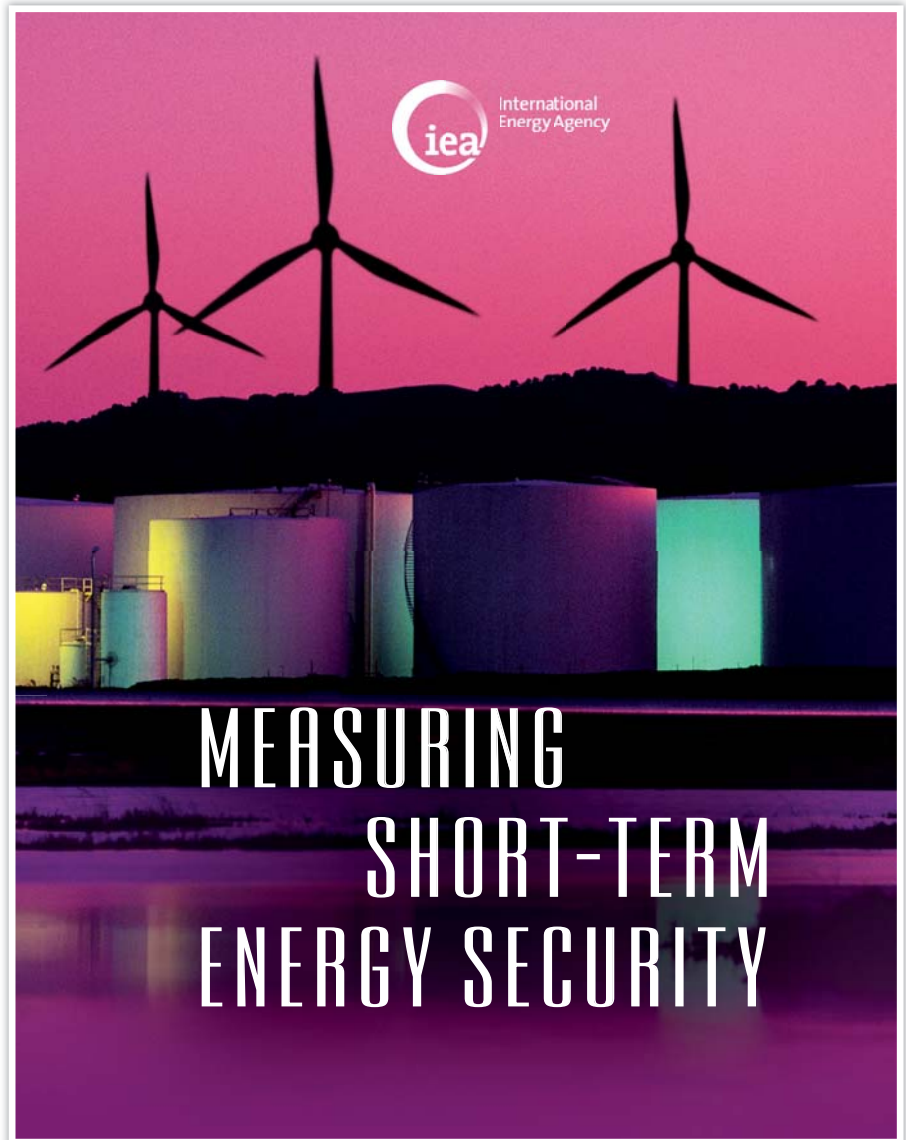
Eight factors determine a country's oil security profile, divided into two categories of external and domestic risk and resilience factors, such as import dependence and storage. Import dependence is based on the percentage of oil consumption that is imported, but a number of other variables also play a role, such as the political stability and diversity of suppliers and the infrastructure by which the oil is imported. The storage indicator is measured by the average level of stocks divided by daily refinery intake.

In the 2011 report, five countries qualified for the A category by importing no more than 15% of consumption, while three countries were in the E group. E group countries not only were importing at least 80% of consumption but also had no more than three crude oil pipelines or a single crude oil-handling port and a maximum of 15 days of crude oil storage. Alternately, they imported as much oil and had just one or two pipelines, low supplier diversity and fewer than 50 days of storage. A third of the countries profiled (nine) were in the middle – C – category, where imports also accounted for 80% or more of crude used but there was far greater resilience in terms of ports, networks and storage.

Risks of nuclear power disruption

MOSES also groups countries by their nuclear power supply security, but its assessment of electricity disruption from nuclear output is just the start of a comprehensive evaluation of all security aspects of electricity. That said, the MOSES evaluation assesses only energy disruption aspects, and not the safety of the nuclear power plants themselves.

The assessment centres solely on domestic aspects, as external risks would not usually affect short-term production – not even delivery of uranium, which is usually stockpiled. Instead, MOSES looks at four indicators: the risks represented by



the country's unplanned outage rate; the average age of the plants; the resilience factors involved in the total number of plants; and the diversity of reactor models.


The IEA tracks unplanned outages. Of the 16 nations examined (not all member countries have nuclear power), seven had outage rates below 3%, while five had high rates, defined as above 6%. A country is deemed to have a suitable number of reactors in terms of supply security with more than 15 reactors, as six of the countries had, while only one country had fewer than four reactors (*i.e.* just one). Of course that country lacked diversity in models, while seven others had medium diversity and eight had high diversity. Diversity matters because, among other reasons, if a problem is found in a reactor, all similar reactors usually are shut down to check for the problem.

The average age of plants is important because outages are more likely at older plants, a problem

for several countries in the MOSES results. This warning does not apply to the safety of the reactors involved; instead, it is a judgement of their likely availability for energy production.

Two countries made the A category with the low outage rate, more than 15 reactors and a moderate to high diversity among those facilities. Only one country, the one with just a single plant, and an old one at that, was in E, with the remaining countries pretty evenly distributed in the middle categories.

MOSES keeps moving on

The IEA plans next to broaden its assessment of member countries' energy security using a comprehensive energy systems approach, including analysis of electricity vulnerability and risks for energy consumers such as the transportation, industrial and residential sectors, creating a comprehensive perspective on global energy security for users and policy makers alike. 

THE THIRD AGE OF ELECTRIC VEHICLES

With an increasing number of models arriving in showrooms, 2012 sales and an IEA initiative are crucial for the road ahead.

The electrification of the vehicle fleet is entering what can be called the third age of electric vehicles (EVs). The first age was in the early 20th century, when EVs were relatively popular until the internal combustion engine displaced them. The second age was in the 1990s, with interest rekindled in France through the French Agency for Environment and Energy Management (ADEME) and in California with the state's Zero Emissions Vehicle (ZEV) mandate, which spurred sales of some EVs but fell short of its billing (though it has recently been revised and enhanced).

Fast-forward to the second decade of the 21st century and the mainstreaming of lithium-ion technology. Last year saw the mass debut of two major EV models: Nissan's LEAF, a full battery electric vehicle (BEV), and Chevrolet's Volt, a plug-in hybrid electric vehicle (PHEV). The first data points of the third age of EVs are coming in and, in light of the continued economic crisis in 2011 and supply bottlenecks caused by the Fukushima disaster, the results are arguably impressive. About 40 000 EVs were sold, the most in any year in history and more than the sales of hybrid electric vehicles (HEVs, such as Toyota's Prius) during their first six



By Tali Trigg

Tali Trigg became an IEA Energy Analyst in 2010. He specialises in transportation technology policy, with an emphasis on smart growth, electric vehicles (spearheading the Agency's work on the Electric Vehicles Initiative) and bus rapid transit.

years of sales combined. Since the nascent market is developing, with more new models being launched each month, it is clear that 2012 auto sales will be crucial in determining the road ahead for electric vehicles.

Motivation for EVs

EVs are a new (or revived, depending on your perspective) technology, and so must clear several stages of development, optimisation and scale-up. Today's EVs are far better than models of a decade ago, but costs remain high and infrastructure is still being developed. In the next two or three years, conservative estimates see EVs passing the 100 000 cumulative sales mark worldwide, though this will represent only a tiny share of the more than 100 million cars sold over the period. This timespan will help cities establish infrastructure and help buyers get to know the technology, and perhaps allow for a much bigger expansion of markets towards the middle of the decade. By 2015, a global target of 1 million EVs on the road seems reasonable, and by 2020 – when there is a good chance EVs will be cost-competitive (or nearly so) with conventional internal combustion vehicles – the goal is 20 million EVs. This figure happens to align with what countries themselves are targeting. Even then, 20 million will represent only about 2% of the world's cars; but that level will set the stage for EVs to play an increasingly important role: the IEA projects that EVs could account for 15% of the global vehicle fleet by 2030.

Besides EVs, other types of new technology vehicles should continue to be developed; however, it will be hard to beat the potential of electric vehicles for cutting oil use and CO₂ on a per-kilometre basis. With a moderately clean electric grid, EVs should be able to emit only 50 grams of CO₂ per kilometer (g/km). Today's efficient cars emit between 100 and 150 g/km; even HEVs have trouble going below 90 g/km.

IEA-led Electric Vehicles Initiative

The International Energy Agency is spearheading the Electric Vehicles Initiative (EVI), a coalition of select IEA member countries and other major economies that have set combined targets of



The plug-in Chevrolet Volt is one of two electric cars introduced by major automakers last year; others are following soon.

Chevrolet Volt: © General Motors



A Tesla Roadster charging up: the niche company's Model S sedan in particular is increasingly available.

more than 20 million EVs on the road by 2020 (see boxed article). This will be very challenging but is achievable if manufacturers make the investments and produce the vehicles and also if consumers are ready to buy them in large numbers.

To get there, EVI partner countries are sharing information about research and development efforts; facilitating city-to-city interaction on best practices; and enhancing common data collection and analysis efforts using projected supply and demand trajectories of PHEVs and EVs based on national targets, city plans and announced manufacturing plans by car and battery companies.

As part of its effort to facilitate city-to-city interaction on best practices, EVI is coordinating a City Casebook that will showcase pioneering EV cities in EVI countries. The Casebook will include case studies from around the world, highlighting the national context and figures on the ground, but also approach the broader EV ecosystem to understand what has and has not worked so far.


The IEA's Technology Roadmap

IEA scenarios for future energy supplies underline the need for low-emission vehicles such as PHEVs and EVs. Consistent with the targets set by countries (and somewhat coincidentally), the Agency is calling for half of sales by 2050 to be electric, plug-in and hybrid vehicles, passing through a 10% sales share point at about 2020.

In June 2011 the IEA updated its *Electric and Plug-in Hybrid Vehicles Technology Roadmap*, originally published in 2009, with the latest analysis on achieving the Agency scenario that outlines pathways to halving global energy-related CO₂ emissions by 2050 compared with 2005 levels. That scenario envisions more than 1 billion EVs and PHEVs on the road by 2050, representing more than half of the global car fleet then.

What to expect in the next year

Besides cars from major automakers such as the Volt and the LEAF, there are also vehicles coming from Renault, Ford, PSA/Mitsubishi plus increased availability of Tesla's Model S and Fisker's Karma. Several models are entering the market this year, such as the Mitsubishi i-MiEV, which is already on sale in Japan and is expected to hit the United States market in June. Also entering the world auto market this year is Toyota with a plug-in variety of the Prius, and BMW is expected to release two EV models in 2014. The increase of models will have a profound effect on the market as pent-up demand is addressed, giving a better understanding of the market size, potential and geography.

There are many types of alternative vehicle technologies, and the IEA takes a technology-neutral position. But what is clear is that some type of action is necessary. EVs come into play not simply for the sake of energy efficiency but because they are a desirable high-technology consumer product. Those factors together make these vehicles one of the likeliest technological solutions to lowering CO₂ emissions and local pollutant emissions in the transport sector in the next 40 years. And their time is now. 

ELECTRIC VEHICLES INITIATIVE

How to get 20 million electric cars on the road by 2020? Only through careful coordination and cooperation worldwide, an effort being led by the IEA through its Electric Vehicles Initiative (EVI).

EVI provides a forum for international development and deployment of EVs country by country through joint strategies and information-sharing on funding and research as well as through best practice and deployment targets.

Besides helping policy makers progress towards the initiative's targets, EVI engages the private sector, helping it realise how it can benefit from EV procurement for corporate fleets and public-private investments in technology innovation, even as the rest of the world gains from the new funding and eventual economies of scale. EVI reaches the general public through a programme for pilot cities that promotes EV demonstrations in urban areas.

EVI was launched at the first Clean Energy Ministerial (CEM) in Washington in 2010, where the goal of 20 million cars was set. Since then the initiative has collected and compiled data from each EVI country on its public investment in research, development and demonstration; national goals for EV deployment; current national stock of EVs and charging equipment; and relevant government policies. EVI has met in Paris, Shanghai and Barcelona. It will present its analysis of gaps among EVI members in public EV investment, as well as potential remedies, at the third CEM, which takes place 25-26 April 2012 in London. (The second CEM was in 2011 in Abu Dhabi.)

EVI groups 14 countries: China, Denmark, Finland, France, Germany, India, Japan, the Netherlands, Portugal, South Africa, Spain, Sweden, the United Kingdom and the United States. Many others, including nations not involved in the CEM process, support the initiative, whose activities are guided by an advisory group made up of representatives from the IEA and each of the 14 EVI countries.

More information about EVI is available at www.iea.org.



Read about the IEA Implementing Agreement for Co-operation on Hybrid and Electric Vehicle Technologies and Programmes at www.ieahev.org.

BIG POTENTIAL, BIG CHALLENGES: MAKING CCS VIABLE

The IEA works with countries to create the right conditions for carbon capture and storage. A new global accord improves the outlook.



By Ellina Levina

Ellina Levina joined the IEA Carbon Capture and Storage Unit in 2010. She brings 18 years of international experience in climate change and energy policy analysis, including directing an international climate programme at the United States-based think tank Center for Clean Air Policy.

Carbon capture and storage (CCS) is part of the solution to the energy sector's challenge of reducing greenhouse gas (GHG) emissions while continuing to fulfil the world's growing demand for energy. CCS involves capturing CO₂ from large point sources during the energy transformation process and storing it deep underground, either in deep saline aquifers or in depleted oil and gas fields. While fossil fuels continue to be used to supply energy, the need for GHG emission reduction technologies is becoming more urgent. CCS is the only known technology besides energy efficiency measures that allows for deep reductions of CO₂ emissions in fossil fuel power generation and many industrial processes.

According to IEA scenarios, CCS could deliver up to 19% of the required emission reductions to keep the global temperature increase to 2° by 2050. However, CCS is generally considered the most expensive GHG mitigation option today. This is because of the high cost of capture technologies, extensive lead time and expenses for storage exploration, transportation infrastructure needs, the administrative burden of a complex legal framework to assure safe storage management, and limited co-benefits outside of climate mitigation. One way to make CCS projects economic is to find an economic use for the captured CO₂ that keeps it out of the atmosphere permanently. The best candidate found for this


so far is to use the CO₂ as a fluid in enhanced oil recovery. The IEA recently co-sponsored with OPEC a workshop on this topic in Kuwait.

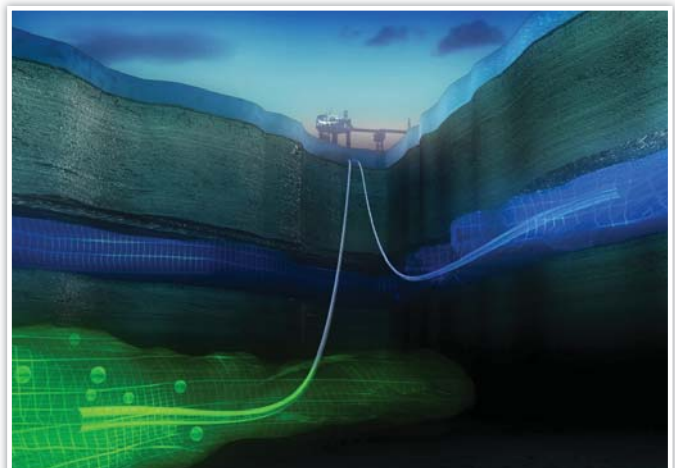
Creating incentives, overcoming barriers

Though all main elements of this technology have existed for a long time, there are only four large-scale integrated CCS projects today: Snøhvit and Sleipner in Norway, In Salah in Algeria and Weyburn in Canada. These projects cover the whole chain of capture, transport and long-term storage, with the necessary monitoring of stored volumes of CO₂. These projects are either in natural gas processing or synthetic gas production operations. A handful of other projects operate parts of the CCS chain. The power sector – a major contributor to CO₂ emissions – has so far not been able to apply this technology on a commercial scale. But there is reason to be hopeful, as there are more than 70 large-scale projects in various stages of development around the world. Many of them could become commercial CCS operations if research and other policy action address the challenges that they face – such as high costs, public opposition, lack of stringent climate mitigation policies and related incentives, and absence of relevant regulations. The IEA is working with its member and non-member governments to assist them with analysing and defining the role of CCS in their national energy strategies and creating the right conditions.

A high carbon price and governmental support to overcome learning costs can make CCS attractive to industry. However, these major drivers are currently very weak. The international agreement at COP17 in Durban in December 2011 towards a process for reaching a long-term global treaty on climate change – to be ready by 2015 and effective from 2020 – provides a positive signal for long-term climate mitigation and related investments. Therefore it creates incentives for CCS development. Durban also produced a decision that gave a direct impetus for CCS technologies in developing countries by accepting CCS as a Clean Development Mechanism activity under the United Nations Framework Convention on Climate Change.

The acceptance of CCS at the international level and high standards for its application could potentially have a positive impact on public perceptions, which are still driven by fears of CO₂ leaks and associated risks to human health and property.

Looking ahead, CO₂ capture from sustainable biomass-operated power and industrial applications could become a necessity given its potential to remove CO₂ from the atmosphere through biological and geological sequestration. Bioenergy with carbon capture and storage may be the CO₂ “vacuum cleaner” of tomorrow. 



Sleipner in Norway is one of four large-scale commercial CCS projects. The platform stores CO₂ generated during natural gas output in stable geological formations deep under the sea floor.

LOWER COSTS, GREATER RESULTS AIDING RESEARCH

The IEA fosters public-private partnerships for research, development, deployment and knowledge transfer of a host of energy technologies.

When the International Energy Agency was created in 1974, it established a programme to coordinate releases of member-country strategic oil stocks in times of crisis. At the same time, the Agency set up a mechanism for any two – or more – IEA member countries to carry out collaborative research to explore energy conservation and other energy sources.

Today, more than 6 000 scientists and experts and nearly 500 government agencies, research organisations, universities, energy companies and consultants take part in these collaborative partnerships, which are formally known as Implementing Agreements.

Implementing Agreements (IAs) help participants reduce costs and avoid research duplication while increasing the knowledge base through greater project scale and opportunities for networking. Harmonised technical standards and streamlined protocols for everything from budget to intellectual property rights help keep the focus on the research and information sharing.

IAs allow true international networking and strengthening of national research and development capabilities for all nations involved. Any country or organisation may ask to be invited to participate in an IA. The agreements are entirely



An open-ring turbine prototype being tested in Europe.

self-supporting, and all participants work on an equal footing by providing expertise and funding, the latter through financial or in-kind contributions.

Hotbeds of expertise

To date, experts in Implementing Agreements have carried out more than 1 200 research projects on energy. There are now 42 IAs working to resolve barriers to technology deployment – from fossil fuels to renewables, from early prototype technologies like fusion power to energy efficiency for consumers and industry, from systems analysis to knowledge exchange.

IMPLEMENTING AGREEMENTS ALLOW TRUE INTERNATIONAL NETWORKING AND STRENGTHENING OF NATIONAL RESEARCH AND DEVELOPMENT CAPABILITIES.

Some IAs cover novel, little-known subjects such as plasma wall interaction, while others seek advances in familiar fields including oil recovery, hydropower or energy-efficient electrical equipment.

Another group of IAs focuses on cross-cutting issues: modelling, energy research abstracts and technology transfer.

Time-proven, flexible mechanism

IAs are a time-proven, flexible mechanism to respond to priorities. The very first IA, created in 1975, focused on research of coal technologies, while the newest, created in 2010, concentrates on smart grids.

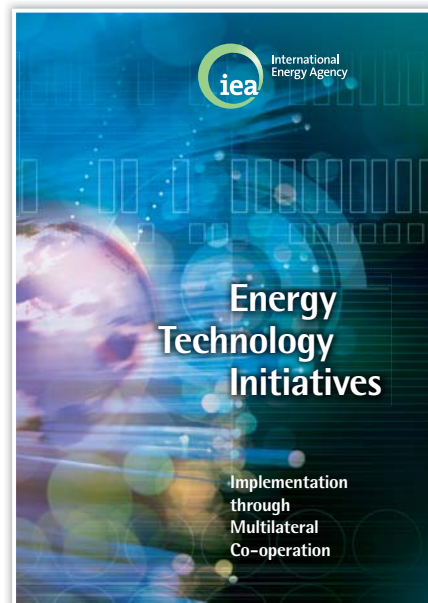
A new IA may be formed at any time as long as the scope, strategic plan and work plan support the Shared Goals of the IEA – energy security, environmental protection and economic growth. Two member countries must agree to take the agreement forward, and it must be approved by the IEA Committee on Energy Research and Technology and the Agency's Governing Board.




By Carrie Pottinger

Programme Manager for Energy Technology R&D Networks in the IEA Energy Technology Policy Division, Carrie Pottinger is the author of more than 30 publications

on such issues as prices, tax policies, R&D policies, supply forecasts, economic indicators, refinery operations and trade flows.



IAs and the IEA benefit each other. The latter offers guidance and its knowledge of greater energy policy issues. Through the IEA Framework for International Energy Technology Co-operation, the Agency provides a legal basis for the expert groups to carry out their independent work. In exchange, an IA may lend up-to-date and specialised expertise on its relevant area to IEA analysis.

The IEA also promotes the work of these groups through specialised publications and the Internet. The most significant recent results of each IA are featured in the bi-annual Agency publication *Energy Technology Initiatives*. The IEA-produced newsletter *OPEN Bulletin* keeps its 18 000 subscribers up-to-date on the latest IA developments and events: sign up online at the subscribe newsletter page at the IEA website, www.iea.org. Finally, each Implementing Agreement operates a separate website, reachable through the IEA website. 



Among the many IEA Implementing Agreements, the one concerning

Greenhouse Gas covers CCS: www.ieaghg.org.

TO FULFIL THE COP ACCORDS, TURN TO THE EXPERTS

The Durban signatories need IEA policy and technology expertise to meet their goals in aspects from energy efficiency to low-carbon technologies.

When the dust settled from the after-the-last-minute agreement at the Durban climate-change talks, the work was just starting for the IEA.

As a principal monitor of countries' efforts to reach goals set under the United Nations Framework Convention on Climate Change (UNFCCC), the IEA collects energy data and develops projections and scenarios assessing energy-sector implications of achieving climate objectives. Parties – as signatory countries to the Convention are known – also rely on IEA policy and technology expertise on issues ranging from energy efficiency to market instruments for carbon pricing, from RD&D support measures to low-carbon technologies.

Some 30 hours after the official end late last year of COP17, or the 17th Conference of the Parties in South Africa, countries agreed on the next steps of the international climate policy process. The mandate of the Durban Platform for Enhanced Action is to come up with a protocol or other legal instrument by 2015 applicable to all countries, with implementation to start by 2020. In short, the Durban agreement opens the door to a fuller engagement of all countries to address climate change. At the

same time, the door to keeping the global temperature increase to less than 2° from the pre-industrial level is closing, as the 2011 edition of the *World Energy Outlook* reports. The space between these two “doors” is where IEA expertise can make a difference between now and 2020.

IEA expertise for fulfilling pledges

Beyond the vulnerability to climate change itself, what is at stake for most countries in the negotiation is how best to engage the transformation of their energy systems towards a low-carbon trajectory. This has been a core mission of the IEA since the adoption of its Shared Goals, alongside energy security and economic development, and energy ministers from IEA member countries reiterated that message at their latest meeting, in October 2011. Countries' current emission pledges for 2020 are not enough for the 2° goal, yet most if not all are taking actions in the energy field that go in the right direction, while also addressing local pollution, energy independence and the search for economic performance. The critical next step is to share that experience, successes and failures alike, with the broad energy policy community. IEA experts are constantly confronted with energy policy



By Richard Baron

Richard Baron is the Head of the IEA Climate Change Unit, where he focuses on market mechanisms for greenhouse-gas emissions mitigation and on policy packages for effective CO₂ reductions in the energy sector. He is also a member of France's Economic Council for Sustainable Development.

questions that some member and non-member countries have solved in practice. Grid integration of variable renewable energy sources is a recurring theme, for example, and there is now extensive experience on how to solve the issue. On the energy efficiency front, the IEA has developed *Policy Pathways* that provide practical answers on implementation.

The challenge is to avoid applying solutions without consideration of the domestic policy, regulatory or technology environment. An interesting example is provided by an IEA project with China's Energy Research Institute on how to use a domestic carbon market to lower CO₂ in the electricity sector. The regulatory environment of power generation in China (*e.g.* regulated prices, annual plans for dispatch) prohibits a direct transposition of the European Union's Emissions Trading System. A carbon market instrument will achieve its cost-effectiveness objective only if Chinese rule-makers provide some flexibility in the way operational and investment decisions are made in China's power sector. The Agency's role is to ensure the adequacy of the instrument with the country's broader energy policy objective, as a prerequisite for its acceptability and duration. It is through the multiplication of such cooperative actions that the energy sector will be best positioned to manage the transition to a low-carbon future – the promise of an international agreement alone will not suffice.

In Durban, Parties also agreed to extend the Kyoto Protocol beyond 2012. This allows the continuation of the protocol's market mechanisms, including the Clean Development Mechanism (CDM) that since 2000 has promoted thousands of projects to reduce greenhouse gases in developing countries. However, the extension of Kyoto emission goals does not include Canada, Japan, Russia, the United States or developing nations. With the protocol thus covering only 15% of global emissions, it is essential that the Durban Platform deliver ambitious objectives by 2015.

Three other developments are worth noting. First, negotiators agreed to create a new international



IEA Executive Director Maria van der Hoeven addressing delegates during COP17. The IEA has long attended COPs.

carbon market instrument to foster emission reductions on a bigger scale than that of CDM projects. The scale is broad sectors, or whole policies; here again, the energy sector looms large. Because the devil is always in the details of implementation, especially in climate-change agreements, this new system will need input from the IEA, especially the Agency's technical support to the UNFCCC negotiations via the OECD/IEA Climate Change Expert Group.

Second, the Parties agreed to establish a Green Climate Fund (GCF) that is to provide resources for country-driven approaches to both greenhouse gas reductions and adaptation. Many questions remain on how the GCF should be financed, but it has already generated a high level of attention among finance experts. Much of the discussion on the margins of Durban revolved around how to mobilise domestic finance towards low-carbon efforts, another area where IEA energy policy expertise can make a difference.

Third, negotiators agreed to the creation of a Technology Mechanism, with a mandate to facilitate technology transfer, including through

sharing of information on technology developments. The IEA *Technology Roadmaps* and the International Low-Carbon Technology Platform show much potential for synergy with the Energy Technology Mechanism's objectives.

The onus is now on the Parties to turn this and other new institutions into effective, non-bureaucratic bodies to foster action against global climate change.


The IEA at COP17 and beyond

No one at Durban, even with the late but crucial accords, pretended that the Parties are on track to limit emissions enough to keep the Earth's average temperature from rising more than 2°.

Should people worry about the 2020, or late, implementation of the future agreement? In a positive light, the lead-time between the completion of the negotiation, scheduled for 2015, and the implementation can be seen as a phase where countries gear up to meet their emission reduction goals. For instance, the Kyoto Protocol was signed in 1997 but the terms were not binding until 2008.

The question is whether the process coming out of Durban will create the policy impetus necessary to strengthen individual countries' energy sector efforts towards a low-carbon future. Guidance from the IEA can help countries gain momentum faster when they focus on reducing CO₂ emissions. The need for objective analysis, rooted in energy sector realities, can only grow after Durban.

The IEA was a significant presence in Durban, providing the expertise contained in its *World Energy Outlook*, roadmaps and other analyses, which were widely distributed. Besides hosting a number of side-events and other informational sessions, the delegation spoke at events organised by the International Emissions Trading Association and the Global Carbon Capture and Storage Institute, among several others.

The IEA expects to be present at the next COP, late this year in Doha, Qatar. It sees its activities at the conferences as critical to fostering the changes needed on the ground globally to achieve a low-carbon energy transformation and to increase the level of ambition sought by the new phase of United Nations climate negotiations. 

IEA-SOUTH AFRICA SIDE-EVENTS

As reported in the previous issue of *IEA Energy*, the UNFCCC negotiations do not address energy policy directly. However, the discussions around the challenges and changes facing the energy sector are in the back of everybody's mind at climate negotiations.

The IEA, apart from feeding into the debate through its technical analysis, scenarios and identification of best policy practice, is also present at the Conferences of the Parties to the UNFCCC to spread its messages and engage in discussions with the broad energy and climate policy community. By means of news conferences and dedicated side-events, the Agency addresses the global energy issues most relevant to climate policy.

At the Durban COP, the IEA role was even more special, as the host government invited the Agency to co-organise a series of side-events with its Department of Energy, a key partner in joint work the IEA does with South Africa. The opportunity also allowed the IEA to work with a number of other South African institutions, including the public

utility Eskom, the CCS Center (SACCCS) and the Energy Development Institute (SANEDI).

For its 10 side-events over the two weeks of the Durban talks, the IEA called upon other international organisations to join it on panels, including the International Renewable Energy Agency (IRENA) and the French Environment and Energy Management Agency (ADEME), among others. The programme encompassed many pressing issues, including clean energy and energy efficiency finance, transport fuel efficiency and renewable energy technologies.

Energy efficiency was a particularly important topic at this forum, even more so for the South African government. Tied to COP17, South Africa launched its National Energy Efficiency Campaign and Energy Efficiency Leadership Network at a special gala, where the IEA delivered a speech, hailing the country's good progress, including its ambitious target to improve energy efficiency by 12% within three years.

The events also launched high-level discussions, as panellists included the South African Minister of Energy, Elizabeth Dipuo Peters,



Eskom, the IEA and IRENA at one of the co-hosted events.

and the Deputy Minister, Barbara Thompson; the executive director for strategy and research at ADEME, François Moisan; and the director general of IRENA, Adnan Z. Amin, alongside IEA Executive Director Maria van der Hoeven and Deputy Executive Director Richard Jones.

Besides complementing the climate debate with a much-needed global perspective on energy issues, the events further reinforced ongoing collaboration between the IEA and South Africa, providing a platform for exchange among a great number of stakeholders from industry, government and specialised agencies.

– Veronika Gyuricza

NETWORK



Access to the world

Royal Vopak is the world's largest independent tank terminal service provider specializing in storage and transshipment solutions for bulk liquid oil products, chemicals, vegetable oils and liquefied gasses. With our global network of more than 80 terminals and dedicated professionals, we offer access to business opportunities in more than 30 countries around the world. With almost 400 years of history and stock-listed in Amsterdam, we work every day to become an integral part of the societies in which we operate. With our tradition of sustainable entrepreneurship, we strive to make a meaningful contribution to our stakeholders by focusing on growth, operational excellence and customer leadership.

2015: PRICEY DELAY FOR CLIMATE ACTION


Policy makers have been preoccupied of late with concerns about economic growth, but it is imperative that they not lose sight of the urgent need for a transformation to a low-carbon energy economy. Despite impressive recent growth in the use of renewable energy, energy-related CO₂ emissions rebounded to a new high in 2010. Current energy sector trends point to CO₂ emissions consistent with a long-term increase in the average global temperature of 6°, which would lead to environmental and economic costs at a scale frightening to imagine.

In its 450 Scenario, the *World Energy Outlook 2011 (WEO 2011)* analysed what it would take from now to 2035 to set the energy sector on a path that stabilises the atmospheric concentration of CO₂ emissions at 450 parts per million, a level limiting the temperature rise to 2° since the start of the industrial era. The analysis emphasises the narrowing window of opportunity to achieve this and, critically, the increasingly high costs of delayed action. To illustrate the magnitude of these costs, and thus the incentive for earlier action, the *WEO* considers the case in which we wait until 2015 to take significant steps to cut CO₂ emissions. The energy sector is assumed to follow a business-as-usual path during the delay, meaning there is a less ambitious shift towards renewable energy sources and low-carbon energy technologies. Instead, investments continue in fossil-fuel-based generation, particularly cheaper, inefficient plants. The effect is that CO₂ emissions overshoot the trajectory of the 450 Scenario in the early years of the projections. To meet climate objectives by 2035, these additional emissions would have to be offset by later reductions.

Realising these reductions entails increasingly expensive actions in the power sector. First, power plants would be retrofitted with carbon capture and storage equipment in circumstances where this is more economic than early retirement. Second, power plants beyond their economic lifetime (*i.e.* the initial investment has been repaid) but that are still safe and profitable would be shut down, and operators would forgo revenues. Third, power plants would have to be retired before the end of their economic lifetime, with operators suffering losses in both sunk costs and forgone revenues. Fourth, additional investment in low-carbon generation would be required. COP17, the United Nations climate talks late last year in South Africa, provided some grounds for optimism, with all of the biggest emitters signing up for the very first time to develop a binding agreement to cut emissions. They were given until 2015 to negotiate the exact details. However, there has been no indication since that this agreement has had a material impact on investment decisions in the energy sector. We remain on an unsustainable course for the climate!

Delaying action on climate change mitigation until 2015 offers limited short-term financial savings but considerably higher costs later. Prior to 2020, delayed action would avoid a net USD 150 billion of investment. Post-2020, however, relatively more low-carbon generating capacity and equipment would need to be installed to compensate for additional CO₂ emissions, incurring extra investment costs of USD 650 billion through 2035. This means that for every USD 1 of avoided investment before 2020, an additional USD 4.30 would need to be spent afterwards to meet the 2° goal. It is clearly in our interest to adopt policies that encourage the transformation to a low-carbon energy economy sooner rather than later.

Where should abatement efforts, and related policies, be concentrated? Shifting away from emissions-intensive energy sources is a key source of reductions in the energy sector: in the 450 Scenario, renewables, nuclear and carbon capture and storage together account for more than half of abatement in 2035 as compared with the baseline. But the single greatest source of abatement is the energy that we avoid using, achieved through energy efficiency measures. These account for some 44% of the emissions reduction. Given energy efficiency's benefits in savings of both energy and emissions, the *WEO 2012* will feature an in-depth analysis of strategies for unlocking its potential.

It is clear that we face a momentous choice between acting boldly now or continuing to delay action. History will not reflect kindly on us if we fail to make the right decision. 



By Fatih Birol

Fatih Birol, Chief Economist of the IEA, has been named by Forbes Magazine as the world's fourth most powerful person in terms of influence on the global energy scene and has been appointed as the Chairman of the World Economic Forum's Energy Advisory Board. In 2009, alongside awards from the Dutch Ministry of Economic Affairs, Polish Ministry of Economy, Russian Academy of Sciences and others, Germany honoured him with its Federal Cross of Merit.

CHALLENGES AMID RICHES: OUTLOOK FOR AFRICA

Modern, reliable energy service is a dream for most Sub-Saharan Africans, but plentiful resources offer hope for improvement.

More things divide Sub-Saharan Africa than one might first think: languages, ethnicities, religions, climates (you can even find ski resorts). However, several challenges are common to the whole region. Diseases are one (malaria and HIV are the most often cited examples), and problems related to energy are another. Although the region is rich in resources (renewables as well as oil and gas) that have the potential to generate wealth and improve the general welfare, few countries manage to reap or distribute the benefits. Hence, modern energy services are out of reach for most, and for two-thirds of the population, power is inaccessible and unaffordable. As energy poverty is a major obstacle to economic and social development, this is very bad news.

Of the 1.3 billion people across the world who lack access to modern energy, the *IEA World Energy Outlook* estimates that 84% are from rural areas – and approximately two-thirds of Sub-Saharan Africa's population live in such areas. This represents a real challenge for people at the “base of the pyramid”, who need to provide for their own energy needs: lighting, heating and cooking.

More than 650 million people in Sub-Saharan Africa rely on traditional biomass for cooking and heating, with fuel wood being a fuel of choice for most. Its share is unlikely to decline, but as long as special attention is paid to very specific challenges, this could prove a benefit. Biomass, often regarded as “unsustainable” and “dirty”, has many advantages despite its reputation: if produced sustainably (to local, regulated markets from managed sources), it can be a low-carbon source of energy. Cleaner cookstoves can burn more efficiently and less harmfully, potentially saving more than a million people who would otherwise die from household air pollution each year. Increasing sustainable biomass production and improving cooking technology are both consistent with the United Nations Millennium Development Goal targets, so the advantages are clearly multiple.

With new, competitive conversion processes, electricity could also be produced using biomass.

Until this approach becomes widespread, however, lighting in the approximately 110 million off-grid households in Sub-Saharan Africa (about 585 million people) will continue to come from more traditional sources: apart from wood crop and waste, candles are used, but kerosene lamps are by far most prevalent. No need to highlight the latter's adverse health effects, but the soot (also known as “black carbon”) they produce from incomplete combustion is also a major concern because of its role in global warming.

For these reasons alone, but also because of their remarkable potential, the continent should capitalise on its vast renewable energy resources on both smaller and larger scales.

Using renewables to leapfrog development

Such was the view of African energy ministers, who gathered late last year ahead of the COP17 climate talks in South Africa. They agreed that creating low-carbon economies is the only way to meet climate challenges while addressing broader development concerns – especially with the rising prices of fossil fuels limiting access for most of Sub-Saharan Africa. Rather than choosing the energy mix and technologies used by OECD countries in the 1950s and 1960s,



By Veronika Gyuricza

Veronika Gyuricza joined the IEA Global Energy Dialogue two years ago, and currently leads the Sub-Saharan Africa Programme. She earned degrees in environmental policy from the Central European

University as well as in engineering and science. For her doctorate, she worked with developing countries.

Sub-Saharan countries could leapfrog to solutions more adapted for low-carbon development, skipping a 20- to 25-year development curve that other parts of the world went through.

In addition to sustainable use of biomass, solar energy is gaining pace across the continent, offering off-grid solutions. It represents a dynamic and rapidly growing market, particularly for lighting, with a broad spectrum of products and with a variety of business models, including jobs.

Modern cooking facilities and off-grid lighting technologies are a very important step forward, especially for the rural poor, but electricity access remains a prerequisite for the delivery of most social services, communication, security and other basic quality-of-life improvements.

For most *IEA Energy* readers, living without electricity is unimaginable, apart from the occasional camping trip: for most Sub-Saharan Africans, it is a daily reality. The generation capacity of all Sub-Saharan African countries is comparable to that of Spain. Exclude South Africa, and this estimated capacity falls to less than half. To make matters worse, a quarter of Sub-Saharan Africa's power plants are not in operating condition – for



Wood gatherers in Madagascar: biomass, prevalent in Africa, can be a low-carbon energy source if produced sustainably.

example, Nigeria can generate only about half of its installed capacity.

As a result, even the one-third of the Sub-Saharan population “on-grid” experiences unreliable service. According to a World Bank study, in almost 20 countries, this means having 10 or more blackouts each month. Freetown, the capital of Sierra Leone, is often referred to as “the darkest city in Africa”. Electricity is also very expensive, with an average tariff of USD 0.14 per kilowatt-hour because of the power systems’ small scales and their reliance on costly oil-based generation.

Renewable resources can make an important contribution to cheaper and faster electricity access through decentralised off-grid and small-scale options. But renewable energy can also play a key role on a larger scale. Hydropower, 92% of which is unexploited in the region, could meet a significant share of additional electricity generation. Geothermal resources in East Africa’s Rift Valley alone could provide 15 gigawatts, enough to electrify 150 million households – very little of this resource is tapped at present. Positive examples exist: in Kenya, more than 56% of electricity came from renewable sources as of 2009, with geothermal contributing up to 10% of total generation. Countries such as Senegal, Ghana and Tanzania rely on hydro for renewable generation. In 2007 the largest grid-linked photovoltaic system in Africa was inaugurated in Rwanda, and large-scale solar- and wind-park projects are under development in South Africa.

Regardless of what is powering the grid – renewables or coal or gas from recent promising finds – regional interconnections could improve electricity access. Smaller countries simply cannot afford large-scale power generation facilities themselves. Regional Economic Communities, the African Union’s “building blocks”, have a key role in developing such interconnectedness.

In any case, to make further improvements, Sub-Saharan Africa needs to establish a correct framework to attract investment and keep prioritising the development of its infrastructure. Policies and regulations must be put in place to create an investor-friendly environment and encourage the private sector to invest in the enormous potential for renewable energy. Governments need to commit to long-term electrification projects, as this can bring about change – witness South Africa’s Integrated National Electrification Programme.

At this point, however, energy and development in Sub-Saharan Africa is very much a chicken




Cape Town’s skyline lights up the night, but blackouts are common across Sub-Saharan Africa.



Victoria Falls: only 8% of Sub-Saharan Africa’s hydropower potential has been tapped so far.

and egg problem. Economic growth is very promising at the moment – according to a World Bank study, Sub-Saharan Africa hosts 10 of the 30 economies with the highest growth since 2005. Furthermore, the region as a whole is consistently growing faster than any other, with this growth less and less dependent on commodities. Countries should be in a much better position to invest in energy infrastructures and services, helping them to alleviate access problems and keep up with population growth.

In financial terms, extending basic energy services to all the deprived in Sub-Saharan Africa would cost USD 20 billion a year, a significant increase from the current investment level but possible when looking at official development aid flows, future GDP growth, foreign direct

investment and new ways of financing, including carbon finance. In turn, improved energy services will facilitate more balanced economic growth, easing the drag that energy poverty currently puts on development. The prospects for initiating a positive cycle are greater than ever before. 

Further reading at www.iea.org:

Renewable Energy: Markets and Prospects by Regions (2011)

Comparative Study on Rural Electrification Policies in Emerging Economies: Keys to Successful Policies (2010)

WEO 2010: Energy Poverty – How to make modern energy access universal? (The WEO excerpt is also available at: www.worldenergyoutlook.org/docs/weo2010/weo2010_poverty.pdf.)

BACK BY POPULAR DEMAND: IEA TRAINING WEEK

For a second year, the IEA is offering high-level courses on best practice to more than 100 energy professionals from around the globe.

In 2011, the IEA launched a new international training initiative, Energy Training Week (ETW). Since it was immediately oversubscribed and received positive reviews from participants, the IEA is repeating the event this April, inviting to Paris more than 100 energy professionals from government and industry. Participants representing more than 50 nations – mainly developing and newly industrialising countries with a more limited access and exposure to IEA work and best practice – have confirmed they will attend.

ETW offers a programme structured into week-long courses that run in parallel, showcasing the latest IEA energy knowledge and research results. Topics range from commodity markets and security to low-carbon options such as energy efficiency and renewables.

Besides lectures, interactive discussions, practical exercises and field trips, the programme allows ample opportunities for networking with Agency experts and colleagues from around the world. Last year, ETW helped many participants develop deeper ties with the IEA by exchanging data and information, collaborating on research projects or reviewing national



Some of the advanced courses feature site visits.

energy policies following the event. Thanks to grants from member countries and international donors, the IEA can offer the programme free of charge and use it as a platform for launching further regional or bilateral training initiatives at other times.

For the 2012 ETW, there are two introductory sessions and five advanced courses covering a wide spectrum of topics – energy security, markets, sustainability, technology and analysis – featuring the latest trends and developments in sectors such as oil, gas and renewables. IEA experts and guest specialists lead the classes.

Advanced classes follow introductory ones

For the two-day introductory courses, participants choose between Energy Security, an overview of the oil and gas industry, politics and market development, and Sustainable Energy, a crash course in energy efficiency, renewables and climate policy.

During the main training week, participants select one of the five advanced courses. Energy Essentials for Decision Makers is intended for experienced managers and policy makers with broad responsibilities; it addresses the latest international energy developments and demonstrates practical tools for policy formulation and planning technology deployment. It focuses in particular on sustainable and low-carbon energy options, such as energy efficiency and renewables.

Energy Markets and Security explores a broad range of issues regarding oil and gas market trends and prices, supply disruption and response, and market regulation, arguing for greater diversity of supply in energy systems. It emphasises strong practical training, including a supply-disruption simulation exercise and site visits to oil and gas facilities.

Energy Efficiency Policy and Measures addresses best practice for energy efficiency, concentrating on such sectors as buildings, industry



By Assen Gasharov


Assen Gasharov leads the IEA Energy Training and Capacity Building Programme, focusing on transferring knowledge and skills from industrialised to developing countries. He has 10 years of experience in energy and climate change; before joining the IEA he worked for international consulting firms in London.



Classes are taught by a mix of IEA and outside specialists.

and transport. Participants master a range of case studies from around the world while using policy development tools, visiting sites and engaging in group problem-solving exercises.

Renewable and Low-Carbon Energy Technology explores how best to formulate policy for renewable energy planning and low-carbon technology deployment. The course demonstrates IEA energy technology roadmaps – a methodology that encompasses the policy objectives, stakeholder engagement and financial incentives necessary to support a particular technology.

The fifth course, Energy Analysis and Modelling, looks at a range of practical IEA applications – from developing energy efficiency indicators to modelling a national power generation portfolio. Participants learn the fundamental principles of energy analysis and modelling and then receive hands-on training. They use tools such as the power generation TIMES model and the transport sector MOMO model, both of which contain large databases of historical information and projections. 

See www.iea.org for more information about Energy Training Week.

FOSSIL FUEL INDEPENDENCE: DENMARK'S PATH

In keeping with its domestic clean-energy plan, Denmark makes “green research and green jobs” a priority during its six-month EU Presidency.

Reaching a consensus is a difficult enough challenge among politicians in the same party, let alone with those in competing parties. Everything from political wrangling to economic pressures can, and often does, derail agreements continuing from one government to the next.

Not so in Denmark, where politicians have formed a broad consensus on the country's ambitious long-term national energy goal: to become independent of fossil fuels by 2050. The detailed document *Energy Strategy 2050* lists policies to get Denmark to this target. One such initiative focuses on boosting use of biofuels as well as promoting electric cars to ensure a 10% share of renewable energy in the transport sector by 2020.

Progress via political consensus

Kieran McNamara, a Desk Officer in the IEA Country Studies Division, argues that while setting such a bold target is easy enough for countries, backing it up with a detailed and well-thought out plan is different. And that, he says, is what Denmark has achieved in its strategy for the next four decades.

“There is an understanding of what is implied by independence from fossil fuels, and the strategy

sets out transparent principles for the transition,” he observes. “This clarity is important as it ensures that there is the broadest possible understanding of the government's goals. It is pragmatic, with an emphasis on what can be done in the short to medium term, and incorporates the flexibility to respond to changing technologies over time. It also highlights the need for targeted measures and interventions.”

McNamara points out that in many cases, governments cannot find common ground on energy policy, which consequently impedes chances of uninterrupted progress. But Danish politics, he notes, are based on shared views – since 1909 no single party has had the majority in Parliament – which has allowed a clear, long-term vision to emerge, generally unimpeded by short-term political changes.

“There is broad consensus on this issue in Parliament,” explains Hans-Jørgen Koch, Deputy State Secretary at the Danish Energy Agency. “Politicians are simply convinced there is a need to move away from fossil fuels.”

In 2007, the government at the time stated that Denmark should be a low-carbon society with a visionary energy and climate policy. This evolved



By Tom Baird

Tom Baird is a writer and communications adviser for the IEA. He previously worked at The Sunday Times newspaper and at the Commonwealth Secretariat, an intergovernmental organisation based in London. He is co-author of the current affairs book *What on Earth Is Going On?*.

into the plan to be free of fossil fuels by 2050. Following a change of power in September 2011, the incoming government has taken on this strategy with gusto.


It is not just the politicians who have united behind this issue, says Koch. “Critics have told me that the *Energy Strategy 2050* will be terribly expensive for Denmark, but estimates show costs will work out at EUR 1 per day per household over the next 40 years. Most Danish homes are ready to pay this as an insurance policy.” He adds, “In Denmark, there are not massively strong social differences, so it is easy for us to have common values and perceptions on what is important and what is not.”

Danes push for a green Europe

Denmark's energy strategy is not just a national ambition, as Helle Thorning-Schmidt, the country's first female Prime Minister, made clear in her speech to the European Parliament this January that marked the beginning of the six-month Danish presidency of the Council of the European Union (EU). Working for a green Europe was one of the four “key priorities” outlined in her speech.

“The EU has developed an ambitious policy on energy and climate issues,” she said. “We are a leader on the global stage. But to maintain our position, and to encourage others, we need new initiatives in areas such as energy efficiency and renewable energy.”

She concluded, “The Danish Presidency will work hard to ensure that the center of green research and green jobs stays in Europe in the future.”

During Denmark's European Presidency, there are a number of energy-related dossiers for the Council to address, including the Union's Energy Strategy 2020 and Energy Roadmap 2050. The prime minister's speech suggested that with these and other EU targets and strategies, the Danes will continue to play an influential role in international negotiations, much like their strong voice as host of the 2009 United Nations climate change conference in Copenhagen. 



Denmark's long-term commitment to a low-carbon future has evolved into a plan for full independence from fossil fuels.

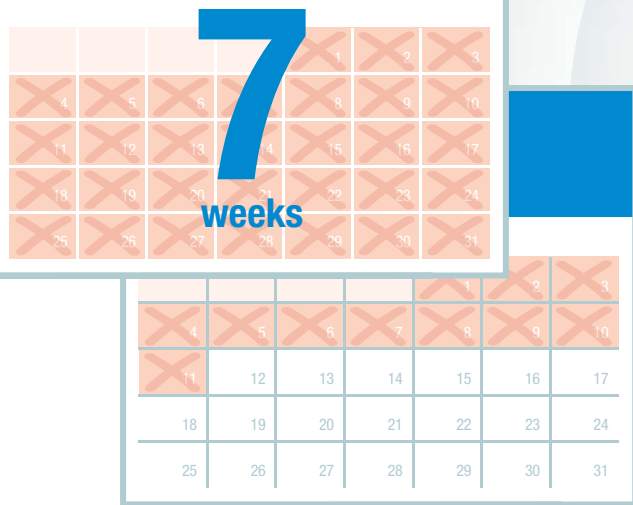
BREAK-EVEN, BROKEN DOWN

How soon can a wind farm offset the greenhouse gases (GHG) emitted to build, run and recycle it over its 20-year life cycle? Among the many factors that affect the break-even point are model, placement, recycling potential, weather and transportation of maintenance crews.

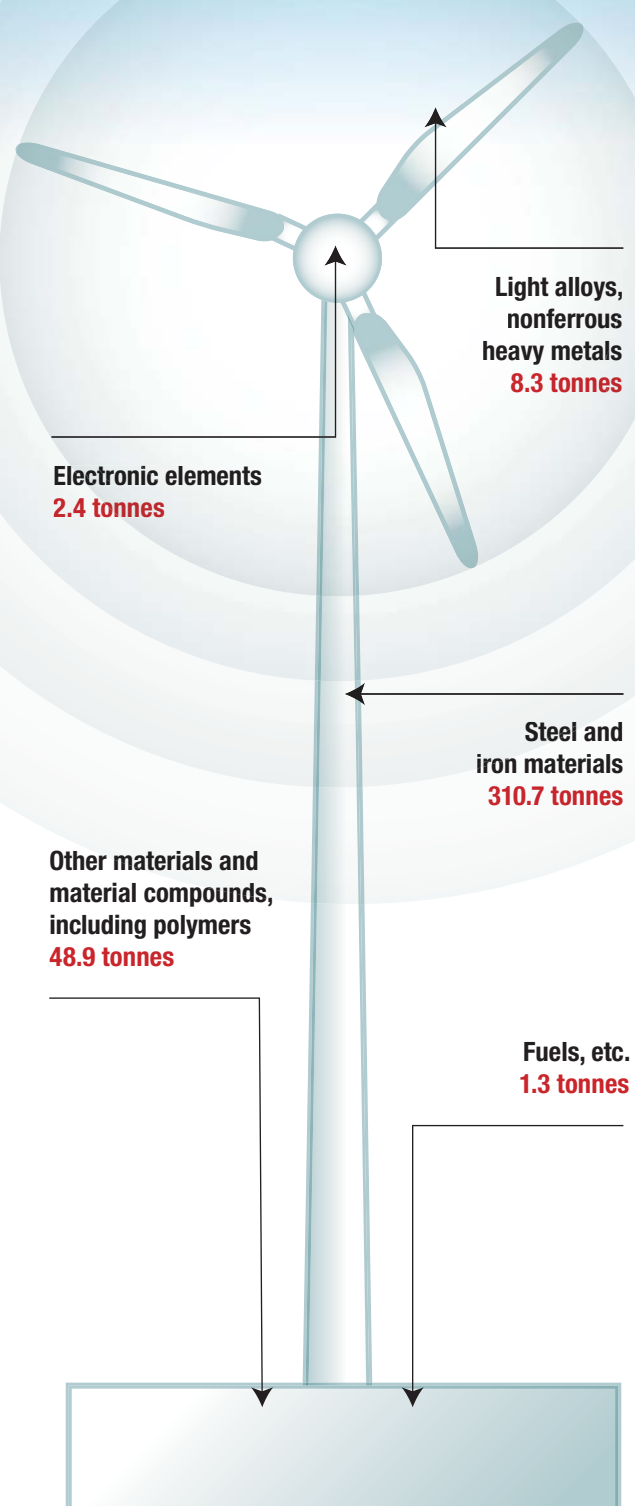
A 33-UNIT FARM OF 3.0 MW TURBINES CAN...

...offset GHG from its creation and operation in as little as

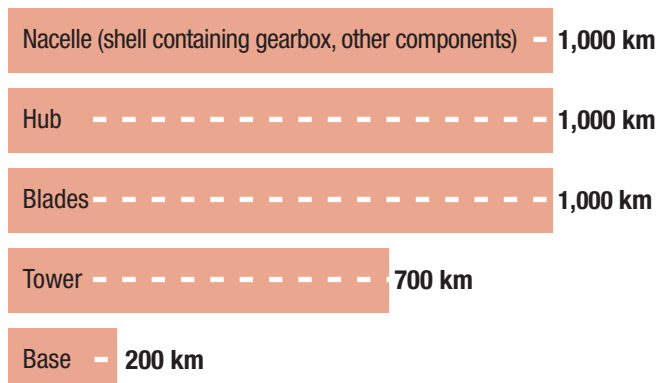
7
weeks



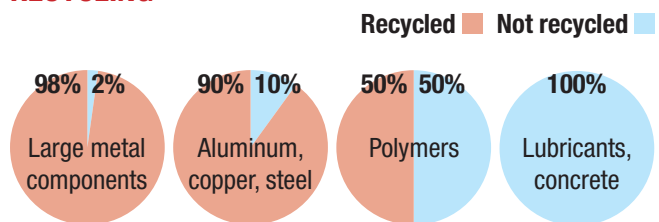
PER-UNIT MATERIALS FOR A 33-UNIT WIND FARM



ESTIMATED TRUCK TRANSPORT OF COMPONENTS TO SITE



RECYCLING



Data source: "Life Cycle Assessment of Electricity Production from a Vestas V112 Turbine Wind Plant", PE North West Europe Aps, February 2011. Graphic: © OECD/IEA, 2012 by Eliot Bejgmon/www.ebejgmon.com

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electricity security & a climate- constrained world

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