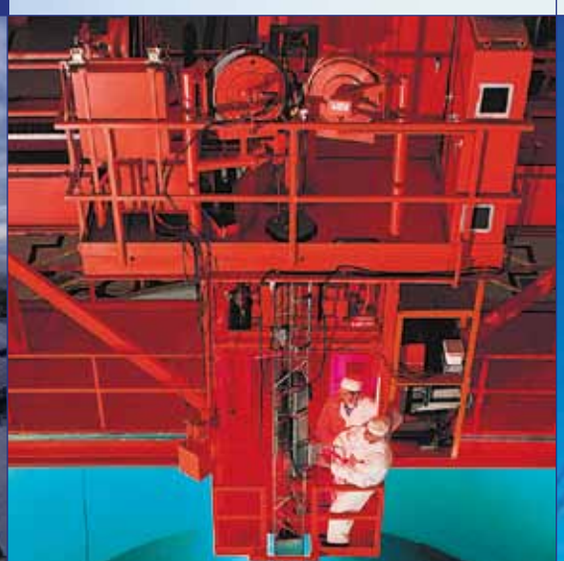
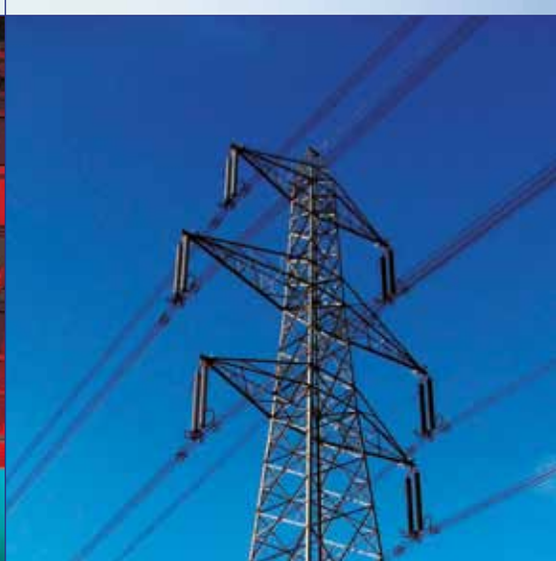
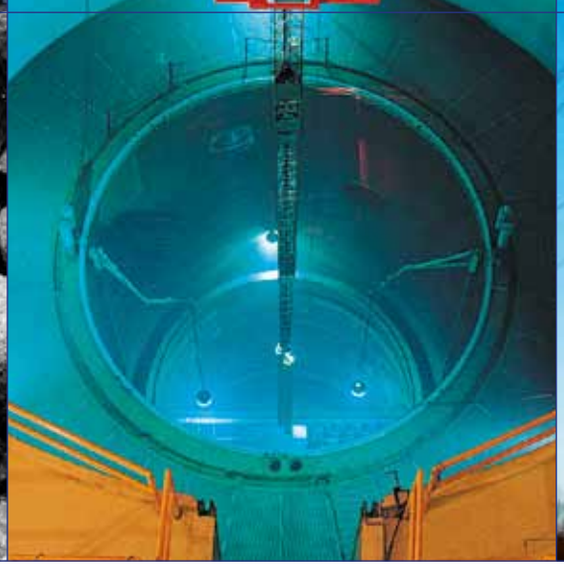
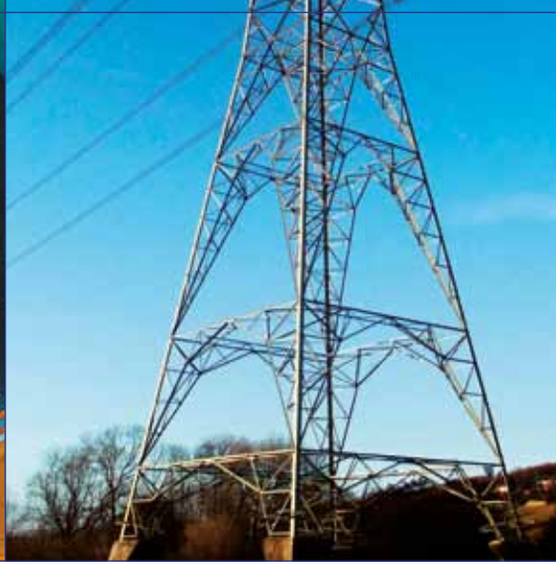
WORLD ENERGY COUNCIL
CONSEIL MONDIAL DE L'ÉNERGIE
For sustainable energy.

World Energy Insight 2011

Official Publication of the World Energy Council

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THE QUEEN'S AWARDS FOR ENTERPRISE 2010

Contents

2011: A year of change for the Energy Industry?

By Pierre Gadonneix, Chairman, World Energy Council
and Honorary Chairman, Electricité de France (EDF)

When I closed the World Energy Congress in Montreal last year I set out the key challenges facing the energy sector: energy security, environment and climate protection, and the struggle against inequalities and energy poverty. This was all in the context of a world starting to recover from the global economic crisis, the oil industry waking up after the dreadful spill in the Gulf of Mexico and the realisation that global energy demand was increasing at an incredible rate, since the energy global demand will at least double by 2050. The challenge I set out at that stage was great and I believe that both governments and the industry were rising to meet it. A consensus was established at that time among all delegates that we would need to invest in infrastructures and in R&D at a level and at a pace never reached before (about 4 per cent of global GDP by 2030), and in a financial context that has become worse and worse: at the time I am drafting this article, the financial markets are in an unprecedented turmoil. A consensus was also established in Montreal that, in order to ensure these investments, we would need a renewed governance at both national and international levels, to give a (visible) hand to the market and help governments, industries and investors make the right decisions as regards investments, R&D, international trade, safety regulations, environment protection, and fight against inequalities.

But little did any of the 7,000 delegates in Montreal know what 2011 had in store. The events in 2011 urge us to move even faster towards a greater coordination and a reinforced international governance of the energy sector, to promote a safer, greener and more equal energy mix. Let us have a deeper look at what 2011 taught us.

The price of oil at the time of the Montreal congress was at US$80 a barrel, and at a level where some commentators were suggesting that it had reached its maximum level. Then the so called “Arab Spring” that sprouted in Tunisia and sprawled to Egypt, Libya and now Syria, has increased the uncertainty in the oil markets and coupled with unprecedented demand from China we now see in 2011 the price of crude reaching US$125 a barrel, with many of the same commentators predicting yet further price rises, also in part due to some shift of demand from countries giving up nuclear.

Indeed, on March 11th tragedy struck the north eastern coast of Japan. Whereas in Montreal, the consensus was that the world would need all energies, including nuclear, to face the challenge of energy security, governments have been forced by this dreadful event to look again at their plans to use nuclear power to meet their countries’ energy needs. While most countries have confirmed their plans to develop nuclear; some are carving out a new route. Yet everywhere, safety measures are being reinforced. The results from WEC’s nuclear survey show that the perception of nuclear safety in developing countries has not changed significantly since Fukushima, in comparison to the reaction in developed countries. Therefore we will continue to see growth in this area, regardless of the recent decisions taken by Germany, Switzerland and Italy. Globally nuclear will move on – driven by China, Korea and Russia.

Countries like China keep on developing nuclear energy to maintain their impressive growth rate. China already has a further 23 reactors under construction in an attempt to keep pace with the ever increasing demand. However, despite their drive to increase the use of renewables, coal continues to be the largest source of energy in China, representing about 79 per cent of their current electricity mix as opposed to only 1.9 per cent for nuclear. The significance of China’s need for oil and gas will continue to put pressure on prices and will impact countries throughout the world.

In the short term gas will be used to meet the demand for energy as we recover from the economic slowdown. This of course has an impact on the many commitments to reduce CO_2 emissions and on energy security.

Even before the event in Japan, we identified in Montreal that gas was becoming increasingly significant, with the impact of shale gas effectively removing the historic link between the gas markets and the oil price. For the same content in energy, the price of gas is today three times cheaper than the price of oil in the US market, which is a far greater gap than the price differential observed in the past. Gas is being looked upon by many developed countries as a convenient way to meet their growing energy needs with a greener energy source than coal without CCS for example. And it is true, gas has a role to play towards a low-carbon energy mix.

Oil will remain the primary source of fuel for the mobility sector well into this millennium and we’d look forward to the finding of our Future Transport 2050 report. Although some suggest that by 2050 the use of fossil fuels to power the world’s transportation needs will have to decrease significantly, with transport responsible for 28 per cent of energy-related CO_2 emissions, this change will create a huge supply gap. Electric vehicles and the use of biofuels will meet this demand in part but both fuels have significant

limitations requiring us to look deeper into new technologies such as hydrogen. In the meantime, hybrid options will become ever more popular in the developed world as we seek to increase the energy efficiency of our transport offer. But they will require, again, huge investments in new infrastructures.

Yet of course, Energy Efficiency is key to help us meet the challenge of energy demand and mitigate up to 40 per cent of possible carbon emissions by 2050, but we know this is not a low hanging fruit: we need to incentivise offer and demand and, for example, real prices of energy can be a helpful device.

The renewables market has great potential but will require significant leadership to fully realise its potential: we need to promote the use of already mature technologies, while fostering R&D for technologies that are not yet mature. This will also require the directions of an inspired regulatory framework.

But providing more efficient forms of energy for those who already have it is only half the battle. We must seek to identify ways of providing electricity access for the 1.5 billion energy poor in developing and also developed countries. Energy poverty hinders development and threatens growth. This is why we are actively supporting the UN Secretary General's "International Year of Sustainable Energy for All" in 2012.

The 2011 events in the energy sector have thus reinforced our need for well oriented and incited investments in all energy resources and technologies, all over the world. Nevertheless, there are no "one size fits all" solution, and the consistent message from WEC's annual issues survey is that the energy sector needs clearer policy frameworks to enable these consistent investments. 2011 has also seen governments reacting more eagerly than ever looking to capitalise on the opportunity to secure a more sustainable model of development and energy provision. President Obama, in his State of the Union address, has challenged law makers in the US to set a new goal; that by 2035, 80 per cent of the nation's electricity will come from clean energy sources. In China, President Hu has included alternative energy as one of the country's new "seven strategic industries." And in Europe the EU has its 20-20-20 target, with Germany and Italy renouncing nuclear power.

These are the signs that the governments will not let the market alone. I believe this is a good step taken: the energy sector needs more national and international governance. This year I have already called for improved global governance for the nuclear industry in the wake of the Fukushima accident. In general for all energy sources, we must ensure that safety cannot be used to provide a competitive advantage in the rush to develop this sector of the green economy.

If we are to face all our challenges, the sector will need clear leadership. It is our duty to contribute to the debate and help leaders make decisions in order to have clear direction and develop a sustainable energy economy. I am committed to ensuring that the World Energy Council will play its full part in sharing experience and knowledge, organising the debate and helping to promote a sustainable supply and use of energy for the greatest benefit of all, as this is at the core of our mission.

2011 has been a significant year of change for the energy industry but as we look to 2012, I foresee even more challenges for the sector. With the first round of the Kyoto protocol coming to an end and a world recovering from the economic and financial crisis, we need to help policy makers guide the frameworks that will deliver sustainable growth for all. The insights within this publication and the work that WEC will be doing to provide the forum for energy leaders will only strengthen this process, along with the ongoing WEC studies and programmes on Energy Policies, 2050 Energy Scenarios, Energy Resources & Technologies, Energy for Urban Innovation, Rules Of Energy Trade and Global Energy Access that we seek to deliver soon.

Let me now wish you a very insightful reading of this edition of *World Energy Insight* and very promising and efficient debates at our many events over the coming year. ❑

Plenary session, World Energy Leaders Summit, Rio de Janeiro

What keeps us awake at night?

By Dr Christoph Frei,
Secretary General, World Energy Council

In 2010 we wrote in the same place that "it has become commonplace to state that the world has fundamentally changed over the past decade." Yet, the events of 2011 will belong to the category of being mentioned in our grandchildren's history books and will have profound effects on the global energy industry. The developments in the Middle East and North Africa region and the tragedy at the Fukushima nuclear power plant have added to the pressure to adapt and are a set-back in solving the global energy challenges: The expected doubling or even tripling of the global energy demand by 2050, the need to cut global greenhouse gases by fifty per cent during the same period (which requires a cut of eighty per cent in OECD countries), the 1.5 billion people who are still without energy and, the need to improve global governance in respect of the management of global risks from large-scale accidents require massive transformational efforts on a global scale.

With these challenges on the one side and the need for global dialogue to find solutions on the other, the founding vision of the World Energy Council is in its fruition. The World Energy Council provides the principal impartial forum to facilitate dialogue among Energy Leaders on the critical issues affecting the global energy agenda. Formed in 1923, with headquarters in London, WEC is the UN-accredited global energy body representing more than 3000 organisations in over 90 countries from governments, private and state corporations, academia, NGOs and energy-related stakeholders. WEC covers the entire energy spectrum promoting the sustainable supply and use of energy for the greatest benefit of all. Assessing the impact of new technologies and innovation on the energy sector, WEC informs global, regional and national energy strategies and policies. WEC does this by hosting high level events, publishing authoritative studies and working through its extensive member network to facilitate the Energy Leaders' dialogue.

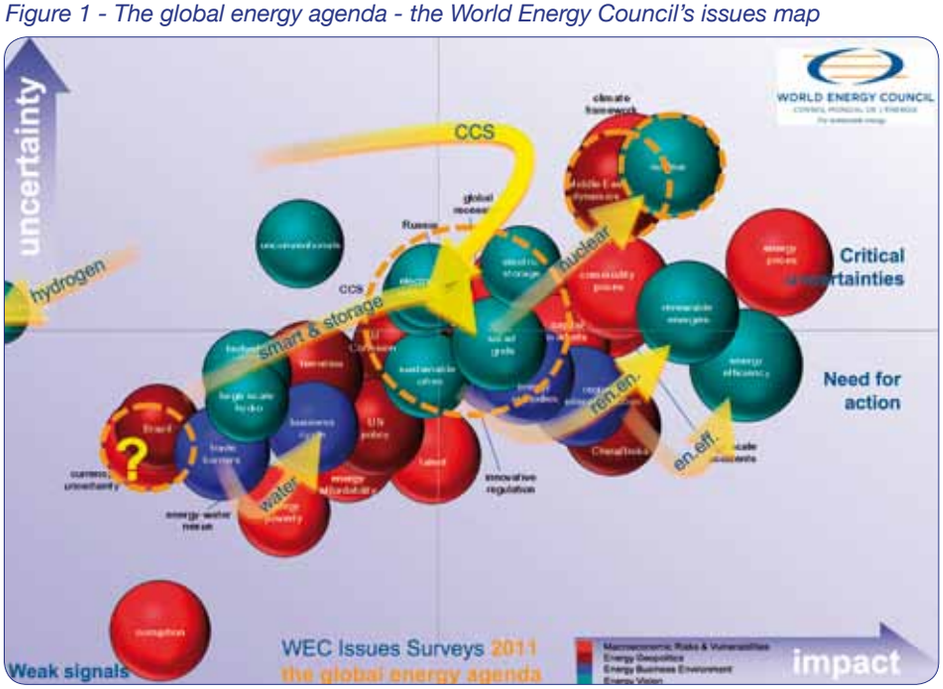
Assessing the Global Energy Agenda

We can only advance a meaningful dialogue among the Global Energy Leaders if we know what keeps them awake at night. It is their perception of what is important that defines the Global Energy Agenda. In order to assess this Global Energy Agenda and its evolution over time, the World Energy Council conducts an annual issues survey with the Chairs of its Member Committees who are Ministers, CEOs and leading experts in over 90 countries.

The survey includes about thirty issues covering macroeconomic risks, geopolitics, business environment as well as energy vision in a high-level "helicopter perspective". The Chairs quantify each issue's impact on the energy sector, the degree of uncertainty related to its impact, and the urgency with which they wish to address the specific issue. The responses are translated into issue maps with the three assessed dimensions as its axes (see Figure 1).

With our content work we then make sure that we can inform their concerns with facts on technologies and resources, successful practices in policy and strategy, and a mapping of risks and critical uncertainties. We facilitate the on-going Energy Leaders Dialogue on identified critical uncertainties through our Congress,

Figure 1 - The global energy agenda - the World Energy Council's issues map



Energy Leaders Summits, Regional and National Forums and build consensus on required policies and strategies.

2011 Results and Interpretation

In 2011, the critical uncertainties space is dominated by climate framework uncertainty, political instability in the Middle East / North Africa region and, uncertainty regarding the nuclear renaissance post-Fukushima. In comparison to 2009, macroeconomic risks related to the financial / economic crisis have lost their dominance as key concern for the energy sector; however, the crisis is still looming and issues including energy price volatility, commodity prices and capital market access remain in an alert position, similar to 2010.

The absence of a global climate framework post 2012 and the lack of progress towards a significant agreement between the big blocks have kept this issue a dominant critical uncertainty for the sector. The "political spring" in the Middle East / North Africa region with its impact on Libyan oil supply has affected energy markets globally, added volatility and triggered the second IEA stock release in the institution's 30 years history. The Fukushima event has pushed the nuclear renaissance from consensus to a critical uncertainty. Taken together, last year's Macondo oil spill and Fukushima have put large-scale accidents on the top of Energy Leaders' agenda.

Our nuclear survey on short-term policy impacts indicates that the leading nuclear nations (except Japan) do not signal change in their nuclear outlook. Russia, China, and Korea, representing two-thirds of the 61 projects underway, have not changed their nuclear ambitions. Countries that have changed their attitude with respect to nuclear include Germany, Switzerland, Italy and Japan. Time will have to show how increased safety costs affect the competitiveness of the technology and whether the aging nuclear park can be replaced in the given context. Our survey indicates that natural gas is the most likely substitute for not-built nuclear plants, followed by coal, then renewables.

On the need-for-action front renewable energies and efficiency remain dominant issues, with their perceived impact further increased. However, we note that also uncertainty around these issues has slightly increased compared to 2010. For energy efficiency this may be explained by the growing understanding that progress does not simply come with capital investment, but equally depends on investment in education and institutional frameworks to promote adequate behaviour and solutions. The on-going looming economic outlook keeps investors prudent on the renewable energies side. Last year's jump of the quartet of smart grid, storage, electric vehicles and sustainable cities is reconfirmed in 2011: These issues have progressed their way to solid presence on the global energy agenda.

Overall it strikes us that the very issues that in previous years were seen as a substantial part of the solution (energy efficiency, renewables, nuclear) are all taxed with higher uncertainties. The risks associated with these issues, ranging from physical accidents over regulatory to financial risks, have increased and have become a growing concern. This indicates that managing relevant risks will be an important part of the agenda going forward.

Carbon capture and sequestration (CCS) was among the highest uncertainties in the last two years: in the absence

The World Energy Council: a brief history

In 1923, a small group of energy experts came together in London to plan a conference which would bring together experts from around the world to help consider how to rebuild the electricity grid in Europe following WWI. The first World Power Conference was then held in London in 1924. It was so successful that the meeting has taken place every three years ever since. Over the years the original purpose was widened, the organisation grew, and the name changed, eventually, to become the World Energy Council. The World Power Conference has evolved into the World Energy Congress and gathers every three years 3,000 energy leaders from 100 countries to assess the state of the energy world.

WEC's work is governed and legitimised through its Executive Assembly (with the principle of "one country one voice", forming an "Energy UN") and its Officers Council, presided by WEC's Chairman, with the Secretary General in the executive function. Our national committees are chaired by energy ministers, leading CEOs or experts. Our studies are complemented by views from a global energy business leaders group (Patrons Roundtable) and ministers (Ministerial Roundtable) which we facilitate during our Energy Leaders Summits.

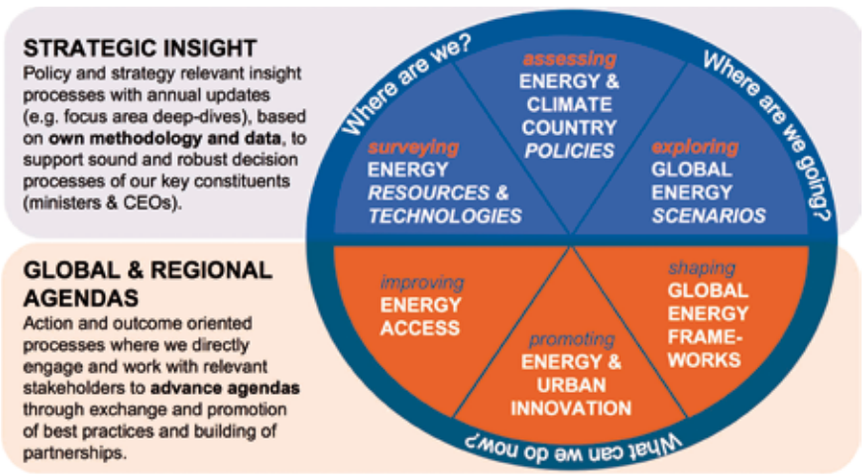


Figure 2 - six activities - WEC's 'activities wheel'

of a climate framework there will be no effective financing mechanisms and incentives to develop this technology beyond the pilot stage. In 2011 we see both the perceived impact and uncertainty decrease. A plausible interpretation is that energy leaders do not trust CCS to be at scale in a desired time horizon – an observation that we may not want to leave unchallenged, given the rapid growth in global coal consumption.

2011/12 World Energy Leaders Summits (WELS)

World Energy Leaders Summits are generally held in countries of critical interest to the global energy situation and are co-hosted with the Energy Minister of the host country. Participation is by invitation only and includes WEC's Patrons' and Global Partners' CEOs, a select number of Energy Ministers, WEC Officers and Chairs of National Committees as well as selected guests and experts (60-80 participants). The agenda of the WELS addresses critical issues identified through WEC's issues surveys, and draws insight from WEC's scenarios, policy assessment and resources and technology work.

Dates:

Rio, September 14-15, 2011
hosted by Brazil's Minister of Energy

Houston, November 1, 2011
within WEC's Houston Energy Business Forum

Istanbul, April 19-20, 2012
hosted by Turkey's Minister of Energy

Other notable issues include the energy-water nexus as a rapidly growing concern. The position of unconventionals remains unchanged, still with significant uncertainty. Hydrogen is not believed to play a big future role as a clean energy vector. Lastly, it surprises that currency uncertainty is not perceived to be of any importance in a context of eurozone instability and dollar downgrade.

The World Energy Council's Activity Areas and Knowledge Networks

The World Energy Council addresses these challenges by developing content in three Strategic Insight areas and by building partnerships around three Global & Regional Agendas. In Strategic Insight we survey resources, and technologies; we assess national energy policies across the world and identify which policies are effective and transferable to other countries; and, we explore possible global energy futures and analyse critical uncertainties. In Global & Regional Agendas we look at how energy access can be improved; we promote best practices in the field of energy and urban innovation; and, we contribute to the dialogue on global frameworks, be it in the context of rules of energy trade or with respect to the global sustainable energy and climate frameworks.

In order to develop expertise on cross-cutting strategic issues WEC has built up a number of Knowledge Networks (see Figure 3). WEC's national Member Committees have nominated 400 experts from over 50 countries into these Knowledge Networks. It is the objective of the World Energy Insight to provide an annual update on these activities and complement it with perspectives from Energy Leaders.

Surveying Energy Resources & Technologies

When will the world run out of oil? What is the status and the potential of shale gas, biomass, wind, solar and other renewable and fossil energy resources? What are the issues with smart grids, energy-water linkages, carbon capture and sequestration, clean coal technologies, generation IV nuclear or the e-mobility? How much difference can benchmarking and improving performance of existing power plant make? The World Energy Council has been

conducting the Survey of Energy Resources since 1934 and now also assesses current and emerging technologies and resources to provide a solid basis for policy and strategy decision processes.

Assessing Energy & Climate Country Policies

We live in a world of change and energy and -related policy innovation will affect our energy future in many ways. In the aftermath of the financial and economic crisis, the world places more emphasis on policy than on Adam Smith's "invisible hand" to guide us towards a sustainable energy future. Which policies balance cost-effectiveness, social equity, environmental viability and effectively enhance the general welfare of the citizens of a nation or region? In the interest of our sustainable energy future, the World Energy Council has developed a methodological framework to identify effective polices around the world and how they can be transferred from one country to another. The methodology is founded on an index based on 22 indicators, an industry executives' survey, a review of over 200 individual policies in over 40 countries, as well as a survey conducted with our Member Committees in over 90 countries.

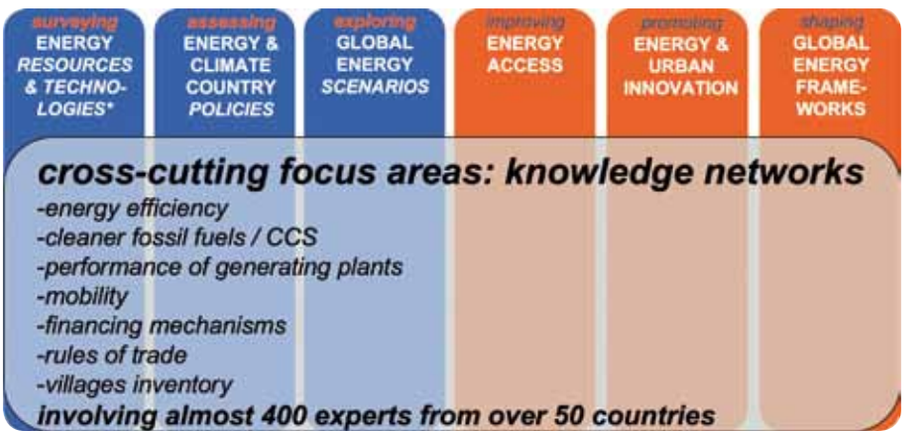
Exploring Possible Global Energy Futures (2050 Scenarios)

What if…? We live in a time of increasing volatility and extraordinary changes, driven by new uncertainties and ambiguous value systems. The financial crisis, the technological shift from conventional to unconventional resources, shifting geopolitics, climate change and the likely future carbon price, the changing water footprint and its impact on the energy value chain, the urbanisation trend and new forms of mobility, competing value systems, armed conflict and ideological extremism … how will all these issues affect our future energy system and what will be the critical drivers to watch? The extrapolation of the past into the future is not a meaningful approach when trying to improve our understanding, especially in terms of effective energy policy and leadership. By drawing on the wisdom and experience of its global membership to develop a small set of distinct but consistent scenarios – "plausible stories of pathways into the future" – the World Energy Council enables decision makers to test the robustness of their own assumptions and to validate policies and strategies.

Shaping Global Energy Frameworks

Resources and skills are unevenly distributed across the world and are not often at the places where they are most urgently needed. Energy access, energy security and climate change are global challenges and therefore have no economic and efficient solutions within national boundaries. This underlines the role of trade in goods and services and makes the global frameworks and rules that govern it an essential building block of the global public good. Nationalistic solutions that lose sight of the global picture delay the necessary international policy convergence. Many international organisations have promoted coordinated and collaborative approaches and have been working on the necessary international policy convergence, but the progress is slow. The resulting highly uncertain investment framework makes infrastructure investments unnecessarily risky and we will all pay the risk premium as part of higher energy prices and further delay in climate change mitigation. Critical issues in this context include defining "green goods and services", the legitimacy of "border tax adjustments" to avoid carbon leakage, or the promotion of technology transfer to developing countries. The World Energy Council promotes dialogue, develops constructive proposals, and shares these with the relevant international organisations and processes including WTO, UN, COP and G20.

Figure 3 - WEC's Knowledge Networks on cross-cutting strategic issues



Promoting Energy & Urban Innovation

Today, 50 per cent of the world's population lives in cities and by 2030, this number will grow to over 60 per cent. Key concerns for the people leading cities include security, pollution, health, wealth and broader well-being for their citizens. These issues directly or indirectly link to energy and resource efficiency: transportation and traffic management, building heating and cooling, sanitation and waste management, and communication networks are among the key processes that determine the energy pattern of a city. Innovative approaches are being implemented in a number of cities across the world. The World Energy Council plays a constructive role through the facilitation of the best practices dialogue and the delivery of expertise to leaders, city planners, managers and leaders.

Improving Energy Access

With only four years left until the 2015 deadline to achieve the Millennium Development Goals, the world is on a path to an "unacceptable failure, both moral and practical." None of the MDGs can be delivered without access to modern energy services for the 1.5 billion people who today live without it. A lack of basic energy service impacts all aspects of these people's lives, from healthcare to clean water, safe housing, education and the potential to earn a living. In recognition of the importance of energy for sustainable development, the United Nations defined in 2011 three major goals by 2030: 1) Ensure universal energy access to modern energy services; 2) Reduce global energy intensity by 40 per cent; and 3) Increase renewable energy use globally to 30 per cent. To achieve these goals, the UN has designated 2012 as the International Year of Sustainable Energy for All.

Rural communities account for 85 per cent of energy poor. Institutions, including the International Financial Institutions (IFIs), and also most governments focus on grid-expansion and densely populated urban areas. This simply leaves the rural poor perpetually exposed and in the dark. Key challenges include the lack of adapted financing mechanisms that can deliver on rural energification schemes; poor education and shortage of local skills for project initiation, implementation and system operation; the absence of easy local access to components for equipment maintenance and enhancement; the lack of understanding and political support necessary to replicate enduring local ownership models. The World Energy Council works with other relevant stakeholders on pragmatic approaches to promote energy access. ❑

Ensuring energy security in times of uncertainty

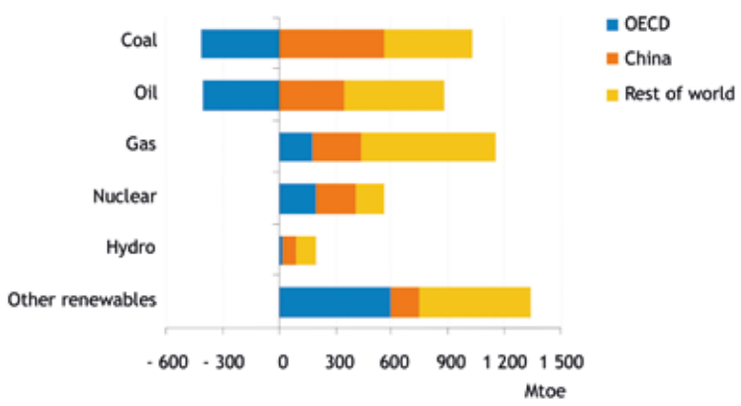
By Maria van der Hoeven,
Executive Director, International Energy Agency

To foster energy security, whether of supply or demand, is to mitigate the risks and manage the uncertainties related to future balances of energy markets. Since its creation in 1974, the IEA's primary mission has been to address issues of supply security, but since then its mission has expanded and its expertise has diversified. And yet the IEA's founding purpose of safeguarding oil supply security remains at the core of our business.

In today's economic climate, the need to ensure energy security is as urgent as ever. But the energy world has faced unprecedented uncertainty over the past year – turmoil in the Middle East and North Africa, a fragile global economy racked by the eurozone crisis, and the devastating Japanese earthquake and tsunami which triggered a grave incident at the Fukushima Daiichi nuclear power plant. These events have highlighted the importance of the stable provision of affordable and sustainable energy to modern economies – and also the clear and present nature of risk.

The future supply and demand balance in global energy markets will be determined by many factors. The pace of economic and population growth, energy efficiency trends, pressure to reduce greenhouse gas emissions, the development and deployment of new energy technologies and whether sufficient investments are forthcoming along the entire energy chain – these will all play a role.

Incremental primary energy demand in the New Policies Scenario, 2008-2035



Demand for all types of energy increases in non-OECD countries, while demand for coal & oil declines in the OECD

Source: World Energy Outlook 2010

Well functioning markets

IEA experience suggests that well functioning markets are essential to addressing supply security concerns. But we are not there yet. The increasing interdependence of producing and consuming countries poses new energy security challenges, so a comprehensive response is needed to improve market performance and to reduce uncertainty.

How can we make markets function better? More transparent, accurate and timely data is crucial for efficient market operation and development. We need better data on reserves, production, inventory and demand. This is especially true for non-OECD countries that will play an increasingly important role in global energy markets. According to IEA projections, non-OECD countries accounted for 47 per cent of world oil demand in 2010, but their share is expected to grow to 61 per cent in 2035 based on current trends. Collection of credible and transparent data from all consuming and producing countries helps to bring more clarity to the analysis of energy market trends.

In addition to transparent data, further integration of energy markets will improve performance and security. That integration should be marked by trade flows based on commercial incentives born of more transparent and cost-reflective prices. Integrated markets will support more efficient and timely investment, and increase the depth and diversity of energy supplies.

Governments need to adopt policies that reinforce and complement market-based responses to deliver energy security at least cost. This includes transparent and predictable legal and regulatory rules, and the greater harmonisation of market frameworks across multiple jurisdictions. Policy uncertainty or the inconsistent application of legal and regulatory rules jeopardises investment and threatens the effective allocation of energy supplies to achieve energy security.

Well-prepared for emergency

Reforms to improve market functioning are essential steps to address long-term investment challenges. At the same time, we must be prepared to take short-term, emergency response measures in case of a serious supply disruption.

The IEA Member countries have in place tried and tested systems for responding rapidly at the

outbreak of an oil disruption. In the first instance, the IEA will expect markets to respond, with the use of commercial stocks and additional production. But if market mechanisms are insufficient or dysfunctional, and the disruption poses a clear threat to the global economy, emergency stockholding systems have a vital role to play in providing additional oil to the market. Employed appropriately, an emergency stock release can contribute to mitigating the impact of an oil supply disruption on the economy.

Most recently, an IEA collective action was launched in June in response to the disruption of oil supplies from Libya. When the disruption started earlier in the year, IEA assessment showed that the market was able to cover the loss and provide adequate supply. But circumstances changed as the disruption continued. As the northern summer driving season approached and refineries ended maintenance, the market tightened notably. To ensure adequate supplies until producers were able to ramp up production, IEA Member countries agreed to make available to the market 60 million barrels of crude oil and oil products from their emergency stocks over an initial period of 30 days. Of these 60 million barrels, some 38 million barrels were released from public stocks and 22 million barrels via a relaxation of obligatory industry stockholding. Public stocks were taken up by the market over the course of July and August. The swift uptake of public stocks demonstrated the need in the market. Fully 97 per cent of public stocks were taken up by market players, compared with 73 per cent during the previous collective action in response to Hurricane Katrina in 2005.

It is our view that the interrupted Libyan supplies have been successfully addressed by a combination of the IEA collective action and increased production from producer countries, against a backdrop of weakening expectations for global oil demand growth.

Worldwide engagement

As an ever greater share of oil is consumed outside of IEA countries, it becomes essential that both Member and non-Member countries cooperate with regard to the pursuit of oil supply security. Strengthening emergency response capabilities within and outside the IEA will be a pressing issue over the next several years. The IEA has already put considerable efforts into cooperation with China and India as well as with ASEAN countries to promote oil stockholding across Asia. The IEA remains committed to providing necessary assistance and cooperation to enhance energy security worldwide.

From the IEA's accumulated experience, we have learned that energy security will not be achieved by risking the security of others – including demand security of producers. Enhanced energy security requires working together to develop resilience in our energy markets and infrastructures, with both greater diversity and flexibility, to limit our vulnerabilities to energy crises and where possible to avoid such crises altogether. The IEA continues to work closely with partner countries and international organisations to address the pressing challenges of investment, technology deployment, statistics, efficiency, and emergency response which will help to ensure our energy security going forward. ❑

Energy security: The supply side of the equation

By Abdalla Salem El-Badri,
Secretary General, OPEC

Many stakeholders in the energy sector talk about security. Industrialised economies sometimes use the expression to speak about the need to expand the energy mix in order to reduce reliance on imported fossil fuels. Developing countries speak of energy security when referring to the challenge of energy poverty.

However, an examination of the concept of 'energy security' as it relates specifically to the oil market suggests a different understanding. For the oil producing Member Countries of OPEC, for example, energy security involves a delicate balance between 'security of supply' and 'security of demand.'

Assessing both parts of this security equation is important. As providers of more than 40 per cent of the world's crude oil production, OPEC's Member Countries must continually assess the supply side of the equation by monitoring global economic conditions and, especially, analysing the demand side.

Given current projections, the world will increasingly need more energy in the long-term. Although uncertainties about the strength of the global economic recovery persist, aggregate demand for energy — and, in particular, oil — is set to increase. OPEC's 2010 World Oil Outlook sees energy use increasing 40 per cent by 2030 — even under scenarios in which significant energy efficiency gains are assumed.

The Energy Mix

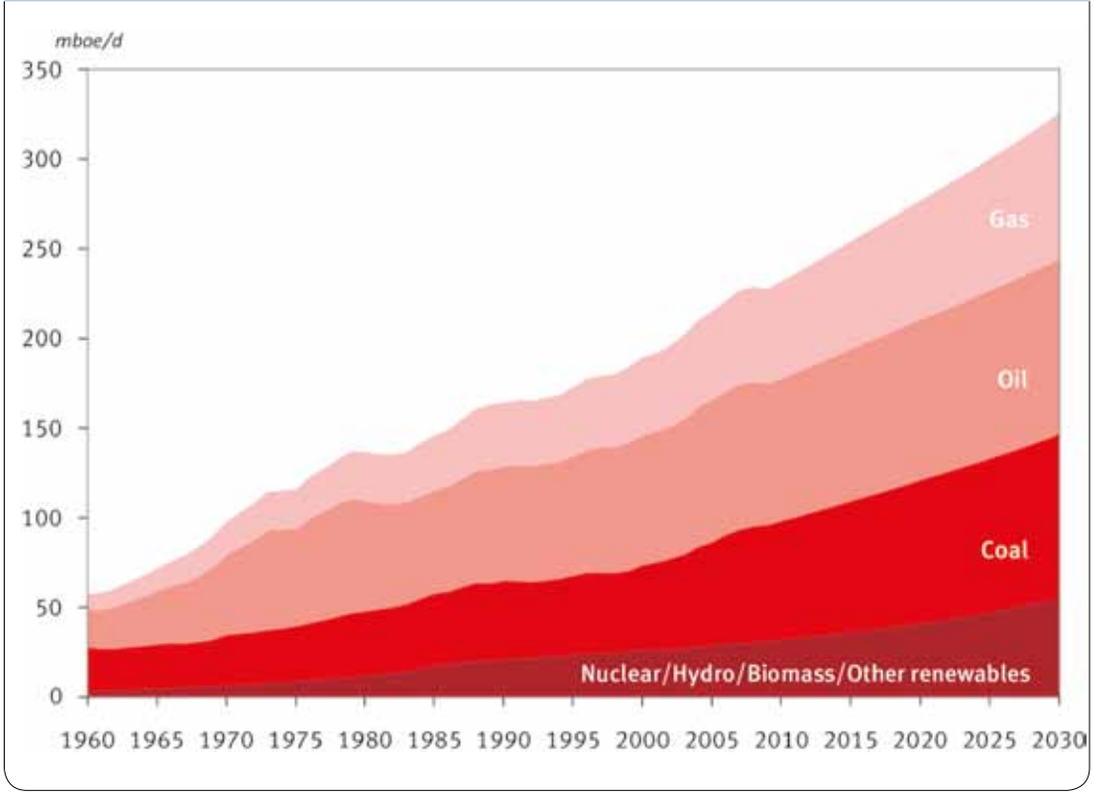
Fortunately, there is a broad, diverse and continually expanding energy mix (see Figure 1). In addition to fossil fuels, alternative forms of energy are also seen as increasing, with nuclear, hydropower, biomass and other renewables all expected to play a complementary role in meeting the world's growing energy needs.

Renewable forms of energy — like solar and wind power — are actually expected to grow more than 7 per cent per year, in part due to government support and tax incentives. But given the growth of other energy sources, their overall share in the global energy mix is expected to remain at 2-3 per cent.

Alternative energies are a welcome and necessary component of the global energy mix. But their practical limitations are worth keeping in mind. Solar and wind power, for example, both have high unit costs and a low energy density. They are also both rather site-specific — and even then, can be quite intermittent in nature.

The contribution of biofuels is also significant, despite the high costs involved. Second generation biofuels can even overcome, to some

Figure 1: Continually expanding energy mix



extent, the potential impact of first generation biofuels on food prices, crop biodiversity and water resources. But they are still far from being available for commercial use.

There is also nuclear power, of course, which has been a reliable source of energy, despite high up-front costs and long lead times. Its future growth, however, is now in question in the wake of Japan's Fukushima nuclear disaster.

But it is fossil fuels — coal, natural gas and oil — that offer the best current prospects for meeting the world's growing energy needs. They have distinct advantages given the prevalence of existing infrastructure around the world, and the relative affordability of upstream and downstream projects.

According to OPEC data, fossil fuels are expected to contribute at least 80 per cent to the global energy mix over the next two decades. And while natural gas availability promises to grow, overall trends suggest that crude oil's overall share in the global energy mix will remain strong — though falling from 35 per cent to around 30 per cent by 2030.

The Supply Outlook

The recent global outlook for oil has been strong. It remains so, with more than enough supply to meet demand levels well into the future. Estimates of total world crude oil and Natural Gas Liquids, for example, in 2009 were around 3.5 trillion barrels. Of this total, 2.1 trillion barrels were in OPEC Member Countries and 1.4 trillion in non-OPEC countries.

Global inventories, too, have been and remain high. US commercial oil inventories in July were at a comfortable 19.5 mb/d above their five-year average and commercial inventories in the OECD have similarly been above recent averages.

Additionally, product stocks have shown modest surpluses. In the US, for example, gasoline stocks in July were 4.5 mb above their five-year average and distillate stocks were at 6.1 mb above the seasonal trend. In the OECD, product stocks have similarly been above recent seasonal averages.

Turning to OPEC's Member Countries, we note that overall resource endowments continue to grow. As of 2010, proven crude oil reserves in Member Countries were nearly 1.2 trillion barrels, representing about 81 per cent of the global total and a 12 per cent increase over the previous year.

Furthermore, in terms of total oil production, most OPEC Member Countries continue to produce at healthy levels. And in 2011, despite some instability in the Middle East and North Africa region, OPEC supply has remained at high enough levels to provide significant forward cover. While recent events have affected spare capacity in some countries, Member Countries collectively continue to hold enough spare upstream capacity to meet the market's needs.

The Importance of Investments

Underlying these figures is the important factor of upstream investments. Today's resources — and future security of supply — depend on timely and well-planned investments. They are the lifeblood of the industry and are the key to ensuring future supply.

OPEC Member Countries remain committed to future investment plans to expand upstream capacity. In the medium-term, between 2011 and 2015, Member Countries are expected to invest an estimated US$310 billion in upstream projects to both maintain current capacity and provide additional spare capacity. Member Countries also continue to invest in downstream projects, both at home and abroad, as well.

Of course, OPEC is continually reviewing the status of these projects. Given the magnitude of investments, an appropriate price environment is necessary. But a certain level of demand certainty and predictability — what we call security of demand — is also required, especially given the oil industry's long lead times and high capital costs.

Security of Demand

Security of demand is the other side of the energy security equation. Without it, ensuring security of supply through investments loses its rationale. But there are a variety of sources of uncertainty that pose challenges to security of demand.

The rising costs of raw materials and industrial commodities, for example, have made many upstream investment projects difficult.

In terms of the global economy, too, doubts persist over the medium- and long-term prospects for economic growth. This uncertainty has been exacerbated by continuing problems in the US and the outbreak of the European debt crisis.

In addition, proposed environmental policies in several oil consuming countries — which aim to favour the development of alternative sources of energy — may also have an adverse effect on future oil consumption and overall demand.

These challenges require concerted efforts to dispel uncertainty and provide the security of demand that

investments need. For example, clear, accurate and timely data — about upstream and downstream activities, as well as the fiscal health of major oil consumers — could help to provide some demand certainty.

But also knowing more about the potential impact of environmental policies in consuming countries could help reduce uncertainty. Additionally, continuing to improve the environmental credentials of oil — both in its production and in its use — through technological advances can help sustain demand among consumers concerned about oil's environmental impact.

The Price Environment

One of the most important conditions required for security of demand is a stable and enabling price environment. This means having crude prices at an appropriate and reasonable level, without extreme fluctuations.

We have seen periods of both record high and low prices, most recently in 2008 (see Figure 2). These experiences have been a reminder that extreme prices benefit no one. Prices that are too high or too low can both be detrimental to investment plans.

Extremely low crude prices, for example, can result in a decline in revenues which can force an oil producer to cut budgets and implement austerity measures, leading to the scaling back of upstream projects through the deferral of engineering, procurement and construction contracts.

Similarly, extremely high prices can be detrimental as they can dampen oil consumption, bring future crude demand levels into question and threaten current investments in expanded supply.

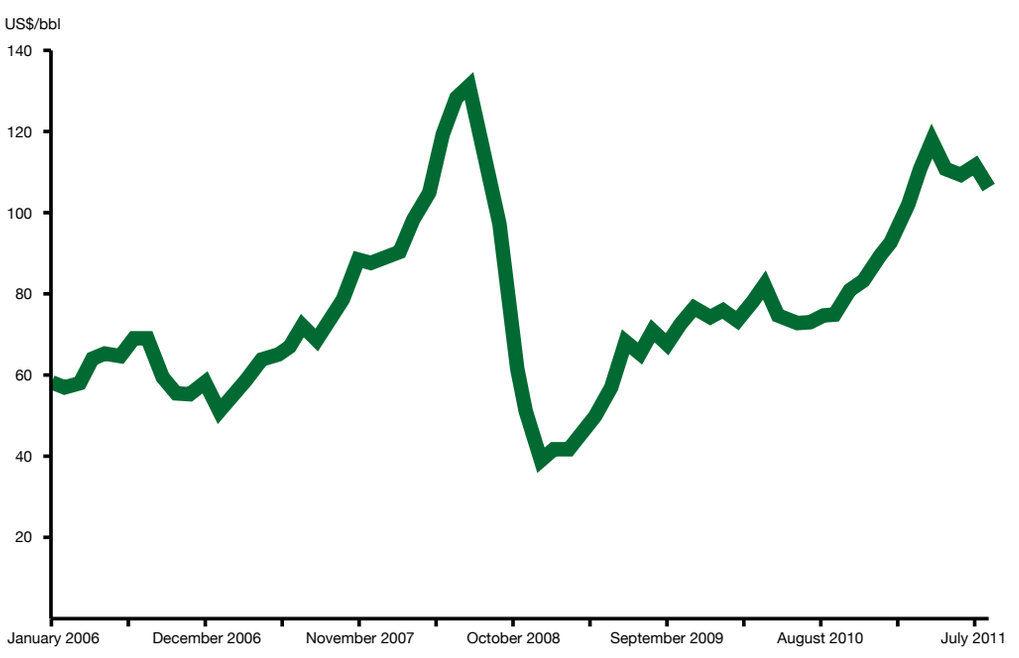
OPEC's Commitments

Recent episodes of price volatility have made it clear that ensuring balance in the market — and working to ensure security of demand as well as of supply — is necessary. One cannot achieve a balanced and well-supplied oil market by focusing on only one side of the energy security equation. Security of demand is needed to maintain security of supply. These go hand in hand.

OPEC remains committed to making investments to meet the world's energy needs and ensure future security of supply. This is one of the pillars of its 51-year old mission. But it continues to stress the need for security of demand, which is necessary to avoid wasting financial resources on unneeded capacity — and prevent a highly damaging situation of oversupply in the future.

It is only with demand security that OPEC can continue ensuring supply security for the benefit of all, with actions that are forward-looking, oriented toward stability and guided by an over-arching interest in balance. ❑

Figure 2: Oil price volatility, January 2006 - July 2011



Bridging the gaps: What would constitute success at Durban?

By Christiana Figueres,
Executive Secretary, UN Framework Convention on Climate Change

The world, and consequently the climate change regime, now stands at a crossroads defined by a number of gaps, all of which are now well-recognised and impossible to ignore.

Captains of almost every industry, organisation and government now recognise that new and future development cannot be carried out under business-as-usual thinking and habits. In this same volume last year, the writers of almost every article identified gaps and the consequent need for a global, systemic transformational shift to close these gaps. This shift was variously identified as needing to be economic, technological, political or behavioral (or, indeed, all of the above) — for whatever was the main envisioned outcome: universal access to energy, the fulfillment of the Millennium Development Goals, or even simply meeting the projected global energy demands of the next half century, while ensuring sustainable development. One year later, these gaps still exist. One year later, gaps in the climate change negotiations also still exist. But one year later, there is perhaps more practical clarity on the tools at hand to close those gaps.

At the international level, some of these gaps wind their way into a number: 40 per cent. In the climate change negotiations, this is the international ambition gap. Collectively, the international pledges to reduce greenhouse gas emissions over the next few decades only takes us 60 per cent of the way to a reasonable chance of capping global temperature rise at 2 degrees Celsius. This 2-degree warming limit, and the potential consequences of this rise as projected and detailed by science, was what the world's leaders accepted on the behalf of all world citizens as acceptable risk. Leaders also agreed to consider reviewing progress and strengthening this goal by 2015.

This was the umbrella tenet of the Cancun Agreements, a set of decisions governments agreed on at the UN Climate Change Conference in Cancun in December 2010. The Cancun Agreements formed the basis for the largest collective effort the world has ever seen to reduce emissions, in a mutually accountable way, with national plans captured formally at international level under the banner of the UNFCCC. They comprise the most comprehensive package ever agreed by Governments to help developing nations deal with climate change. They include finance, technology and capacity-building support, to help them meet the urgent need to adapt to climate change, and to speed up their plans to adopt sustainable paths to low emission economies that can also resist the negative impacts of climate change.

In concrete terms, the most developed parts of the Cancun Agreements include:

- Creating a Green Climate Fund to disburse US$100 billion per year by 2020 to assist developing countries in their adaptation and mitigation action;
- The Cancun Adaptation Framework, with the objective of increasing action on adaptation through approaches that draw in all aspects of international cooperation; and
- A Technology Mechanism to boost distribution and use of climate-sound technologies, especially in developing countries.

Through 2011, Parties to the Convention have been working make these agreements operational, while continuing to progress in other areas essential to an enhanced, effective and sustained international response to climate change— the top-down legal framework that would help ensure trust among countries through transparency, accountability and collectively-defined fairness and responsibility. This top-down response needs to meet, guide and hold accountable the bottom-up approach currently favoured by governments, which is based on self-assessed domestic capability, including political acceptability at home.

This approach has seen pledged mitigation commitments and actions made official in Cancun — but they are not yet formally anchored within the UNFCCC process. Governments will need to find a way to do this, to make clear the legal status of these pledges, without locking in the current insufficient level of ambition.

This is where the second gap in the international response emerges: the governance gap. Under the Kyoto Protocol, the first commitment period for reducing emissions will expire in 2012. In the negotiations, there is currently a lot of uncertainty on how the nature and status of emission reductions should be handled beyond 2012. Nations are divided on whether current pledges should be inscribed in a new commitment period under the Kyoto Protocol or formally anchored and monitored in a new mitigation framework under the Climate Change Convention. We are approaching a world entirely without a working mitigation framework. A governance gap after 2012 will have serious consequences for accountable emission reductions and for the carbon market created by the Kyoto Protocol.

The third gap is the finance gap. In 2011, governments have worked hard to design the Green Climate Fund and

develop its institutional, governance and disbursement structures. But it is still unclear how the Fund will be capitalised, and how industrialised countries will ramp up financing to reach US$100 billion per year by 2020.

These key gaps will be addressed by the UN Climate Change Conference in Durban at the end of the year.

In the mean time, the world stands at this crossroads: there are some who have long sensed economic opportunity. The private sector — in all its forms — has over the years led a parallel process of dealing with future climate change related risk, sometimes on its own, and often in response to sporadic policy attempts by national and sub-national governments. These sporadic (though occasionally sustained) examples of the transformational power of what happens when the art of the possible meets the private sector, provide us with glimpses of potential should all efforts be coordinated and concerted, and driven by political will.

A thriving mitigation-related market has grown in the last two decades. Large multinationals and other national and local iconic companies found value in searching for carbon and energy efficiency and reduction opportunities in supply chains and operations, which paid off in co-benefits including saved costs, employee productivity, tapping latent demand and market differentiation. Businesses that joined a carbon-trading program could make money through reducing their carbon emissions. Corporate social responsibility and in-house green advocates began carbon reporting and auditing, and tracking the carbon footprint of products, services and operations. These became mainstream in many large companies as part of their environmental reporting standards. Companies that sat on the margins of climate change action were compelled to join in by the possibility of carbon taxation or cap and trade schemes. There are many other examples of action, and those companies that are taking action, are reaping benefits, both from efficiency gains in themselves and from taking advantage of clean, new energy policies. But a large part of the private sector has not yet taken action. Not enough companies are looking for the opportunities, and taking advantage of the possibilities. And they are not doing this because there is not enough by way

Christiana Figueres, Mexico's Foreign Minister Patricia Espinosa and Mexico's President Felipe Calderon attend the talks in Cancun

of concerted policy efforts to compel them to, and to make the risk of innovation worth the potential payoff.

With the right policies in place, action can happen much faster. For example, following the March earthquake and Fukushima incident, Japan's new energy drive, which includes a massive business and society-wide energy-saving drive, has driven down peak energy demand by 10 to 20 per cent — and, as many have observed, kept the lights on all summer.

Of course energy efficiency and conservation potential, in both "mainstream" and more creative methods and technologies, have been around for, quite literally, generations now. They have been overlooked precisely because the potential gain was so obvious — yet governments for decades have wondered how to encourage companies to do the obvious. Eventually, the private sector worked out models for implementing and sharing the cost of increasing energy or fuel efficiency sprung up and thrived, some even based on state-level legislation — which got over a few of the small but numerous barriers to reaping energy efficiency profits. At this crossroads, governments now have an avenue to give the private sector the impetus to do what it does best — innovate, bring to market, find profit, with their eye on the prize of a sustainable business within a sustainable economy.

The Cancun Agreements now provide one of the strongest signals governments have ever sent to the private sector that the future is low-carbon. Success at Durban will, in a large part, be defined by how far governments get in closing the gaps we earlier mentioned (and in how well they do so) — in other words, how far they get in attaining three broad goals:

- Resolving the open political question over the Kyoto Protocol (and, in conjunction, the nature and status of mitigation measures post-2012); and providing a clear signal to the carbon market;
- Launching the newly-created Green Climate Fund and providing clarity on how to generate the agreed climate finance of US$100 billion per year by 2020; and
- Delivering tangible progress towards operationalising the new technology and adaptation institutions that were agreed by the community of nations in Cancun in 2010.

As the international community, we are 60 per cent of the way to a 50 percent chance of keeping temperature rise to 2 degrees, based on the art of the possible. The ambition gap of 40 percent will have to be closed by a response built on government and private sector efforts. It has been widely and oft-repeated that the technology and innovative capacity to get us to that goal are there — and it has almost become an adage that all that is lacking now is political will.

Fukushima Daiichi nuclear power plant Number One reactor building

In the face of adversity, Japan has demonstrated that much can be achieved with political will and company, business and citizen buy-in — it has demonstrated that all kinds of sustained transformative changes, including behavioral transformation — can be achieved by sheer force of collective will.

It IS possible. If we extrapolate from what Japan has been able to achieve already, and is set to achieve as they rebuild their economy and energy sectors — imagine how much untapped potential can be unlocked in the form of new energy policies to bring us that much closer to bridging the remaining 40 per cent gaps. ❑

Green Goods: Opportunities for climate change mitigation and trade

By Pascal Lamy,
Director-General, World Trade Organisation

Climate change mitigation and the race for alternatives to fossil fuel energy pose unique challenges to the international community. Multilateral cooperation and increased efforts in different fora are required to meet these challenges. The WTO has much to contribute. In this context, the WTO offers an important forum for multilateral co-operation. It also provides disciplines to facilitate global trade and to guard against protectionism. At the same time, WTO rules ensure Members have the necessary flexibilities they need to pursue environmental objectives and the WTO serves as the venue to promote greater trade opportunities, including for green goods.

In the Marrakesh Agreement establishing the WTO, Members drew a clear link between sustainable development and trade in order to ensure that market opening goes hand-in-hand with environmental and social objectives. Furthering trade opening and market access for green technologies can make a substantial contribution to global climate and energy concerns and improve the overall allocation of the limited resources of our planet.

The Intergovernmental Panel on Climate Change (IPCC) has highlighted in its Fourth Assessment Report that many mitigation technologies are currently commercially available and more are expected to be commercialised soon. From an environmental perspective however, the development and deployment of renewable energy technologies and the use of more energy-efficient goods may not be occurring at a rate fast enough to respond to environmental challenges. In part, this is due to the weak cost competitiveness of green goods and renewable energy technologies relative to traditional goods and fossil-fuel energy technologies. Deepened trade opening in green goods could improve their cost competitiveness and deployment, and also enhance market access to more efficient and diverse goods, including goods that can contribute to climate change mitigation.

Technologies for mitigation and adaptation in the field of renewable energy involve a number of different products. Trade therefore has an important role to play in the deployment of green technologies and there may be substantial room for technological improvement through this process. For instance, in the wind energy sector, the installation of a wind farm requires access to equipment such as electrical generators, blades, and gearboxes. Likewise, in the solar energy sector, a wide range of goods are necessary for commercial and residential application of solar panels; another set of goods would also be required for the deployment of solar energy directly to consumers, such as solar ovens or solar water cookers, which are important to both climate change mitigation and promoting sustainable development in communities without access to an electrical grid.

Deepened trade opening in green goods could improve their competitiveness

The elimination or reduction of tariff and non-tariff barriers to trade in green goods can lead to a so-called “triple-win-situation”: a win for the environment, a win for trade and a win for development. Firstly, the availability of environmental goods at lower costs may increase deployment of environmental technologies, promoting technology transfer and innovation, and may lead to welfare improvements and reduced “negative externalities” of goods or practices damaging the environment. If increased deployment leads to market growth and further maturation

of green technologies and goods, this may generate further cost reductions, deployment, and beneficial environmental outcomes. Secondly, trade wins because these products become less costly and efficient producers of such technologies can find new markets. Lastly, increased access to environmental goods may assist developing countries in realising sustainable development strategies.

Two positive environmental effects are expected from a reduction of tariff and other trade barriers. First, lowered trade barriers should lead to a reduction of prices of green products. Deployment of environmental products is therefore facilitated and occurring at the lowest possible cost. Although of course it should be noted that the price of climate-friendly goods is not the only factor that affects the diffusion of these technologies. Other important factors include a country's regulatory framework for climate change action and its level of foreign direct investment.

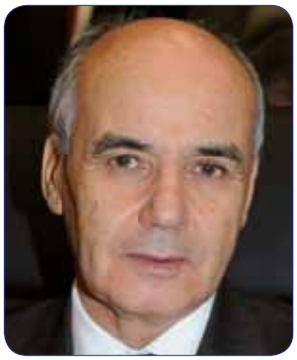
Since there are a number of high tariffs that remain in the renewable energy sector, tariff reductions would lead to improved access to these goods and to a wider diffusion of technologies. In the context of WTO work, a number of renewable energy products have been under discussion in the Doha Round of trade negotiations. The applied tariff rates on these lines range from 0 to 60 per cent in developing countries, 0 to 44 per cent in least-developed countries, and 0 to 10 per cent in developed countries.This illustrates the potential that trade can bring to the diffusion of technologies on a worldwide scale.

A second decisive element is the positive effect that trade opening of climate-friendly goods may have on producers, providing incentives to expand exports and production. Increased trade opportunities might lead to larger markets for climate-friendly goods, profits to producers from economies of scale and increased competition, fostering technological innovation.

Trade in environmental goods is an extremely topical issue given the boom in the demand for these products that we have witnessed in recent years. Many developing countries, such as China, Republic of Korea, Malaysia, India and Indonesia, have emerged as leading producers in the clean energy sector, such as in wind and solar energy and efficient lighting. In fact, five developing countries, China, Hong Kong (China), Korea, Mexico and Singapore, are among the top ten exporters of renewable energy goods.

Overall, trade in climate-friendly goods has increased over the last few years. In the period from 2002 to 2007, exports of renewable energy goods represented 20 per cent of developing country export growth, 47 per cent of that of the least-developed world's, and 12 per cent of that of the developed's. Although the economic literature indicates that more open trade is likely at first to increase CO_2 emissions as a result of increased economic activity (the scale effect), trade opening will facilitate the adoption of technologies that reduce the emission-intensity of goods and their production process (the technique effect). Trade opening can also lead to a change in a country's mix of production from energy-intensive to less energy-intensive sectors, if the country has a comparative advantage in the latter (the composition effect). International trade can therefore serve as a conduit for the diffusion of key technologies. ❑

Trade has an important role to play in the deployment of green technologies



From consolidation of conventional energies to the promotion of renewables

By Youcef Yousfi,
Minister of Energy and Mining, Algeria

Throughout the world, energy policies have, for the last forty years, evolved according to national and regional differentiated approaches, whether in the choice of fuel mix components, consumption patterns or through other means, especially, taxation, subsidies and standards. However, climate change and in particular the successive natural disasters of these last years, have mobilised public opinions around environmental challenges, reviving the debate of globalisation of energy policies and the regulation of physical and financial energy markets.

Due to its impact on climate change, energy policy has become a priority in the agenda of many countries and several international organisations' economic policies. The themes that are generally covered are:

- The security and competitiveness of energy supply;
- The energy efficiency and the development of renewables;
- The capture and sequestration of CO_2;
- The social and the economic development and co-operation between Northern and Southern countries.

Volatility of crude oil price which remain the driving price of energy is another important dimension of energy policy.

High volatility of the price of oil has led to an increasingly common perception of the need for stability of oil prices at a level sufficiently remunerative to ensure future demand for clean energy and justify investment in energy efficiency.

Both producers and consumers have interest in stable prices at a level which allows, among other things, the development of new oilfields, to meet the growing demand driven by the emerging countries today.

It is clear that environmental protection is a concern to the whole world which has to be taken in due consideration in elaborating and implementing energy policies. However, the differences between approaches and requirements remain important. It is well known that security of supply of consuming countries cannot be disconnected from the vital need of producing countries to secure markets and to preserve revenues generated from hydrocarbons.

Besides that, there are nearly two billion people with no access to energy and the solution to such an acceptable situation must come from a sound international solidarity. The development of bio-fuels led to strong tensions on the prices of food products and reduced significantly the land dedicated to these products, penalising mostly Southern countries, which are the first victims of climate change despite their low emission of greenhouse gases.

As for Algeria, it is committed to the transformation of its energy policy around two fundamentals:

- Reinforcing its hydrocarbons reserves;
- Promoting renewables.

Maximising the value of energy potential while protecting the environment

For decades, environmental protection has been very present in the energy policy of Algeria. Algeria made large investments to reduce flared gases and implemented with its partners CO_2 sequestration in the In Salah gas field to prevent the emission into the atmosphere of approximately one million tons of CO_2 per year.

The Algerian mining potential offers promising perspectives and Algeria intends to continue and intensify its exploration effort in order to renew its hydrocarbon reserves, not only to ensure its domestic long-term needs, but also to assume its position of an oil and gas supplier.

Indeed, Algeria has an enormous potential for new discoveries in relation to its huge under-explored area estimated at 1.6 million km2 of onshore sedimentary basins and 100.000 km2 of offshore area.

Moreover, the Algerian mining domain conceals important resources of tight and shale gas. Algeria is interested in unconventional resources associated with Silurian and Frasnian which are rich in organic matter across most of the Algerian Saharan basins. The thickness of these levels exceeds locally one hundred metres and the shale objectives are at moderate depths (1000 to 3000 m).

The preliminary results of evaluation of shale gas potential carried out indicate that the potential in hot shales is comparable to that of the United States.

Based on geochemical modeling, the various estimates of total volumes generated from two principal source rocks of the Algerian Saharan platform might be as high as hundreds of Tcf.

To ensure the development of gas production from unconventional gas reservoirs, the recourse to partnership will be privileged. Considering the technological challenges and the importance of the financial costs, the development of unconventional hydrocarbons will be necessarily carried out with international companies that have demonstrated their know-how in this field.

A programme has been launched to confirm the potential of shale gas and to look at the possibilities of development in the Algerian context in order to quickly identify the conditions to achieve the objectives.

The process of collecting necessary data and determining the most suitable areas is, currently, ongoing before launching pilot operations.

Incentive measures to encourage partnership in this new field are being studied.

With regards to conventional hydrocarbons, the exploration programme is substantial. Sonatrach intends to invest US$2.5 billion per year in exploration with its partners.

Above meeting the domestic demand, our medium-term objective is to export 2.5 mboe/d.

Preserving energy resources through rational consumption

The national policy of energy efficiency/saving will allow the harvesting of the energy efficiency potential, mainly in thermal insulation of buildings, lighting, the motorisation of vehicles and the conversion of power plants from simple cycle to combined cycle.

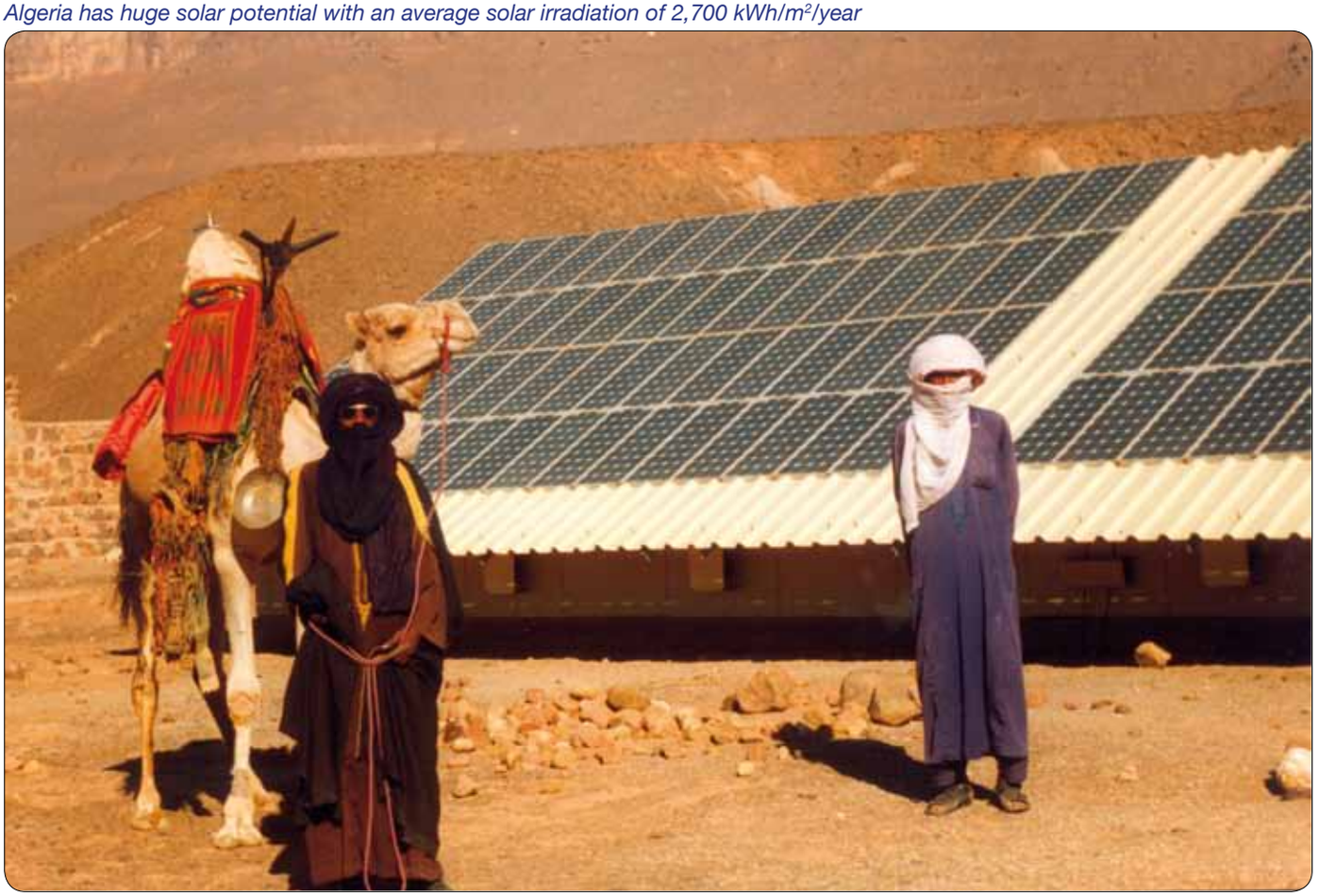
Renewables: Ambition vs Challenge

Aiming towards sustainable energy development, Algeria has adopted an ambitious programme for the development of renewables over the next twenty years.

The programme consists of installing up to 22,000 MW of power generating capacity from renewable sources between 2011 and 2030, of which 12,000 MW will be intended to meet 40 per cent of the domestic electricity demand and 10,000 MW for export.

Solar (thermal and photovoltaic) is the strategic choice of this programme. This choice is motivated by the huge

Algeria has huge solar potential with an average solar irradiation of 2,700 kWh/m²/year



solar potential of Algeria (with an average solar irradiation of 2,700 kWh/m^2/year)

The programme will be carried out in three phases:

- The first phase, between 2011 and 2013, will be devoted to the achievement of pilot projects to test the different available technologies;
- The second phase (2014 – 2015) will mark the beginning of the deployment of the programme;
- The last phase, between 2016 and 2020, will be devoted to the large-scale deployment of the programme.

The programme includes the gradual installation of power generation capacities using the following technologies:

Solar thermal: In addition to the operational hybrid plant of 150 MW, including 25 MW in solar, two more concentrating solar power plants, 150 MW each, have been launched.

By 2020, four solar thermal power plants with a total capacity of about 1 200 MW will be commissioned. Between 2021 and 2030, a capacity of 5000 MW will be installed.

Solar photovoltaic: Several solar photovoltaic projects with a total capacity of 800 MWp will be implemented by 2020. A capacity of 2000 MWp will be achieved over the 2021-2030 period.

Wind: The first wind farm of 10 MW will be operational in 2013. Between 2014 and 2015, two wind farms with a capacity of 20 MW each are to be developed. The plan is to realise other projects during the period 2016-2030 with a capacity of 1700 MW.

Renewables: a driver of industrial integration

To reinforce the programme, Algeria intends to develop its industrial capabilities in the field of renewables, focusing on selected technologies, with direct state funding and encouraging entrepreneurship.

The industrial integration rate for solar thermal, is expected to reach 50 per cent by 2020 through the implementation of factories for the manufacturing of (i) mirror, (ii) heat transfer fluid and storage equipment and (ii) power block equipment.

While for solar photovoltaic technology, the programme aims to achieve an integration rate of 60 per cent by building, before 2013, a plant for the manufacturing of photovoltaic modules with a capacity of 120 MWp/year and the construction of a silicon production plant, by 2020.

Moreover, a national subcontracting network is to be established for the manufacturing of inverters, batteries, transformers, cables and other equipment used in the construction of a photovoltaic power plant. As such, the renewable energy programme will allow the creation of thousands of direct and indirect jobs.

Acquiring and maintaining knowledge

The development of renewables will rely on a research & development programme which will mobilise national experts and will lead to the establishment of an efficient know-how, particularly in engineering and project management.

The implementation of this programme will require the development of a national human capacity capable to assume assigned goals of accumulation of knowledge and technology transfer. In this perspective, the Algerian Institute of Renewable Energies was created to offer training programmes that will cover, in particular, engineering, safety and security, energy audit and project management.

Regulation, stimulation and coordination

The legal framework for renewable energies in Algeria consists of the energy efficiency law, the electricity law, the law for the promotion of renewables and many other regulatory texts.

Coordination of the execution of the programme and synergies among stakeholders will be achieved through the future creation of the Commission for Renewable Energies. The latter will have both authority and means to ensure a sound fulfillment of the various actions envisaged in the programme.

Incentives measures and encouragement are provided for the actions and the projects which contribute to promote renewable energies. To encourage and support the industrial companies in the realisation of this programme, is planned, among others, the reduction of the customs duties and the VAT on the import of the components, raw materials and semi-finished products used in the manufacturing of equipments, in Algeria, in renewable energies and energy efficiency domains.

In the new national energy policy, the financing of the programme component related domestic demand through the National Fund for Renewable Energies which is funded using 2 per cent of oil royalty. The export programme will benefit from partnerships that will be made with European players involved in the import of green electricity.

This approach in terms of allocation of fiscal resources reflects the desire of Algeria to ensure that hydrocarbons, available in the country, support the investments necessary to the development of new and renewable energy for the benefit of future generations. ❑

Reform of energy markets to meet the CO_2 challenge

By Chris Huhne,
Secretary of State for Energy and Climate Change, United Kingdom

Since our electricity market was liberalised in the 1980s, the system has delivered secure and affordable electricity for the UK. But in the years ahead, we face unprecedented challenges. The existing market was not designed to meet them.

The days of self-sufficiency are long gone; our native resources can no longer match demand. Our fossil fuel habit leaves us hostage to global energy markets. Today, we rely on imported fossil fuels to provide a third of our energy; in fewer than fifteen years, it will be half.

This would not matter so much if we had a balanced energy portfolio where nuclear and renewables smoothed out volatile gas prices. But we are 25th out of 27 European countries for renewables, and have not built a nuclear power station since 1987.

Most of our electricity comes from gas-fired power stations, and so household bills track global prices. When wholesale gas prices rise, so does the cost of living in Britain.

Our ageing power stations also need replacing. Demand for electricity could double by 2050 as we opt for electric vehicles and heating. If we do not do something now, supply will not keep up and the lights will go out.

A quarter of the UK's capacity will need replacing before the decade is out, as old coal and nuclear plants come to the end of their useful lives. It would not be safe, efficient or legal to prolong them. And we face ambitious carbon emissions and renewable energy targets, as we seek to build a cleaner energy future for Britain and the world.

Keeping the lights on and our carbon emissions down means raising a record amount of investment.

Our energy regulator estimates we need £110 billion of electricity investment by 2020. That is £30 million per day for ten years – double the investment rate of the previous decade. It is the equivalent of twenty new power stations together with the infrastructure to connect them to the grid.

The current market arrangements will not deliver investment at the scale and the pace that we need. The 'big six energy suppliers' – who provide 99 per cent of the electricity in Britain – cannot meet the investment challenge alone. We need new blood in the electricity market.

That is why the Coalition government has set out the most significant reform of our electricity market for thirty years. It will deliver secure, affordable energy for generations to come.

By reforming the market, we can build a cleaner, more diverse, more sustainable electricity mix. This will mean reducing risks for investors by setting out a clear and stable investment framework – and making sure we create the right conditions to attract the capital needed to transform our system.

It also means establishing a system where, in time, low-carbon technologies can compete against each other on a level-playing field to find their place in the energy mix.

And it means making the existing market fairer – to low-carbon suppliers, who

Chris Huhne examines part of a wind turbine at the Vestas Medina Mills site, Isle of White

Photo: Rick Tomlinson/DECC

currently have to compete in a market in which they are at a natural disadvantage. To new entrants, who struggle to sell their electricity in a market dominated by six big firms. And to consumers, who want investment to take place in the most cost-effective way.

There are four parts to our reforms.

First, we will ensure the security of our energy supply by changing the way we contract for our back-up electricity. A capacity mechanism will make certain that when the nation's kettles flick on at half-time in FA Cup final, the system can cope.

Second, a new carbon price floor will put a fairer, firmer price on carbon emissions. This reduces the uncertainty for investors, and provides an incentive to invest in low-carbon generation now.

Third, we will introduce a new system of long-term contracts to remove uncertainty and make low-carbon energy more attractive. Companies will be attracted to build new plant in our market because they will be able to plan for the price they will receive. If the market price is too low, they will get a top-up. But the good news for consumers is that if prices go sky-high, companies will pay back the difference.

The new price contracts will spur investment in all forms of low-carbon energy. By ironing out price volatility, they will lower the cost of capital which is particularly crucial for both renewables and nuclear, which have high up-front construction costs but low running costs.

Fourth, we will set a limit on the pollution of carbon from new fossil-fuel power stations with an Emissions Performance Standard. This means no new coal power can be built without a system to capture and store its carbon, but it will encourage new gas plants to keep the lights on in the short term.

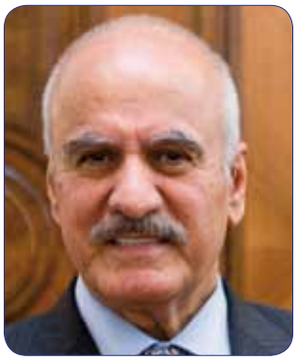
Together, these reforms will secure our energy future. They will get us off the fossil fuel hook and onto clean, green and secure energy. They will insulate our economy – and our household finances – from volatile global prices, and they will bring new entrants into the market to boost competition and help consumers. Crucially, they will keep household bills lower than they would be if we stuck with the existing arrangements.

But our reforms are about more than incentivising investment in new supply capacity. The most cost-effective way to secure our future supplies is not just to build new power stations. That is why we have put demand reduction at the heart of our policy programme. From next year, a nationwide energy efficiency programme will begin; energy saving packages worth thousands of pounds will be installed in millions of homes and businesses, right across the country.

The Coalition, when it comes to energy security as elsewhere, is determined to take the tough decisions to protect our Nation's interests. These reforms will yield the biggest transformation of the market since liberalisation, heralding the shift toward a low-carbon economy. They will put us back to the forefront of low-carbon technological development. And they will deliver secure, affordable, sustainable energy for generations to come. ❑

Assembly of a turbine in the Horns Rev wind farm in the North Sea

Photo: DONG Energy A/S



Powering up the South through energy poverty alleviation

By Suleiman J Al-Herbish,
Director General, OPEC Fund for International Development (OFID)

Energy poverty is one of the biggest obstacles to sustainable economic growth and development in the South, hindering efforts to reach the poverty reduction and related UN Millennium Development Goals (MDGs). Worldwide, 2.7 billion people rely on traditional biomass such as fuelwood, charcoal or crop residues for cooking, agro-processing and heating, and over 1.4 billion people lack access to electricity.

In recognition of these challenges and the need to address them, 2012 has been designated the International Year of Sustainable Energy for All, with the aim of kick-starting efforts towards achieving the goal of Universal Energy Access by 2030.

In the wake of the financial crisis, and as economic growth rates pick up in Africa and other developing regions, it is critical that energy access and supply should not be one of the stumbling blocks in the way of realising national potentials. In the case of Africa, electricity supply has emerged as a major bottleneck in the majority of countries. With a population of about one billion people – a number expected to almost double by 2050 – per capita electricity consumption in the region is one of the lowest in the world,and 70 per cent of the population is not connected to a power grid.

OFID/Helen Abu Jurji

Within this context, the situation in sub-Saharan Africa (SSA) is of particular concern. The sub-region is home to the majority of the Least Developed Countries (LDCs), most of which have suffered acute energy crises in the past. Unless rapid and concerted action is taken towards improving electricity generation and distribution, the number of people without electricity in SSA will rise by 60 million to an estimated 600 million in 2030.

At the fourth UN Conference on the LDCs, Istanbul, Turkey, May 2011, world leaders called upon the international community to assume part of the responsibility for improving access to basic energy services for the very poor. The Istanbul Programme of Action highlights the need to strengthen productive capacities in the world's poorest countries, with energy among the top priorities within a "new global partnership." The Programme of Action further specifies that, in helping to develop the energy sector in LDCs, development partners are – amongst others – to provide "enhanced financial and technical support."

For sure, meeting the goal of universal energy access by 2030 will be a highly capital intensive endeavour, with the current US$9-10 billion devoted annually to energy poverty alleviation having to increase four or five-fold. The financing, moreover, will have to be diversified, involving official sources (ODA), multilateral institutions, the private sector and developing country governments.

Such an approach was highlighted at the April 2011 Crans Montana Forum High Level Panel on energy poverty reduction, which was hosted by OFID at its Headquarters in Vienna. Organised under the sub-title *Energy Poverty: Can Industry Lead the Necessary Change?* the Panel examined market-based solutions and public-private partnership for boosting investment and developing sustainable business models for rural energy production and distribution.

As well as a diversified financing mix, energy poverty alleviation will also require a diversified fuel mix. Solutions will have to include the continued use of fossil fuels alongside renewable forms of energy, such as hydro, wind and solar power, as well as second-generation

***OFID** is the development finance institution founded in 1976 by the Member Countries of OPEC as their collective channel of aid to the developing countries. OFID works in cooperation with developing country partners and the international donor community to stimulate economic growth and alleviate poverty in all disadvantaged regions of the world. It does this by providing financing to build essential infrastructure, strengthen social services delivery and promote productivity, competitiveness and trade. Suleiman Al-Herbish, a Saudi national, has been Director-General of OFID since November 2003.*

biofuels. Such flexibility, coupled with innovation, will see large-scale infrastructure projects combining with efficient, affordable, small-scale schemes designed to deliver energy faster to poor communities in urgent need.

As a development financing institution with a mandate to eradicate poverty, OFID welcomes the rising profile of energy poverty on the international agenda. Indeed, OFID stands at the forefront of global efforts to fight energy poverty through its Energy for the Poor Initiative (EPI). The EPI was launched in direct response to calls at the November 2007, Third OPEC Summit in Riyadh, where Member Countries acknowledged the "strong interrelationships between energy and development" and urged all OPEC aid institutions, including OFID, to work to eliminate energy poverty in the developing countries.

On the dialogue front, OFID is working to convince its partner countries to make energy provision a priority in their national development strategies; and, moreover, to adopt pro-poor policies with a view to making energy services' access more affordable; for example, and where appropriate, with well-targeted subsidies that effectively reach the poor.

Secondly, moving from dialogue to action, OFID is substantially stepping up its assistance to the energy sector. Until three years ago, energy accounted for around 19 per cent of total commitments. In 2010, this allocation grew to 24 per cent, with funds supporting a wide range of projects in a large number of countries. The resulting, enhanced energy access is expected to lead to increased industrial and agricultural productivity, as well as improved social services delivery.

In addition, and in recognition of the need for more grassroots initiatives, the institution recently set up a special enhanced grant programme aimed exclusively at providing basic energy access for poor populations through off-grid and other solutions. The programme will foster partnerships with national governments, UN agencies, the energy industry and NGOs, and has launched with a scheme in association with the Shell Foundation to supply poor rural families in Kenya and Tanzania with solar lanterns.

In June 2011, at their annual ministerial meeting, OFID Member Countries substantiated their support of the EPI by pledging US$1 billion in fresh resources to the institution. These additional funds will allow OFID to deepen its presence, particularly in the poorest countries, and strengthen partnerships to power broad-based sustainable growth and development in the South. ❑

Best world practices are no longer found in the most developed countries

Delivering sustainability through effective policy

By Joan MacNaughton,
Senior Vice President for Power and Environmental Policies, Alstom

Energy is at the heart of the quality of life which most of us enjoy. It supports the necessities of life, notably clean water, as well as driving economic prosperity. The 1.4 billion people who, according to the IEA, lack access to electricity, are denied these benefits. The three challenges of delivering security of energy supply, of ensuring the environmental sustainability of energy systems, and of providing access to affordable energy for all, constitute one of the most difficult and important policy tasks for government and multilateral institutions: a policy task which if not executed effectively threatens the discharge of many of their other responsibilities.

This "trilemma", as it is often called, has been the focus of recent policy assessments by the World Energy Council, drawing on the expertise of its membership. Perhaps uniquely, the lessons derived from this work reflect the perspectives and expertise of both policy makers and of the private sector engaged in energy supply, transformation and use across several industries. The WEC's policy assessment work authoritatively synthesises these perspectives and contains some important messages for both policy makers and business leaders.

Why should the policy challenge in relation to energy be perceived as any different from other policy areas, many of which embody the need to balance competing interests or to make trade-offs, such as between affordability and the level of performance, for example? Among the reasons are:

- Policy maturity: while it is some decades since the science was perceived as requiring significant policy action to tackle climate change, this nevertheless is a relatively new area of focus for policy makers compared to many other, more traditional, topics.
- Scale: addressing climate change will require a transformation in how we source, distribute and use energy – requiring the replacement of legacy systems in the energy, buildings, and transport sectors, legacy systems which have been built up over more than a century in the developed world. And all this has to happen at the same time as new systems are being built apace to meet basic needs and to deliver security of energy supply to burgeoning populations and expanding economies in the developing world, and at a time when many energy resources are becoming more difficult and/or expensive to access. The IEA estimates an investment requirement in the energy sector of US$ 316 trillion by 2035, well above the trend rate of investment hitherto.
- Multiplicity of actors: policy is fundamental to deliver sustainable energy investment and to drive forward the deployment of such clean technologies at affordable prices for consumers, but most of the required investment will come from the private sector. Industry can and will provide innovation in low carbon, affordable solutions, but this dependence on the private sector to deliver is much more marked than in many policy areas.
- Timescales: many energy projects are huge and have significant pay back periods. Power grids are an obvious example. Even the lifetime of a power plant can be anything from 20 to 50 years or even longer. The right policy framework needs to give clarity, and enough confidence for the medium to long term, so that companies can make informed decisions. Of course, no-one believes, or even wants, that policies are set in concrete and unable to be adapted to changing circumstances. But a strategic vision must be communicated. Yet, though investments must look to a long-term horizon, they cannot be delayed without adding to the costs of mitigation of, and adaptation to, climate change.

Above all, these are global issues requiring all countries to act – with the consequences of inaction likely to be visited on the most vulnerable who are not responsible for GHG emissions historically.

The WEC Policy Assessment Process

The WEC methodological framework developed over the last three years aims to identify effective policies and how they can be replicated, and does so through an index of country energy performance data; a review of selected country energy policies; and opinion surveys of energy industry executives and WEC member committees.

"Pursuing sustainability": 2010 Assessment of country energy and climate policies

The WEC 2010 report showed how countries that have gained energy autonomy, using a diverse energy mix, with established energy efficiency programmes and that are balancing an environment favourable for investment with affordable energy, all supported by a strong policy framework, are in the top positions regardless of their initial energy resource or economic starting point. What makes the difference is a robust policy environment.

From the 2010 survey of energy industry executives, the major perceived threats – apart from the important exception

of increasing fuel/electricity costs or prices – were the following key inhibitors of successful policy implementation:

- an unfavourable regulatory environment
- low public acceptance of policy measures
- mismatching of policy vision and industry preferences and
- slow execution of planning processes.

It is clear therefore that energy industry executives consider successful policies to anticipate and mitigate the impact of rising energy costs, and the removal of barriers impeding policy implementation, as essential to facilitate investment. The 2010 survey examined the barriers to investment, as well as the effect of policy uncertainty. The liberalisation of energy markets was believed to have driven performance improvements in some countries while, in others, problems with implementation affected the achievement of key policy goals. Subsidies or price caps, on the other hand, were thought to have deterred investment over significant periods – also with deleterious effects on security of supply and sometimes (paradoxically) on access to energy.

While just over half of industry executives were sanguine about the prospects for profitability, there were many with a more negative outlook and, for them, a major concern was possible changes in the policy or regulatory environment. As the report concluded, steps need to be taken to give greater certainty for large scale investments. Mechanisms to mitigate risk – such as loan guarantees, insurance schemes, co-investments, and policy stability – should be considered. Distortionary instruments such as price controls or subsidies should be removed to increase the availability of capital and, importantly, incentive packages should be underpinned by clear transparent analyses of the costs relative to the benefits. Moreover, policy design needs to factor in key co-dependencies, to ensure transmission and distribution infrastructure keeps pace with the development of new assets for power generation.

The WEC 2011 Policy Assessment develops this analysis further and offer additional insights to help policy makers and businesses meet these challenges.

Conclusion

In the energy context, there is not a single stark choice between a market-based approach and government intervention. All systems exhibit features of both. The key design challenge is ensuring the policy framework is fit for purpose in delivering security of supply, sustainability, and access to affordable energy; while identifying and facilitating the appropriate contributions from the market.

Alstom Power eco-building, Massy, France

I would offer two suggestions for how to facilitate successful policy design:

- First, transparency: meaningful public consultation on the need to act, a realistic and frank account of the risks and benefits of various options, and transparent analysis of the evidence on which choices are being based, not only helps secure popular buy-in. It also provides insights to inform companies in making investment decisions: as well as enabling the validity of the choices among the policy options to be tested.
- Second, involve the private sector.

Among the contributions businesses can make are:

- avoiding the delay which an uncommercial approach might entail, by advising on which approaches are most likely to succeed, and quickly discarding less promising ones;
- drawing on their practical multinational experience to advise on the status of particular technologies;
- helping to devise delivery frameworks which minimise overhead or transaction costs;
- advising on how best to allocate risk among the various market participants; and
- giving feedback to policy-makers about the interactions among different strands of policy, which are often not apparent to officials working on individual dossiers.

By engaging widely on such issues, and by harnessing the innovative approaches which business brings, policy design can be made more likely to succeed. ❑

Smart grids: bridging the knowledge gap

By Michael Valocchi,
Global Energy and Utilities Leader, IBM Global Business Services

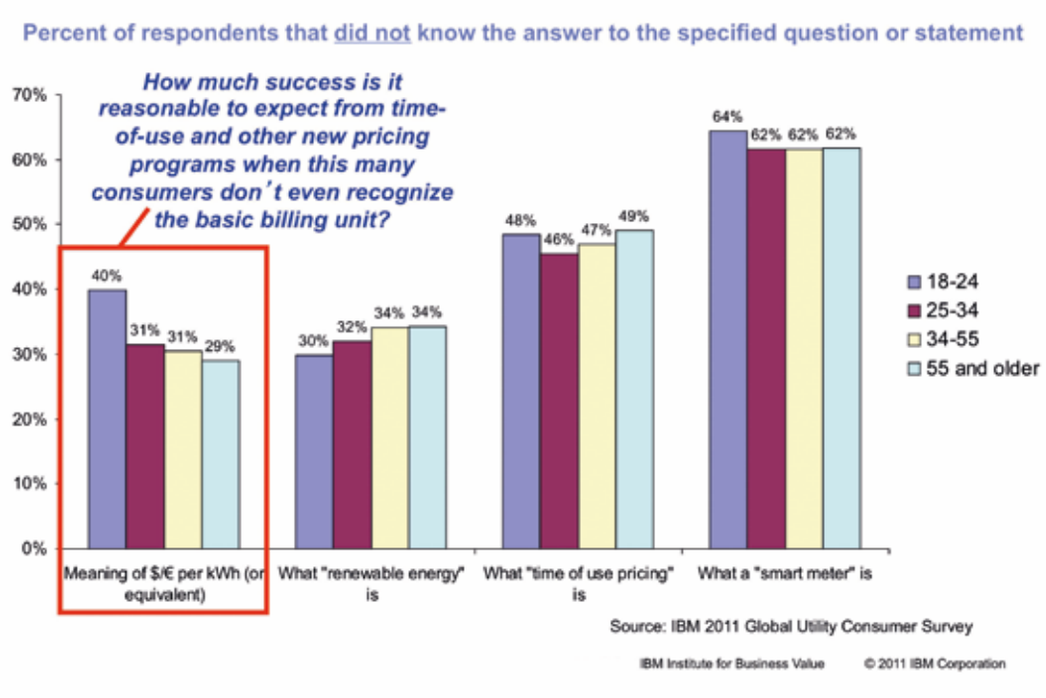
In 2007 and 2009, IBM released the results of its first and second Global Utility Consumer Surveys. In the first survey, the focus was on what consumers would want from a future relationship with providers that leveraged smart meters and the information they could make available. Based on the results in 2007, IBM was able to categorise residential energy customers based on their goals and on important factors such as environmental concerns, financial considerations, and convenience. The 2009 survey showed persistence of these distinct patterns of interest in new ways to control energy usage and interact with providers, but in a drastically different economic environment which reduced willingness to spend to achieve specific goals. In the past few years, however, consumer resistance was greater and engagement was less than some had expected as new technologies rolled out in markets around the world, and this shaped some of the questions devised for our 2011 survey.

For 2011, the survey scope was expanded to 15 countries, approximately 10,000 responses, and nine languages. To investigate the sources of possible attitudinal shifts, additional questions centred on what consumers' views and expectations are as smart meter programmes are deployed, experienced personally, and covered in the media – rather than focused on what consumers might want in the future.

Knowledge gaps – bigger than assumed?

The survey results clearly indicate that there are major gaps in electricity consumers' knowledge, even for basic concepts. For example, when asked if they understand the basic pricing unit for consumption (i.e. cents per kWh), over 30 per cent of consumers report that they have never heard of the unit or do not know what it means. This has major implications for the implementation of programs like time-of-use pricing (a term itself which half of those surveyed do not recognise at all). Over 60 per cent don't know what "smart meter" and "smart grid" mean; and "customer energy portal" has no meaning to 80 per cent. (See Figure 1.)

Figure 1: Major knowledge gaps exist across all age groups that could hinder industry progress toward participatory networks



The results show that consumers' knowledge strongly correlates with both willingness to change behaviour to meet societal goals (e.g., help reduce peak demand by changing the time when energy is used) and with overall approval of smart grid programmes that are being deployed or proposed locally. For example, among consumers with very little knowledge of common industry terms, only 43 per cent approve of technology deployment

programmes, versus 50 per cent for those with moderate knowledge and 61 per cent with strong knowledge. Similar correlation can be seen in responses to questions about whether these programmes will benefit their families and if they are likely to change energy use patterns. For virtually all measures of a consumer's likelihood of embracing changes, this stepwise, increasing pattern appears. (See Figure 2.) The good news is that greater consumer knowledge of smart grids correlates with higher levels of approval; the bad news is that almost half of consumers lack even basic knowledge.

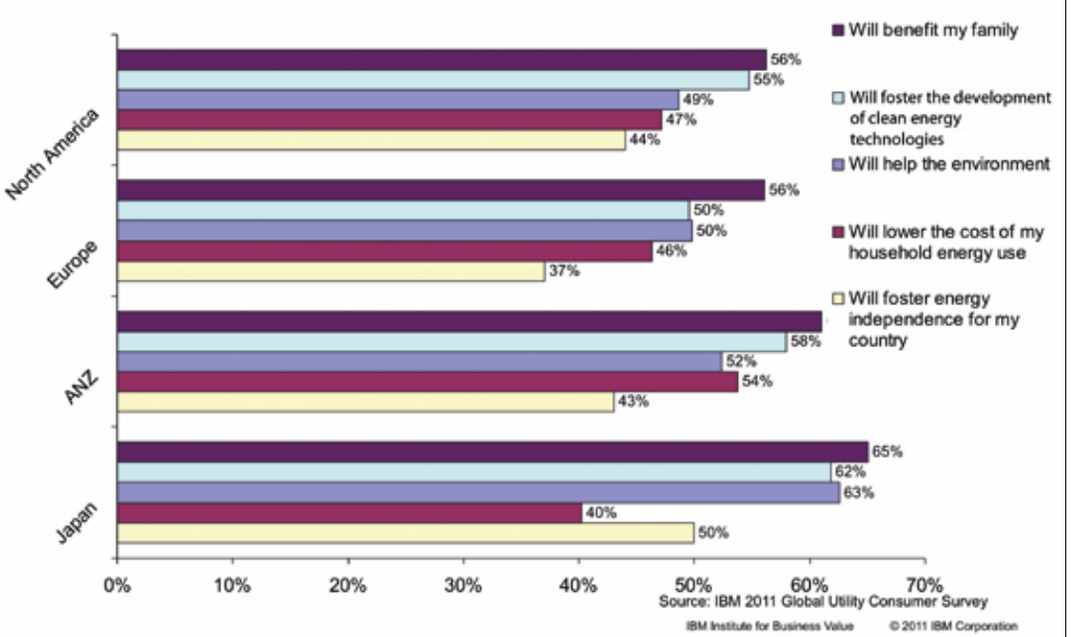
Shifting perceptions and influences

What, then, are the best ways to reach consumers to improve their knowledge? As one would expect, the responses show significant distinctions among age groups in how information is obtained. Online social networking and video content are as much as nine times more likely to be a primary information source for those under 25 than for those over 35. Those under 25 are also looking for information "close to home," being three times more likely to rely on friends and family as their first source, than on government sources. Those over 55 are only half as likely to look to their own personal contacts as to government sources.

Another factor that shifts across age groups is the nature of messages most likely to resonate. Although, as in prior years, saving money is the strongest motivator, the impact of other motivations is growing. Among younger consumers – particularly those under 25 – the influence of environmental concerns is much higher. Conversely, those over 45 are up to 40 per cent more likely to be driven by concerns related to cost control, energy independence, and the impact of energy prices on the national economy. There are similar differences across countries, as well, some representing significant shifts from 2007 and 2009. In about half of the countries surveyed, motivations for changing energy consumption behaviour are driven less by the desires to conserve natural resources and lessen impact on the environment than by concerns about energy independence and the nation's economic health.

The most significant finding about messages and influences, however, comes from looking at the aggregate contribution of sources which have significant external influence on consumers' knowledge and perceptions. In this year's survey, the percentage of people reporting that they use an information source that is not under

Figure 2: Consumers believe the promise of smart grid and smart meters, and are expecting the promise to be fulfilled



the control of the consumer's provider exceeds the percentage that use a source directly under the control of that provider. This points to a major shift in messaging power. Consumers are now relying less on information that comes from their own energy provider and more on other external influences. The effect increases when looking at the emerging economies, and is stronger for younger consumers than for older ones. These findings seem in line with the explosion of social media and the diffusion of information and opinion via the Internet that are changing the way companies in almost every industry engage their customers.

Behavioural levers

Last year, experts in consumer decision-making from IBM and academia examined energy decision-making processes through the lens of behavioural economics. Often, industry advertising campaigns focus strongly on a particular long-term impact that smart meters and smart grid technology may have on the individual, typically in terms of costs, environmental impact, reliability, or reduced dependence on non-domestic energy sources. These core themes vary from geography to geography, but are often deployed across a broad media spectrum. This strategy is often less effective than distinct messages targeted at audiences for a specific medium. Price levers (such as time-of-use pricing) can drive changes in consumer behaviour, but at a risk of sometimes seeming driven by penalties ("I am paying more for this") and not by incentives ("I am choosing to do this"). If the relative weight of cost in decision-making continues to decline among key segments of the population, then understanding and addressing the additional factors that motivate consumers seems critical to succeeding in changing behaviour.

This does not, however, mean that options should be provided to address every priority suggested by all the various consumer segments. Aside from the expense and contradictions inherent in trying to do so, the resulting complexity would be likely to de-motivate consumers completely. In fact, the survey results showed that friends and family – especially for the youngest utility customers – are increasingly seen as the preferred source to identify best choice among options. Behavioural economics suggests (and experience has demonstrated in multiple areas) that, when faced with what they perceive as too many choices, people are more likely to lean on the recommendations and choices of such preferred sources, rather than sort through options on their own. By presenting a more limited, but well-balanced set of options, energy providers can avoid the kind of complexity that can confuse people and stifle their desire to make independent choices.

Tapping into people's inherently social nature is one way to encourage the adoption of new ideas. "Social proof," or the behaviour of others, is a critical determinant in how people react to unfamiliar situations. This is the key idea behind new concepts such as Web portals that allow consumers to compare their energy usage to that of their neighbours. Being able to make comparisons also taps into the instinct many people have for competition. For utility service providers such as Enemalta Corporation and Water Services Corporation in Malta, the portal is instrumental in encouraging consumer action and lowering overall usage.

Conclusion

There appears to be insufficient understanding that to maximise the benefits of smart grids and smart meters, consumers will need to take a more active role in managing their energy consumption. This lack of understanding leaves the marketplace ripe for confusion and misinformation – and is exacerbated by factors such as people's growing tendency to get information about smart grids from sources other than the utility itself and the decrease in relative importance of price as a motivation to change consumption. To counter this lack of understanding – and the lack of support that is correlated with it – utilities and other advocates for smart grids need to engage consumers with (segmented) messages that address their specific motivations, and do so through the trusted channels (such as friends and family, for younger consumers) they already use. One place to begin could be to find terms that are more intuitively understood by consumers: for example, more than half of consumers don't know what "time-of-use" pricing means in the domain of electric power, but the vast majority already understands the same concept when applied to the domain of mobile phones. Since many of the broader societal shifts echoed in the findings of the Global Utility Consumer Survey are already affecting many other sectors, it seems likely that many of the same marketing techniques being used in industries with longer traditions of direct consumer engagement could also help address the very real knowledge gaps for smart grids. ❑

Japan's Energy Policy – Pre and Post Fukushima

By Jun Arima,
Director General, JETRO (Japan External Trade Organisation), London

Japan has almost no domestic fossil resources. Even regarding nuclear as domestic energy, Japan's energy self sufficiency in 2008 was 14 per cent, which is significantly lower compared with other major economies such as China (94 per cent), UK (80 per cent), US (75 per cent), France (51 per cent) and Germany (40 per cent).

Since the two oil crises, energy security through reducing their dependency on Middle Eastern oil has been the centerpiece of Japanese energy policy. To this end, Japan has been vigorously promoting energy efficiency. Currently, Japan's energy intensity is the lowest among the major countries. Japan has been reducing dependency on oil in the power sector by promoting coal, natural gas and nuclear as its alternatives. The share of oil in power generation dropped from 73 per cent in 1973 to 13 per cent in 2007, while the share of nuclear, gas and coal increased to 26 per cent, 27 per cent, and 25 per cent respectively.

Since the 1990s, Japan's energy policy has been pursuing simultaneous achievement of 3Es, namely, energy security, environment (i.e., climate change mitigation) and economic efficiency (i.e., lowering energy cost). However, this is not at all easy. Promotion of coal is good for energy security and economic efficiency but will conflict with the climate change agenda. Promotion of renewable energy is good for energy security and climate change mitigation but tends to be more costly. It is for this reason that Japan has been promoting the nuclear option as a key for achieving 3Es.

In September 2009, Japan announced 25 per cent GHG emissions reduction target in the context of the UN climate negotiation. While this is a conditional target subject to the outcome of the negotiation, this has made the simultaneous achievement of 3Es further challenging. Since Japan's energy efficiency is already very high, marginal abatement cost for further mitigation is extremely expensive. If 25 per cent reduction is achieved solely by domestic action, its marginal cost is estimated to be over US$450 per ton, 3-4 times higher than that of other countries.

Lack of international grid connection is another boundary condition. Unlike European countries which can import power from neighbours, Japan needs to domestically generate all the necessary power.

Pre-Fukushima - Strategic Plan of Energy 2010

Taking all of these boundary conditions into account, Japan set out the Strategic Plan of Energy in June 2010 with a series of ambitious goals.

On the demand side, it aimed at halving CO_2 emissions of the residential/commercial sector by 2030, a drastic reversal of 42 per cent increase from 1990 to 2007. On the supply side, it aimed at increasing the share of non-fossil fuel in the power sector from 34 per cent to 70 per cent (nuclear 52 per cent, RE 19 per cent), establishing 14 new and additional nuclear power plants by 2030 and raising the utilisation ratio of nuclear from 60 per cent to 90 per cent and 10 times expansion of the market volume for renewable through the FIT (feed-in tariff). If all of these goals are fulfilled, energy related CO_2 emissions in 2030 could be 30 per cent lower than 1990 level.

Post Fukushima – Into the Unknown

The Fukushima nuclear accident has completely changed the above picture. Japan's energy policies are facing unprecedented challenges from short, mid and long-term perspectives.

Currently, 39 out of 54 existing nuclear power plants are out of operation. The average capacity factor of Japanese power companies is -3.3 per cent. This is a rather worrisome figure given that 3 per cent capacity factor is normally regarded as the minimum requirement. The most imminent challenge is how to weather over Japan's hot summer this year. In the eastern part of Japan, the industrial consumers are legally obliged to save their power consumption by 15 per cent.

The more fundamental problem is what if nuclear power plants cannot come back to operation due to the lack of consent from the local communities even though they satisfy safety requirements, which are to be substantially strengthened after Fukushima? Furthermore, during the coming months, currently operating nuclear power plants will be stopped one after another for periodic inspections. If the current situation continues, all the nuclear power plants in Japan will have been stopped by next June and 30 per cent of total power generation will be lost. This will cause significant damage to Japan's economic recovery from the earthquake.

Energy and Environment Council

On 29 July 2011, the Energy and Environment Council, which was established under the Prime Minister with the participation of all relevant Ministers, spelled out measures to cope with the short-term power supply/demand balance in the next 3 years. They enumerate 1) energy efficiency (e.g., dissemination of high efficiency product, promotion of energy efficiency investment, smart metering and tariff menu for encouraging peak cut), 2) renewable energy (e.g.,

introduction of the FIT), 3) high-efficiency thermal power, 4) distributed power generation and smart community and 5) electricity market reform (e.g., neutrality of transmission/distribution, vertical separation of generation and transmission). They have also included the resumption of nuclear power plants of which safety has been confirmed.

The Council also laid out an interim wrap up towards a mid/long-term Innovative Energy & Environment Strategy to be published sometime next year. The 2010 Plan putting strong emphasis on nuclear will be overhauled from scratch. While avoiding energy shortage and energy price hike, the Council intends to make a comprehensive review of nuclear policy and to draw a scenario towards reducing dependency on nuclear. In doing so, the general public will be informed of objective data (e.g., cost comparison among different power sources) and engaged in broad dialogue. Six pillars, namely, energy efficiency, renewable, fossil fuel, nuclear, power supply system and energy/environment industries will be addressed in a comprehensive manner.

No Silver Bullet

At present, it is not clear which energy/power mix Japan is aiming at in 2030-50. The 2010 Plan tried to achieve the 3Es by setting ambitious goals on nuclear, renewable and energy efficiency. Given nuclear centric equilibrium looks difficult, a new equilibrium must be sought. While there seems to be a broad support among general public to reducing dependency on nuclear, it is subject to intensive debate how far, how quickly and at what cost it will be implemented.

Replacing nuclear with other sources is not so easy. While gas-fired power plants could be constructed relatively quickly, an estimate suggests that replacing all the nuclear power with thermal power will additionally incur US $38 billion per year for fuel import. This will raise monthly electricity bills for households and industry by 18 per cent and 36 per cent respectively. Such price hike could result in industry hollowing and significantly damage the Japanese economy. In addition, Japan's CO_2 emissions in 2020 will be 18 per cent above 1990 level.

Replacing nuclear with renewables is challenging as well. Currently, generation costs of PV, geothermal and wind power are 49 JPY/kwh, 8-22 JPY/kwh and 10-14 JPY/kwh respectively, far more expensive than thermal and nuclear power sources. Of course, the current cost comparison should not be taken for granted. Nuclear could become more expensive taking into account more stringent safety measures and payments to local communities where nuclear plants are sited. Massive penetration of renewable energy through FIT and RD&D efforts could certainly reduce its generation cost over time. In the long-term horizon, more penetration of renewable energy will raise energy self-sufficiency and save the cost of imported fossil fuel. However, in the short to mid-term perspective, the Japanese economy will have to bear considerably higher electricity price. Careful assessment of job creation in renewable industries and job losses in energy intensive industries is warranted. Low energy density of PV and wind power due to their intermittency is another bottleneck. An estimate indicates that replacement of all the nuclear with PV requires 200 GW PVs with US$1 trillion investment and 5260 km^2 space. Replacement with wind power also needs 152 GW wind mills with US$375 billion investment and 5000 km^2 space. This huge investment cost does not include back-up power facilities or battery facilities to cope with intermittency.

Each power source has advantages and disadvantages in terms of economic cost, supply stability, spatial constraint, climate change and social acceptance. In short, there is no silver bullet.

Vigilant Journey

A comprehensive review of Japan's energy policy has just started. Its final conclusion remains to be seen. The new energy policy will continuously seek to strike a balance between 3Es, but S (safety) will be put as the prerequisite. Since there is no silver bullet, all the options, including nuclear, should be kept open in finding a new pragmatic energy mix.

All the stakeholders (industry, consumer, academia, local communities) must be engaged in the review and informed of all the relevant data including cost comparison of various power sources, implication to Japanese economy and GHG emissions. Widespread "nuclearphobia" after Fukushima is not surprising. Japanese people could choose "nuclear-free" if they so wish, but its economic consequences in the coming 5-10-20 years needs to be fully analysed beforehand. Investors of energy-related facilities need predictability. Rash decisions now without sober cost-benefit analysis could easily be reversed afterwards when encountering adversities. This will in the end erode policy predictability, hamper new investment and risk national security. We are still on a journey, but we must be a vigilant traveller. ❑

This article represents the author's personal view.

Global energy scenarios to 2050

By Karl Rose,
Senior Fellow, Scenarios, World Energy Council

Much has transpired since *World Energy Insight 2010* was published — the US is beginning to come to terms with its gargantuan debt, the EU is attempting to staunch financial contagion from spreading beyond Portugal, Ireland, and Greece, commodity prices which have surged over the past year are beginning to slow, the price of gold is soaring as markets react to global financial instability, the events at Fukushima have caused Germany and Switzerland to exit future nuclear plans, and old regimes in the Middle East and North Africa are being toppled. In addition, there is increasing consensus that over the next 2-3 years global economic growth is going to decelerate. In such an environment companies are finding it challenging to plan and commit themselves to long-term energy projects. This uncertainty will undoubtedly have an impact on the future of the global energy system.

In September 2010 the World Energy Council launched its new flagship scenarios project which aims to make sense of this uncertainty by providing policy makers with potential scenarios to 2050, to aid them in making better strategic decisions. Since then, an energy scenario study group has been formed, which organised itself into five major work-streams, covering the areas of economics/finance/trade, energy systems & technologies, resource availability and access, consumer behaviour and acceptance, and government policies. The work-streams then identified a total of twenty-nine critical issues for the energy system that have been allocated for research and write-up to members of the global study group. Additionally, four regional scenario workshops have been conducted so far in Johannesburg, Bangkok, Thessaloniki, and Washington DC. The scenarios core team has used the input from WEC members as well as external participants to collect local feedback during these workshops and gain valuable insights on regional and global driving forces that will guide the construction of the scenarios in the second phase of the project. In the coming months, three more regional workshops are being planned in Rio de Janeiro, Paris and Houston, after which the first phase of orientation and identification of the scenarios project will be completed. This first phase has been work intensive and involved extensive research of the energy system by study group members. Results are being documented in issues papers that will be used together with all the insights from the regional workshops to identify predetermined trends, regional and global drivers and critical uncertainties of the energy system. During the next phase of the scenarios project the study group will construct a first set of scenario assumptions, which will then be discussed and challenged for robustness and logic with a wider audience of WEC members and experts.

It is evident that different regions around the world have different priorities with respect to energy. In Africa, the sentiment that affordable energy access has to precede other factors, e.g. accelerated renewable energy rollout, is very strong. Currently, many countries in sub-Saharan Africa are grappling with the problem of providing universal energy access. A basket of solutions has been proposed, which includes a strong fossil fuel component. There is no ambiguity that Africa will exploit its fossil fuel reserves to fuel its economic growth, as reserves are abundant, technologies are mature, costs in comparison to renewable energy are cheaper, and the required labour is available. At the same time the challenge of expanding centralised transmission systems is being overcome by the construction of smaller decentralised grids. The number of mini-hydro projects has sharply increased over the past decade and interregional power sharing pools between countries are also being developed. We will see the formation of a regional South African power grid in a few years' time. The solar market in Africa has huge potential and a large number of Chinese firms have already established a significant presence in the region. Problems with logistics, lack of local manufacturing capacities and skilled labour, as well as deficient government frameworks and local corruption continue to be problems that need to be overcome in many countries. With regard to North Africa, in the aftermath of recent political uprisings it remains to be seen how the new governments will develop their energy policies. It is expected that gas exports will continue to play a major role in this region in the years to come. The Gulf Cooperation Council has been taking measures to include some of the North African countries in its membership. This could eventually lead to the formation of a powerful MENA regional energy trading bloc.

In Asia, the story is similar to that of Africa — providing secure, affordable and universal energy access is the main challenge for the rapidly growing continent, followed closely by efforts to minimise energy-related pollution

levels where possible. Coal mining in India has intensified, helped along with market support, as was evident when Coal India's IPO was oversubscribed 15 times. Chinese consumption of coal doubled between 2000 and 2010, and currently stands at 1713.5 Mtoe (2010). Both China and India have plans of significantly expanding their nuclear portfolio, with the former planning to build 28 nuclear plants by 2015 and the latter planning to bring 20,000MWe of nuclear generating capacity online by 2020. It is apparent that Asia will continue to consume fossil fuels along with nuclear as countries fuel their economic growth with cheap energy and also attempt to provide affordable electricity to significant sections of their population. In Japan, the Fukushima incident has affected the future of nuclear in the country. Since Japan lacks fossil fuel resources, the decline in nuclear capacity will have to be offset by an increase in LNG consumption. South Korea will also continue to depend heavily on LNG. In addition, both Japan and Korea will continue to depend on coal for meeting their energy needs. Australia will rely on its abundant coal and gas reserves to fuel its growth, while the potential to invest in solar projects remains high. China is leading regional and global growth in most energy sectors including efforts to add capacity in renewables. China's investments in renewables are on par with the US and the largest globally in absolute terms.

The transition to a renewables-dominated energy future also remains also uppermost in the minds of Europe's policy-makers. The 2020 targets are binding on all EU states and will require significant investment to build up the needed infrastructure. The policy however gives freedom to EU-states in the manner in which they will meet these targets. For example, the recent decision of Germany to exit nuclear will drive it towards dependence on gas-fired power stations to provide base-load as renewables capacity increases. The UK on the other hand, has no intention of exiting nuclear and has plans of building potentially 10 new reactors. Gas will continue to play an important role in the rest of Europe complemented by the Alpine hydro systems in the move towards a low carbon future. The construction of the "Nabucco" and "South Stream" gas pipelines has the potential to bring needed additional gas volumes to Europe. Energy transformation will come at a cost, however, and politicians in some European countries may soon be faced with the spectre of having to compensate for energy poverty within the weaker parts of their society. This will require new policy instruments that balance incentives for new and cleaner technologies with the need for social equity and affordable prices.

The role of unconventional gas and oil will be of high importance in North America. Canada has surged ahead in the development of its oil sands and is consolidating its position as the largest oil exporter to the US by developing its transnational oil pipeline infrastructure. In the US, the shale gas revolution has impacted the gas picture worldwide. Shale gas is estimated to account for half of domestic US gas production by 2030. As a result of the US weaning itself off gas imports a large amount of LNG has become available on the worldwide LNG spot market. These volumes have made landfall in Europe, driving down the spot price of gas and have affected European gas and electricity markets considerably. It has become apparent through these developments that LNG will play a crucial role in the years to come, especially with floating LNG terminals recently coming online.

In South America biofuels will play an important role in Brazil, gas in Bolivia, and oil in Venezuela & Brazil. The IEA (*New Policies Scenario: WEO 2010*) expects regional power infrastructure investment in the region to be over US$700 billion from 2010–2035, while the figure for oil is around US$1.5 trillion. The region is experiencing a growth spurt in its mining industry in order to service Chinese demand. We expect to see new infrastructure projects being constructed and the level of electrification increasing.

The above are only a limited excerpt of some of the regional messages the scenarios team has collected so far in the first phase of the project. The second phase will try to identify the most critical drivers and describe their interactions with each other, in order to be able to describe potential pathways for the energy future to 2050. This will be carried out over a series of scenario building workshops scheduled towards the end of this year and the beginning of the next. WEC members and selected energy experts and professionals will be invited to participate in these workshops with the scenarios study group. Once the scenarios have been framed, work begins on drawing the storylines and testing & reaffirming the assumptions. The scenarios will be rigorously tested to be plausible, structurally sound, consistent, and challenging. WEC hopes to have these energy scenarios ready by the middle of next year. ❑

Carbon capture utilisation and storage: An evolving approach to mitigating climate change

By Barbara McKee,
Chair, World Energy Council Cleaner Fossil Fuel Systems Committee

Carbon Capture and Storage (CCS) is a set of technologies under development to reduce carbon dioxide (CO_2) emissions from large stationary sources, notably fossil energy power plants and industrial facilities. CCS involves the separation and compression of CO_2 from an exhaust stream of an industrial or power plant, its transportation to a storage site and injection into a deep geologic storage formation. The fate of the CO_2 is secure and safe disposal in that formation through various geologic trapping mechanisms. In recent years, innovative scientists and engineers have been expanding the ways to dispose of captured CO_2 to include beneficial reuse of the CO_2 for various purposes.

Carbon capture utilisation and storage (CCUS)

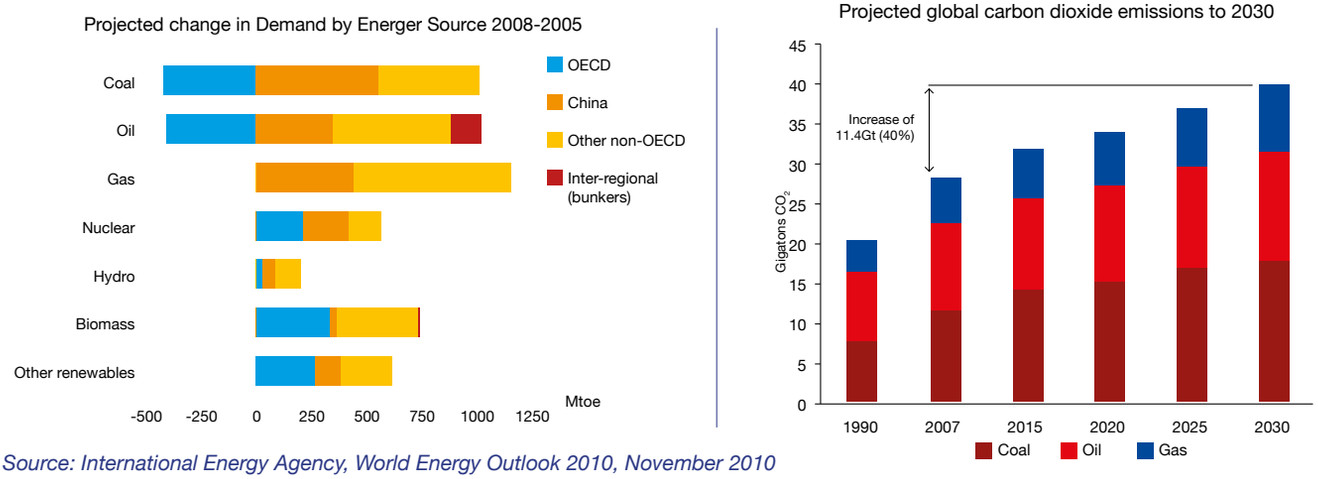
Probably the most well-developed type of reuse is Enhanced Oil Recovery (EOR). In EOR, injected CO_2 raises the pressure in reducing oil fields, increasing the production of oil. This ability to increase oil production gives the CO_2 a monetary value. Similar methods to increase natural gas production through Enhanced Gas Recovery (EGR) from decreasing natural gas fields and Enhanced Coal Bed Methane (ECBM) from deep un-mineable coal seams. Relatively small amounts of CO_2 have also already been captured from various industrial sources for decades for various high-value industrial uses such as carbonated drinks, growing flowers in greenhouses and chemical processes.

Newer beneficial reuse applications include fertiliser, cement, algae and plastics production. Most are in an early stage of development. Research into reuse applications for CO_2 has been increasing and a new term is emerging: Carbon Capture Utilisation and Storage (CCUS). While beneficial reuse is unlikely to be applied to most captured CO_2, early beneficial reuse applications can help to accelerate the use of CO_2 capture technologies, improve their economics and widen their applicability.

The Need for CCUS

CCUS is projected to play a large, critical and unique role in reducing CO_2 emissions on a significant scale to avoid climate change. There is now a broad global consensus to set a goal of making CCS widely commercial by 2020. CCUS together with nuclear hydropower is the only available large scale low carbon technology. As Figure 1 shows, CO_2 emissions, if uncontrolled, are projected to grow rapidly over the coming decades. This growth is largely driven by expected increases in global demand for fossil fuels, particularly in China and other developing (non-OECD) countries. This increase in energy demand is a natural result of the rapid economic expansion of their economies as the emerging economies strive to provide their people with the basic requirements of modern life. This creates a dilemma — reconciling that need for fossil

Figure 1: projected energy demand and CO_2 emissions under current polices



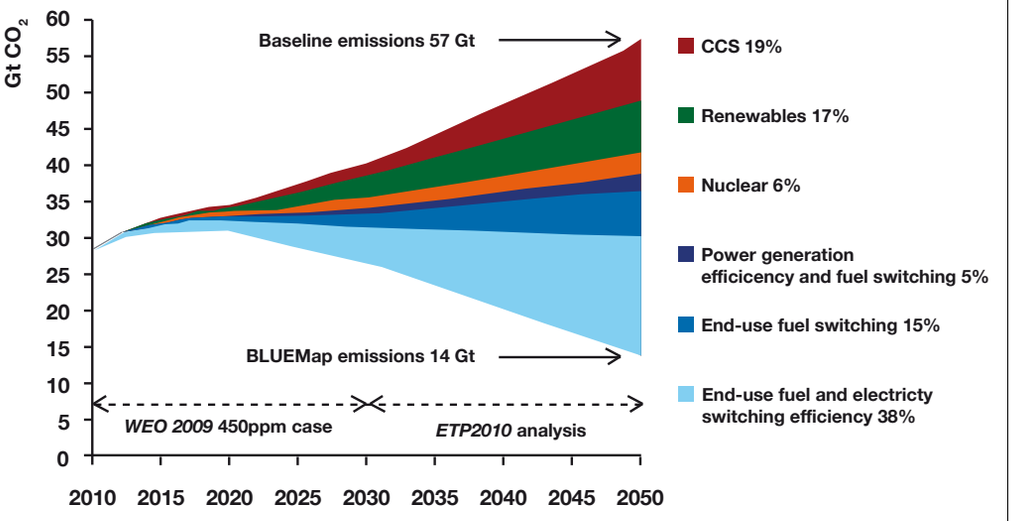
Source: International Energy Agency, World Energy Outlook 2010, November 2010

energy with the necessity to reduce CO_2 emissions. CCUS will be vital to resolving that dilemma because it enables fossil energy use without the corresponding emissions.

Role of CCUS in Reducing Global CO2 Emissions

The International Energy Agency recently conducted what is probably the most thorough and detailed analysis of how CO_2 emissions can be cut in half by 2050, which is the minimum reduction the UN Intergovernmental Panel on Climate Change (IPCC) estimates is necessary to prevent most of the damage resulting from climate change. The results are shown in Figure 2.

Figure 2: Key technologies for reducing C0$_2$ emmissions



Source: International Energy Agency, World Energy Outlook 2010, November 2010

While this study focused on the subset of CCUS applications that can be termed CCS, several conclusions can be drawn from this figure:

- A wide range of technologies will be necessary to achieve the 50 per cent emissions reduction goal.
- The largest opportunity to reduce emissions is to improve energy efficiency.
- CCUS can achieve the second largest emission reductions, even greater than renewable energy.

The conclusion about the large potential for CCUS is not widely known. It is based on the large number of potential cost-effective applications worldwide in both power generation and industry. This conclusion would be even more strongly supported had the full range of potential applications for beneficial reuse been considered.

Progress on CCUS

Engineers and scientists have been developing CCS for nearly twenty years and have made substantial progress. Work to develop CCS technologies and practices, in particular, has been ramping up considerably throughout the world over the last decade. Once just the exotic dream of a few scientists, CCS is now well on its way to becoming a commercial reality. This work is now expanding to cover CCUS.

Capture technologies can be used for the full range of CCUS applications. Several pilot-scale capture projects are currently in operation and numerous tests of geologic storage have been undertaken and are proving successful in demonstrating safe and secure long-term storage. A wide range of capture technologies for power generation have been developed and are currently being refined, with costs of capture now starting to come down. Millions of tons of CO_2 have now been injected into diverse geologic formations around the world. Much has been learned about how to inject CO_2 safely, how to monitor it underground, and what happens to the CO_2 in the geologic formations into which it has been injected.

Several large-scale commercial projects are now reliably in operation, some for over a decade. These include the Great Plains Gasification/Weyburn-Midale project in the United States and Canada (an example of CCUS), the Sleipner and Snøhvit projects offshore from Norway, In Salah in Algeria, and the Gorgon Project in Australia.

The Great Plains/Weyburn-Midale project is a particularly interesting example of CCUS because it is fully commercial

and involves the capture of CO_2 from a coal gasification plant in the US state of North Dakota and its storage and use for EOR in depleting oil fields in the Canadian province of Saskatchewan. The CO_2 is carried by pipeline about 200 miles to the oil fields.

The capture technology at the Great Plains Gasification Plant (shown in Figure 4) is pre-combustion capture, one of several approaches to capture. The Weyburn-Midale CO_2 storage component of this project in Saskatchewan also hosts a major international research project led by the IEA Greenhouse Gas R&D Programme to monitor what happens to the injected CO_2. The results of over a decade show that the CO_2 is securely trapped in formation and that the CO_2 can be reliably monitored.

Great Plains Gasification and CO_2 Capture Plant

Photo courtesy of Basin Electric Power Cooperative

Overcoming the Remaining Challenges

While progress to develop CCUS has been substantial, much more work remains to be done to make it widely commercial. Substantial challenges remain. Some are technical and others are institutional. These include:

Technical Challenges

- High capture costs and energy requirements
- Work to develop beneficial reuse applications
- Need for further storage experience
- Undeveloped CO_2 transport infrastructure in most regions
- Water requirements for capture

Institutional Challenges

- Lack of value for CO_2 emissions reductions
- Inadequate legal and regulatory frameworks
- Limited public awareness of CCS, its benefits and safety

These challenges vary by country. They are particularly severe in developing countries where CO_2 emissions are expected to increase the most. In developing countries, the highest priority is generally economic development, financial capacity is the most restricted, and capacity to implement CCUS is most limited.

Work is underway throughout the world to overcome these challenges and technical progress has been particularly great. Increasingly, progress involves global collaboration through such organisations as the Carbon Sequestration Leadership Forum and the WEC Committee on Cleaner Fossil Fuel Systems.

Legal and regulatory frameworks for CCUS are being put in place in several international, national and sub-national jurisdictions. The most fundamental challenge is that, in most places, reducing CO_2 emissions through emissions trading schemes, tax incentives, carbon taxes, or other mechanisms lacks adequate economic value to justify widespread commercial investments in CCUS. ❑

Fukushima and the future of nuclear energy

By Alessandro Clerici, Chair of the WEC Nuclear Task Force and Senior Advisor to the President, ABB (Italy)

The impact of the incident at the Fukushima Daiichi nuclear power plant, which resulted from the devastating earthquake and subsequent tsunami on March 11th, 2011, will have wide-ranging consequences for the global energy mix as governments and companies seek to address the challenges of providing a sustainable supply of energy for the greatest benefit of all. As part of the World Energy Council's flagship Scenarios study a Nuclear Task Force was set up to consider the impact of this incident and look into all aspects of nuclear, including safety systems and how nuclear governance is organised worldwide. In a series of 24 conference calls task force members discussed the future of nuclear and also drew on the results of a perception survey conducted through WEC member committees in countries where nuclear power is already part of the energy mix, with 27 out of 33 countries responding. All aspects of the topic will be further developed as a critical issue within the energy scenarios exercise, with this note focusing mainly on thoughts around the question of public perception and international governance of nuclear following Fukushima.

When evaluating the impact of Fukushima and the future development of nuclear energy, we need to take into account that positive as well as negative aspects of nuclear energy have to be seen from both a reality and a public perception point of view. The history of nuclear power is one of constant improvement and technological development based on the lessons learned in the construction and operation of the plants and great public debate and division about the safety of the technology. Accidents, like Three Mile Island, Chernobyl and now Fukushima tend to polarise these discussions and emphasise the public perception angle. In reality, past accidents triggered in-depth examinations of equipment, training procedures and safety culture, and these led to profound changes and adaptations to increase safety. The Fukushima accident will undoubtedly also contribute with major inputs for continuous improvements into the design and emergency operation aspects of the technology, once the circumstances have been thoroughly analysed and understood.

Over the last 10 years the world nuclear energy production has been practically constant, with the so called "nuclear renaissance" happening at the public perception front, where the major concerns after Chernobyl changed little by little from large accident to questions around final waste disposal. Contributing factors were the price volatility of fossil fuels (and the actual or expected long-term rise of their current prices), the problem of security of supply and the environmental issues connected to greenhouse gas emissions. Going forward, safety concerns, economic considerations, public perception and very long lead times will form large obstacles for "greenfield" nuclear projects. Most reactors currently under construction are in China (27), Russia (11), South Korea (5) and India (6).

Out of the existing 30-plus countries that have nuclear energy programmes, a few countries appear to have experienced the most profound public reactions and public policy changes: Japan, Germany, Italy, and Switzerland. The most significant development has been in Germany where the government shut down the seven oldest nuclear power plants within a few days following the Fukushima event, in addition to the one plant that was temporarily offline due to technical reasons. The German government has now decided to keep these 8 facilities closed permanently while it is accelerating its plans to phase out all of its remaining nuclear power plants stepwise by 2022 (one plant each in 2015, 2017, 2019; 3 plants each in 2021 and 2022). Nuclear not only accounts for approximately a quarter of electricity generated in Germany, but the impact of Germany's decision to phase-out nuclear by 2022 is going to affect the energy system in Europe, as more electricity will be traded across borders and as gas-powered plants are expected to be brought online to balance the system. This will have price implications for both the electricity and gas markets in Europe which are unknown at the moment. It seems likely, however, that the price of energy will have to increase during the transition period and that Germany's exit from nuclear power will increase CO_2 emissions until renewable energy sources have filled the gap. Switzerland will decommission its five nuclear power plants stepwise between 2019 and 2034. While the Swiss phase-out steps will be orientated on the safety of the operating plants and is expected to lead to a total lifetime of about 50 years for each plant, the German phase-out path is supposed to be the fastest possible way of shutting down the remaining nuclear power capacities without running into critical system-instabilities, leading to an average plant-lifetime of approximately 30 years. Japan and Italy have decided to scale back their previous plans to increase or, in the case of Italy, to begin nuclear-generated electricity. For the remainder of the world's nuclear energy programmess, governments to date continue to stand by their use of nuclear energy in principle.

Anticipated longer-term outcomes of public reaction to nuclear in light of Fukushima include a justification of pre-existing views on nuclear energy in regions and countries that have long held ambivalent to negative opinions on nuclear energy and its safety. The Fukushima accident will serve as an additional example of why to oppose it and local, national, and regional politics will prevail over the longer-time frame. There will also be an increase in "not in my backyard" mentality, with the general public not wanting facilities/plants in their immediate vicinity or neighbourhood. In particular, these will be a larger issue for those living in areas vulnerable to natural disasters. Those in favour of nuclear energy will call for improved safety procedures and plans and point out that the global community can learn from Fukushima. Risk profiles are reactor-dependent and site-dependent and therefore response capabilities will have to be different, which makes discussions about minimum safety standards problematic. But at least best-practice examples of nuclear safety should be shared between countries and operators.

The WEC member survey shows that most countries that have existing nuclear power installations believe that their own national nuclear authority is independent, resourced, transparent, and empowered with enforcement. But most respondents also answered with a lot of uncertainty with regard to the perception of other countries' nuclear governance. There seems to be a high willingness to strengthen national nuclear authority in light of Fukushima and there is very high agreement that there is a need to improve public understanding of nuclear technology/costs/risks. While there seems to be relatively high political support for the adoption and convergence of international safety regulations, there seems to be comparatively lower political support for the international enforcement of safety standards. The response has been unanimous: that the media affects the public discourse of nuclear energy the most. Therefore the most pressing barrier for the future of nuclear has been identified as public perception, followed by lack of policy. Skills shortage was not deemed a major barrier.

When asked about the potential for substitution fuels,

Changes in government policy toward nuclear energy following Fukushima in countries using or intending to use nuclear energy (as of June 14, 2011)

Existing Nuclear Installations

Use of nuclear power in principle is not being contested[1]	Argentina, Brazil, Belgium, Bulgaria, China, Czech Republic, Finland, France, Hungary, India, Japan, the Netherlands, Romania, Russia, Slovakia, South Africa, South Korea, Spain, Sweden, Switzerland[2], Ukraine, United Kingdom, United States
Use of existing nuclear power is being rejected[3]	Germany

Construction of New Nuclear Installations

Construction projects in principle are not being contested[4]	Brazil, China, Czech Republic, Finland, France, Hungary, India, Jordan, the Netherlands, Poland, Russia, Saudi Arabia, Slovakia, South Africa, South Korea, Sweden, Turkey, Ukraine, the United Arab Emirates, the United Kingdom, the United States, Vietnam
Basic assessment of extension-pathways respectively the introduction of nuclear power	Japan
Construction projects are precluded	Germany, Switzerland, Italy, Venezuela

Notes: (1) Assessment of safety installations (incorporating lessons learned); (2) expected closure of the five nuclear power plant units between 2019 and 2034 (after the end of approximately 50 years of operating time); (3) immediate shutdown of 8 nuclear installations following the Fukushima event and phased-out closure of remaining power plants as fast as possible, independently from safety aspects; (4) possible partial modification of safety standards or licensing procedures.

gas has emerged as the clear winner globally, with biomass being a strong contender. Renewables are only mentioned in countries with high potential, e.g. solar in Spain. Higher electricity prices have been deemed as the most direct implication of nuclear substitution, with energy security concerns and higher GHG emissions also highlighted by many countries. Regional analysis further shows that the perception of nuclear safety in developing countries has not changed significantly compared to developed countries. Especially the lack of skilled technicians/engineers is an important barrier for the future of nuclear in developing countries and coal as well as fuel imports will continue to play an important part for energy security in those areas compared to developed countries. China and India are special "planets" which use local resources (mainly coal and some hydro) with however strong development of new nuclear plants.

Undoubtedly, the consequences of nuclear power production provide unique challenges for governance. National boundaries are irrelevant when considering the impact of nuclear incidents and there is still room for improvement of international governance arrangements. Currently, nuclear governance rests with nation states, along with a limited level of oversight provided by the International Atomic Energy Agency (IAEA) and peer review arrangements such as WANO and INPO. The fundamental objective of the IAEA is to ensure that atomic energy is not put to any military use and it has no power to intervene in the nuclear affairs of a state, unless it is specifically requested to do so by the state itself. In all cases the sovereignty of the state supersedes that of the IAEA. In addition to the IAEA, the World Association of Nuclear Operators (WANO), based in London, exist to help its members achieve the highest levels of operational safety and reliability. They do this through peer reviews, technical support and access to a global library of operating experience. While they work directly with their members, WANO is not a regulatory body and they do not advise companies or countries on reactor design issues.

Under the existing system of nuclear governance there is clear need to strengthen global regulation of nuclear energy. The aircraft industry, for example, also has competing designers, manufacturers and operators, all functioning under national aviation authorities, but there is also a process of international certification standards for airworthiness, as well as protocols for navigation systems etc. In line with this train of thoughts, the following points were highlighted by the nuclear task force as a contribution for further debate at the energy leader summit in Rio de Janeiro and similar events in future:

1. Standards – National nuclear safety agencies must adopt minimum safety operation, maintenance, and transparency standards, including site location parameters, and training certification.
2. Verification – An international organisation should be empowered to work with each national nuclear safety agency to draw up these standards and verify adherence to them. Such verification should be publicly available to enhance transparency.
3. Design – The same organisation should produce an international accreditation standard for reactor design.
4. Finance – Funding mechanisms should be revised to ensure strict compliance to national and international standards.
5. Structure – At national and international levels there should be unbundling of responsibilities for the promotion and safety of nuclear power to reduce the potential for conflicts of interest. ❑

Acknowledgements: many thanks to Karl Rose and all the WEC Nuclear Task Force Members for their very valuable contributions.

Energy efficiency: potential in oil and gas

By Elena V. Nekhaev,
Director of Programmes, World Energy Council

Energy efficiency has been making headlines for some time now. Any publication or discussion of energy-related matters inevitably makes some reference to energy efficiency. This is not without reason. If we look around, we see a wide range of devices which have significant potential for improving the efficiency of energy use. This potential is present throughout the entire energy value chain, starting from the exploration of primary energy.

For example, Oil & Gas (O&G), which is the most energy-intensive of all industries, has significant potential for efficiency improvements. O&G consumes about 20 per cent of its output for its own processes and, as reservoirs become depleted and extraction deeper and deeper, oil industry energy demand will grow even further. Moreover, the energy efficiency of O&G is very low by current standards, barely reaching 20 per cent. The industry needs to take urgent action to improve its performance in terms of energy efficiency and reduce its own energy demand. This will increase the profitability of its operations and improve its environmental performance.

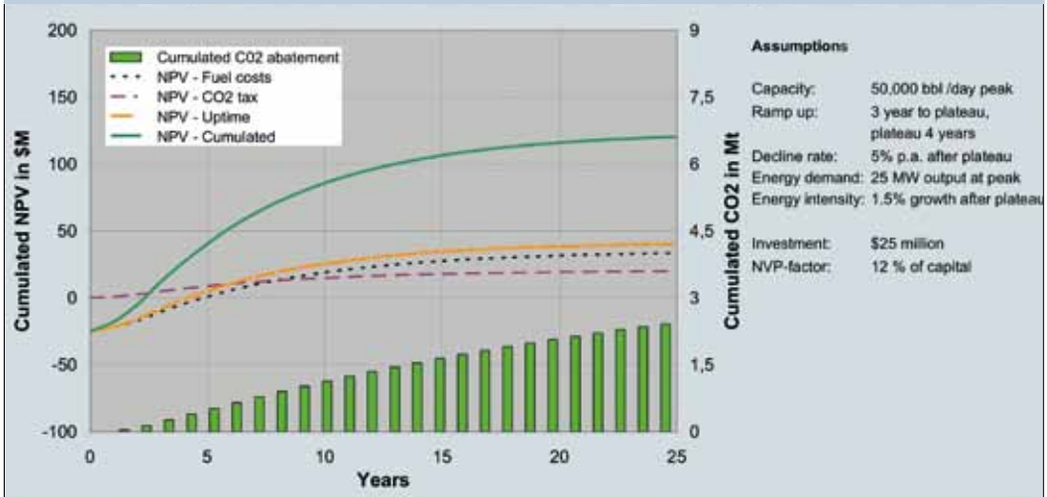
For example, a bottom-up assessment of energy efficiency top-down targets, such as Emissions, CO_2 Abatement, Profitability, Output and Cost can produce useful insights into the efficiency of the entire process. It helps evaluate the impact on energy efficiency improvements and develop a common understanding of drivers behind these improvements. It helps reduce fuel consumption, availability and profitability.

Measuring the impacts of energy efficiency

How can the impact of energy efficient technologies be measured and recorded? What savings can be achieved by deciding to use one appliance over another? To be able to answer such questions, it is necessary to define the reference point (baseline) to be used for measuring efficiency improvements. The baseline should also take into consideration 'business as usual' type efficiency improvements, i.e. the improvements that are due to take place anyway without adopting any specific efficiency measures.

Real energy savings are usually far less than what can be expected from technologies, often because of consumer behaviour (e.g. purchase of more efficient but larger refrigerators, higher indoor temperature and other so called 'rebound' effects). It is therefore necessary to study in more depth and detail the impact of consumer behaviour and consumer choices and promote technologies that can limit the impact of inefficient behaviour (e.g. speed limiters, thermal regulation of room temperature, automatic lighting controls in unoccupied rooms, light sensors, programmes automatically set to saving modes for washing appliances, etc). It is also necessary to provide tools to the consumers to enable them to manage their energy consumption better, such as informative billing or in-house display devices. One form of informative billing is to provide comparative

NPV of an incremental investment in uptime from 94% to 96%
30,000 bbl/d peak, US$50/bbl wellhead, US$25/bbl oe fuel, US$/t CO_2



Investments to improve efficiency and uptime may increase profitability and will abate million tones of CO_2

information that enables each consumer to understand the bill and compare consumption levels of similar consumers (for households) or similar companies (in industry and services). In the transport and household sectors, improving the efficiency of new equipment, vehicles and buildings is important, but it is equally important to maintain and service the equipment and vehicles to avoid a progressive loss of efficiency.

There are a number of different approaches the industry has developed, including the "All-Electric Oil and Gas" concept developed by Siemens. This concept offers better energy efficiency, higher plant availability and improved asset economics.

What's next?

Taking into account the many benefits provided by energy efficiency improvements, from reduced CO_2 to billions of dollars in potential savings from lower energy bills, it is surprising that energy efficiency still remains more a theoretical possibility than a practical solution. To achieve more progress in improving energy efficiency, communication and information should become first priority, even more important than incentives. This is where governments can and should take a much more proactive approach. All energy efficiency measures should be based on a cost/benefit analysis that includes environmental costs.

Energy efficiency must be considered as an opportunity not only for the technology suppliers but especially for the country and its industries which are using these efficient technologies. It is necessary to concentrate the investments on the existing technologies that are able to provide a fast payback time. Information, communication and education are essential instruments for spreading the energy efficiency culture.

In addition, it is fundamental to consider appropriate and reliable certification of energy consuming devices and the corresponding controls to minimise the risks which counterfeit products can create for the end-user. It is necessary to develop a culture that not only pays attention to the initial investment costs, but also takes into account the full life cycle costs, including operation and maintenance (O&M) and the costs of energy, which will become higher and higher during the technology lifetime. ❑

The "All Electric Oil and Gas" concept offers better energy efficiency, higher plant availability and improved asset economics

Efficiency	Asset economics	People shortage
• Lower CO_2 emissions • High efficiency (50+ per cent improvment) • Integrated heat generation (steam) • Concentration of emitting sources in one location (pre-requisite for CCS)	• Less fuel consumption • More hydrocarbons for sale • Improved asset productivity and availability (N+1, E-system management) • Payback of additional CAPEX as quick as two years	• Easier remote and unmanned operations • Less maintainance • More failure resilient (N+1, E-system management)

- Basic technologies available (adaptation to O&G environments required)
- Concept support Sustainability and Kyoto targets

Global Transport 2050: Shifting patterns

By Ayed Al-Qahtani,
Senior Project Manager, Energy Scenarios, World Energy Council

Over the next four decades, the global transportation sector will face several unprecedented challenges. World population is expected to increase by about 2.3 billion reaching 9.2 billion, with more than 70 per cent living in cities compared to 50 per cent today. In addition, the number of megacities is expected to increase from the present level of 22 to between 60 and 100. Many of these megacities, emerging mostly in Asia, Africa, and Latin America will face high levels of traffic congestion, local pollution, and noise. Furthermore, such an effect will be amplified by the 2 to 3 billion cars and trucks that could be in circulation.

Over the same period, travel and road freight will at least double due to the fact that demand for mobility goes hand in hand with economic development and improvements in standard of living. Driven by increases in all travel modes, some experts expect the energy consumption of the transport sector to increase between 80 per cent and 130 per cent above today's levels. The demand will come mostly from regions that are undergoing strong economic and population growth (China, India, Latin America, Africa, and the Middle East).

Challenges relating to demographics, urbanisation, and growth in fuel demand, will all be compounded by uncertainties emerging from the unpredicted degree of government intervention and regulations, regional and global cooperation, unstable global economic situations, and potential technology breakthroughs.

Capitalising on previous studies conducted in 1995 and 1998, the World Energy Council (WEC) has decided to re-examine the future of the relationship between energy and transport by building transport scenarios to 2050. This effort is undertaken in parallel with, and under the umbrella of, the Energy Scenarios exercise, but focuses solely on the mobility and transport sector. The aim of this project is to construct and describe global transport scenarios that will reflect potential developments in transport fuels, technologies, systems, and environmental policies over the course of the next forty years.

To achieve this goal, WEC assembled a team of 54 industry experts from 29 countries. The first objective of the team was to identify and evaluate existing and potential fuel and transport technologies, qualitatively and quantitatively. The qualitative assessment sought to address current and potential developments in global transport systems, as well as current and potential energy policies that could be adopted at national and regional levels. The network used information from completed and on-going WEC studies and also from proprietary and publicly available sources. The team also used case studies, and quantified examples of available and emerging technologies and enabling policies to form the foundation for the study.

The information gathered by the team was compiled into a background document, which formed the input on technologies, fuels, and systems. In parallel, regional inputs on mobility and transport policies, and local issues and drivers were gathered during a series of regional workshops held in Johannesburg, Bangkok, London, Thessaloniki, Washington DC, and Rio de Janeiro. A series of mobility questions were prepared for each workshop and discussed at length with local experts and WEC Member Committees. The insights from these workshops were instrumental in forming the assumptions for the development of mobility scenarios from a bottom-up perspective.

The information from the background documents on technologies and fuel systems, along with all regional assumptions were then combined into a working draft for two mobility scenarios, which were constructed by the members of the network during a scenario building workshop in London. The "Full Throttle" scenario envisages a world with solutions where pure market forces prevail to create a climate for open global competition. Higher levels of privatisation, deregulation, and liberalisation have stimulated the role of the private sector, and entrepreneurs and global companies emerge as central players. The second scenario, "The Cruise", can be best described as a regulated world where governments, politicians, investors, and consumers decide to put common interests at the forefront and intervene in markets. In such an environment, the global economy which is more fragmented and differentiated suffers more trade restrictions. However, the world as a whole has witnessed increasing international cooperation on climate change issues in the short to medium term.

The fully described scenario stories along with the complete regional inputs were then translated into numeric assumptions which were fed into the mobility model provided by the Paul Scherrer Institute (PSI) in Switzerland. Evidently, the two scenarios describe two extreme global transport worlds in 2050. We envision

that the actual world will be somewhere in between.

Preliminary modelling results reveal that between 2010 and 2050, the total fuel demand in all transport modes will increase between 30 per cent to 82 per cent over 2010 levels. This growth is mainly driven by mass/cargo transport and aviation, i.e. trucks, buses, trains, ships and airplanes. Demand in this sector is expected to grow by about 64 per cent to 200 per cent. The fuel demand for light duty vehicles (LDVs), which currently constitutes about 52 per cent of the transport market, will range between an increase of 51 per cent in the Full Throttle scenario and a drop of 13 per cent in the Cruise scenario.

The transport sector as a whole will still heavily depend on gasoline, diesel, and jet fuel, as they will all still constitute the bulk of transport market fuels (80-90 per cent). In fact, the demand for these three fuels will increase by 10 per cent to 68 per cent over the scenario period. The main growth will be in diesel and jet fuel, where diesel will grow by 46 per cent to 200 per cent, while jet fuel will grow by 200 per cent to 300 per cent. In contrast, the demand for gasoline is expected to drop by 16 per cent to 63 per cent. Biofuels demand will increase 4 fold while alternative fuels (electricity, hydrogen, CNG, and methanol) will increase by 6 to 7 fold.

Fuel demand for personal cars (LDVs) will still heavily depend on gasoline and diesel which will satisfy 52 per cent to 80 per cent of the demand. In fact, growth will entirely be from diesel, as gasoline demand drops by 16 per cent to 63 per cent, while the demand for diesel increases by 200 per cent to 900 per cent. Biofuels in cars will grow 5 fold while the other fuels which will grow by 12 to 26 fold. Similarly, the mass/cargo transport and aviation market will still be heavily dependent on diesel and jet fuels which will satisfy 93 per cent of the transport fuel demand. In fact, the demand for diesel will increase by 42 per cent to 65 per cent, while the demand for jet fuel will increase by 225 per cent to 380 per cent. The remaining demand will be satisfied by biofuels which are expected to increase by up to 540 per cent and alternative fuels which will increase by 330 per cent to 480 per cent.

Over the scenario period, the bulk of the new transport fuel demand will come from non-OECD countries, which will increase their consumption by 200 per cent to 300 per cent. In contrast, the transport fuel demand for OECD countries will drop by up to 20 per cent. Hence, non-OECD countries will be 60 per cent to 70 per cent of the transport demand in the future, while OECD countries will account for 30-40 per cent. In fact, the demand of the non-OECD countries surpasses that of the OECD countries by the year in 2025, if not earlier.

The total number of cars globally, will increase by 2.2 to 2.6 times, reaching between 1.7 billion to 2 billion cars. Most of this increase will come from non-OECD countries in which numbers will increase by 430 per cent to 557 per cent, while OECD countries will increase by 36 per cent to 41 per cent only. By the end of the scenario period, non-OECD countries are expected to have about 55 per cent to 61 per cent of the global fleet. The global car fleet will still depend on conventional gasoline and diesel ICEVs. Growth will be centred around mainly diesel ICEVs which are expected to grow by 61 per cent to 1000 per cent, while gasoline ICEVs drop by 54 per cent in the Cruise scenarios or increase by 23 per cent in the Full Throttle scenario. Other drivetrain technologies will capture the remaining market share.

With these higher levels of transport demands, the total emission from the transport sector is expected to increase by 16 per cent to 79 per cent, with emission from cars accounting for 20 per cent to 32 per cent of the total.

With this complete picture of the transport sector in 2050, and in light of the recognised major drivers, we are confident that the global transport sector can and will overcome the many challenges which lie ahead. The biggest of these challenges will be to provide a sustainable transport world for more than 6 billion people at the lowest social cost, where congestion, pollution, and noise generated by additional traffic and freight volumes are minimal.

Indeed, the dynamics and magnitude of these developments offers the opportunity to adjust the manner in which consumers, entrepreneurs, governments, and private businesses view their future plans and expectations. We have no doubt that the birth of the producer-consumer dialogue, breakthroughs in conventional and unconventional energy resource extraction, expansion in the use of renewable energies, technological improvements in efficiency, mileage, zero-emission fossil fuels, and policies specifically tailored to suit regional needs, will together ensure a sustainable future for transport, and will raise optimism about a better quality of life for current and future generations. ❑

Making the Green Revolution work

By Younghoon David Kim,
Vice Chair, Asia-Pacific and South Asia, World Energy Council

Making the green revolution work requires an understanding of the issue in both the larger context of energy history and in specific case studies of effective — and revolutionary — projects that offer solutions.

Let's start with energy history. We all know that there have been relatively smooth transitions from the use of wood to the use of coal and, later on, from coal to oil and/or natural gas. Why were these transitions smooth? Well, perhaps mainly because the new fuel had an obvious superiority over the existing fuel as the new opinions offered convenience as well as being more economically viable choices.

But the next great historical shift we are facing is not so clear cut. What we do know is that we will be moving from oil, not to a single fuel, but rather to multiple fuel sources. While the green revolution is arriving with many alternatives, which may be good, it does mean by the very fact that there are so many new choices this time around the transition will not be as smooth.

Another thing to consider is that the green revolution will require great commitment from both government and private sector. As the IEA forecast fossil fuels — oil, coal and natural gas — will remain the dominant energy sources until 2035. I feel the greatest hope for increasing the use of renewables in absolute terms lies in the power sector. In the *New Policies Scenario* by the IEA we see renewable-based generation triple between 2008 and 2035 and the share of renewables in global electricity generation increasing 19 per cent in 2008 to almost one-third (and, in effect, catching up to the level of coal). The increase will come primarily from wind and hydropower, though hydropower will remain dominant from 2008 to 2035. But, when grid parity is achieved, renewable energy will take the bigger share of electricity. Finally, the IEA emphasises that the future of renewables hinges critically on strong governmental support.

For wind energy, grid parity is very close. For photovoltaic power, it is still further behind. Right now solar PV generation costs about US$0.22/kWh, compared to traditional generational costs of about US$0.08/kWh. It is expected that the cost of solar power generation will reach grid parity with other fuels by 2013. The economics of other renewables such as ocean energy and bio-energy are far behind those of conventional fuel. Great effort has been focused in these areas in order to increase economic viability and shorten the time to achieving grid parity.

Replacing oil in the transportation sector is much harder than in the power industry. The automotive industry is seeking a solution in the form of the hybrid car. This trend will continue throughout the transition period. Hydrogen is considered as a future automotive fuel, however many obstacles remain thus making this an area that demands much effort in RD&D.

In terms of renewables the government's role has been to provide feed-in tariffs (FIT) and offer the renewable portfolio standard (RPS) systems. Some countries have seen success with FIT, while the effectiveness of the RPS system needs to be decided by further evaluation. Until grid parity is achieved, these types of governmental support should be continued.

In addition to FIT and RPS systems, governmental efforts are indispensable in the realm of RD&D. Basic research should be initiated by government funding because in an era of financial turbulence it is very difficult for the private sector to take the lead. In the long-term, the sphere of RD&D necessitates a partnership between the public and private sectors. Here I would now like to turn to two successful case studies.

The first is a Korean-Mongolian PPP project which began in 2009 in Ulaanbaatar, Mongolia. This initiative, the Green Eco-energy Park (GEEP) Project was designated a flagship project by WEC for the Asia-Pacific region and offers a solution to the FEW (food-energy-water) challenge. The concept is to generate power using SolaWin (a hybrid solar and wind power system). Groundwater is then pumped to be used for drinking and irrigation so that not only can appropriate local crops be grown, but also desertification combated in vulnerable regions. The Korean half of the partnership as represented by Daesung Group provided funding and technology while the Mongolian side offered a 40-year lease of the land at no charge.

The success of GEEP has inspired a number of similar projects. Last year the SolaWin system was installed in Mandakh, a village 550 kilometers south of Ulaanbaatar which serves 150 households (approximately 600 people) providing them with electricity and drinking water. Now the villagers are able to grow vegetables, also with the water produced by the pump.

In addition SolaWin was selected by the Korea International Cooperation Agency (KOICA) for installation in other areas around the world with significant off-grid energy and water needs. SolaWin will be providing electricity, drinking water as well as water for agricultural use in countries KOICA serves such as Kazakhstan, Bangladesh, and Ethiopia. After a

recent trip to Africa by Korea's president, the introduction of SolaWin on a much larger scale in the Congo and other countries in the region is planned.

The second case study involves a RD&D effort, Korea's first concentrating solar power (CSP) project, which launched in June 2011 in Daegu, South Korea. It is situated on a 20,300m² area with 450 heliostats two metres in diameter, which reflect solar heat and a 50m tower equipped with a solar heat absorber and a 200kW power generator. Initiated by the Korean government, private sector participants were lead by Daseung Group.

As the IEA forecasted, there is promise in CSP especially in arid and semi-arid lands including North Africa, southern Africa, the Middle East, northwestern India, the southwestern United States, Mexico, Peru, Chile, and the western parts of China and Australia. Finally, in order to enhance the value of CSP capacities, thermal storage and backup or hybridisation are a must.

The construction of this solar power system developed to be used solely as a power generating cycle is a major achievement for Korea. Looking ahead plans are to build on this technology and expand into the worldwide CSP market including countries such as Mongolia by utilising high technology such as sun tracking and high-efficient light concentration.

The beautiful natural environment that surrounds Daegu was selected for the building of the solar power tower system because the area receives little rain and is sunny throughout much of the year. In addition, as the 2013 World Energy Congress will be held in Daegu, it is expected this will be the perfect opportunity to let people not only in Korea but also from all over the world learn about CSP. Moreover, with the 2013 Congress in mind, Daegu would like to show the world the prominence of the city as an eco-friendly energy leader.

Yet amid all these positive developments, the aftermath of the earthquake and tsunami in Japan in March has caused us to pause. With the destruction of the Fukushima nuclear power plant we have seen two types of reactions from countries with nuclear power. One reaction has been to maintain that there is no substitute for nuclear power and therefore it will continue to be used. The other reaction can be summarised as "we dare not to use it." In any event, it is now no longer clear what exactly the role of nuclear energy is in the green revolution.

In conclusion it is obvious that the green revolution, in order to be truly "revolutionary" still needs enormous input from both the public and private sectors. Especially in the area of RD&D there needs to be strong and sustained government support. As this historical shift occurs, the private sector should make more effort to shorten the time to grid parity for every type of renewable energy source. With successful implementation, the green revolution will become our green reality. ❑

Korea's first solar system project

A capability-based strategy following local market demands

By Frank Mastiaux,
CEO, International Energy, E.ON, Germany

Energy is at the core of economic development, which makes it one of the few sustainable long-term growth businesses. At the same time hardly any other industry needs to adapt more strongly to emerging new technologies, new political realities, new competition and changing consumer demands.

In Europe traditional value pools of conventional power generation will decline and possibly not return, but at the same time new opportunities will arise. Europe is still heading for a very capital intensive transformation of its entire energy system by showing limited underlying demand growth in energy consumption. Therefore, in Europe power companies will direct an even greater share of their resources towards new value pools such as renewables and decentralised energy solutions. This will naturally increase the competitive pressure on the remaining conventional generation.

At a global level, the situation looks markedly different. Whilst renewable generation is on the rise, demand for conventional power generation capacity is still significant. Since material growth of power demand is expected, large investments in power generation will be needed. Such investments will require markets to allow investors to receive an adequate return on their capital.

As part of a strategic review of the company, E.ON has recently decided to significantly broaden its geographic footprint outside its traditional European base. Whilst E.ON has already a strong position in Russia and the US, the company will now extend its presence to Brazil, India and Turkey in the short- to mid-term. In these countries and at this point in time, E.ON sees the best opportunities to make use of its broad expertise in conventional and renewable power generation, given the strong demand situation in line with GDP growth.

Major energy companies in European countries: From growth to transformation

On the grounds of demographic developments, growth of energy demand in Europe will be rather modest over the next years to come. The European power market in the last two decades was basically driven by competition and environmental goals. Major energy companies that are active in the liberalised European markets have consequently learned e.g. to become more competitive by cutting costs in operating power plants, to build new power plants at lowest possible costs and risks, to run a portfolio with a mix of conventional and intermittent wind and solar power plants, to optimise a power plant portfolio with national and cross-border trading, and to re-design existing power plants in order to fulfil stricter emission targets. Particularly strong renewable goals in Europe made some European energy companies to global leaders in developing and operating onshore and offshore wind power plants, while simultaneously improving their conventional power plants in order to compensate for the intermittent renewable electricity generation. The latter is especially true for countries with an already high share of wind and solar generation such as Germany and Spain.

This transformation process in Europe is just taking new momentum: Improving grid structures, more decentralised generation, enhancing demand response, developing electricity storage will be further cornerstones of the European development. Hence, the transformation will lead to the continued development of technological solutions – and also their large scale implementation. In this sense, Europe could be viewed as one important laboratory for the energy solutions of the future. The knowledge that will be gained in Europe might become relevant and applicable for other regions in the near future. And this knowledge does not only include the technologies – but importantly the infrastructure in which power has to be generated and distributed reliably and at competitive costs. In the future there will be more

Blue skies thinking: the road to cleaner and better energy

interplay between generation and consumption that will influence the operations of power plants. Electronic signals from the consumers will indicate the need for power and trigger appropriate generation levels. This will ultimately lead to a closer relationship between producers and consumers and to a combination of technologies from the power sector with technologies from the communication and IT sector.

The system transformation that Europe and especially Germany has embarked upon is capital intensive, but we see new value pools emerging, for example around decentralised energy solutions. In Germany decentralised renewable generation such as PV solar and small-scale wind has grown from less than 2 per cent of total power generation in 2000 to almost 12 per cent last year. E.ON is a major participant in the transformation of the European power system towards renewable generation, with major positions in wind, biomass and solar power. We continue to push for an industrial style application of these technologies with the aim to bring the cost down even further and move up its technical availability.

A demand-driven capability transfer from Europe to other regions

Emerging economies still have a growth story in their energy markets. Their challenge is to build in a sustainable manner the needed combination of generation technologies and a powerful and flexible infrastructure that guarantees affordable access to energy. Energy companies with strong experience can play a supporting role: Backed by their broad knowledge in all parts of the value chain and being familiar with all types of power generation, they can deliver valuable insights to design the needed energy system in a cleaner and better way.

As part of a broader strategic review, E.ON believes that it can contribute to the massive expansion of power generation in markets outside Europe on the grounds of a capability-based strategy. Following a detailed analysis, E.ON has determined three regions where E.ON will focus its new and future activities outside of Europe: Brazil, India and Turkey. These regions meet E.ON's strict requirements of a long-term, sustainable and accessible growth potential and of market attractiveness. The mega-growth in these markets is grounded in solid domestic demand increase, even if in each market with a different profile. Additionally there is an increasing relevance of new entrants into the power market with limited capabilities in particular at multi-plant level which represents a good capability inroad for E.ON. Finally these markets offer an attractive risk/return ratio. Since August 2011 E.ON has a presence in these three countries by experienced management teams with material local expertise supplementing extensive capability on the power sector. The teams have started to pursue specific business opportunities, in particular aiming at cooperation with strong local partners.

The key element for E.ON, however, is not the pure display of subject-matter expertise, but rather combining it with a strong focus on understanding first the specific local needs and subsequently providing tailor-made solutions from a very strong capability set in the power generation landscape. Capabilities in this context are all abilities to deliver the organisation's strategy, by means of people, processes, technology and systems. E.ON is looking at its capabilities at three distinctive levels:

- at single power plant level: with an extensive operator experience over the full life cycle of plant from origination to decommissioning;
- at multi-plant level: the capability to manage complex portfolios of power generation assets;
- at power market level: integrating technical with commercial understanding of how markets work technologically, commercially and competitively at different stages of market maturity.

We believe that partnerships between incumbents in the local markets and energy companies like E.ON have the power to significantly boost development of power generation: E.ON for instance is active in many European countries, Russia and the US, each market with a different set of regulatory frameworks, demand profiles and market dynamics. In addition, E.ON over the past years has developed dedicated programs for fleet and single-plant optimisation, across the full range of conventional and renewable generation technologies.

E.ON will maintain its position as an industry-shaping company in Europe, but will increasingly take positions outside Europe on the grounds of a capability-driven strategy that strictly follows consumer market demands and will build strongly on partnerships with local companies. Based on many decades of experience with the entire set of power generation technologies and being a company striving for the best performance, E.ON will position itself as a partner that will contribute in designing the optimum energy solutions in line with our strategic mantra 'cleaner and better energy.' ❑

Clean energy to keep Latin America competitive

By Juan Araluce y Martinez de Azagra,
President, Vestas Mediterranean

In these rough and tough times, growth remains sluggish in some of the major economies of the world. Latin American economies are, however, charging on despite global economic woes, with annual GDP growth rates of 7 per cent or even higher in some countries. Energy needs are expected to grow in tandem or even faster; for instance power demand grew a whopping 11.5 per cent in Brazil in 2010, and an average 4.5 per cent per year since 2001 in the region as a whole. Brazil and Mexico, among other Latin American economies, are in dire need of new electricity generation to fuel their growing economies.

Economies need to become more resilient to price shocks and price variability risks, in energy as well as in everything else. Several countries in the region depend on imported fossil fuels for power, especially in Central America. Ever growing energy needs, energy security concerns, rising fuel costs, and in some cases fluctuating weather patterns affecting the region's sizeable hydro resources, have led to energy being a key focus area for the region.

Furthermore, the need to curtail increasing carbon emissions resulting from strong economic growth is an imperative to Latin American countries, if they are to remain competitive and to maintain a sustainable energy growth. Demand for goods is becoming ever more sensitive to the carbon footprint they carry, especially in developed countries. The IEA's Current Policies Scenario from their yearly World Energy Outlook publication states that Latin America could increase its CO_2 emissions by roughly 50 per cent between 2008 and 2035. Clean energy can be an important part of averting this outcome.

The good news is, the potential for wind and other clean energies in Latin American countries is tremendous. Latin America already has a long tradition of utilising renewable energy sources like large-scale hydropower, biofuels and biomass; hydropower capacity in Latin America is 20 per cent of the global installed capacity. Brazil boasts up to 350GW wind potential at 100 metre hub height; for comparison, global installed wind power capacity at the end of 2010 was 197GW. Mexico could has 11GW of wind potential with an above-30 per cent capacity factor; and Argentina's wind resources could "supply Latin America's entire electricity demand several times over" according to GWEC, the Global Wind Energy Council. Wind adds to the existing portfolio of renewables and helps offset some of the challenges that climate change-related changes in weather patterns can mean for hydropower and other renewables. In fact, in some areas of Latin America the wind blows strongest in the periods where hydropower basins are at their lowest levels, making wind energy an ideal complement to hydropower and allowing energy storage in hydro basins when the wind is blowing.

While classically, clean energy comes at a premium, this general convention doesn't hold in Latin America. Clean energy is available, and at a competitive price relative to conventional energy sources. For instance, wind energy is much cheaper than oil in the Dominican Republic, whose power is based on almost 90 per cent imported fuels. This is also the case in neighbouring countries. Although the tariff for wind in the Dominican Republic is nearly double what is available in some other Latin American countries, that value is still lower than the local spot market price for electricity. The average spot market price for power in Chile's Central Grid, supplying the needs of the vast majority of the population, has averaged over US$200/MWh in 2011, a result of imported fuel prices, drought and power demand growth. Homegrown, clean energy investments, such as wind, can protect Latin American countries from price shocks and price variability risks in the rest of world.

The competitiveness of wind energy is reflected in the prices being paid for wind power and installed capacity trends in the region. Brazil's national development bank BNDES was one of the two top global lenders to clean energy projects in 2010, lending over US$3 billion. Investments in clean energy in 2010 in the region were 40 per cent above those of the previous year; and wind energy is expected to continue to be the technology of choice after receiving almost half of all investment dedicated to clean energy the same year. Installations of wind power in 2010 jumped 62 per cent compared to 2009, and the renewable energy auctions in December 2009 and August 2010 and 2011 have led to contracts for 5 GW in Brazil, besides the already built 1GW wind plus additional installations to come, contracted for outside the auctions just mentioned. The pace of wind capacity installations in Latin America could nearly double every year, reaching 17GW in 2015 if the current trend continues. Uruguay, for instance, aims to reach 20 per cent wind in its electricity generation mix by 2015, in relative terms a commitment comparable to those of Spain and Denmark. Tariffs for wind energy have nearly halved in the last decade, coming below conventional fuel costs in some countries already.

Brazil and Mexico, as the strongest wind energy markets

in Latin America, are setting examples for the rest of the region in the development of clean energies. The support of key institutional and development lenders has been crucial. Several Latin American countries are now turning to reverse auctions to contract for wind energy and other renewables, following closely the developments in Brazil. At the most recent Brazilian auction, the average price for wind was lower than the prices for hydropower and natural gas. Transmission build-out rights, like power contracts, are sold at auction in Brazil; with Mexico building transmission based on rental agreements drawn up prior to construction for use of the new transmission capacity. As the interconnectedness of transmission systems across Latin America increases, all energy resources benefit; the output of variable sources like wind evens out and helps provide stable base load power.

Latin America's growth potential, vast resources and solid business case present a win-win opportunity for the region and for clean energy investors. All countries that have designed and implemented regulatory frameworks to encourage clean energy have borne the fruits of this development in terms of investments, and no country has turned back on their decision. Brazil has already become a regional production hub for the wind industry, with several international manufacturers having already built, or committed to building, production facilities.

We are one of the players in the wind industry that have established local production in Brazil. Our facility in Fortaleza, Ceará, to assemble V90 and V100 nacelles, will be operational by the end of 2011. We will also establish a new operations cluster including a Service Centre, Training Centre and Supply Chain and Spare Parts Centre. We are working to create a strong network of local suppliers, supported by the solid industrial infrastructure already in place. This is the first major milestone of a larger industrial plan to develop a top-class local value chain in Brazil, following our "in the region for the region" approach. Our turbines are designed for performance with a low cost of energy and, we believe, this gives us a strong position in a competitive market with strong wind conditions and demanding customers. Brazil has a qualified workforce as a result of other manufacturing industries, who can bring valuable expertise and experience. We have been actively recruiting in recent months, and will continue to support local job creation. As the local wind value chain expands and matures, the economics of wind energy are expected to improve even further.

Latin America is still developing more coherent policies and regulatory frameworks for all renewable energy sources, as commitment to renewables in general grows. We expect that current challenges will be ironed out in time, allowing clean energy investments to increase even more in the region. This will secure a clean and competitive future energy supply that will support economic growth, also positioning the region's countries well, as the cost of fuels and emissions increases in the future. Wind energy will help keep Latin America competitive. ❑

The Gargau wind power plant in Brazil

Setting new benchmarks in efficiency enhancement

By Dr Michael Süss,
CEO, Siemens Energy

Renewables like wind and solar power are volatile sources of energy, i.e. the contribution they make to energy supply fluctuates. Renewables-based power generation therefore has to be complemented by production that is independent of the weather and time of day. It should react with a high degree of flexibility to grid requirements and also be as climate-compatible as possible. One option in this respect are natural gas-fired combined cycle power plants, which offer ongoing efficiency enhancement and constitute an ideal complement to renewables. The Irsching 4 combined cycle power plant located in the vicinity of Ingolstadt, Bavaria, which was built by Siemens under contract to E.ON and was handed over to the customer E.ON in July 2011 for commercial operation, is setting new benchmarks in this respect.

Germany is facing radical changes to its energy supply system – the motto in a nutshell is "phase out nuclear energy and introduce even more renewables." The change in energy policy is political will and is in the meantime not only backed by all of the political parties but also welcomed by major sections of the general public. The gradual phase-out of existing nuclear power plants and the accelerated development of renewables will require massive efforts both of a technical and economic nature. Today, we are increasingly confronted with distributed solar- and wind-based power generation. The share of fluctuating feed-in is constantly rising. On the other hand, the possibilities for power storage offered by facilities including pumped-storage and compressed-air storage power plants are limited, and large storage systems on a chemical basis, such as stationary lithium-ion batteries or large-scale production and storage of hydrogen or synthesis methane, are not yet available. For that reason, the role of compensating, fast-response power plants is increasingly gaining in importance for grid stability. In addition, the use of natural gas in such power plants has the positive effect that it is ecofriendly with particulate, NOx, SO_2 and CO_2 emissions significantly lower than with any other fossil-based generating facility. For example, the new Siemens combined cycle power plant emits considerably less than one-third of the CO_2 emitted by the current coal-fired fleet per kWh generated. As replacements for old coal-fired power plants it is thus possible to additionally reduce annual CO_2 emissions by approximately four million tons per 1000 MW of output.

Writing engineering history

In this context, Unit 4 of the Irsching power plant operated by E.ON Kraftwerke GmbH is an exemplary project. More than ten years after the start of the ambitious innovation programme for a new generation of H-Class gas turbines, we have developed in the SGT5-8000H a machine which passed its trials with flying colours and has been in commercial operation since July.

The first plant featuring the new H Class is already writing engineering history because it has become the first gas turbine to top the figure of 60 per cent efficiency in combined cycle duty. The world record figure achieved is exactly 60.75 per cent at an electrical output of 578 megawatts (MW) – a truly historic dimension. Above all, however, the Irsching 4 plant is characterised by its particular operating flexibility, with which the plant can react very quickly to a wide variety of load requirements. In less than 30 minutes it is up to full load, and in less than 30 minutes it has been run back again – properties, which are most welcome for conventional compensation with respect to renewables.

The Siemens "8000H Programme" kicked off back in October 2000 with a fundamental market and requirements analysis. After the first development and engineering phase and the successful preliminary trials of critical components, the turbine was built in our manufacturing plant in Berlin and subsequently installed and tested in the Irsching 4 power plant under real conditions in simple cycle duty. Right from this first phase we succeeded in securing E.ON as a partner for the demanding power plant project – a good choice as it turned out, because the SGT5-8000H developed into a success story in a very short space of time.

All of the project milestones were achieved on schedule after construction had commenced in 2006. Important intermediate steps were first firing in December 2007, first synchronisation with the grid in March 2008, and base-load operation in April 2008. The validation programme was completed in August 2009. The plant has successfully passed all tests under the toughest operating conditions. Trial operation encompassed a total of 123 days, over which over 170 starts and more than 1500 operating hours were clocked up. Following that, work commenced of extending the facility to a combined cycle power plant, which was completed on schedule in December 2010.

Entry in the Guinness Book of Records

The performance of the SGT5-8000H exceeded all expectations. The turbine was released for the market with a rated capacity (ISO) of 375 MW. It is the largest operating gas turbine in the world and has even made it into the Guinness Book of Records. The turbine is available both as a 50-Hertz version and as a smaller scaled 60-Hertz machine. The two versions have complete internal cooling and therefore enable fast startup and load cycling. In addition, the other power plant components and auxiliary and ancillary systems, for example the Benson heat-recovery steam generator, were enhanced and developed further for high temperatures and pressure. For example, the water/steam cycle operates at 600°C and 170 bar. All in all, we have achieved even higher operating flexibility through the optimum interaction between the individual components. And that is urgently required. Because that flexibility will in the future decide whether we in Germany can maintain the high level of assured supply, to which we have been accustomed in the past.

As early as 2020, possibly even earlier, nearly the entire power plant fleet based on non-renewables will have to be started up and shut down on a daily basis because certain regions in Germany can meet the entire power demand on sunny days with a lot of wind for certain periods purely with the aid of wind, solar, hydro and biomass power plants. However, if the weather situation suddenly changes, then we will need approximately 20 to 50 gigawatts from other sources within the space of a few minutes or hours. Such outputs are not to be anticipated within a defined timeframe from large-scale storage systems like hydro power plants. For that reason, power plant solutions are required, which we can start and run up accordingly from standstill within this timeframe to compensate fluctuations in generation. With today's fleet of coal-fired and nuclear power plants, which are also on call, that it only possible with major limitations. This example illustrates that conventional power plants are facing completely new technical challenges.

The provision of additional capacity in the form of high-performance, high-flexibility combined cycle plants is therefore an important possible solution. Against this backdrop, Irsching 4 has passed all the performance and flexibility tests and overfulfilled all of the technical guarantees agreed with E.ON. A key element of plant flexibility for the defined market conditions is the time required for a hot start, which for the most part takes place in the early hours of the day after a standstill of between six and eight hours when the demand in the grid rises again. Here, we demonstrated that the entire plant can be run up very reliably to full load within less than 30 minutes using the fast cycling (FACY) feature. Just as important is the opposite case, when plant load has to be very quickly reduced or the plant even shut down if grid disturbances suddenly occur or if wind- and solar-based power feed-in call for this. Here, too, we demonstrated that shutdown or continued operation at low load are possible within 30 minutes. Despite its world-record performance the plant can be operated stably on demand at approximately 100 MW and thus below 20 per cent of total capacity in combined cycle duty at an efficiency typical of straight peak-load power plants (open cycle). This plant can thus be deployed highly efficiently both in base, intermediate and peak load duty. We have tested the appropriate load ramps to be able to quickly fulfil the requirements for extra and reduced output. The results show that the plant also achieves top performance of as much as 35 MW per minute.

A redefinition of spinning reserve

Implementation of the change in energy policy in Germany calls for a sustainable solution to the problem of spinning reserve. Thanks to their flexible operating options our new combined cycle plants are available for this. For future owners of such power plants a redefinition of compensation for spinning reserve or simply for the provision of on-demand availability would be necessary. A constant equilibrium between power generation and demand is a key prerequisite for stable, reliable grid operation. Power plants making special contributions in this respect should also receive appropriate compensation. Opportunities and risks must also be redistributed when completely revamping energy supply.

In the new 8000H Class Siemens has made available the most advanced and modern technology for cost-effective, ecofriendly gas-based power generation. What seemed impossible at the start of the programme, namely an efficiency level of more than 60 per cent in combined cycle duty, was demonstrated for the first time under real conditions in a power plant in Germany. Combined with high operating flexibility, we have a solution in our portfolio, which fully meets the requirements of the changing energy markets. Following the successful market launch of this technology in Irsching 4, marketing of our standout turbine is making good progress: Orders for another seven machines have in the meantime been secured from the US and South Korea, and further projects are being negotiated. ❑

Tapping into the potential of hydropower to reduce greenhouse gas emissions

By Thierry Vandal,
President and Chief Executive Officer, Hydro-Québec

According to recent forecasts from the US Energy Information Administration, world net electricity generation will increase by 87 per cent between 2007 and 2035. Over the same period, the International Energy Agency's *World Energy Outlook* foresees that hydropower will likely continue to account for approximately 16 per cent of the world's total electricity generation. Most of the increase in hydropower generation will occur in non-OECD countries such as Brazil and China, where remaining potential is highest, with development continuing as well in Canada, the European Union and Turkey.

There are a number of reasons why this generating option will continue to play such a key role in meeting customers' electricity needs around the globe.

Concentrations of greenhouse gas (GHG) emissions in the atmosphere will remain on the increase if the world's energy demand continues to be met with fossil fuels, especially those extracted from oil sands. The major environmental challenge we face today is to replace the fossil fuels used to generate electricity — particularly coal — and the oil used in ground transportation, in order to improve air quality and reduce GHG emissions.

Towards cleaner electricity generation

Coal is used to generate half of North America's electricity. This poses a real environmental problem and a real public health problem. In the greater Central Valley region of California, one out of every six children carries an inhalator because of respiratory problems. Continuing to fuel our cars with oil is only making matters worse.

Throughout the world, efforts are being made to generate more electricity from renewable energy sources. Reducing the environmental footprint of the energy sector has become a topic of discussion for the general public, civil society and governments. Energy companies are increasingly turning to renewable energy to meet their customers' needs.

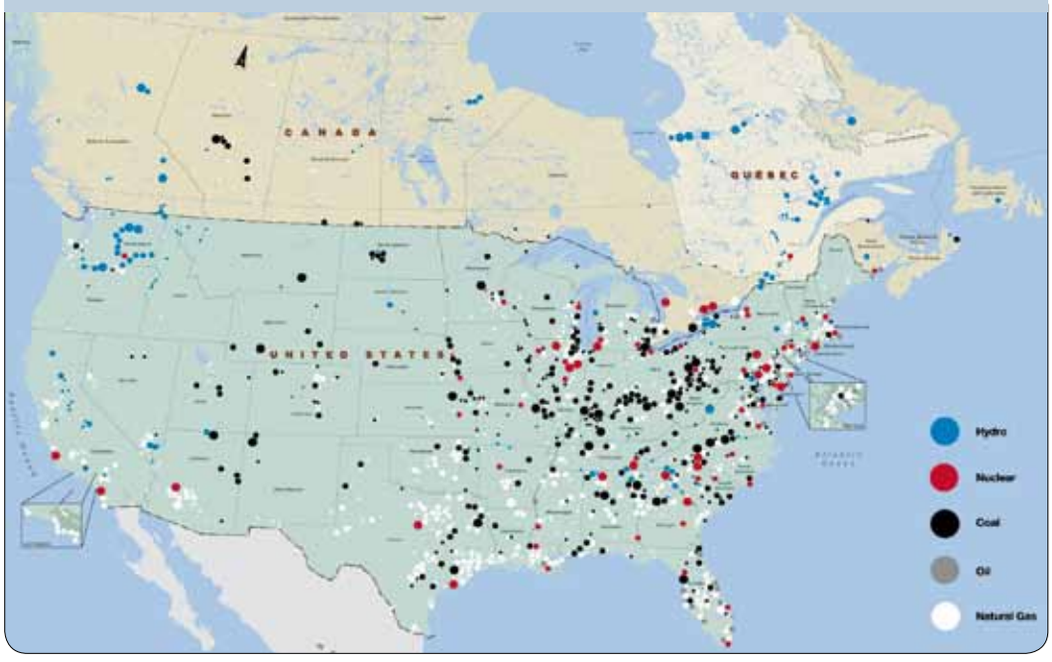
Ensuring air quality and reducing greenhouse gas emissions

In Québec, hydropower is the cornerstone of electricity generation. Our great advantage is to have a baseload energy derived from water resources, which are renewable. Unlike thermal power plants fired by coal or natural gas, hydropower generating stations do not emit pollutants that contribute to phenomena such as smog or acid rain.

While all electricity generation creates GHG emissions, whether directly or indirectly, Québec hydropower ranks as one of the lowest-emission generating options per kilowatthour. Emissions from reservoir generating stations in Québec are comparable to those produced by wind generation and represent about a quarter of those from photovoltaic solar facilities, mainly because of the processes involved in manufacturing wind turbines and solar panels.

A gas-fired power plant produces about 40 times more GHG emissions than one of Hydro-Québec's reservoir generating stations

Electricity generation in the United States and Canada



and a coal-fired plant, about 100 times more.

All natural aquatic areas emit greenhouse gases. Generally speaking, emissions from northern reservoirs return to the level observed in natural lakes within 10 years. Therefore, even though the flooding of large areas of land leads to an increase in GHG emissions, this is a temporary phenomenon.

From 2003 to 2009, a large-scale scientific study was carried out to measure net GHG emissions from a reservoir located in a northern region. The study's goal was to compare the emissions of the natural environment prior to the reservoir's creations and those of the Eastmain 1 reservoir after impoundment. Results show that, among all generating options, hydropower boasts one of the lowest levels of GHG emissions.

Replacing oil with clean electricity in ground transportation

Worldwide, the two largest sources of GHG emissions are electricity generation and transportation. Public and personal transportation account for about a quarter of GHG emissions in North America.

The situation is somewhat different in Québec, however. Thanks to our hydropower development, the electricity sector accounted for a mere 0.5 per cent of Québec's GHG emissions in 2008, compared with 43 per cent (36 million metric tons) for the transportation sector. While oil has dominated the ground transportation sector for the last century, electricity will play an increasingly important role in both personal and public transportation from now on. Ensuring a cleaner power mix in the transportation sector is essential if we are to significantly reduce our carbon footprint.

The electric car is a promising development in our industry. Many models are hitting the market: the Nissan LEAF, the GM Volt, the Mitsubishi i-MiEV, the Ford Focus, and the list goes on. Hydro-Québec is partnering with various car manufacturers — including Ford, Mitsubishi, Toyota, and Renault-Nissan — to test and use electric and plug-in hybrid vehicles before they are marketed on a large scale. These demonstration projects have been designed to determine the charging performance of vehicles, particularly under northern conditions, as well as driver experience and overall satisfaction.

Battery materials are the key to a successful future for electric cars and buses. Lithium ore phosphate shows a great deal of promise for increasing the stability and safety of lithium-ion batteries and reducing their cost.

Paving the way to a sustainable energy future

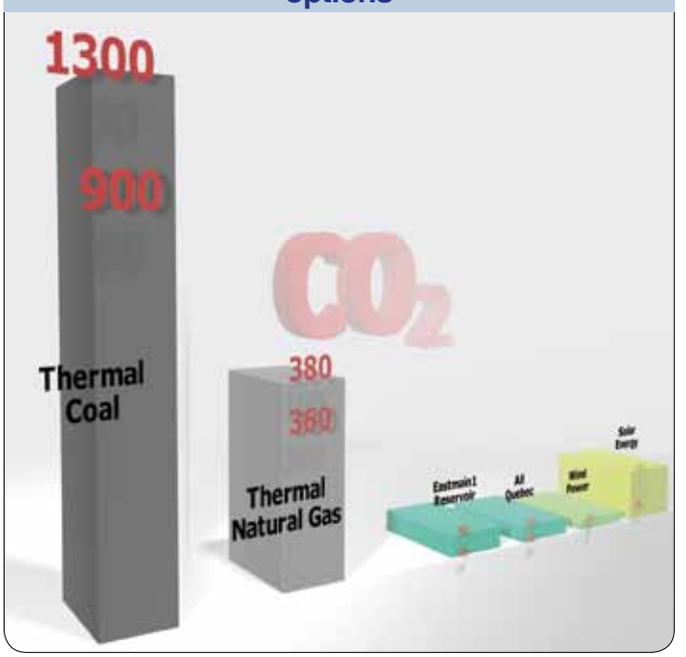
To ensure continued sustainable economic growth, the world must use its energy more efficiently and concentrate on the development of all forms of renewable energy: hydro, wind, solar, biomass, geothermal, etc. There are no bad choices among these energy sources, and different regions will specialise in those sources that are in line with their natural resources and make sense for their markets.

Regions with a strong resource base for generating clean, renewable electricity can export more of that energy to neighbouring regions. For example, between 2008 and 2010, Hydro-Québec's net electricity exports avoided the emission of 41 million metric tons of GHGs in North America. That is the equivalent of the annual emissions from about 10 million vehicles.

A low-carbon economy is not only possible, it is a necessity. Hydropower, the most flexible and reliable renewable energy, is key to this sustainable energy future. ❑

A team of 80 experts from Université du Québec à Montréal, McGill University and Environnement Illimité Inc. collected and analyzed some 100,000 measurements as part of this unique research program. The results of the study can be found at http://hydroforthefuture.com/energie/2/one-of-the-cleanest-generating-options.

GHG emissions from different generating options



Outcomes of the 2011 World Energy Leaders' Summit Rio de Janeiro, Brazil

By Seijin Kim,
Senior Fellow, Global Agenda, World Energy Council

Organised in partnership with WEC's Brazilian Member Committee and supported by Eletrobras and Petrobras, the Rio World Energy Leaders' Summit (WELS) saw Global Energy Leaders engaging in high-level dialogue on the current and emerging issues affecting the energy world under the theme: "2011, a Year of Change for the Energy Industry?"

Co-hosted by Edison Lobão, Brazilian Minister of Mines and Energy, and Eduardo Paes, Mayor of Rio de Janeiro together with Pierre Gadonneix, Chairman of WEC, and Dr Christoph Frei, Secretary General of WEC, the forum took place in the historic Rio City Hall, Palacio da Cidade.

Nearly 100 energy leaders from over 26 countries, including Youcef Yousfi, Algeria's Minister of Energy and Mining, joined a series of round-tables held in "closed" session to encourage freer discussions and openness.

In his opening speech, Pierre Gadonneix welcomed the audience and highlighted the importance of such a meeting. In a time of ever-changing context, it is important to confront the fundamental long-term challenges of the energy sector: energy security, climate protection and energy access for all. Mr Gadonneix invited energy leaders to consider the energy world beyond the confusion of the daily news and observed the need for the sector to create a governance system to pursue long-term objectives and to contribute to sustainable global growth. He prompted each leader to play a key role in the dynamic process towards clear energy leadership: encouraging industry leaders to support governments while delivering growth, and political leaders to deliver a clear framework for sustainable investment.

This dynamic process started with José da Costa Carvalho Neto, President and CEO of Eletrobras, and José Sergio Gabrielli de Azevedo, President and CEO of Petrobras stimulating the opening plenary debate around the implications of the major events: MENA (Middle East and North Africa) regime changes and Fukushima plus the implications of climate challenge and energy poverty, especially in the context of the International Year of Sustainable Energy for All in 2012.

The plenary was followed by three thematic round-tables focusing on key issues topping the current Global Energy Agenda, which are:

- Expanding the Frontiers: The Future of Unconventionals and Deep Water
- Policy Uncertainty: Challenging the Financing of Future Energy Infrastructure
- Smart Grids: The Journey Begins

Key Takeaways

- World Energy Council 2011 Issues Survey finds higher uncertainty around all the issues that were seen to be part of the solution including renewables, energy efficiency and nuclear. The top uncertainties are climate framework, nuclear and MENA.
- MENA has 60 per cent of total oil reserves and 45 per cent of gas reserves. The so called "Arab Spring" plays an essential role in energy security.
- The most significant impact of the Fukushima accident is that nuclear technology and experts have lost the trust of the public in a number of countries. To regain the trust of the people, global safety governance must be strengthened.
- Today we see 10 times more trade in paper than the physical trade of oil. Low interest rates and tight supply and demand provide a perfect context for speculation.
- Unconventional resources will be game changers. They are crucial to meet future energy demand increases. 50 per cent of oil and gas reserves will come from unconventionals in the future.

• It will be a political decision whether and when the US will export LNG (from shale gas). Canada may well move before the US.
• Delay on a carbon tax decision has increased the electricity cost by over 10 per cent in some cases. (Policy Risk Premium)
• Some of the large global oil companies take US$ 40-50 per ton of CO_2 as a criteria to evaluate the profitability of future developments.
• Brazilian law requires companies to invest 1 per cent of turnover in R&D, which makes a leading Brazilian oil company most innovative.
• Smart grid is not an option, but a must. We need to convey a doubling of electricity supply with existing grids and we have to reduce CO_2 emissions.
• Most smart grid business cases are weak, because we overestimate the customer engagement and grossly underestimate the cost and benefit.

Session Summary Notes

Opening Plenary

MENA (Middle East and North Africa) has 60 per cent of total oil reserves and 45 per cent of gas reserves. It also has large potential for future expansion in the gas market. Analysts agree that the solution of MENA issues, i.e. the "Arab Spring", plays an essential role in energy security. In North Africa, natural gas has much more regional significance than the oil market, in particular, for southern Europe. Due to geographical location and climate conditions, North Africa is suitable for renewables, mostly solar development.

Concerning price volatility, there is no physical shortage in the oil market because OPEC members have increased their production and they have spare capacity. Speculation and psychology have caused the price volatility. Low interest rate and tight supply and demand provide the perfect context for the speculation. Today we see 10 times more trade in paper than the physical trade of oil.

A reduction in the consumption of oil products per capita has been seen in Europe, the US and Japan, in contrast to a steep increase in oil demand from China, India and Brazil. We need to improve the recovery rate of the current wells with improved technology if we are to add new barrels of oil. One third of demand is being met from new discoveries. The new discoveries are in deep water and unconventionals and in the areas that need infrastructure. This may lead to a higher price of oil to meet the investment.

Japan is experiencing very heavy impacts as a result of the nuclear accident at Fukushima. Significantly, nuclear technology and experts have lost the "trust" of the public. The majority of people in Japan want to phase-out nuclear and want more renewables. However, the public do not recognise that this choice of energy mix brings with it instability and higher costs. To regain the trust of the people, global safety governance must be strengthened. Communication is vitally important.

According to the WEC 2011 Issues Survey, the absence of a global climate framework post 2012 and the lack of progress towards a significant agreement have kept the issue a dominant critical uncertainty. On the need for action front renewables and energy efficiency remain dominant issues with their perceived impact further increased this year.

1.5 billion people are without the benefit of electricity access, which is unacceptable. We should guarantee energy access for everybody. It is the role of state and every one of us to contribute so that this does not occur.

Latin America has 16 per cent of the world's oil reserves, 4 per cent of gas reserves and huge potential of shale gas. 60 per cent of electricity is based on hydro and other renewables. However, energy richness has not been yet delivered equitably to all of the 570 million inhabitants. Latin America needs to be more effective in energy integration actions. Operational expenditure reduction of US$1 billion per year can be expected through only four main power interconnection lines.

Brazil has huge potential and big opportunities. A third of all major discoveries in the past 10 years have come from Brazil. The current production of pre-salt in Brazil is over 150,000 b/d and it will be around 2.5 million b/d by 2020. Only 2 per cent of the agricultural land in Brazil is used for ethanol – sugarcane production. 90 per cent of new car sales are flex cars. Brazil has 260 GW of hydroelectricity potential and currently over 80 per cent of electricity is originated from hydro power. Wind power potential is 350 GW, which is even more than hydro potential. Brazil also continues to expand its nuclear capcity in order to maintain a diversified mix and thus long-term flexibility and lower vulnerability.

Expanding the Frontier: The Future of Unconventionals and Deep Water

Unconventional resources will be game changers. They are crucial to meet future energy demand increases. 50 per

cent of oil and gas reserves will come from unconventionals in the future. Currently 3 per cent of oil comes from unconventional sources, but this will increase to 8 per cent by 2030. Unconventional gas production will increase to 30 per cent by 2030 and 70 per cent of this will come from the US and Canada.

Shale gas in North America is available in enormous quantities at a low cost and this could be reproduced in China and South America. The supply could last over a hundred years. The cash cost is US$ 2 per bcf (billion cubic feet) and net present value based break-even price is US$ 3-5. It will be a political decision whether and when the US will export LNG (from shale gas). Canada may well move before the US. Such exports will cause dramatic changes in the global gas market.

Oil shale has a huge potential in the US and it is estimated that the reserves have the potential to be 3-8 times bigger than conventional oil. Scaling up the technology will be the key issue as oil shale is not yet cheap enough. In the short term, it will have a limited impact on world energy supply, but in the long term, it has the potential to cause change.

The next question is whether the potential will be realised. Unconventional resources face several challenges: water requirements, energy conservation, mitigating CO_2 emissions and environmental impacts, improving political and public confidence, and risk management.

Stronger environmental and safety regulatory requirements will have an impact and will present complications. However, there is a need for government and industry to work together in streamlining approval processes and reducing investment risk. We also need higher levels of collaboration and leadership among business, governments, science academy and societies.

There are also tremendous opportunities with deep water. Technology is a key to success in this area. Deep water covers 8.5 per cent of world supply in 2010 and 90 per cent comes from just four countries: Nigeria, Angola, Brazil and US Gulf of Mexico.

Policy Uncertainty: Challenging the Financing of Future Energy Infrastructure

The size of the investments required for future energy infrastructure is most challenging. It is estimated that tens of trillion US$ will be required over the next several decades. Government funds are currently very limited and unable to meet this challenge. Private sector investments will be required to meet this challenging total. What policies make the difference? What are the financial options?

Policy is a major driver of energy markets and policy is still the single most important driver for clean energy. However, policy uncertainty has been increasing. There will be no significant private sector investment without policy stability. The problem is that policy risk is difficult to assess and to insure against. Delay on a carbon tax decision has increased the electricity cost by over 10 per cent in some cases. And some of the large global oil companies take US$ 40-50 per ton of CO_2 as a criteria to evaluate the profitability of future developments.

Energy is a long-cycle industry and normal financial models struggle with this timescale. Political solutions are difficult because national policies constantly change. We therefore need to find solutions that move away from national policies. We have to promote common policies by driving through on regional and international frameworks. Policy should also promote more demand side management (DSM).

Market expectation of wind is quite significant, but there are risks, including technological and financial risk.

Regulation has to provide a framework to unlock financing. Without regulation, investment will not follow.

Growth in production and reserve replacement has been the key challenge over recent years. Geopolitical risk is most difficult, but policy uncertainty also makes financing more difficult. We need more sophisticated insurance, consortiums and a rigorous definition of stress case. We also need incentives for R&D. Brazilian law requires companies to invest 1 per cent of turnover in R&D, which makes a leading Brazilian oil company most innovative.

The Cancun COP 16 meeting agreed to launch a new fund, the Green Climate Fund, which aims to raise US$ 100 billion per year by 2020 (and fast-track US$ 20 billion by 2012). But it is still unclear how the fund will be capitalised. Institutions need to work together to mitigate risks. And we need to develop public-private partnerships (PPPs).

Smart grids: the journey begins

According to WEC Issues Survey, smart grids are gaining increasing recognition. Why do we need smart grids? There are a lot of changes in power generation. We need to convey a doubling of electricity supply with existing grids and we have to reduce CO_2 emissions. Smart grid is not an option, but a must.

Smart grids include the technology of generation (whether centralised or distributed), transmission and distribution, IT and software for monitoring the system. With all of them, the smart grid will accept more energy from various sources and options and it will also enable more interactive participation of consumers.

There is a patchwork of diverse technologies spread across countries. Less than a quarter of countries have smart grid initiatives. The most visible technologies are Advanced Metering Infrastructure (AMI) and Distribution Management System (DMS). The smart grid industry is very risk-adverse. The utilities want 99.999 per cent assurance, but the technology is new and nothing yet has been proved to deliver such ubiquitous high performance.

In some countries, stakeholder opposition is a significant issue, and in some cases, there have been perceived issues of privacy. When the new digital meters replaced the old meters, the usage reading was more accurate and many people felt their utility bill increased. One piece of analysis shows that the smart technology could save US$ 3 billion for customers over 20 years. In one case, US$ 800 million invested in a smart grid would result in a benefit of US$ 2.4 billion.

Most utility business cases with smart grid are “weak” because we overestimate the customer engagement and grossly underestimate the cost and benefit. Rationalisation should be clear: better customer services and overall lower cost in the long run.

Education and engagement are essential for success and utilities should share the news of success by demonstrating benefits such as cost reduction, tariff, response time and theft, plus power flow improvement and conservation. Vendors need to cooperate on standards, features and capabilities.

The key to establishing a business model or scaling the grid to commercial levels, is the cross cooperation of policy-makers, technology companies and utilities for executing solutions for the future and shaping the right regulatory framework for it. ❑