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World Energy Insight 2013

Official Publication of the
World Energy Council
to mark the 22nd World Energy
Congress, Daegu, Korea

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THE QUEEN'S AWARDS FOR ENTERPRISE 2013

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Laying the groundwork for a sustainable energy future

By Yoon Sang-jick
Minister of Trade, Industry and Energy, Republic of Korea

I am very pleased to have the opportunity to meet the men and women responsible for shaping the energy policies of nations all over the earth at the 2013 World Energy Congress in Daegu.

The UN has described sustainable energy as the "golden thread" that connects economic growth and social equality, as well as climate stability and living environment. Indeed, energy is one of the most critical issues facing humanity today.

The global energy market is in the midst of a major seismic shift. While efforts are being made to replace existing energy sources with new and renewable energy, the rise of shale gas and oil is demanding new perspectives and policies on conventional energy. In the past, the policy emphasis was on developing technology related to energy supply, but now the focus is shifting to technology related to energy demand, including energy demand management through the use of ICT.

However, there are still 1.3 billion people around the world without access to energy. Cooperation between advanced and developing nations is needed to address the issue of energy poverty. At the same time, climate change caused by the use of fossil fuels and concerns about the safety of nuclear power and other energy sources pose great challenges to ensuring sustainable energy sources.

As we confront these challenges, the best way forward begins with policy adjustment, international cooperation, and expanding the international trade of energy. It is my sincere hope that by facilitating an active exchange of opinions on pressing global energy issues, the Daegu WEC will lay the groundwork for cooperation to secure sustainable energy sources for the future. ❑

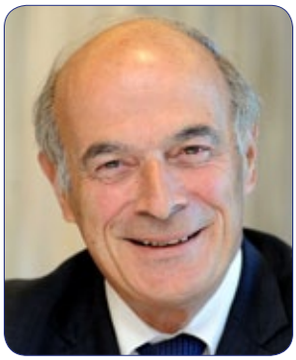
Right place, right time

By Cho Hwan-eik, President and Chief Executive Officer, KEPCO
and Chairman, WEC Daegu 2013 Organising Committee

Dear Friends,

As Chair of the Congress Organising Committee and President and CEO of KEPCO, I would like to welcome you to the 22nd World Energy Congress Daegu 2013. This year's Congress is especially meaningful in that it marks only the third time in the Congress's 90-year history that an Asian nation has staged the event. Asia has become the world's biggest and most dynamic energy market, with both China and India expected to drive energy consumption for years to come on top of rising demand in the region's developing nations. Centrally located Korea, therefore, represents the right place to hold an event of this magnitude and importance. At the 22nd World Energy Congress in Daegu, the more than 5,000 participants, as well as the 20,000 or more visitors expected to visit the Exhibition, will benefit from the unprecedented opportunity to not only hear from but network with top global players, explore business opportunities and gain access to new markets. The technical visits to several of Korea's leading companies and power plants which have been added to the overall programme are certain to provide unique perspectives on Korea's energy industry. In addition to my wish that you find the 22nd World Energy Congress to be a value-added event which offers unique benefit for both you and your business, it is also my hope that you return home with fond memories of your time in Korea.

Thank you. ❑



Creating a new platform for global energy governance

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

It gives me great pleasure to welcome you all to our 22nd World Energy Congress in Daegu, South Korea!

It is a very special Congress for me personally because it will be my last Congress as Chair of the World Energy Council. It is also special because I see this Congress in 2013 as marking a turning point in the energy sector.

Looking back at the last 6 years of my Chairmanship, the energy landscape has undergone tremendous changes. We see new issues, new constraints, and also most certainly new opportunities. However, the sector is still struggling with some of the same enduring challenges, that we at WEC call the "Energy Trilemma": energy security, environmental and climate impacts, and energy equity.

This changing landscape provides a sense of urgency that we have never experienced before, and that should urge us to drive immediate actions to actively promote a new framework for the governance of energy and climate.

Let me illustrate this with two of the main changes we have experienced recently in the sector:

The shale boom clearly refutes the notion of peak oil

The discovery of new unconventional fossil fuel resources poses many challenges for a world seeking sustainable energy solutions. More precisely, it brings to the fore the issue of what is the right balance, or arbitrage, between long-term choices and short-term costs. As we look to transition to a low-carbon energy system this challenge further highlights the need for public understanding. How to deal with the urgency of climate change mitigation and with the necessity of ensuring economic recovery in a world weakened by an economic crisis in some of the world's major markets.

There is therefore an arbitrage to make between either giving us some more time with the new fossil resources and accepting that the costs of adaptation and mitigation will be higher in the future; or changing our energy systems and behaviours immediately, but at high social costs in the short term. The latter option could, however, make the transition unacceptable to the public and thus reduce the feasibility of delivering on the climate goals. We need to build a consensus on the way forward and build smart policies that deliver for the long and short term.

The solutions ahead

My vision is that we shall use all the newly discovered fossil resources only to moderate the social costs of the inevitable energy transition. To be pragmatic, switching too quickly to a low-carbon energy system might fall short of delivering public acceptability and hence feasibility.

Therefore, I would favour a more progressive approach, but one which also requires us to keep our long-term goal in mind. To summarise, this means:

- Substitute fossil energy with low carbon energies as soon as possible in the sectors where it can be achieved at acceptable costs. Thus, keeping fossil energies for the sectors where no competitive alternative fuel is available to the levels required, such as aviation and transport, or when the fuel is vital to ensure economic growth and energy access.
- Encourage the decarbonisation of our energy systems through improved energy efficiency, competitive renewable energies, nuclear, and the roll-out of carbon capture use or storage technologies.
- Prepare for adaptation to climate change.

This pragmatic view is indeed already at the heart of many countries' energy and climate policies. This, however, leads me to the second major trend I would like to highlight here.

The challenge

The economic crisis, in significant parts of the world, has prompted many countries to put the competitiveness of their economies at the heart of their policies and especially competitiveness of their energy supply.

In developing countries, the current economic context with high oil price volatility and economic depression in many of their importing partners is already having an impact. According to IMF forecasts, growth in developing countries is now 1.5 percentage points lower than pre-crisis trends. Therefore in developing countries there is a need to reduce fossil imports and energy bills, which will help to pull their people out of energy poverty. This may also help to accelerate the move from export-led development to a more domestic consumption-led growth.

It is interesting to note that the global fossil fuel import bill reached US$2 trillion in 2011. In terms of percentage of GDP, the impact of this cost is higher for developing countries than for industrialised ones. This presents a significant challenge, and of course opportunities, as I will set out below.

China spent 2.9 per cent of its GDP on oil and gas imports in 2011. This figure rises to around 4 per cent for India. All major importers – except for the US – will in the future, if

no specific counter-strategy is implemented, experience increasing import costs. This includes Europe, which is set to import 80 per cent of its gas and 90 per cent of its oil by 2035. The US Energy Information Administration expects China to import about 75 per cent of its crude oil by 2035, and consequently increase by 200 per cent its current fossil fuel import bill by that time. This already becomes unbearable for countries, particularly developing ones likes China and India. That is why they are increasingly developing resources locally, deploying technologies according to their "economic merit order" in order to preserve growth. Countries tend to start with the most competitive technologies, like better performing coal power plants, to optimise their domestic coal resources, combined cycle gas turbines and co-generation, but also hydro and nuclear (China accounts for half the world total of nuclear plants under construction).

The US has clearly promoted the local production of shale oils and gas in order to reduce its energy dependence. According to the EIA, the US, which imported 15 per cent of its gas in 2010, will export gas by 2017 and reduce by 10 per cent its total oil imports by 2020. The effect of this is to reduce the country's energy bill and promote competitive energy prices for US industry: US gas prices are now disconnected from oil prices, and are between 50 per cent and 33 per cent of the level in Europe and 20 per cent of that of Asia. Lastly, power prices in the US are now one third of those in Europe.

Concurrently, these countries face urgent environmental challenges and have to make real – though progressive – efforts to contribute to the struggle against climate change and air pollution. Here, again, the approach has been pragmatic and progressive.

Substituting gas for coal for example in the US, along with increasingly strict norms on vehicles' exhaust fumes, has helped the US reduce CO_2 emissions by 7 per cent between 2006-2012.

Developing renewable energies is part of this pragmatic toolbox: deploying wind turbines in very windy locations such as Mexico, Brazil and North-West China, and deploying solar PV where sun is plentiful, including India, Southern Africa and the Middle East and North Africa region. Solar PV can also play a role where the peak demand occurs during the day in summer, as in California, and this technology has a significant role to play in suitable areas which are far from the grid. This pragmatic approach has made China

the world's leader in wind capacity (totalling 77GW) and it is noticeable that the continued surge in new renewable energies has shifted from Europe to the other parts of the world, notably China and the US.

All countries must develop energy efficiency strategies, especially where the potential is the greatest, starting with the industry sector where, as experience in OECD countries tells us, efficiency gains can be cost-effective and relatively easier to implement. New houses and buildings, where costs can be kept in check and transaction costs limited through norms and standards, represent a real opportunity for developing countries whose share of new buildings is very significant.

The threats

Nevertheless, while some countries endorse pragmatic and nationally tailored approaches, some other regions, such as Europe, still try to promote a more ambitious and inclusive, yet also more idealistic, top-down approach. This prioritises the preservation of the global good – limiting climate change – but generates new economic difficulties for the continent and creates room for increasing social tensions within Europe and between Europe and its partners.

More globally, the rise of pragmatic national public policies building on all available assets, makes the failure of multinational negotiations on climate change all the more unfortunate. Growing energy needs, energy insecurity, climate change, but also economic competition, can be open doors to new tensions and geopolitical risks.

Such developments can also create room for improved cooperation with many countries facing common risks and similar economic and technological challenges. Even industrialised countries now face, with their own specificities, the three issues of energy poverty, energy supply at competitive costs, and environmental impact mitigation.

Therefore, I conclude that the only way we can, together, reconcile climate, energy security and sustainable economic growth for all, is by promoting a more efficient governance on energy.

This governance is required globally, regionally and locally. It must recognise the best from all countries' experiences, including those making the energy transition, the technologies it requires and the costs it bears, to be acceptable.

How can we now give concrete reality to this governance?

This is the question I would now like to put to all our speakers and participants in Daegu.

Our WEC reports, which I am proud to launch in the final year of my 6-year mandate, particularly the *World Energy Trilemma*, and *World Energy Scenarios to 2050* reports, will provide a common ground for debate on what could be the possible energy future and what could be the consensual trajectories to reach solutions.

This 22nd World Energy Congress offers a unique opportunity for all stakeholders of the energy sector to meet and exchange visions and practices, during four days of very intensive and interesting sessions, roundtables and exhibitions. More than 5,000 energy leaders will gather from around the world: Let us create a new platform for global energy governance! ❑

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 over 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 World Energy Leaders Summits.

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Key Group figures at June 30, 2013*

* Pro forma figures with equity consolidation of SUEZ Environnement as of January 1, 2012

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Securing tomorrow's energy today: Energy in transformation

By Christoph Frei
Secretary General, World Energy Council

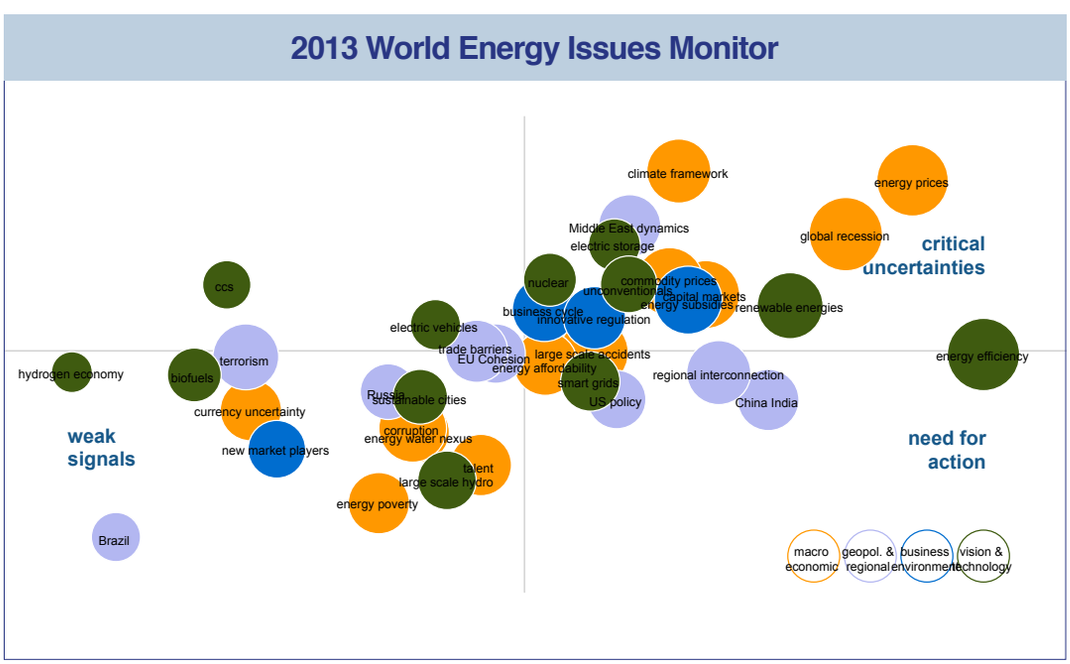
This is a time of unprecedented uncertainty for the energy sector. Energy demand will continue to increase, driven by non-OECD economic growth. The pressure and challenge to further develop and transform the energy system is immense. To make things more daunting, policy makers and business leaders today have to take critical decisions on our future energy infrastructure in a context of unprecedented uncertainty. Over the last five years we have seen acceleration and increased complexity of various energy policy drivers and investment signals. The latest World Energy Issues Monitor illustrates that uncertainties on future CO_2 prices, recession and energy prices continue to be what most keeps energy leaders awake at night. There is indeed great dynamism in investment signals, with cheap natural gas prices de-linking from oil prices, collapsing solar prices, uncertain carbon emission prices or increasing nuclear costs affected by enhanced post-Fukushima safety requirements. As a result, there is much greater uncertainty behind the outlook for nuclear or renewables than five years ago; there is much greater optimism regarding energy resources today compared to five years ago (shale gas versus peak oil); and, there is much greater and new awareness of the energy access and affordability issues, driven by the 2012 UN year of Sustainable Energy for All on the one hand and by financial hardship on the other. Yet, awareness is one thing, delivering in time is another. We are still very far away from a global deal on these issues.

2013 World Energy Issues Monitor

We are all struggling to take long-term investment decisions that are robust and deliver the resilient energy infrastructure we will need. We will be locked into the energy infrastructure that we build today for the next half-century – for good or for bad. Physical assets with long lifetimes therefore need to be robust with regard to different possible futures driven by technology innovation or global policy developments and resilient to change driven by greater stress from the accelerating energy-water-food nexus, from extreme weather events or, by new threats from cyber terrorism. In this context, finding the right policies that build on own resources and recognise specific limitations is a struggle for every single country.

Only a sound policy framework enables the delivery of a robust and resilient infrastructure, whereas an opportunistic policy approach may endanger energy security, hamper environmental viability, decrease social equity and put national competitiveness at risk. It is with these considerations of complexity and uncertainty that WEC promotes the 'Energy Trilemma' approach, with the objective to deliver balanced, predictable and stable policy frameworks. It is such balance that mitigates political risk, which too often keeps the necessary investments from flowing.

With the urgency to take critical decisions in a context of daunting uncertainty, more than ever do we need an impartial, inclusive and fact-based dialogue on our future: to improve our common understanding of the implications of today's decisions and actions so we can make



them the ones that deliver the future we want. A key foundation for policy and investment decisions is a thorough understanding of critical drivers and uncertainties, which will define our future. Exploratory scenarios – plausible and coherent stories of how our future may unfold, based on a systemic analysis of critical drivers and uncertainties – provide a reference point to challenge and test our own assumptions and thereby strengthen the foundation for our capacity to define balanced policies and take informed investment decisions. This foundation is as strong as it is impartial, capable of capturing signals from very different regional or sectorial dynamics, and transparent to interested stakeholders. I am personally convinced that the World Energy Council, together with our knowledge networks and project partners, is uniquely placed to be the world's reference for energy scenarios, with our unparalleled network of 3,000 organisations in almost 100 countries, including the public and private sectors and academia, including BRICs, developing and industrialised countries, including producing and consuming countries, and covering all technologies. With this in mind, WEC is committed to developing its scenarios with an 'open source' spirit to ensure that our insights are accessible to all and enable energy leaders to work on our sustainable energy future for the greatest benefit of all. Already today we have organisations that have chosen to use (at no cost) the model that we are jointly developing with our Project Partners in order to quantify our scenario stories and we are committed to support the growing interest from governments and private sector in this regard.

What can "Symphony" and "Jazz" do for us? There are many ways to read the two scenarios, which describe two very different future worlds: One, in which the world attempts to orchestrate mitigation; and one in which the world will focus on adaptation. One, in which trust is placed in leadership and cooperation; and one, where trust is placed in decentralised decisions and markets. One, in which energy access is programmed by governments; and one, where market driven growth provides the rising tide that lift all boats. The hard truth is that in both worlds we seem unable to mitigate the climate challenge in time to the extent our scientists believe is necessary to avoid the risk of dramatic climate effects. In a Symphony world we will take this as a call for greater urgency to adopt a global deal and coordinated action. In a Jazz world we will take this as call to redefine physical, economic and social resilience. I believe that both Jazz and Symphony provide us with valuable guidance and that we must prevent ideological discussions that will only slow down the finding of effective solutions to face the challenges ahead. The real discussion must be on how can we can do both: enhance greater collaboration with a view to further strengthening institutions in charge of safety, green trade, development finance, the exchange of best practices and technologies, and a focused R&D effort in critical game-changing areas such as energy storage or CCS. And also on how we can make our world into one that is resilient against change that we must be prepared for.

There can hardly be a more meaningful context to hold the 22nd World Energy Congress. It is the opportunity for all of us to make it a milestone in the sharpening of Global Energy Leaders' and our own thinking and truly improve our common understanding of the implications of today's decisions and actions so we can make them the ones that deliver the future we want. The main ingredients are all there to combine and make this a truly meaningful event: the right timing, the right questions, the right people and, the right place. In the changing energy scene, we see a shift in traditional energy from the East to the West: the US and Canada are now becoming the new Middle East in terms of oil and gas; we see a shift in renewable energy/clean energy from the West to the East; we also – perhaps most significantly – see a big demand shift from West to East. In other words: the energy map is being redrawn. Given the shift of demand to Asia, the location for the World Energy Congress this year is all the more appropriate. All eyes are naturally on China. Korea is politically equidistant from the key players in Asia. Korea is the ideal good faith partner and therefore ideal host for such a globally important forum. With the outlined challenges at hand, finding solutions has become a priority for many prime ministers and even presidents. What makes this 22nd World Energy Congress in Korea truly unique is that it brings together the leading international actors from governments, multilateral institutions, civil society and all segments and technologies of the private sector, at a tipping point in the global energy transformation and in the heart of Asia, the transformation of which will affect the entire world. It is a time to work out new visions, renew leadership, provide creative new thinking and deliver new partnerships.

I look forward to our discussions and to incorporating your insights into our flagship studies: World Energy Scenarios, World Energy Resources and the World Energy Trilemma. ❑

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The future is looking musical: WEC Scenarios to 2050

By Rob Whitney
Chair, World Energy Scenario Study Group

Secure, reliable, affordable, clean and socially equal energy supply is fundamental to global economic growth and human development. Future energy supply and demand, future environmental and social contexts are subject to a knot of uncertainties which are difficult to predict, such as the global economic context, technical innovations and geopolitics. In a world becoming more global, where new technologies foster ever quicker innovations and demand or behavioural responses, the task of predicting the future becomes harder.

WEC World Energy Scenarios to 2050 are based on a unique and original bottom-up approach, building on the extended global network of WEC's 93 member committees and 3,000 member organisations. WEC Energy Scenarios were built through numerous workshops gathering key energy stakeholders around the world and thus benefit from a truly regional approach which enables them to deliver regionally contrasted trajectories and a series of eight regional scenarios. The WEC scenarios are exploratory, in that we have not set a predetermined endpoint such as a specific target for atmospheric CO_2 levels.

We have adopted a musical theme for our Scenarios. We have taken two pathways forward, which we have named Jazz and Symphony, and we have worked out where they might lead at a global and regional level. They are meant to be credible rather than aspirational: what we think could happen, not what we would like to happen. The Citizen plays a key role in both scenarios.

In Jazz, people are consumers, driving a scenario in which consumers make the choices in a liberal, free-trade environment. Jazz is a style of music characterised by a strong but flexible rhythmic structure with solo and ensemble improvisations on basic tunes and chord patterns. In Jazz, musicians have freedom to take the lead and improvise; others in the band will often follow. As an energy scenario, Jazz has a focus on energy equity, with priority given to achieving individual access and affordability of energy through economic growth.

In Symphony, people are voters, influencing governments worldwide to strive for sustainable development. A Symphony is a complex piece of music with a fixed structure composed to be played by a Symphony Orchestra. The Orchestra will have a conductor, with each member having a specific role to play and score to follow. As an energy scenario, Symphony has a focus on achieving environmental sustainability through internationally coordinated policies and practices.

Unlike some other scenarios, we have not been transfixed by global CO_2 levels. We have developed a metric based on the WEC Trilemma goals, giving equal consideration to energy equity (access and affordability) and to energy security, as we do to environmental sustainability.

The project has involved working closely with our partner the Paul Scherrer Institute (PSI) which we entrusted with the complex modelling task of putting numbers on our scenarios. We debated long and hard how the key input parameters, GDP growth and the price of carbon, would progress in the two scenarios and across the regions. Part of this discussion was the recognition of the difference between the cost of carbon – the technological avoidance cost of CO_2 emissions, and the price of carbon – what society would be prepared to pay to reduce CO_2 emissions.

Global energy consumption will continue to rise, but at a much lower rate than in previous decades. We estimate that global energy supply will increase by 60 per cent in Jazz and 27 per cent in Symphony. Meeting both global and regional energy demand will be a challenge. In Symphony, we will see a larger switch to electricity and a greater improvement in energy efficiency. We will still be dependent on fossil fuels in both scenarios, but in Symphony there will be a greater uptake of renewables, especially solar, which will begin to overtake hydro by 2050.

Future economic growth shifts from developed countries to developing and transition economies, in particular in Asia. Asia, of all the eight regions considered in this scenario study, will be the region that can be characterised by highest economic growth, both in relative and absolute terms. By 2050, both for Jazz and Symphony, nearly half of all economic growth will occur in Asia and its three sub-regions: Central and South Asia, East Asia and Southeast Asia and Pacific.

Jazz and Symphony score well on Energy Security. Symphony makes use of a wider diversity of energy resource types, and has government-promoted investment in infrastructure. In Jazz there is higher energy production and a greater trading and diversity of international fossil energy suppliers.

For Energy Sustainability and Environmental Impact mitigation there is a clear differentiation. In Jazz, CO_2 emissions only level out at the end of the period; the world continues to depend on fossil fuels and will have to focus on adaption to climate change. In Symphony, CO_2 emissions begin to drop before 2030 and we get close to achieving

the 450ppm atmospheric stabilisation level for CO_2. Some would say this is still not enough and there is room for further improvements, but in Symphony we do see a big increase in renewables especially solar, wide adoption of Carbon Capture and Storage, and progress with nuclear.

There is a price in terms of economic growth and hence energy equity, access and affordability. Energy equity progresses better in Jazz. More people are able to afford more energy because the global market leads to higher GDP growth and there is almost universal access to electricity in all the WEC regions except sub-Saharan Africa. Energy equity is less in Symphony because there are inevitably interventions restricting GDP growth. In the Symphony scenario, funds directed into low carbon initiatives would actually start diverting funds from other government priorities such as health care and other programmes. Financial resources are not limitless, governments have to set spending priorities. In Symphony, there are still over half a billion people without access to electricity.

The publication of this report and the roll-out of Scenarios at the Daegu Congress should not be the end, it should be the beginning. The Scenarios are not forecasts; they are credible explorations of two futures. In one, we pass through the so-called Doha Gateway (the agreements reached at the 2012 climate meeting in Qatar), and global governments all make the concessions necessary for global CO_2 governance. In the other, we leave it to market forces to choose between consumption and sustainability in an increasingly global energy market. In the event we expect the future will lie somewhere between the two, depending on the choices we make.

Rather than telling policy makers and senior energy leaders what to do, in order to achieve a specific policy goal, WEC's World Energy Scenarios to 2050 will allow them to test the key assumptions that they decide to make to shape the energy of tomorrow. Investors can use this tool to assess where are likely to be the most dynamic areas and real game changers of tomorrow. These scenarios are therefore likely to change the way energy decision makers consider the choices they make by understanding the real impact of their actions in the long term.

The WEC Energy Trilemma Flagship Programme sets out a roadmap for actions to address the world energy Trilemma. Our next step should be demonstrating with our scenario tools how this action plan could make substantial progress on achieving all three Trilemma goals by 2050. Are we "In the Mood" for big band Jazz music? Will governments and the energy sector work together so that we get the best of both worlds with the markets reflecting a citizens' consensus on social equity and energy sustainability, and governments doing what only governments can do to enable the goals? The alternative is "A Cacophony", the worst of both worlds – governments making economically suboptimal policy decisions without getting citizen buy- in, and markets focussing on short-term price signals and encouraging self-interest, thus increasing both energy poverty and atmospheric CO_2 levels. ❑

WEC's 10 key scenario signal messages at a glance

1	Energy system complexity will increase by 2050: Integrated system modelling will deserve more attention in the future
2	The energy mix in 2050 will mainly be fossil based
3	The global economy will be challenged to meet the 450ppm target without unacceptable carbon prices
4	Balancing the energy trilemma means making hard choices
5	Regional priorities differ: There is no 'one size fits all solution' to the energy conundrum
6	Energy efficiency is crucial in dealing with demand outstripping supply
7	CC(U)S technology, solar energy and energy storage are the key uncertainties moving forward up to 2050
8	A low carbon future is not only linked to renewables: CC(U)S is important and consumer behaviour needs changing
9	Energy policy should ensure that energy and carbon markets deliver
10	Functioning energy markets require investments and regional integration to deliver benefits to all consumers

Climate change: Buying time at no cost

By Dr Fatih Birol
Chief Economist, International Energy Agency

The short and simple truth is that the world is not on track to meet the target agreed by governments to limit the long-term rise in the average global temperature to 2 degrees Celsius (°C). We have seen some encouraging signs of renewed action on climate change in recent months, such as new cooperation between the United States and China, and President Obama's climate action plan, which includes strong positive actions. New action from the world's largest economies reminds us that we cannot afford to let the threat of global warming slip from our agenda. Overall, we must accept the reality that action to tackle climate change is not something to be done only in the 'good times', and that current economic concerns cannot be seen as a reason to dawdle and delay.

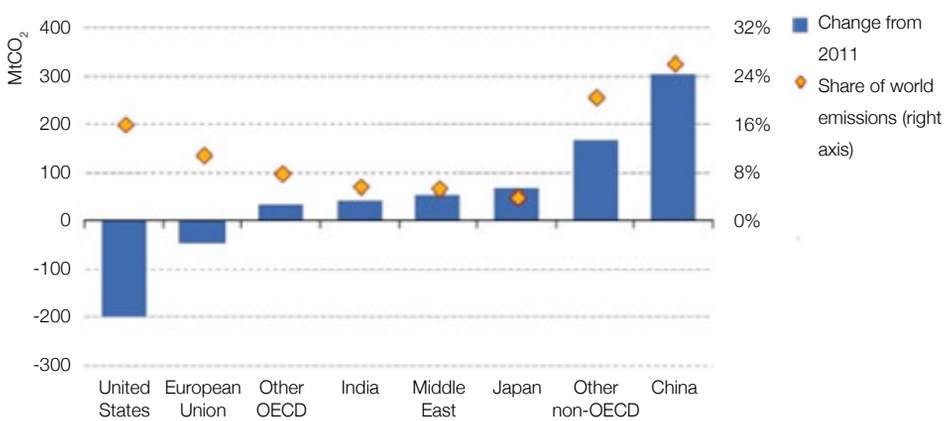
The energy sector accounts for around two-thirds of global greenhouse-gas emissions and is therefore crucial to tackling climate change. Despite positive developments in some countries, global energy-related carbon dioxide (CO_2) emissions increased by 1.4 per cent to reach 31.6 gigatonnes (Gt) in 2012, a historic high. China made the largest contribution to the increase, but its growth was one of the lowest it has seen in a decade, driven largely by the deployment of renewables and a significant improvement in the energy intensity of its economy (Figure 1) In the US, a switch from coal to gas in power generation helped reduce emissions, bringing them back to the level of the mid-1990s. However, the encouraging trends in China and the US could easily both be reversed.

Global leaders have committed to a goal to limit the increase in average global temperatures to 2°C, but existing emissions trends will take us way beyond the 2°C goal. Average temperature increases over land, particularly in high northern latitudes, would be much higher than this and temperatures in cities would be higher still. Weather systems and rainfall patterns will change too, with floods and droughts, heatwaves, and wind storms all being affected. There is also the risk that we push beyond climate thresholds, triggering the release of large amounts of greenhouse-gas emissions from, for example, thawing permafrost or the destabilisation of the Greenland or West Antarctic Ice Sheets.

Climate action at no net cost

The good news is that much more can be done to tackle these emissions without jeopardising economic growth. In the IEA's *World Energy Outlook Special Report: Redrawing the Energy-Climate Map*, we identified four national energy policies that could stop the growth in global energy-related emissions by the end of this decade at no net economic cost (modelled as a "4-for-2°C Scenario"). First, adopt targeted energy efficiency measures for specific products, mainly in the form of minimum energy performance standards. The energy savings achieved means that these would more than pay for themselves. Second, limit the construction and use of the least-efficient coal-fired power plants, also helping to reduce local pollution. Third, reduce methane emissions into the atmosphere that occur during oil and gas production. Finally, phase out fossil-fuel subsidies that act as an incentive to consume fossil fuels, which are much higher than any carbon price existing today. These pragmatic policies have been selected because they can deliver significant reductions in energy-sector emissions in the near-term, relying only on

Figure 1: CO_2 emissions in 2012



Source: IEA World Energy Outlook Special Report Redrawing the energy-climate map (2013)

existing technologies that have already been adopted and proven in several countries.

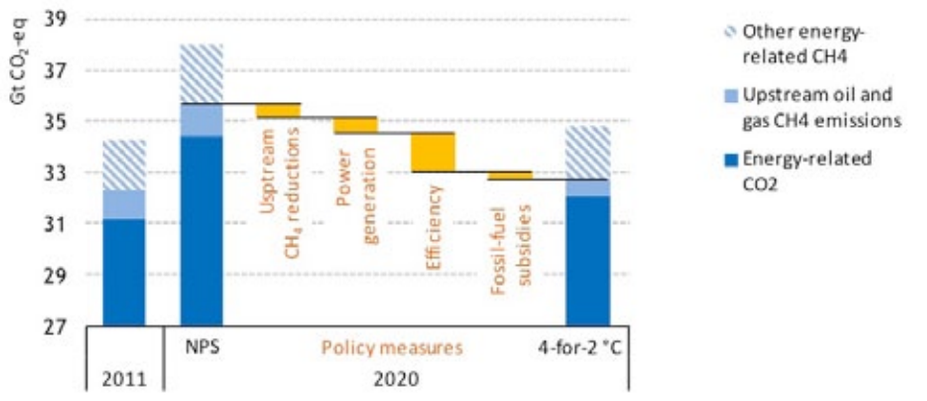
Collectively, these policies would reduce global greenhouse-gas emissions by 3.1 Gt CO_2-equivalent relative to that otherwise expected in 2020 (Figure 2), at no net economic cost for any country or region. Rapid and widespread adoption of these policies could also act as an important bridge to further action, buying precious time while international climate negotiations continue. In parallel to these actions, we must also continue our efforts to deploy and reduce the costs of critical low-carbon technologies at scale, such as renewables, particularly wind and solar, and carbon capture and storage (CCS). CCS is an important asset protection strategy for the energy sector, helping unlock fossil fuel resources that would otherwise need to remain underground. In fact, a delay in CCS deployment could increase the cost of power sector decarbonisation by US$1 trillion and result in lost revenues for fossil fuel producers, particularly coal operators. While increased climate action need not impact negatively on the economic recovery, delay in taking action would make the climate goal more difficult and more costly to achieve, risking significant economic and social disruption for future generations, especially in the most vulnerable regions.

The global energy sector is not immune from the physical impacts of climate change and must adapt. The energy system is currently vulnerable to a range of climate change-related impacts, including extreme weather events that can be sudden and damage or destroy power plants and grids, oil and gas installations, wind farms and other infrastructure. In response to the damage caused by Hurricane Sandy, New York announced a $20 billion investment plan to enhance infrastructure to prevent flooding, increase the resilience of power systems and so on. It is likely that other cities will need to follow its lead in making their critical infrastructure more climate-resilient, particularly where rising sea level increases vulnerability. Other climate impacts are more gradual, such as changes to heating and cooling demand, sea level rise on coastal infrastructure, shifting weather patterns on hydropower and water scarcity on power plants. To improve the climate resilience of the energy system, governments will need to design and implement frameworks that encourage prudent adaptation, while the private sector will need to assess the relevant risks and impacts as part of its investment decisions.

A burden of responsibility

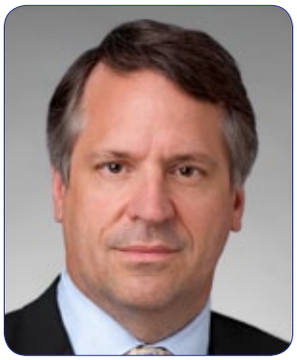
As the largest source of greenhouse-gas emissions, a significant burden lies with the energy sector to deliver the 2°C climate goal committed to by governments. The industry can rise to the challenges brought about by climate change, but this will require the reorientation of a system valued at trillions of dollars and expected to receive trillions more in new investment over the coming decades. In considering our efforts to tackle climate change, we must be careful not to fool ourselves on two fronts. Firstly, we must not think that we can put off action until tomorrow and, secondly, we must not lapse into thinking that a temperature increase of 3, 4 or 5°C is acceptable. The weight of scientific evidence does not justify such a position and it should be challenged before it evolves into a creeping consensus. Our current climate trajectory needs to be seen as a reason to raise ambitions, not as an excuse to lower our expectations. ❑

Figure 2: Change in world energy-related CO_2 and CH_4 emissions by policy measure in the 4-for-2°C Scenario



Notes: CH_4 = methane. NPS = New Policies Scenario. The New Policies Scenario is the central scenario of the IEA's World Energy Outlook and reflects its projections of energy developments based on existing policies and the cautious implementation of announced policies yet to be implemented.

Source: IEA World Energy Outlook Special Report Redrawing the energy-climate map (2013)



Sustainable Policies for Sustainable Energy

By John Drzik
Chief Executive Officer, Oliver Wyman Group

Sustainable energy needs sustainable policy. By 2030, the United Nations hopes there will be universal access to modern energy services, a doubling of the share of renewable energy sources in the global energy mix, and a doubling of the global rate of improvement in energy efficiency. These are ambitious goals. But few, if any, countries have figured out the policies and regulations that will foster truly sustainable energy systems which provide the secure, affordable, and clean energy that these goals will require.

Research conducted by the World Energy Council with Oliver Wyman shows that most countries focus on just one of three dimensions of an energy trilemma that exists at the heart of sustainable energy systems. Nearly half (59) of 129 countries ranked by the World Energy Council/Oliver Wyman Energy Sustainability Index rank within the top 25 countries of the world on one dimension. On a comparative basis, their energy is either secure, or affordable, or environmentally sustainable. But only 13 countries perform strongly across two dimensions. Only 5 are leaders across all three (see table).

Policymakers face a challenge in in trying to form policies that will improve their countries' performance across all three of these dimensions, especially since no form of energy is strong on all three. Fossil fuels continue to beat renewable forms of energy in terms of both affordability and reliability. Solar and wind power are much cleaner, but still operate intermittently and continue to be more expensive than conventional energy.

As a result, policymakers struggle to reconcile the often conflicting agendas of the energy trilemma in deciding which forms of energy development and usage to encourage. Energy sustainability targets can also conflict with economic growth goals, complicating the policy development process. Further, radical change in energy supply, such as that unleashed by the technological revolution underway in horizontal drilling, threatens governments' commitment to sustainable energy. As a result of these various challenges, energy policies have been shifting and policy changes have been hard to predict. The resulting uncertainty around energy policy has created a logjam, slowing investment in developing new energy sources, updating aging infrastructure, and building the new plants and networks necessary for a sustainable energy system.

Accelerating the transition to a more sustainable energy infrastructure requires action from both policymakers and energy industry executives. Each is dependent on the other to move forward. Policymakers are looking to the energy industry and institutional investors to take the risks necessary to develop the technology and infrastructure for sustainable energy systems. Meanwhile, energy executives and investors need policymakers to come up with coherent and predictable policies that justify significant investment.

The result of this logjam: energy systems around the world are under significant strain, the demand/supply gap is growing, billions of people may be forced to live without reliable electricity, and economic growth may be put in jeopardy. Today, 1.3 billion people live without access to electricity. This number could increase since global demand is expected to rise by as much as 30 per cent over the next two decades, according to the International Energy Agency.

So how do we ensure that the world's energy systems become more sustainable?

The first step is for policy makers to internalise that "sustainable" energy policy is policy that can accommodate across a wide spectrum of possible futures. Just as we have seen from the pressure exerted by the discovery of massive amounts of relatively inexpensive hydrocarbons in North America, policy needs to be robust across potential changes in the landscape – such as a more plentiful supply of inexpensive fossil fuels (that will challenge the commitment to more expensive clean energy sources) or a prolonged period of economic stagnation. Policymakers and industry leaders should test policy proposals prior to their adoption for their ability to work toward the three dimensions of energy sustainability goals across a variety of possible futures.

This does not mean energy policies need to be static in the face of significant changes. However, it is important for the goals of policy to be consistent and for policy evolution to be predictable, in order to encourage the long-term investments required by investors. Predictable energy policies with respect to taxes, subsidies, public/private investment partnerships and market support mechanisms (such as "green banks") will help to provide a clearer picture of risks and returns, and encourage industry participants and financial investors to make the long-term investments which are required.

At the same time, policymakers should increase the consistency of sustainable energy goals, policies, and priorities across all government departments. Developing sustainable energy systems involves policies not just for the energy sector, but also for transportation, industry, and the environment – almost every aspect of a country's economy. Energy companies and institutional investors must be assured that if a country's energy department encourages them to invest, their assets will not be stranded after a change in transportation policy or environmental regulation.

Finally, political and business leaders need to work more closely with scientists to accelerate research on the development of additional clean energy technologies and practices by encouraging more information sharing globally. Research should also be shared on behavioral response to energy policy changes. Historical evidence shows that changes which lead to higher energy efficiency lead over time, to higher energy usage – a "rebound effect" which offsets the potential gains from actions to increase energy efficiency. For example, after major car companies introduced more energy efficient vehicles in California, driving distance increased, offsetting the savings from fuel efficiency. A fuller understanding of how and why the rebound effect varies across countries could help all policy makers weigh their choices more effectively.

Developing sustainable energy systems is a long-term proposition. Energy systems are made up of many highly interconnected and interdependent parts, most of which have lives measured in decades. After years of focusing policy on one dimension of the energy trilemma , it's very difficult to switch and address the other dimensions. So, it's important to set a course now which is sensitive to all three dimensions.

With clearly defined, sustainable energy policies, countries will be able to attract the investments and technologies necessary to realise sustainable energy systems. Without them, they may remain locked into systems that will be very expensive, and painful, to correct later. ❑

World Energy Council/Oliver Wyman Energy Sustainability Index

Strong performance in the overall index does not necessarily equate to a strong performance across all index dimensions – not one country ranks in the top 10 on all three dimensions.

Rank 2013	Energy Sustainability Index	Energy security	Energy equity	Environmental sustainability
1	**Switzerland** (1)	**Canada** (2)	**United States** (1)	**Switzerland** (1)
2	**Denmark** (5)	Russia (1)	**Canada** (2)	Costa Rica (2)
3	**Sweden** (3)	**Denmark** (5)	**Australia** (3)	Albania (3)
4	Austria (4)	Bolivia (21)	Luxembourg (6)	**Colombia** (4)
5	**United Kingdom** (2)	**Colombia** (6)	France (8)	Uruguay (5)
6	Canada (10)	Kazakhstan (8)	**Switzerland** (4)	**Sweden** (8)
7	Norway (6)	Angola (10)	**Austria** (7)	**Austria** (7)
8	New Zealand (7)	**Qatar** (7)	**United Kingdom** (5)	**Norway** (6)
9	**Spain** (12)	Romania (4)	**Qatar** (11)	**France** (9)
10	France (9)	**Australia** (14)	**Norway** (10)	**Denmark** (19)
11	Germany (8)	**United Kingdom** (3)	Germany (13)	El Salvador (11)
12	Netherlands (13)	**United States** (17)	Saudi Arabia (14)	Gabon (10)
13	Finland (11)	Nigeria (13)	Belgium (15)	Paraguay (13)
14	Australia (16)	Argentina (11)	**Sweden** (21)	Latvia (18)
15	United States (16)	New Zealand (19)	Iceland (12)	Ireland (15)
16	Japan (14)	Czech Republic (16)	**Spain** (24)	Mauritius (17)
17	Belgium (20)	Indonesia (37)	Japan (9)	Brazil (12)
18	Qatar (17)	China (12)	Greece (26)	Panama (14)
19	Luxembourg (18)	**Switzerland** (26)	**Bahrain** (19)	**United Kingdom** (20)
20	Ireland (21)	Slovakia (20)	Oman (16)	Portugal (26)
21	Costa Rica (37)	Peru (9)	Finland (20)	Croatia (21)
22	Slovakia (22)	**Spain** (31)	Taiwan, China (17)	Georgia (30)
23	Portugal (25)	**Bahrain** (40)	Netherlands (22)	**Spain** (23)
24	Colombia (26)	**Sweden** (18)	Hong Kong, China (25)	Italy (22)
25	Slovenia (23)	Ecuador (23)	**Denmark** (34)	Barbados (25)

Ranking for 2012 in brackets ■ *= leader across two dimensions* ■ *= leader across two dimensions*

Framing the right conditions for sustainable energy investment

Interview with Joan MacNaughton
Executive Chair, WEC World Energy Trilemma

Why is the 2013 Trilemma Report focused on the case for investment?

Analysis shows that a huge increase is needed in the trend rate of investment in energy supply infrastructure to meet growing energy needs, and to deliver access to to electricity and clean cooking facilities to the billions who currently lack it; a sum put at US$37 trillion by 2035 by the International Energy Agency. But radical changes in the way energy supplies are produced, and technological advances which aim to reduce the environmental footprint of our production and use of energy, are posing significant challenges to those responsible for setting policy and regulatory frameworks. Yet when we interviewed CEOs and senior representatives from 40 global energy companies in our 2012 WEC Trilemma Report, we learnt that they consider those frameworks to be the most important determinant of their investment decisions. They called upon policy makers to set coherent and predictable policies; to set stable regulatory frameworks to support long-term investments and correct market failures in a way which levels the playing field for clean technologies; and to put more into joint Research and Development to help drive innovation in clean energy investment. Only by doing so, they reasoned, could countries succeed in attaining the three goals of a truly sustainable energy policy – energy security, energy equity (affordability/access) and environmental sustainability.

So this year we took these recommendations from industry to 50 interviewees – ministers and officials at national level, and top representatives of multilateral organisations – and sought their responses, as well as conducting our annual ranking of countries according to how well the data shows they are doing in tackling the Trilemma. We've sought to show why some countries outperform those you would expect to be their peers, and to identify what can be done to smooth the way to delivering more sustainable energy systems.

So, what are the main messages coming from the policymakers?

Those in government interviewed for the 2013 Report broadly agree with the diagnosis we got from industry representatives last year. But they are finding it difficult to translate intent into effective action – given the speed with which the energy sector is changing, both technically and in terms of patterns of supply. They – like the CEOs last year – express concern over how the lack of a global agreement on tackling climate change, and hence a vision for the target profile of the energy system long term, exacerbates the difficulty of crafting and implementing policies which are future-proofed. How to address this? The policymakers say it will take a much more proactive role from the energy industry in sharing their knowledge and experience with governments, who are often at a disadvantage in assessing the true state of the advances being made technologically, and who are anxious not to make decisions which could lock their countries into technologies which risk becoming obsolete. Policymakers also believe the energy industry could do much more to help build consensus on long-term energy goals. My own sense is that much of the industry would be quite willing to play their part in helping to design policy and to build consensus because they themselves recognise the complexity of the policy challenge and its importance in creating the right conditions for their businesses to thrive. But I do not think anyone should underestimate the resource demands which doing this properly would place on companies. Nor do I think policymakers can expect businesses to step up to the plate unless they recognise that companies can only justify such an investment of resources in the process if it is based on mutual trust and that it is seen to deliver some significant results.

But isn't all this just so much wishful thinking, given the challenge of the Trilemma is to meet three often conflicting goals and the realities of the political process?

Clearly we are a long way from the ideal world in which policymakers are fully informed and seek to attain the best balance they can among the three dimensions of the Trilemma taking into account their national circumstances, including their political, social and economic characteristics and the strength or otherwise of their natural resource endowments, without being swayed by political fashion or other extraneous considerations. But what we find really interesting when we look at the results of our country rankings in the Energy Sustainability Index is how widely performance differs among apparently similar countries, and that the major explanation for the difference is the quality of their policymaking. And, moreover, that those at the top of the Index are characterised by a tradition of meaningful consultation in making policy, consistency and predictability in making regulatory decisions (including a lack of corruption), and clear long-term goals.

A few examples: Denmark, in the number two position,

has had long-term goals to decarbonise its economy which have facilitated innovative approaches such as in its use of renewables (supplying 35 per cent of its electricity) and its district heating. Sweden has a system of certifying there has been proper internal co-ordination among government departments before policies see the light of day. Such approaches enable a small group of countries to achieve an AAA score for the way in which they balance the three dimensions of the Trilemma.

Nor should we settle for thinking that only the richest countries who dominate the higher reaches of the index are equipped to perform well. Costa Rica, in 21st position, in Group III (GDP per capita of US$6,000-$14,300) sits higher than five countries in Group I above US$33,500 per capita) and all but two in group II (US$14,300-$33,500). Colombia, another Group III country, is 24th and both have relatively balanced scores – AAB and AAC respectively – and the quality of their policies has been cited as attracting the investment they needed to achieve such relatively high positions, such as Colombia's Electricity Act of 1994. This has remained broadly unchanged for nearly 20 years, giving companies confidence in assessing the likely returns on long term investment projects.

You've stressed the importance of investment. What specifically did the policymakers recommend on that?
The lessons on investment in the 2013 Report focus on two areas – avoiding too simplistic an approach to assessing risk, and ensuring risk is allocated where it is most effectively managed.

Many interviewees in developing countries pointed to the oversimplified approach of many project developers and said potential investors needed to be less risk averse. Investors were inclined to attribute a high degree of risk to projects in a country with a poor credit rating even if the economics of, say, the power sector were strong and power projects should thus be assessed as very bankable.

On risk alignment, there was widespread recognition in 2012 as well as in this report that optimal risk alignment starts with minimising political and regulatory risk through well designed policy and regulatory frameworks, as I've already described. But risk could be better aligned between government and the private sector if the latter were more forthcoming in sharing with government its perspective about the underlying economics of a project. There is a clear need to attract investment from those not well represented here, such as institutional investors and pension funds, less than one per cent of whose holdings are invested in the energy sector globally. Energy companies could help here by engaging with potential investors outside the sector whose understanding may need to be improved to give them confidence in calibrating risk. More use should be made of instruments such as insurance policies and loan guarantees to manage risk – an issue on which governments, multilateral development banks and project developers need to work together.

Surely the priority for developing countries is to fill the energy gap in the most affordable way, which means usually through using fossil fuels?
That is obviously a key need for such countries, but as well as bringing power to the villages and towns which have no electricity or are vulnerable to interruptions, governments in such countries should also be thinking about the advantages they will have if they avoid getting locked in to a high carbon infrastructure – which will create health and environmental problems down the line, and require further investment before the end of the lifespan of such projects. We have seen the consequences of disregard for environmental impact pretty starkly in some cities and countries round the world – London itself learnt the hard way, through the fatalities caused by smogs in the 1950s and 1960s, which led to the UK's clean air legislation. Perhaps most crucially, though, is our finding that there are countries – Brazil and Uruguay are prime examples – which have succeeded in meeting the growth in energy demand of growing economies in a more sustainable way. They have put a lot of effort into developing their renewable sector, with a large reliance on hydropower and more recently the development of vibrant wind sectors, enabling them to contain their environmental footprint. Innovative approaches to funding – wind power reverse auctions in the case of Brazil – have kept costs containable. Brazil has also been a trailblazer for biofuel, with at least half of all cars equipped to run on bioethanol as well as gasoline.

So what is the key message you would like people to take from the Trilemma?
I think the key message is that we face unprecedented challenges in delivering energy security, energy equity, and environmental sustainability; and industry and policymakers both have important roles to play in meeting them, and these are interdependent. So it is crucial that they take substantive steps to deepen their dialogue. ❑

Sustainable energy central to realising global development goals

By Kandeh Yumkella
Chief Executive, Sustainable Energy for All (SE4ALL)

Modern energy has been the engine of economic growth for the last 150 years, and it continues to power opportunity the world over. However, our current global energy system, based largely on fossil fuel sources, is both inequitable and unsustainable. Some 1.2 billion people lack reliable access to electricity. At the same time, our planet is dangerously over-heating.

Today we have two challenges: We need to turn on the power for every household, while turning down the global thermostat. The good news is that we can do both by providing sustainable energy for all. To my mind, promoting sustainable energy is the best way to generate equitable growth, open up new markets, create jobs, and protect our environment.

It seems incredible that in today's era of modern technologies, one in five people around the planet do not have access to electricity. Twice that many, nearly three billion, rely on wood, charcoal or animal waste for cooking and heating. This energy poverty is devastating to human development.

In industrialised countries, we find the opposite problem: waste and pollution, not shortages. Inefficient, carbon intensive energy use harms our economic productivity and contributes to the changes in our climate that drive extreme weather events costing lives, livelihoods and billions of dollars in damages.

The UN Secretary-General created the Sustainable Energy for All initiative to tackle both these problems simultaneously. Working with the President of the World Bank, he has set out three energy objectives for the world to achieve by 2030: ensuring universal access to modern energy services, doubling the global rate of improvement in energy efficiency, and doubling the share of renewable energy in the global energy mix. These goals are complementary, and making progress on any one of them will help with progress toward the others.

Achieving sustainable energy for all is an ambitious but achievable goal. Technological innovations, innovative business models and a growing body of best practices that can be adapted and scaled up are bringing this goal within reach. The transition to sustainable energy systems presents one of the greatest investment opportunities of the 21st century. To spur investment to transform the world's energy systems, to eliminate energy poverty, and to enhance prosperity requires taking action in three inter-linked areas:

- Ensuring universal access to modern energy services including electrification, cooking facilities and/or fuels, is a precondition for poverty reduction and equitable, inclusive growth. Lack of modern energy access is a global threat. Kitchen smoke is causing around four million premature deaths annually, mostly poor women and children. Options to expand energy access should involve sustainable development of all sources and include both decentralised and centralised energy solutions prioritised according to countries' specific circumstances, and should take into account availability, affordability and quality of energy services. Small/micro entrepreneurs, community bodies and civil society organisations can drive action in energy access, especially in rural areas.
- Investing in energy efficiency presents one of the most cost-effective options to accelerate transition toward a sustainable energy system. By enhancing resource productivity and creating new economic growth opportunities, action to enhance energy efficiency can offer significant investment opportunities for private and public sectors both in developed and developing countries.
- Increasing the share of renewable energy is a fundamental driver for the transformation of the world's energy systems. Renewable energy technologies are increasingly cost-effective. Supporting rapid advances in renewable energy technologies and their deployment will be critical in accelerating this transition that can dramatically reduce greenhouse gas emissions, insulate countries from fuel price volatility, and benefit hundreds of millions of people everywhere.

Governments must establish their own clear targets and strategies, and design and implement a set of national policies, regulations and financial environments that enable change which the market alone will not deliver. Enabling conditions should also be designed to support bottom-up approaches to better identify needs and accelerate scaling-up of proven solutions. International support must build on national ownership of policies, and complement local efforts and fiscal resources.

The private sector has an enormously important role to play. Companies can invest in research and innovation and create new energy products, services and markets that deliver solutions on the scale we need. They can improve energy efficiency and adopt renewable energy in their business operations and supply chains.

This partnership model is a central theme of the Sustainable Energy for All initiative. Momentum is growing.

At the Rio+20 summit last year, world leaders expressed

their determination “to act to make sustainable energy for all a reality and, through this, help to eradicate poverty and lead to sustainable development and global prosperity.”

Many countries and regions such as Africa, the European Union, and Small Island Developing States (SIDS) have endorsed sustainable energy for all as a political priority through explicit declarations and commitments to action. Hundreds of leaders from other countries, businesses, civil society organisations and international bodies have also come forward with concrete commitments.

Furthermore, the United Nations General Assembly has declared 2014-2024 the UN Decade of Sustainable Energy for All.

Earlier this year, the United Nations secretariat, joined by Mexico, Norway and Tanzania, facilitated a series of consultations on why and how energy should be integrated into the post-2015 development agenda, i.e. the global framework beyond the Millennium Development Goals that are set to expire in 2015. Overall, a picture emerges where energy is central both to achieving the Millennium Development Goals (MDGs) in the years to come and to realising sustainable development in the future. “The High-Level Dialogue on Energy in the Post-2015 Development Agenda” that took place in Oslo, Norway in April 2013, concluded that energy must be fully integrated into the universal, post-2015 development agenda and called on broad support for “sustainable energy for all” as a global goal.

Importantly, the Secretary-General’s High-Level Panel on the Post-2015 Development Agenda has proposed “securing sustainable energy for all” as one of the 12 illustrative goals for the post-2015 framework, a significant milestone towards establishing a robust goal framework beyond 2015.

All of us working on energy must remain fully engaged with intergovernmental processes such as the Open Working Group on the Sustainable Development Goals, to ensure that energy is kept fully integrated into the final deliberation on the post-2015 framework.

Sustainable energy for all is an investment in our collective future. It will improve lives, grow businesses, generate jobs and create new markets. And by using energy more efficiently, and investing in renewable energy sources, we can build the clean energy economies that will shape tomorrow, today. I invite you all to join hands to make it a reality. ❑

Carpentry shops like this one in Rwanda can work more effectively with reliable grid electricity

Many diverse roads will take us to Sustainable Energy for All in 2030

By S. Vijay Iyer
Director, Sustainable Energy, World Bank Group

About a quarter of Mongolia's 2.8 million people are nomadic herders of yaks, cattle, sheep, goats and camels who live in gers — as their traditional tent dwellings are known — on the country's vast steppes. It is a simple life that has endured for centuries. Until recently, it was also a life without electricity.

That has changed for about 100,000 herder families, whose daily lives have been transformed by off-grid solar home systems which generate enough power for lights, televisions, radios, mobile phone charging and small appliances. The herders have gained access to solar power through a programme launched by the Mongolian government with support from the World Bank and the government of the Netherlands. Thanks to the National 100,000 Solar Ger Electrification Programme, over half a million men, women and children, covering half the rural population of Mongolia and 70 per cent of herders, now have access to modern electricity.

"A few years ago, country herders managed with candles and lanterns. The change in life between then and now is like night and day," said herder Baatar Khandaa. "I believe that the quality of life in the countryside and the city are now about the same."

Families can now relax and spend time together at night under electric lights. Children can learn by reading and from watching television. Herders often tune in to radio and television weather reports that help them manage their livestock, and use mobile phones to find out about market prices for wool and cashmere.

The programme provided portable solar home systems adapted to herders' nomadic way of life. Herders can easily set them up and dismantle them when they relocate. The project employed a balanced approach to pricing the systems, albeit with a subsidy that covered about half the costs. It made the systems affordable to herders while helping to expand sales.

Rural off-grid and urban on-grid

This project is a case in which solar PV technology, because it is flexible, off-grid and affordable, is the best option to deliver electricity to nomadic people living in remote regions. More often, however, especially in urban areas, grid-based solutions are a better fit as they deliver more electricity to more homes at lower cost.

In Rwanda, for example, the government – with assistance from the World Bank Group, among others – tripled household connections to the grid from 110,000 to 332,000 in just three years. The expansion reached schools too, with the number connected to the grid having risen by 70 per cent since 2009, from 715 to 1,226. Health centres with electric power have risen in number from 169 to 286. "Electricity is very useful to us," said Pascaline Uwizera, a first-year student in secondary school. "I can now use a computer and we carry out our evening studies properly."

The reality is that there are multiple and diverse approaches to achieve the first of the three goals of the Sustainable Energy for All initiative, namely to expand electricity to all of the 1.2 billion people worldwide who are without it, along with safe cooking solutions to the 2.8 billion who currently use wood or other biomass. The purpose behind the Sustainable Energy for All (SE4ALL) initiative launched by UN Secretary General Ban Ki-moon in 2011 – is to galvanise action for a massive scale-up in electrification efforts worldwide.

SE4ALL a priority for World Bank Group

World Bank President Jim Yong Kim is now co-leading this initiative, and both leaders are seizing an opportunity for the UN and the Bank to develop a "new way of doing business" not just at the level of senior executives, but at the country level too. This collaboration is in its early stages, but already it shows promise. The Bank Group has mobilised several new initiatives to support achievement of SE4ALL's three global energy objectives. These objectives are to achieve, by 2030, universal access to electricity and clean cooking fuels; a doubling in the share of the world's energy supplied by renewable sources from 18 to 36 per cent; and a doubling in the rate of improvement in energy efficiency.

With 77 countries having opted in to SE4ALL so far, the World Bank Group has committed itself to doubling the leverage of its energy financing, and providing technical assistance to several opt-in countries and supporting initiatives in partnership with the Energy Sector Management Assistance Program (ESMAP). It has launched a global Sustainable Energy for All Technical Assistance Programme, with US$15 million from ESMAP. This is starting in five countries in sub-Saharan Africa, namely Burundi, Guinea, Liberia, Mozambique and Senegal, in which a comprehensive approach will support these countries' efforts to expand energy access, and build a prospectus of investment-ready projects to facilitate that expansion. Together, these are expected to catalyse donor funding and private investment enabling countries to achieve universal access to electricity

and safe household energy solutions by the year 2030.

Another new initiative is the Renewable Energy Mapping Programme, managed by ESMAP, which will produce the maps needed by governments and project developers to identify renewable resource 'hot spots' at a national scale. This will provide vital information to investors, both public and private, interested in developing countries' renewable energy sectors. With US$11.6 million, this programme covers resource mapping for solar, wind, biomass and small hydropower potential. Nine countries will participate in its initial stage: Indonesia, Lesotho, Madagascar, Maldives, Pakistan, Papua New Guinea, Tanzania, Vietnam and Zambia.

The Bank Group has also launched a Global Geothermal Development Plan (GGDP) to better manage and reduce risks of exploratory drilling to bring what is now a marginal renewable energy source into the mainstream, and deliver power to millions. This plan's initial target is to mobilise US$500 million. Donors can participate in the GGDP by identifying viable projects, and through bilateral assistance, as well as existing channels such as the Climate Investment Funds or the Global Environment Facility (GEF). The GGDP will also be managed by the World Bank's ESMAP. This complements the Bank Group's financing for geothermal development, which has increased from US$73 million in 2007 to US$336 million in 2012, and now represents almost 10 per cent of the Bank's total renewable energy lending.

On another front, partners in the World Bank-led Global Gas Flaring Reduction (GGFR) Partnership agreed to a fourth phase of its work, which has already helped reduce gas flaring by 20 per cent worldwide since 2005. This new phase has as its goal to reduce flaring from 140 billion cubic metres (bcm) of gas flared in 2011 to 100 bcm by end of 2017, a reduction in CO_2 emissions equivalent to taking 60 million cars off the road.

On the analytical side, the World Bank Group led a team of experts from 15 agencies, including the World Energy Council, to produce the Sustainable Energy for All Global Tracking Framework Report. Launched in May 2013, the report provides baseline information on where we are in the journey towards meeting the global energy goals. The baseline enables everyone involved in the SE4ALL effort to track their progress towards the 2030 targets; it will provide the basis for subsequent editions of the Global Tracking Framework Report, which will be produced every second year until 2030.

In addition to its baselines on energy, the report provides data-driven guidance on where to focus efforts to achieve the SE4ALL objectives, by identifying high-impact countries that offer the most potential to make rapid progress. These include 20 countries in Asia and Africa that account for about two-thirds of all people without electricity access and three-quarters of those using solid household fuels.

They also include another set of 20 countries accounting for 80 per cent of energy consumption. These are "high-impact" countries for achieving the other two SE4ALL goals about increasing renewable energy and energy efficiency.

This is a global effort. The UN and the World Bank Group are united behind it, and they are joined by many other partners, the so-called opt-in donor countries such as Norway, Denmark, the United States and Iceland, as well as a growing number of private companies and civil society organisations, including the World Energy Council. This demonstrates a worldwide consensus behind the three SE4ALL goals. Some projects, like solar panels for Mongolian herder families, address two goals at once, delivering electricity with renewable technology. In other cases, some countries will focus on access, while others, having achieved full electrification, will make their energy sectors more efficient, and more reliant on renewables. Together, by multiplying these efforts, we have an opportunity to reach 2030 with an energy sector in transformation in a world free of poverty. ❑

Solar home systems have been provided to 100,000 herder families in Mongolia

Photo: UN Photo/Eskinder Debede

Shifting the energy paradigm: A sustainable reality

By Jim Leape
Director General, WWF International

Food, water and energy are central to our existence and are the cornerstones of our economy. The dynamic interactions between these resources are now clearer than at any time in human history.

As the world's population rises to over 9 billion by the middle of this century, ensuring food, water and energy for all faces a growing challenge – a challenge that is only being aggravated by climate change.

Energy is essential for poverty reduction, yet the means by which we have been producing energy – fossil fuel combustion – is the biggest contributor to climate change. We have an obligation to provide energy to those who need it, but burning more coal, oil and gas is going to worsen global warming, only further threatening food and water security for them and for all of us.

WWF's goal is for the world to embark on 100 per cent renewables by 2050 and thus develop an equitable, low-carbon economy, which is resilient to the climate change that is unavoidable. All efforts should be undertaken to limit warming of global average temperature to not exceed 1.5°C compared to 1850.

Growth of energy use is not universal – the average American uses as much energy as 20 Bangladeshis. Almost 87 per cent of world primary energy comes from high-carbon fossil fuels such as oil, gas and coal.

Fossil fuel combustion is primarily responsible for the exponential increase in atmospheric CO_2 concentrations since the industrial revolution and the principal cause of anthropogenic climate change. Today the world faces a record atmospheric CO_2 concentration of 400 parts per million (ppm) that is unprecedented in human history. While 2°C would be a dangerous increase in global mean temperature, our current path is likely to lead us to more than 4°C above pre-industrial levels, with severe economic, social and environmental consequences.

Our dependence on fossil fuel energy is impacting energy security for nations across the world. We see rising negative effects of burning fossil fuels – particularly coal – on human health and the environment. Global air pollution from fossil fuels kills about 2 million people annually. According to the International Energy Agency's *World Energy Outlook 2012*, more than two-thirds of proven fossil fuel reserves must remain unburned if the world is to prevent dangerous climate change.

We must choose to correct this course – much worse impacts are in store if we do not. Renewable energy and energy efficiency can lower our global carbon footprint and help mitigate dangerous climate change. But while renewable energy is advancing swiftly, we have yet to achieve the growth rate needed to prevent dangerous climate change. Most energy decision-makers do not understand the current realities of energy markets, costs and technologies, and have not established the policies, support mechanisms and investments that will transform the global energy system for the greater good.

The cornerstone of this agenda is renewable energy. Renewable energy is abundant by nature. Solar, wind, geothermal, hydropower, ocean and bioenergy can provide 100 times the present global energy consumption. With a potential like this, delivering 100 per cent renewable energy for the entire world could be done sustainably with sound long-term strategies paired with strong energy efficiency measures.

We just need political commitment, strong investment, and global action to make this a reality.

The case is compelling. Renewable energy technologies are already becoming more competitive with fossil fuel in many parts of the world. In many cases, renewable energy systems are the first and easiest source of electricity for remote communities who before had none. Investments in renewables averaged US$245 billion annually from 2010-2012, already a fourfold increase since 2006. While on a projected curve of growth, this year the figures are expected to be roughly the same. We know we need more – US$ 350 billion annually over the next four years as a starting point.

To achieve that growth, governments need to provide enabling policies and certainty, to tilt the balance of investment away from fossil fuels and towards renewables. This means ambitious renewable energy targets, grid connectivity, research and development, and ending fossil fuel subsidies.

As investments rise in renewables, manufacturing costs fall fast and renewable power generation becomes increasingly competitive year after year. For example, in some markets, prices for solar photo voltaic modules have fallen by more than 60 per cent compared to 2009 and wind turbines by around 25 per cent. At current prices for conventional technologies, renewables are the most cost-effective option for off-grid electrification and some centralised technologies. In geologically active regions such as the Pacific Ring of Fire, geothermal electricity has already reached or surpassed grid parity in countries like the Philippines.

If externalities such as air pollution, waste generation, decommissioning of plants and of course CO_2 emission of conventional fuels were to be included in the costing exercise, electricity prices would be 30 per cent to 150 per cent higher – and most renewables are already more cost-effective than nuclear and fossil fuels today.

We can already see this shift in energy paradigm. Today, Denmark, Germany, Ireland, Spain, Portugal, Australia, Italy, the Philippines and some states in the US all get a large share of their energy from renewable sources. And South Africa was the global champion last year, investing close to one per cent of its GDP in renewables.

Some 138 countries now have renewable energy targets. We have seen many countries just in the last few years acting to increase their renewable electricity share, such as Costa Rica, New Zealand, China, Uganda, the Philippines, Morocco, Tunisia, Mexico, India and South Africa to name just a few newcomers. Even Saudi Arabia agreed to run most of its power supply by 2030 with solar and wind.

In addition to lower costs and a cleaner climate, renewable energy offers many other advantages. Solar, geothermal and wind energy hardly use any freshwater in their operations. Conventional energy today is the second largest consumer sector of freshwater worldwide after agriculture. Clean renewable energy does not emit noxious gases that create smog, health problems, acid rain and reduce agricultural harvests. Neither do they create water pollution or radioactive waste.

And investment in renewables creates jobs. The renewable energy industry now provides almost 6 million jobs. The worldwide 20 largest oil and gas companies employ only about 2 million people.

Like all energy sources, the growth of renewables must not be at the expense of the natural environment. This is particularly important for technologies such as hydropower and bioenergy, which can have significant negative environmental and social impacts if not managed carefully.

But despite the fast growth of renewables in the world energy supply, we are still far from reaching that global shift in energy paradigm. Understanding the nexus between food, water and energy is essential to creating management plans that will ensure the long-term wellbeing of people and the planet. We must transform. We must transition in a way that is just and fair. And we must succeed.

To facilitate inclusive and sustainable development, the world must invest much more money now in clean, renewable energy.

Investment in renewables must be ramped up to about US$500 billion per year by 2020 in order to avoid dangerous climate change. Yes, this comes with challenges – not least resisting the economic interests and influence of conventional energy players.

But achieving the world we want is also achieving the world we can't live without. It is less a choice than an imperative. And it's possible. The time to act is now. ❑

In some markets, prices for solar PV modules have fallen by more than 60 per cent since 2009

Energy, water and food: A systems approach

By Martina Otto
Energy Branch, United Nations Environment Programme

Energy relates to water and food in many ways. Energy enables access to water, through water pumping, distribution and treatment. Energy is needed in modern agriculture systems, from irrigation to use of fertilisers and machinery, to food preservation, processing, transport and cooking. At the same time, energy production has an impact on natural resources such as land and water, which are equally input to the agricultural sector. Land is actually the fourth dimension that needs to be taken into account in the Nexus debate.

Water is used for extraction, mining, processing, refining, and residue disposal of fossil fuels; for growing feedstock for biofuels and electricity; and as source of energy in the case of hydropower. Any water demand from the energy sector comes on top of over 70 per cent of freshwater being used in the agricultural sector already. But not only water availability is an issue. Many forms of energy production through fossil fuels can pollute water, especially extraction from tar sands and shale. And return flows from power plants to rivers are warmer than the water that was taken in, and if polluted can consequently compromise other downstream usage as well as ecosystems. The production of biomass for bioenergy can lead to important run-off from fertiliser and pesticide use, as is the case for any agricultural production.

Many countries are already facing a triple energy-water-food crisis, and combined pressures threaten to drive ecological and social systems beyond critical thresholds:

- About 900 million people lack access to safe drinking water and an ever-increasing number of people are affected by water shortages. If we continue with business as usual we will have – in less than two decades – globally 40 per cent less freshwater resources available than we need for ensuring water, energy, and food security for all.
- 1.3 billion people lack access to electricity and 2.7 billion have no access to modern and healthy forms of cooking; energy demand is projected to grow by one-third by 2035. If present patterns of energy production and use are pursued, the climate target of keeping global temperature increases below 2 degrees will not be met.
- Close to 1 billion people are undernourished, and food price rises globally are of great concern, particularly to poorer segments of society who already spend a significant amount of their budget on food. If current consumption patterns, such as dietary changes to more protein-rich diets, and food waste continue, agriculture will have to produce 70 per cent more food by 2050, which may result in a 20 per cent increase in use of water and 10 per cent increase in land use change.

Addressing sectors in isolation will not get us to access to clean energy, water and food for all within the planetary boundaries. We must move towards greater integration of these key sectors, looking at them as a system. This approach needs to be reflected in assessments, planning and policy processes, as well as new business models and investment decisions.

Integrated planning processes, engaging relevant stakeholders

To identify system efficiencies and manage resources sustainably, integrated assessments need to consider

Global Bio-energy Partnership

24 indicators, 3 pillars

Economic
- Price and supply of a national food basket
- Access to land, water and other natural resources
- Labour conditions
- Rural and social development
- Access to energy
- Human health and safety

Environmental
- Lifecycle GHG emissions
- Productive capacity of land and ecosystems: soil quality, wood harvest levels
- Air quality: non-GHG air pollutant emissions
- Water availability, use efficiency and quality
- Biological diversity in the landscape
- Land-use change, including indirect effects

Social
- Resource availability & use efficiencies in bioenergy production, conversion, distribution and end-use
- Economic development
- Economic viability & competitiveness of bioenergy
- Access to technology and technological capabilities
- Energy security

multiple impacts across the full life cycle, and not only sector by sector or even technology by technology, but for entire systems. The International Resource Panel, for which UNEP hosts the Secretariat, is preparing a series of reports that further elucidate the issues at stake; the upcoming land report, for example, homes in on competition for land for multiple uses, including energy and food production.

Although the issue is bigger than bioenergy, it is worth looking at the literature and tools produced and used to address the Energy-Water-Food Nexus, as soaring bioenergy demand triggered the Energy-Water-Food Nexus debate. Under the framework of UN Energy, UNEP and FAO have developed step-wise guidance to ground bioenergy decision-making in science, and put it into a broader systems perspective. A 'decision tree' describes an integrated strategic planning process, analysing domestic energy and food needs, and assessing the status of critical resources such as water and land, and factoring in projected trends and impacts from major global threats such as climate change. The process implies multiple feedback loops to identify and study conflicting objectives and trade offs as well as synergies and co-benefits. Tools comprise Integrated Water Resource Assessment as well as Agro-Ecological Zoning. The latter uses a combination of GIS data and ground-truthing, and involves among other parameters assessment of carbon storage value, biodiversity value beyond simple reference to Protected Areas designated under the Convention on Biological Diversity, state of food production and security, and land tenure rights.

Planning processes need to engage relevant stakeholders. To facilitate the consultation both across national, regional and local government, and with the private sector and civil society, the Decision Support Tool suggests the creation of a Stakeholder Forum in which all interested parties can participate, and an Inter-ministerial Group, which facilitates the decision-making and acts as the executive organ. Such a process would facilitate the mutual understanding and cooperation needed to develop new integrated business models.

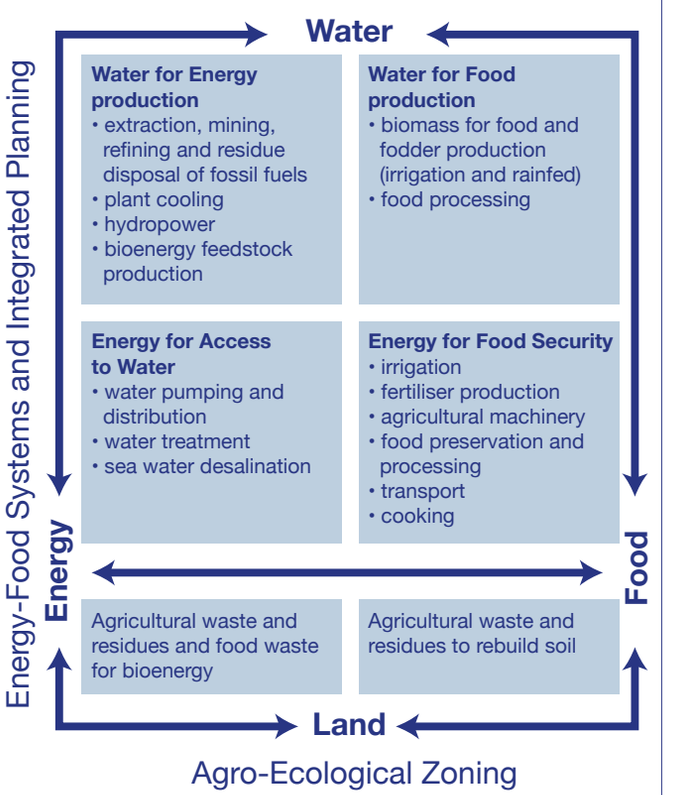
Integrated strategies and policies

As was stated in the 2011 Bonn Conference on the Nexus, water, energy and food strategies and policies need to articulate a plan for security of supply and sustainable access to basic services taking into account the implications on other sectors.

- Develop innovative, synergistic environmental policy measures and instruments which concurrently respond to several environmental challenges and minimise trade-offs.
- Create more with less by increasing resource productivity, establishing mechanisms to identify the optimal allocation of scarce resources for productive purposes, and sustainably intensifying the use of land and water to achieve equitable social, economic and environmentally sound development.

The Agricultural and the Energy sectors are particularly subsidy-heavy. Created to support poorer segments of society and other vulnerable groups to gain access to food and energy, or smallholder farmers in the case of agricultural subsidies, these subsidies often do not only benefit the target groups. At times they even promote waste. In addition, as in the case of fossil fuel subsidies,

Integrated Water Resource Management



Source: M. Otto

they can distort the competitiveness of alternatives.

• Reformulate or remove those subsidies that are harmful to resource use and climate while implementing better targeted support mechanisms for vulnerable groups that are decoupled from resource use.

• Market instruments that encourage more efficient and equitable resource allocation and use, leaving business to find the best technological solutions and new business concepts.

In the work on Bioenergy it was found that securing land tenure rights and water rights for vulnerable groups are critical in achieving social goals and helping address over-exploitation of these resources.

• Review / develop land tenure and water rights benefitting vulnerable people.

To ensure policy effectiveness, it is important to monitor progress towards or away from policy objectives, and help to identify impacts and trade-offs on related sectors

The Global Bioenergy Partnership developed a set of 24 sustainability indicators to address sustainability in the bioenergy area, with 8 economic, 8 social and 8 environmental criteria, speaking to land and water, as well as access to energy and food security. This set can serve as inspiration for monitoring effectiveness of Nexus policies.

• Develop solid measures to monitor and evaluate the added value of integrated nexus planning and mutual beneficial outcomes.

Investments in business models taking a systems approach

Energy, Water and Agriculture were three of the 10 sectors highlighted in UNEP's Green Economy report as critical. The report had found that investment of 2 per cent of global GDP invested in 10 key sectors could kick-start a transition towards a low-carbon, resource-efficient economy. The integration of the three sectors requires new business models and redirecting investments. This opens up new opportunities, but initial barriers need to be overcome.

• Work with the investor communities and the financial sector to increase confidence in these new business models.

• Promote integrated Food-Energy Systems and good agricultural practices through agricultural extension services.

End waste

The most cost-effective way to reduce pressures on natural resources and reduce the carbon footprint is to end waste and minimise losses along supply chains. As is often said, the cleanest and cheapest energy is the energy that is not consumed. Another example stems from the agriculture sector where one-third of the food we produce is lost and wasted, using critical resources such as water and emitting a certain amount of CO_2, while at the same time 12 per cent of the world population is estimated to be undernourished. To manage waste and loss down, UNEP with the Food and Agricultural Organisation of the UN has launched a global campaign called "Think. Eat. Save: Reduce Your Foodprint." Consumer choices are critical to end waste and reduce water, energy, food and other resource footprints.

• Promote sustainable consumption patterns.

Investments in sustaining ecosystems

Not least since the Millennium Ecosystems Assessment, the value of natural infrastructure has been recognised. Biodiversity and ecosystems deliver provisioning services for water, food and energy, and support nutrient cycles that maintain the conditions for life on Earth. Investments to secure, improve and restore ecosystem services are needed.

• Promote investments into ecosystems through regulation and market-based instruments.

What next?

The interrelation between Energy, Water and Food will be an important topic also in the decades to come. In the ongoing consultations on the post-2015 development agenda all three areas are being considered, and were subject to respective specific thematic consultations. It is important now to bring these elements together. As we move towards formulating Sustainable Development Goals (SDGs), a number of suggestions have been made already, for example by the High-level Panel of Eminent Persons on the Post-2015 Development Agenda set up by the UN Secretary General and the Sustainable Development Solutions Network. All capture the importance of energy, water and food security. In the formulation of the SDGs and their related targets and indicators we now need to establish the cross-references between the sectors.

Under the secretary-general's initiative for a Sustainable Energy for All, partners will be able to coordinate and scale up their activities. Realising long-term water, energy and food security for all within our planet's boundaries is certainly part of the future we aspire to. It can become reality, if we put our collective means to it. ❑

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Efficiency at the heart of the solution to the Energy 'Trilemma'

By Maria van der Hoeven
Executive Director, International Energy Agency

The triad of energy security, sustainability, and economic development is a familiar one in energy policy circles. Achieving secure and affordable energy supplies across the economy in support of human welfare and economic activity can present the appearance of a false trade-off with environmental sustainability and the achievement of climate change goals. The reality is that those challenges can be met simultaneously with policy, technology, and industry practices working together. Responsible unconventional gas extraction has substantially cut North American carbon emissions while delivering affordable energy to the market, and renewable energy technologies are increasingly competitive in specific applications, such as bringing clean energy access to remote areas. Yet IEA analysis consistently identifies one policy area that stands to contribute the lion's share of cuts to carbon emissions, reductions in local pollution, and cost-effective energy security – energy efficiency. Simply put, the cleanest megawatt will be the one we never need, and the most secure barrel of oil the one we never burn.

Yet the *World Energy Outlook 2012* demonstrates that not enough is being done to improve energy efficiency. Improvements at the global level are difficult to measure, but if we take global energy intensity (a measure of the amount of energy required to produce a unit of GDP), then we see that it actually deteriorated in the two years that followed the 2008 economic crisis, reversing a historical trend of improvement. Fortunately, some major energy-consuming countries have recently announced new measures to boost energy efficiency. China is targeting a 16 per cent reduction in energy intensity by 2015; the United States has adopted new fuel-economy standards; the European Union has committed to a cut of 20 per cent in its 2020 energy demand; and Japan aims to cut 10 per cent from electricity consumption by 2030.

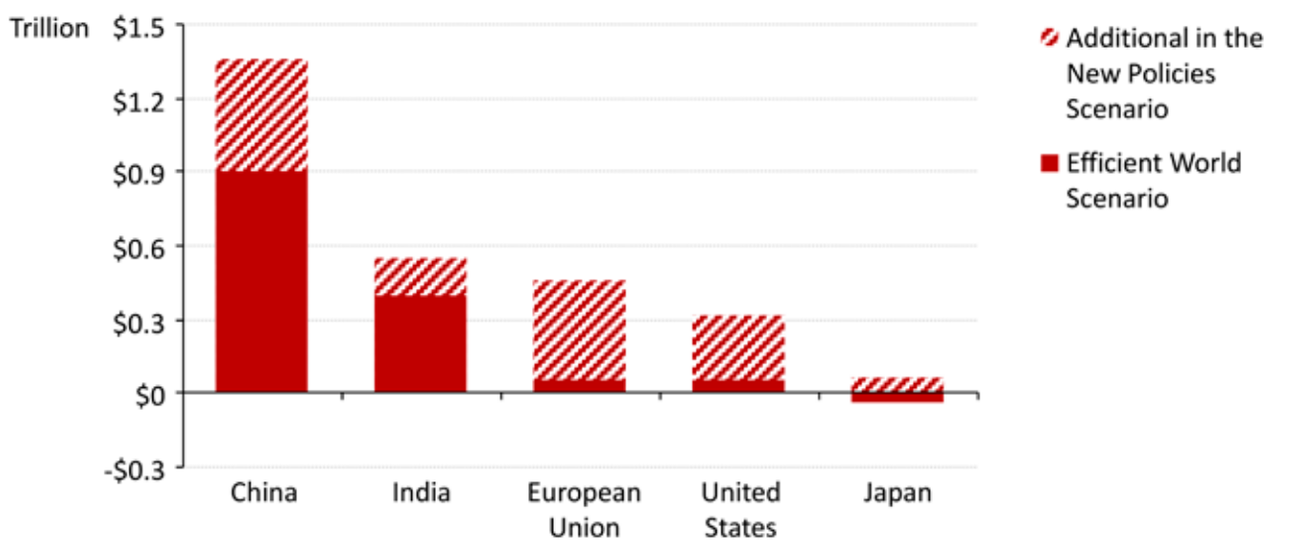
In June, the IEA released a *World Energy Outlook* Special Report, *Redrawing the Energy-Climate Map*. The report examined four critical steps that can be taken before 2020, in the absence of implementation of a multilateral agreement on climate change, to keep the world on track to limiting long-term global temperature rises to 2 degrees Celsius. They cannot get us there on their own. Rather, these time-critical measures, which incur zero net economic cost and use proven technologies, can help keep the fast-closing door open to that important international goal. Of the four (which also include limiting the construction of least-efficient coal power plants, minimising methane emissions from upstream oil and gas production, and accelerating the phase-out of fossil fuel subsidies), energy efficiency measures accounted for nearly half of all carbon savings over the outlook period.

On a longer horizon to 2035, the *World Energy Outlook 2012* showed that energy efficiency accounted for 42 per cent of carbon savings between the greener "450" scenario (consistent with a 2 degree Celsius trajectory) and the baseline "New Policies" scenario. A special "Efficient World" scenario shows what can be achieved to 2035 simply by adopting known best technologies. Global energy demand is cut by half compared to the baseline scenario; oil demand peaks by 2020; savings in natural gas are equivalent to US production in 2010; fuel bills are cut by 20 per

Modern 'ultra supercritical' technology raises efficeny in coal-fired power plants

Photo: Siemens

Energy expenditure in 2035 compared with 2010



In addition to cutting energy expenditures by an average of 20 per cent, improved efficiency brings wider economic gains, particularly for India, China, the United States and Europe

cent on average; and the global economy is boosted by a cumulative US$18 trillion to 2035.

Still, energy efficiency as such covers a wide range of topics and sectors – from transport to industry to buildings. With urbanisation on the rise, particularly in the developing world, urban energy policy design including smart transport and efficient buildings will be particularly key elements. Currently, over 70 per cent of global energy demand is consumed in cities, where roughly half the world's population lives – and that number is set to grow substantially to 2050, when 70 per cent of the population will be urban. Urban energy efficiency policies should strive to create an effective link between national, regional, and local needs. Several of the most important areas to address include city planning, building energy efficiency, transportation, and energy generation, distribution and delivery. Analysing the impact of such policy areas should employ a cross-sectoral approach, since efficiencies typically show up across the system. The link between energy and transport for example is apparent, but less obvious interdependencies can also be important, such as the interplay of energy policies with waste and water management.

Yet sometimes the obvious linkages are indeed the most significant. For example, with such rapid urbanisation comes increasing demand for energy and mobility. Urban travel increased more than 15 per cent between 2000 and 2010, to roughly 13 trillion passenger kilometres. In other words, for every urban inhabitant added to cities between 2000 and 2010, overall urban travel increased by nearly 5,000 passenger kilometres each year. Given that 6.3 billion people are expected to live in cities by 2050, it is likely that urban passenger travel will more than double in coming decades. In some regions, it could increase as much as 10 fold. These issues require immediate action. Already in many cities, especially in developing countries, there is a critical need for efficient, safe and high-capacity transport solutions.

In effect, the world has reached a turning point. The 20th century changed how we move with rapid transit and motorised transport. The 21st century must now address how to move people and goods throughout cities most efficiently. In July the IEA released a Policy Pathway entitled *A Tale of Renewed Cities*, which looks at public transport and demand management solutions around the world

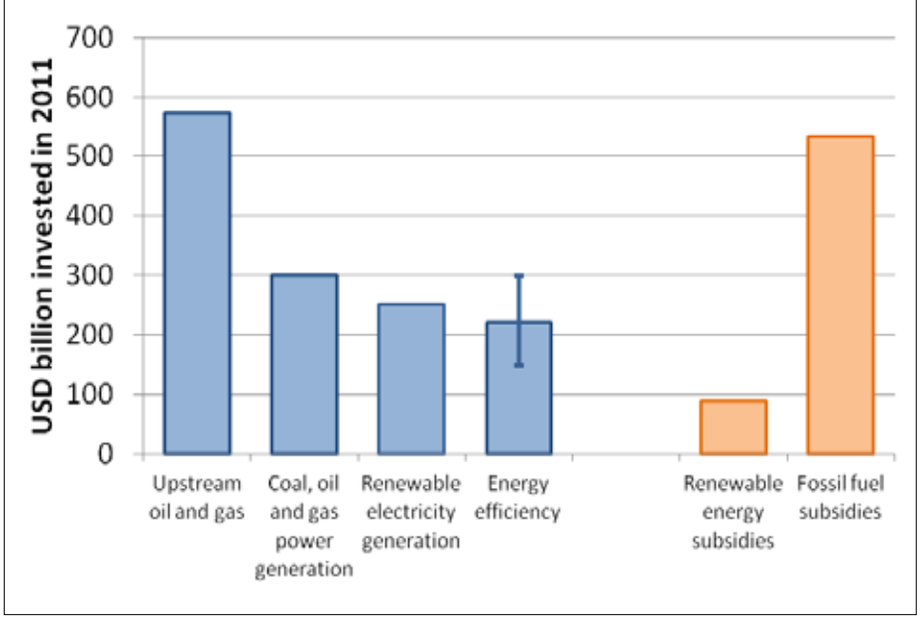
as potential models. Given the importance of transport to tackling the energy policy triad, this pathway provides precisely the kind of best-practice exchange that the IEA promotes.

Certain sectors therefore deserve focus, within an interlinked constellation of energy efficiency opportunities. Understanding that constellation as a market, however, is a relatively new undertaking. At this year's World Energy Congress, the IEA will be launching its first *Energy Efficiency Market Report*. This report joins our series of market reports on coal, oil, gas, and renewable energy – highlighting the importance we place on efficiency as a "hidden fuel". That is because, in general, energy efficiency represents an important potential alternative to investing in traditional supply-side fuels, and provides important benefits to countries looking to balance energy supply with a demand profile that supports sustainable economic growth. In addition to avoiding the need for new energy supply infrastructure, country case studies featured in this report show that energy efficiency also delivers improved service, economic productivity and consumer benefits, and reduced energy demand growth.

According to IEA estimates, the savings from energy efficiency investments have exceeded the output from any other fuel source in many IEA countries. This reflects an increase in investments in energy efficiency over the last several decades, as well as the "locking-in" of some savings from those investments. At the same time, a variety of factors will affect both the magnitude and sustainability of any savings (of the avoided demand), including increased expenditures on energy supply generated from increased disposable income that result from the savings (a "rebound" effect). Consequently, there remains an important need for better measurement of energy efficiency outputs relative to other traditional fuels to better assess its impact over time. This is particularly true with respect to energy efficiency investments that are far off.

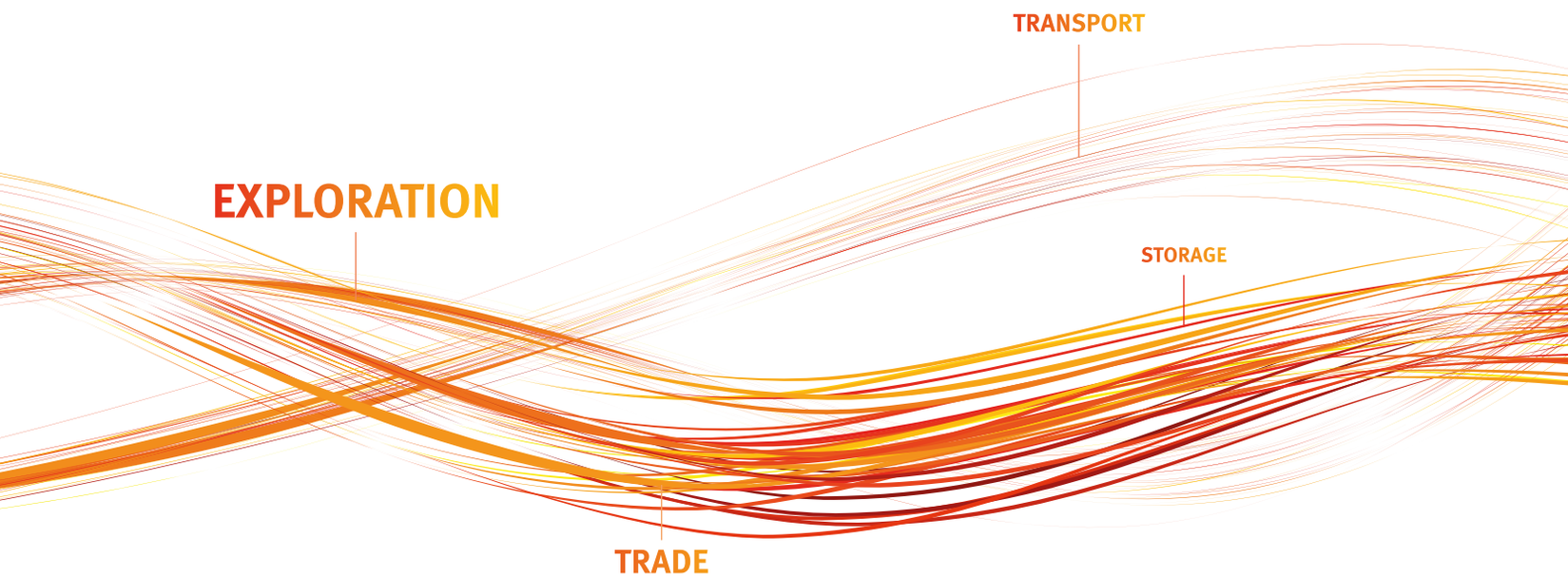
The energy efficiency market is at a crossroads, and the way forward will vary across countries. Indeed, energy efficiency markets have weathered the financial crisis rather well - stimulus spending has injected US$56 billion into energy efficiency markets and the leveraging of private investment. However, the winding down of stimulus programmes, combined with continued slow growth, has created a shift in energy efficiency market drivers. The result is that significant cost-effective energy efficiency opportunities are not being exploited. While the energy efficiency market is large and growing (based on recent policies and targets), countries can do much more to analyse the role that energy efficiency can play, and the level of investment needed, to meet economic, security, and environmental goals. Opportunities are different across countries, regions and economic sectors, depending on economic structures, resource endowments, and development levels. However, the potential gains from efficiency are enormous. While the issue may not be so politically exciting as new plants and cutting edge technologies, energy efficiency really is at the heart of any solution to the energy 'trilemma'. ❑

Global levels of investment and subsidies in selected areas of the energy system



What is the best way to overcome the challenges of the „Energiewende“?

Integrated thinking with natural gas!



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Shaping the future

Global tracking framework puts numbers to sustainable energy goals

By Vivien Foster
Energy Sector Manager, World Bank Group

How many people around the world lack access to electricity and safe household fuels? What's the share of renewable energy in the global mix? How are we doing in improving energy efficiency?

The Sustainable Energy for All Global Tracking Framework Report, produced by a 15-agency team that included the World Energy Council, answers these questions. It presents detailed country-level and global data that outline the scale of the challenges ahead as countries try to meet the three objectives of the Sustainable Energy for All Initiative: providing universal access to modern energy, doubling the share of renewable energy in the global energy mix, and doubling the rate of improvement in energy efficiency – all by 2030.

The report tells us that 1.2 billion people – almost equal to the population of India – don't have access to electricity, and that 2.8 billion rely on wood or other biomass for household fuel. Those solid household fuels produce health-damaging indoor pollution that contributes to about four million premature deaths a year, most of them women and children. The report also tells us that most of the people still without access live in 20 countries in developing Asia and Sub-Saharan Africa, and that about 80 percent of them live in rural areas.

How quickly is energy access expanding?

Although 1.8 billion people obtained connections to electricity between 1990 and 2010, the rate was only slightly ahead of the population growth of 1.6 billion over the same period. Electricity expansion growth will have to double to meet the 100 per cent access target by 2030. Getting there will require an additional US$45 billion invested in access every year, five times the current annual level. The carbon cost of such expansion, however, is low: to bring electricity to those without it would increase global carbon dioxide emissions by less than one per cent.

Sustainable Energy for All, a global coalition of governments, the private sector, civil society, and international organisations, aims to achieve this while also doubling the amount of renewable energy in the global energy mix from its current share of 18 percent to 36 per cent by 2030. The initiative also seeks to double the rate of improvement in energy efficiency. SE4ALL was launched in 2011 by United Nations Secretary-General Ban Ki-moon, who now chairs its advisory board with World Bank Group President Jim Yong Kim.

The Global Tracking Framework is a milestone in this effort, according to World Bank Vice President for Sustainable Development Rachel Kyte, a member of the Sustainable Energy for All Initiative's executive committee. "It provides baseline information on where we are in the journey toward meeting global energy goals," she adds. "Everyone will be able to measure their progress towards the baseline. And we know that's important, because what gets measured is what gets done."

Where can we make the biggest difference?

The report identifies high-impact countries that offer the most potential to make rapid progress:

- Twenty high-impact countries in Asia and Africa account for about two-thirds of all people without electricity access and three-quarters of those using solid household fuels.
- Another 20 high-impact countries account for 80 per cent of energy consumption and will need to lead the way on doubling the share of renewables to 36 per cent of the global energy mix and doubling improvement in energy efficiency.
- One example of high-impact progress is China: the world's most populous country is the largest consumer of energy, but it is also leading the world in expansion of renewable energy and the rate of improvement in energy efficiency.

The report concludes that decisive action is needed to achieve these goals, including fiscal, financial and economic policy incentives, phasing out fossil fuel subsidies, and pricing carbon.

The global community will also have to invest in energy improvements. The report estimates that existing investments in energy totaling about US$409 billion a year need to more than double to achieve the three goals. An additional US$600-800 billion is needed, the report says, including at least US$45 billion for electricity expansion, US$4.4 billion for modern cooking fuels, US$394 billion for energy efficiency, and US$174 billion for renewable energy.

The Global Tracking Framework also clarifies the likely pattern of efforts across geographical regions toward the achievement of the three objectives, based on their starting points, their potential for improvement, and their comparative advantage. For energy efficiency, the highest rates of improvement – about minus four per cent annually – are projected for Asia (particularly China) and the countries of the former Soviet Union. For renewable energy, Latin America and Sub-Saharan Africa (the latter owing to its strong reliance on traditional biomass) emerge as the regions projected to reach the highest share of renewable energy in 2030 – in excess of 50 per cent, while much of the rest of the world will be in the 20-40 per cent range. ❑

Energy efficiency: Going beyond the slogan

By François Moisan
Director of Strategy and Research, ADEME

For many years, energy efficiency has been considered as an option only for developed and rich countries as a way, first in the 1970s and 1980s to reduce oil dependency and then, since the 1990s, to contain CO_2 emissions. It was up to governments to introduce policies, and for industry it was just a rational choice to adapt to energy prices, among other factors.

The increase in energy demand at world level with the strong economic growth of merging economies has changed the perspective. On the supply side, long-term prices of fossil energies remain on a rising trend, even if some exceptions could be expected in some countries with shale gas resources. The amount of investment required for energy accessibility to 9 billion people is huge and competing with other priorities. Climate change issues are more and more a worldwide preoccupation, even if, at this stage, an international regime is still far from agreed. Nuclear and renewable energy could be part of the solution but the acceptance of the first and the cost of the second one must be seriously improved.

ADEME and WEC, with the support of ENERDATA, have been conducting for several years a "panorama" study on energy efficiency throughout the world, aimed at identifying trends in energy efficiency and policy practices. The 2013 edition is rich in lessons about this:

Since 1990, primary energy intensity decreased at the world level at the pace of 1.3 per cent per year on average. That means that if energy demand had grown at the same rhythm as economy we should have consumed 4.2 Gtoe more than we did in 2011 (one third higher). The decrease of final energy intensity was even more important, 1.6 per cent per year; the rapid increase in electricity consumption, still dominantly supplied by thermal power plants, explains the difference.

The increase of efficiency in energy use is observed in almost every region of the world, but at different paces. The overall result is strongly influenced by emerging economies, particularly China, whose energy intensity decreased by 7 per cent per year in the 1990s and by 3 per cent per year in the last decade. In the rest of the world, however, the decrease for the last two decades is around 1 per cent per year.

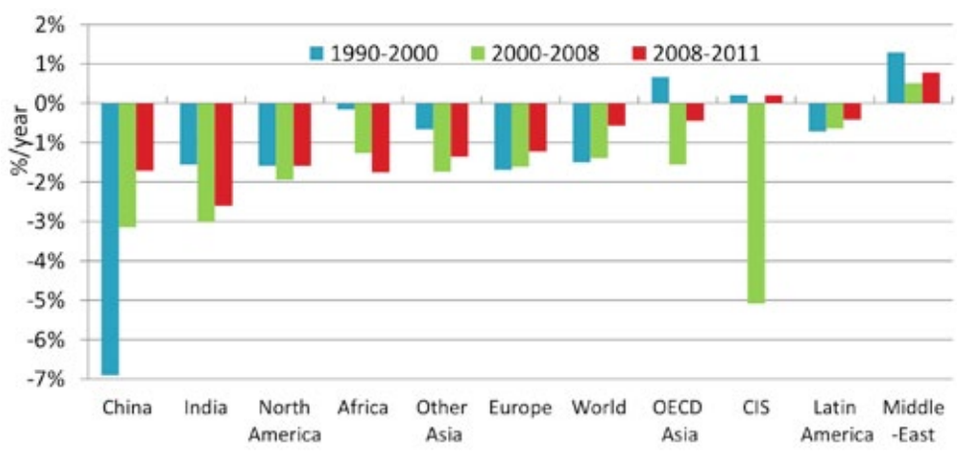
The energy intensity of world regions and main countries can be classified in three groups :

- Countries with the lowest energy intensity: Europe, Japan and Latin America
- Countries with an energy intensity 30 to 50 per cent higher than the previous group and around the world average: North America, India and other Asian countries (except China)
- Countries with a much higher energy intensity (double that of the first group: China, Africa and the Middle East) or even more higher (three times in the case of former Soviet or CIS states)

However, these discrepancies in primary energy intensity cannot be explained only by energy efficiency performance. The share of industry versus services in GDP and the energy mix in the electricity conversion explain another part of the difference. Energy intensity of industry has declined in every region of the world, except in the Middle East, and a convergence between all regions can be observed. The industrial specialisation of some countries explains the difference (with China, CIS and the Middle East having more heavy industry than the average).

The energy intensity of the transport sector (energy consumption of per unit of GDP) has declined in all parts of the world, by 10 per cent on average between 1990 and

Figure 1: Primary energy intensity trends by region



2011, more strongly in China and India where the transport energy consumption per GDP is lower than in OECD. The progress in cars' energy efficiency all around the world, except where the main market is second hand, as in Africa, the cost of motor fuel and the share of railway transport for several countries (India, China which multiplied by three the degree of rail travel per inhabitant between 1990 and 2011) explain this trend and these differences.

The residential sector presents the most important discrepancies. While the energy consumption per household decreased by 0.8 per cent per year on average at the world level in the last two decades, in OECD countries this is mainly due to the increase of performance of heating and cooling equipment, while in developing countries it is mainly due to substitution of traditional biomass by more efficient fuels. The global consumption of electrical equipment per household is growing everywhere - slower in the OECD region, where there is some saturation of demand and better efficiency of high-consuming appliances is observed, much stronger in emerging economies where more and more households have access to these appliances. There is still a huge discrepancy among countries regarding the unit consumption of electricity per household, even excluding electricity used for space-heating: 750 kWh/household/year in India, 1,300 in China, 3,500 in Europe, 5,000 in Japan and 10,000 in North America.

The study done by ADEME within the WEC programme on energy efficiency is not only related to the assessment of energy efficiency trends. It also addresses the policies conducted by governments in each country, through a survey covering 85 countries representing more than 95 per cent of world energy consumption.

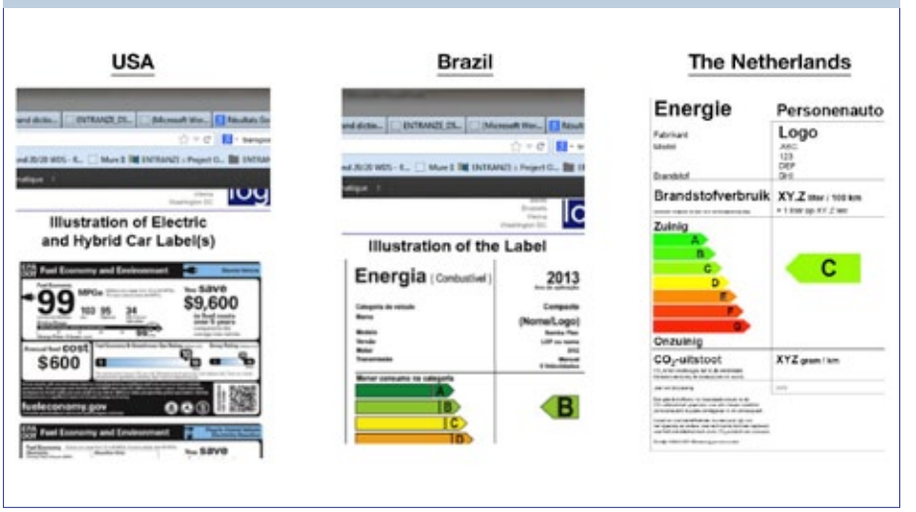
Energy efficiency is becoming a priority for all countries. Around 3-4 per cent of countries now have a dedicated institution (agency) to implement their national energy efficiency policies; while in 2006 only 40 per cent of countries had quantitative targets on energy efficiency; now, more than 80 per cent have such targets.

The main measures implemented by governments are far-reaching regulations but also financial mechanisms and fiscal measures (mainly in the OECD for this last category). Seventy per cent of countries surveyed adopted the ban on incandescent lamps.

Regulations such as minimum efficiency standards (MEPS), labels or mandatory audits remain the most important measures deployed by governments. The residential sector is also the main sector concerned by energy efficiency measures (more than 50 per cent, and close to 30 per cent in the services sector). Labeling and minimum efficiency standards are spreading in all regions and not only in the OECD as it was in the past. Seventy-one of the countries surveyed have an energy efficiency label policy (100 per cent in the OECD, 90 per cent in Asia, 50 per cent in Africa), which is mandatory in 87 per cent of them. Ninety per cent of surveyed countries have implemented at least one MEPS. Minimum Energy Efficiency Standards on lamps, appliances (refrigerators, washing machines and AC) and new constructions are implemented in 80 per cent of the surveyed countries. MEPS on vehicles and solar water heaters are less common.

Seventy per cent of the countries surveyed have implemented fiscal or financial measures (mainly direct subsidies for investments but more and more replaced by low-interest loans in OECD countries). Financial measures target mainly the building sector (40 per cent) while fiscal measures apply often for cars. In industry measures implemented are energy audits (subsidised or mandatory), financial or fiscal measures and some labels or MEPS (electrical motors).

Figure 2: Labels on cars in different countries



More than half of countries have implemented measures on cars, mainly regulations such as standards and labels, but also fiscal incentives (tax based on CO_2 emissions).

In the residential sector, the most common measure are regulations such as building codes. Seventy per cent of countries implement building codes for new buildings, which are mandatory in 90 per cent of these countries. Labelling of buildings is a new approach that has been implemented recently in European Union countries and is spreading to other regions such as Chile. MEPS aim to remove the least energy-efficient lighting (incandescent lamps), heating, ventilation and air conditioning products from the market.

For appliances the most common measure is labelling, with an increasing number of appliances labelled (e.g. nine in EU countries, more than 10 in Canada, China and Brazil, and to up to 19 in the US). Dynamic labelling is expanding, in the EU with new efficiency classes A+, A++ and A+++ or in Japan with the top runner programme, to account for the fact that most of the sold appliances are already in the most efficient class). Labelling is also a way to introduce MEPS.

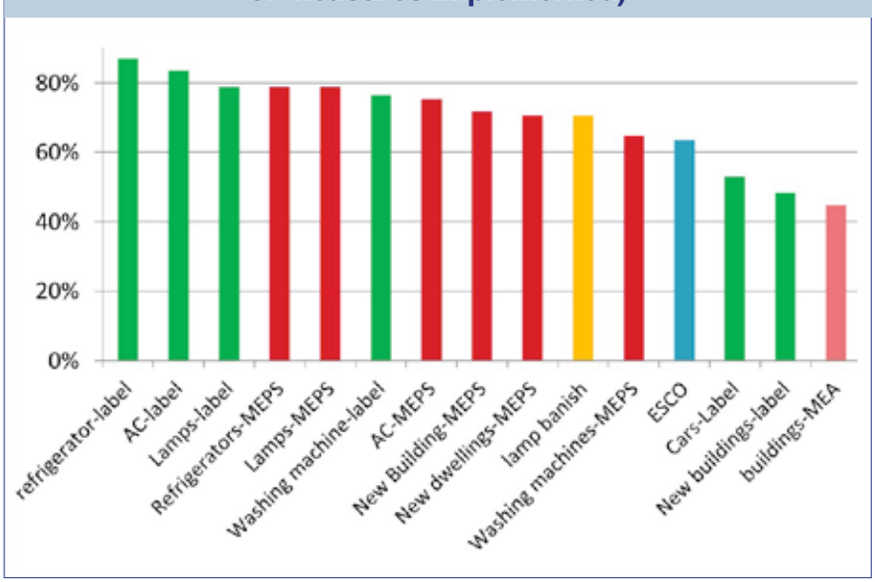
The frequency of regulatory measures implemented in the different countries increased by 30 per cent on average between 2009 and 2012.

Several issues should be raised in conclusion :

- Energy efficiency policies are spreading in all countries and several measures have proven to be relevant, such as regulation for equipment and buildings. Emerging countries took advantage of the experiences of OECD countries, which were the first movers in the 1970s. But the specificity of each country calls for new measures appropriate to the national context (such as second hand equipment).
- The pace of energy efficiency slowed down in the last decade, especially in developed countries, due to the fact that the easiest potential has been exploited and further innovative measures should be designed. This is the case in Europe for existing building refurbishment. Despite the proven cost-effective opportunity to reduce energy consumption in existing buildings, a significant proportion of the potential is not being realised. A key reason for this relates to the financing of energy efficiency. So far, energy efficiency has not been able to attract significant amounts of private capital. Financial obstacles include the initial cost barrier, high transaction costs, long payback time, risk exposure, the lack of knowledge among finance providers and the absence of standardised measurement and verification practices. In OECD countries and mainly in Europe several mechanisms are implemented.
- While energy efficiency policies were for several decades a task for governments, more and more energy producers are now involved. Energy efficiency is becoming a resource for utilities by varying the price of electricity. Instead of building new capacity it becomes more rational to incentivise consumers to avoid consumption at certain periods through dynamic pricing which is a new field of expansion for business.
- Governments are trying out innovative measures in order to reduce the public transaction cost of policies. They include energy efficiency obligations imposed on energy suppliers, and white certificate markets to introduce more flexibility in the achievement of energy efficiency targets.

Energy efficiency is no longer a political slogan, but rather an effective priority. The debate is not any more whether there is or is not “low-hanging fruit”, but how to climb into the trees to reach it. ❑

WEC top 15 of 2012 energy efficiency measures (frequency of measures implemented)



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Tomorrow's energy: Connecting possibilities

By Dr Michael Suess
CEO, Energy Sector, Siemens

Energy is one of the most important prerequisites for the development of every society. Prosperity and growth depend directly on the reliability of a country's infrastructure, above all its energy system. Of course, the situation differs from country to country and from region to region. While the demand for electricity in industrialised nations is expected to remain fairly constant over the medium term, the hunger for electricity in many developing and emerging countries is soaring. Around 1.2 billion people worldwide still have no access to a regular power supply.

In order to ensure reliable, economical and climate-friendly power supplies, numerous issues have to be clarified. And there can be conclusive answers only when the search for solutions extends beyond national and regional borders, and only when one thinks in the larger context. There certainly is enough potential for improvements, and the resources as well as the required technologies are already available for sustainably realising the vision of "electricity for everyone."

If you look at the great potential of energy systems in individual countries, regions and continents theoretically available from the respective resources, you quickly get the impression of a world with an excess of energy. And in fact, there are more than enough resources to provide reliable electricity supplies to all of mankind. The problem is, the established energy systems throughout the world developed slowly and organically – that is, largely unstructured – over the last one hundred years. The consequence is that today we have a worldwide power plant fleet that converts only slightly more than one-third of the consumed primary energy resources into electricity. In other words, in large parts of the world, power supplies are primarily generated with ageing and inefficient technologies. Moreover, the development and expansion of energy infrastructures in many countries simply cannot keep up with the soaring demand.

The World Energy Congress in Daegu offers Siemens a welcome opportunity to take a closer look at the energy situation in various countries and regions. Our goal is not to focus on ways to make minor improvements here and there, but to think in a larger context. What overall opportunities does each energy system offer? What kind of savings of resources and capital could be achieved with the major restructuring of a country's power plant fleet or a major change in its current energy development plans? In a study, Siemens developed scenarios for various countries and regions – and revealed theoretical potential with impressive results.

Impressive potential

In both core areas of an energy system – power generation and distribution – one can calculate scenarios that offer high savings potential depending on the respective situation in the country or region. At the moment, these ideal calculations are only theoretical, yet nonetheless technically feasible.

Take Europe as an example. In many countries of the European Union there are development plans for renewable energies, in particular wind and solar. Considerable possibilities for optimisation would be available if one focused on the choice of locations. Around 138 gigawatts of new photovoltaic capacity alone will be installed in Europe by 2030. If solar units are built in the sunniest locations, the higher yield of electricity – thanks to better geographic conditions – would save 39 gigawatts in solar units, yet produce the same yield. This principle also applies to wind power. If one calculates the right scenario, around 45 billion euros in investments could be saved by 2030 in developing the share of renewable energies. The additional power grid expansions required by this scenario is already taken into account in the calculation.

The example of the United States demonstrates the benefits that modernisation of the power grid offers. A scenario in the study calculates that consequential costs of up to US$80 billion from blackouts could be eliminated every year with a modern system. Not only would the country's supply security be improved, but the power grid would be far more efficient and power losses would be reduced by 2 percentage points to 4.5 percent. This would translate to annual savings of 85 terawatt-hours with a market value of US$4 billion.

In China, on the other hand, the biggest lever in the energy system lies in expanding the country's renewable energies. Water, wind and solar already account for a 19 per cent share of China's energy mix. The government plans to increase this share to 27 per cent by 2030. If one developed theoretically feasible potential, a renewables share of nearly 50 per cent could be reached in the same period. As a consequence, CO_2 emissions of China's power sector would remain at today's level. Considering the enormous growth rates for the country's power consumption, the great potential available here is obvious. Similar savings in emissions, however, could also be achieved – with far lower investments – if substantially more natural gas were used rather than coal for China's fossil power generation.

One need only highlight some of these scenarios to

show the enormous savings potential that is available for a sustainable, secure – and above all, economical – energy supply. But there are two prerequisites for implementing these scenarios.

The first prerequisite is reliable investment conditions. The basis here is always a legal framework that, on the one hand, sends the right signals to investors to develop the most viable energy mix on the basis of the respective resource situation. On the other hand, all regulations should allow the greatest possible freedom for unhindered competition, since the best technologies can prevail economically only in a market-oriented environment.

As long as the energy system involves individual countries, responsibility here lies in the hands of the respective government. The situation is different in a community of states. In the European Union, for example, sovereignty for most energy legislation does not lie with the European Parliament and Council of Ministers, but rather with national governments. As a result, it is ambitious to try to create an integrated energy market in Europe. Yet exactly such conditions are necessary for creating a market for the location-optimised development of renewable energies.

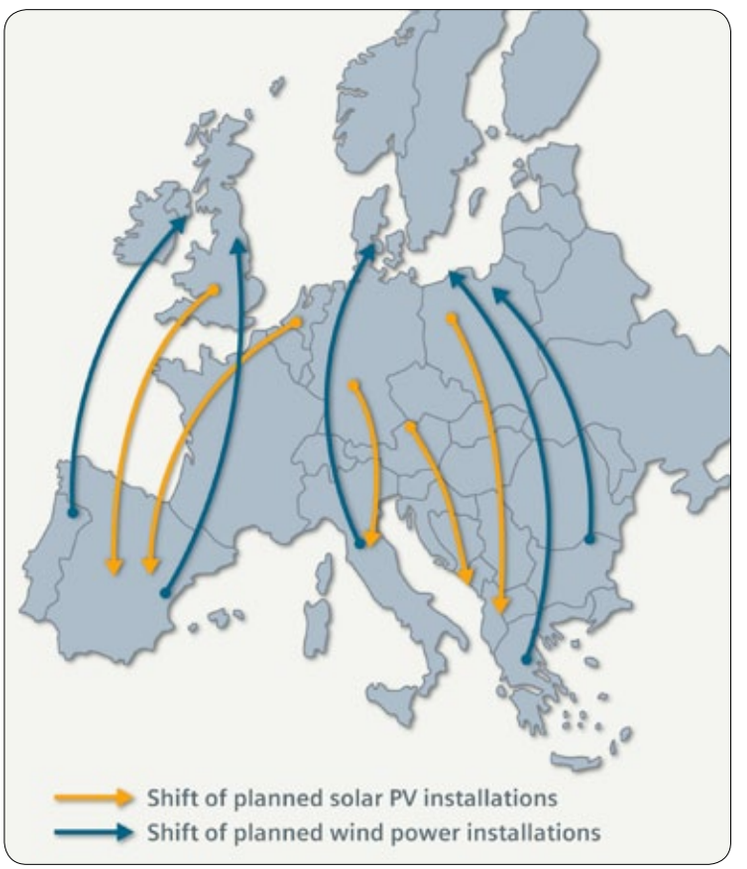
Atrractive investment conditions must also allow the commodity of electricity to physically change ownership. At present, this is often impossible due to varying technical conditions among the countries, and not only in Europe. In order to turn the vision "electricity for everyone" into reality, there has to be a power grid infrastructure that securely connects and integrates countries and regions. Only then can the available energy potential be used reciprocally in the grids as well.

The second prerequisite for achieving comprehensive improvements in energy systems throughout the world is an ongoing flow of innovations. Every type of improvement is based on technical advances, whether it be shifting the power generation mix to renewables or making fossil power generation fleets more efficient. Thirty years ago, wind turbines had a maximum capacity of 300 kilowatts; today they have reached 6 megawatts. Another example is the efficiency of gas-fired power plants. While fossil plant fleets (coal and gas) worldwide operate at an average efficiency of slightly above 30 per cent, the most modern combined cycle plant from Siemens has an efficiency of over 60 per cent.

Innovations, of course, are not only necessary for increasing the performance and efficiency of energy systems, but also for making industries – such as the manufacturing of technologies for renewable energies – more economical. While the auto industry has generally optimised all of its industrial processes, the shift to industrial production for renewable technologies – such as for wind power plants – is still underway.

If a good and effective market design provides an optimal framework for investment security, the best technologies will also be used. In the end, innovative technologies for greater efficiency pay off through better climate and environmental protection as well as greater economic efficiency. And ultimately this means greater prosperity for all. ❑

Optimising renewable potential by putting more solar projects in the south and wind in the north could save €45 billion in investment costs by 2030



Expertise and investment: A service company view

By Paal Kibsgaard
Chief Executive Officer, Schlumberger

With nearly five years now having passed since the start of the financial crisis, the global economic outlook is starting to offer some positive news as a more encouraging picture emerges within the OECD. In the US, growth is being driven by consumer spending although various fiscal factors are currently slowing momentum. In Europe, while the eurozone remains in recession, the risk of any particular country leaving the monetary union has significantly decreased. On the other hand, expectations of lower growth have risen in many of the developing economies. In China, for example, the latest data have been mixed, but the outlook for a long and progressive soft landing remains unchanged and among other emerging markets, the outlooks for India and Brazil remain soft in the short term before increasing late this year or early next.

Against this landscape, levels of supply and demand in the oil market this year are expected to be similar to 2012. Demand is forecast to increase by around 1 per cent, or approximately 900,000 bopd, driven by the non-OECD economies with China accounting for almost half of the net global year-on-year increase. On the supply side, the continuing surge in North American output from light tight oil will almost equal the increase in overall demand. We can therefore expect the oil market to remain tight, and this will continue to support oil prices more or less at current levels.

Within the natural gas markets, demand is expected to increase in all areas of the world driven by growth in the emerging countries, particularly in Asia, and by expanded use of gas for power generation in the OECD. Much of the supply response will come from North America, the former Soviet Union, China and the Pacific region.

Looking at production from unconventional reservoirs, North America will remain the centre of activity with liquids being the primary objective. Internationally, the short-term focus will mostly remain on pilot projects but activity and production will become more meaningful toward the end of the decade. Production from deepwater fields will also grow as successful recent exploration leads to new developments. Central to such operations will be the drive towards increased recovery through sophisticated subsea technology development.

Overall, upstream well-related capex and opex are expected to grow steadily, driven by exploration, new development and higher investment to offset mature production decline. In this environment, oil and gas operators are likely to intensify their plans on reducing finding, development and lifting costs. This should encourage closer partnerships with service companies to leverage the latters' technical expertise and allow faster technology adoption and integration.

Growth Opportunities

A number of geographical areas stand out in terms of growth opportunities in both the near and medium term. Within these, different service company investment strategies are required to adapt to particular market characteristics. In all cases, it is important to align global business models with local priorities, guided by engagement with stakeholders that include customers, regulators, government bodies, suppliers, professional organisations, universities and technical training schools. The objective must be to manage national content to comply with obligations, to strengthen individual business cases, and to achieve objectives in a sustainable manner.

Russia

Russia represents an area where growth is driven by maintaining oil production at current levels, supported in turn by incentives to stimulate E&P investment. Since our return to Russia in the early 1990s, we have invested in people, technology and infrastructure to be able to offer tailor-made services for the local market. Our operational footprint spans all the major oil and gas regions and we count almost 14,000 Russians among our workforce. In 2012, we opened state-of-the-art facilities in Sakhalin, Russia, and Aktau, Kazakhstan, to bring our total number of locations in the area to almost 140.

The key to success in the Russian oilfield market is the development of fit-for-purpose technology, whether on land in Siberia, offshore Sakhalin or in Arctic areas. As examples, we have recently begun offering customers a tailor-made ESP pump, designed and manufactured for the Russian market in the Tyumen Product Centre in Western Siberia. We have also developed new PDC bits designed to overcome specific challenges in Russia while a new fibre fracturing technology, which has already penetrated markets in 15 countries worldwide, was developed in our Novosibirsk product centre.

In addition to these engineering and manufacturing successes, we have also established a significant research programme in Russia, which is managed by our research

centre in Moscow. This centre, opened in 1998, now houses more than 100 researchers and capitalises on a collaborative academic network in Russia covering more than 40 projects and involving over 250 Russian scientists. The extent of this network is tremendous, offering as it does a significant extension to a worldwide effort.

China

In China, for example, activity growth is driven by a combination of maximising production from conventional resources, accelerating development of unconventional gas resources, and pursuing deepwater exploration and development. Schlumberger has been working in country since 1980 and today, we are supplying products and services from across our extensive technology portfolio from a total of 40 operating bases spread around the country. We have more than 4,500 employees in China, of whom 93 per cent are Chinese nationals. We also have more than 1,000 senior Chinese employees on international assignment throughout our global operations sharing expertise and gaining worldwide experience.

New technology is finding application in China within the domestic land market in response to growing technical complexity and increasing requirements to meet production targets as demand for oil and gas grows. And new business models are also proving successful. These include innovations such as the lease of land seismic systems and the introduction of proprietary service company fluid technology to be deployed through customer-operated hydraulic fracturing equipment. Our own R&D activity in China is led by a software engineering centre in Beijing, and last year we opened the Schlumberger China Petroleum Institute, which provides petrotechnical expertise for the exploration and development of both conventional and unconventional resources.

Saudi Arabia

Another important market, the Middle East, has played a central role in the E&P industry and for Schlumberger for more than 70 years. The largest operational area in the region is in Saudi Arabia, where activity is driven by the development of the country's large oil production base and by increasing domestic demand for natural gas. Onshore, the focus continues to be on conventional oil and gas developments and on the management of mature production. Natural gas exploration from unconventional resources has begun, but is currently limited to smaller pilot projects. Offshore, operations are steadily moving into deepwater basins following last

Schlumberger Integrated Operations team working on a shale gas well in the Erdos basin, ShaanXi Province, China

Central lab bay at the Schlumberger Dhahran Carbonate Research Centre showing different teams working to improve the evaluation of carbonate rocks in terms of porosity, permeability, mineralogy, saturation and recovery

year's gas discovery in the Red Sea.

Schlumberger has been operating in Saudi Arabia since 1941. In 2010 we opened one of our largest worldwide operational facilities in Al-Khobar. This together with facilities in Udhailiyah and Dhahran provides the strong infrastructure needed to service all the oil and gas fields in the country. In addition to ongoing operations involving most of our 16 product lines, we have owned a 49 per cent stake in the Arabian Drilling Company since 1971. This highly successful joint venture operates more than 20 high-performance drilling rigs in the Kingdom on a variety of projects both offshore and on land and shows further benefits of customer and service company partnership.

Saudi Arabia is also home to one of six Schlumberger research centres. The decision to open this centre in 2006 was based on the need to address regional technical challenges – such as carbonate reservoir understanding – as well as a desire to establish research facilities in locations closer to our customers. The centre is staffed by 28 scientists and engineers, including a growing number of Saudi nationals, and more than 100 patents have been filed since 2006.

Brazil

The last of the four areas I would like to mention is Brazil, where activity is driven by a focus on maintaining oil production in mature onshore and offshore fields along with the development of the huge deepwater pre-salt reserves that will make the production of the future. As in many other countries, Schlumberger has been present in Brazil for almost 70 years since we acquired the first electric log onshore Bahia in 1945. Almost all Schlumberger product lines are present supplying products and services from a wide footprint of operating facilities spread across the country. In response to customer demand, and in line with our commitment to R&D, we signed a landmark technology cooperation agreement in 2009, which led to the construction of the Brazil Research & GeoEngineering Centre on the campus of the Federal University of Rio de Janeiro. With an initial focus on reservoir characterisation studies in pre-salt carbonates, the scope of this new centre has since expanded to include integrated drilling and production enhancement projects as well as the emerging technical challenges of unconventional reservoirs.

New technology continues to play an important role in deepwater exploration and development in Brazil. In reservoir characterisation, new formation dynamics tester systems with three-dimensional probes have enabled recovery of higher quality reservoir samples while reducing rig time. In drilling, deep-reading resistivity measurements while drilling have enabled optimised reservoir contact and eliminated unnecessary costly pilot holes. In production, new offshore treatment vessels, the largest in the world, have established new standards for operational quality in the matrix stimulation of horizontal wells in presalt carbonate reservoirs.

These examples have shown what can be achieved when global business models are combined with local and national priorities. Continuous investment in expanding regional markets enables sustained long-term growth while the development of closer partnerships between customer and service company leads to mutual benefit and value generation. Through more collaborative technical problem solving, customers can better utilise complementary expertise and further leverage a wide technology portfolio, integration capability and global footprint. The result is improved reservoir performance. ❑

From climate offender to raw material

By Tony van Osselaer
Head of Industrial Operations, Bayer MaterialScience

Global CO_2 emissions are rising rather than falling. Steps taken to date to curb emissions clearly have been inadequate. A contribution could be made by the chemical industry, however, by using carbon dioxide as a new building block for key plastics. Doing so would both conserve fossil resources and help the climate.

The latest figures are alarming. Despite all efforts, energy-related CO_2 emissions increased worldwide in 2012 by 1.4 per cent to the record mark of 31.6 billion metric tons. And in May 2013, the carbon dioxide concentration in the atmosphere reached a new level for the first time in hundreds of thousands of years. It is now at over 400 parts per million.

According to the International Energy Agency, if we continue in this way, we will not succeed in limiting global warming to two per cent in the long term. In other words, additional efforts are urgently needed to stem CO_2 emissions. But that is easier said than done, as the current dispute in the European Union surrounding the surplus of pollution rights shows.

On the other hand, the EU, in particular, has set very ambitious targets. By mid-century, emissions there are to be reduced by at least 80 per cent, and the ecological restructuring of our industrial society into a low carbon society is to be far advanced.

Chemical industry offers solutions

Besides certificate trading, the main instrument the Europeans are using to get there is greater efficiency. Managing energy and fossil fuels more efficiently is the second most important means for protecting the climate. The chemical industry can do a number of things to contribute in this context. For instance, the industry in Germany today uses only half as much energy for the same product as it did two decades ago.

And new opportunities for improvement are being discovered all the time. Chlorine, for example, can now be produced with one-third less electricity using a new technology developed by Bayer and Thyssen. If this technology were used throughout Germany, it would reduce the country's total electricity consumption by one per cent. These examples illustrate just how much potential still exists for improving energy efficiency. Potential we must exploit, because the best solution undoubtedly is to conserve resources and avoid releasing greenhouse gas in the first place.

Another idea is to separate CO_2 at its source, such as a power plant, and to store it geologically long-term – Carbon Capture and Storage (CCS) is the technical term for this process. However, separation causes efficiency losses during power generation. What is more, there is still some uncertainty as to the capacities and safety of CO_2 sequestration, and in many locations such projects have met with resistance from local residents.

CO_2 as a supplier of carbon

But we can do more with carbon dioxide than just bury it underground, because the gas contains something quite valuable: the element carbon, the foundation of all life. The chemist and writer Primo Levi recognised this fact years ago: "Man has never tried to extract from carbon dioxide the carbon he needs to feed, clothe and warm himself," the Italian noted in his 1975 book The Periodic Table. "He has not done so because he has not needed to. But for how many more decades?"

Today this question can be answered. Some 40 years later, we have reached the point where the CO_2 produced

New process: At this pilot plant in Leverkusen, Bayer produces a key chemical intermediate with the help of CO_2

by man can no longer be viewed merely as something useless and harmful. On the contrary, this climate gas can be put to good use, for instance as a new raw material for the manufacture of high-grade plastics.

Carbon Capture and Usage (CCU) is the name of this third method, which several chemical companies worldwide already are pursuing, including Bayer. The public sector likewise is pinning its hopes on this option and funding related projects. The German government, for example, has set aside a total of 100 million euros for this purpose, and its investment apparently is a good one. German Minister of Research Johanna Wanka stressed in spring 2013 that "impressive progress" has been made in the field.

Of course, we basically have been using carbon dioxide for a long time. As an industrial gas, CO_2 provides the carbonic acid in sparkling water, can be found in fire extinguishers and also serves as a coolant. In addition, it is traditionally used as a synthesis building block in chemical reactions to make products such as fertilisers and drugs.

Substitute for petroleum

But now there is a new and promising possibility: to also manufacture plastics using carbon dioxide. Plastics in the past were based primarily on petrochemical raw materials, meaning ultimately petroleum. However, unlike CO_2, this important carbon source has only limited availability, and its price is constantly rising. Furthermore, processing petroleum into chemical precursors consumes a tremendous amount of energy, meaning it releases CO_2.

Using carbon dioxide to manufacture plastics thus benefits the environment in two ways. First, CO_2 emissions are avoided from the outset by partially eliminating the use of oil as a raw material. Second, CO_2 that would otherwise escape into the atmosphere is captured and bound in chemicals.

Naturally, this alone cannot save the climate. The demand for CO_2 for plastics and other chemical products is much too low. It is estimated at 180 million metric tons a year, which would be equivalent to 0.6 per cent of current global carbon dioxide emissions. However, a number of small steps together can add up to a great leap in progress.

The Dream Production project is an undertaking of this kind, in which the German power company RWE, the University of Aachen and its associated CAT Catalytic Center have joined forces under the leadership of Bayer. They have developed a process for manufacturing polyurethane foam using carbon dioxide from the energy industry. Polyurethane foam is a ubiquitous material in our everyday lives, used, for example, in mattresses, shoe soles and auto parts, or for insulating homes and refrigerators against heat and cold.

New raw material: The petroleum in these foam samples has been replaced in part by captured carbon dioxide from the energy industry

Products made from polyurethane promote sustainability in many ways. For instance, insulating panels made of the material can help to save 70 times more energy during their service life than is required for their manufacture.

Pilot plant in Leverkusen

With CO_2 as a raw material, polyurethane now also boasts a highly sustainable manufacturing process, which Bayer has been testing since early 2011 in a pilot plant at its company headquarters in Leverkusen, western Germany. The facility produces an important polyurethane precursor called polyol, initially for test purposes.

What is new is its chemical composition. The chemical no longer comprises only petroleum derivatives, rather it now contains

a double-digit percentage of carbon dioxide. The CO_2 originates from a lignite-fired power plant operated by RWE near Cologne, where it is scrubbed from the flue gas and liquefied.

From the novel polyol, Bayer then manufactures polyurethane samples. The quality of these foams is just as high as that of the conventional material; the carbon dioxide remains bound in the substance even at high temperatures.

But why has the industry waited so long to go this route, which Primo Levi and others already recognised decades ago? The reason was a seemingly insurmountable problem: the natural inertness of carbon dioxide. Forcing this gas to enter into a chemical bond normally requires a high energy input, which in turn generates CO_2 emissions. It was quite a dilemma — until now, that is.

Extensive tests: Bayer researcher Dr Christoph Gürtler with a foam sample made from CO_2

Catalysis makes the difference

The answer was a special catalyst, discovered by Bayer researchers and developed together with partners at the CAT Catalytic Center. Only with this "chemical matchmaker" does the CO_2 reaction run efficiently. The new process is ecologically effective, as verified by an analysis conducted by RWTH Aachen University, because in the end it releases not more, but less CO_2, also compared with traditional production processes.

CO_2-based foams are to be introduced to the market as from 2015. Developers have their eyes on mattresses as the first end product. This and other industries have already signaled great interest in such applications.

But more ideas exist as well, such as coupling CO_2 with renewable energies. This is the object of a research project called CO2RRECT, which includes 10 partners in industry and academia headed by Bayer and likewise receives public funding. In this case, excess wind power is used to produce hydrogen by means of electrolysis, enabling the otherwise short-lived electricity to be stored quasi chemically.

Doubly sustainable

The energy is "released" when the ecologically produced hydrogen is put to use. This is where the carbon dioxide comes in. If the two are combined, they produce important chemical intermediates – once again for polyurethanes or the high-performance plastic polycarbonate. This makes a twofold contribution to sustainability.

However, the process could be useful beyond the chemical industry. For example, it could help countries like Germany to succeed in restructuring their energy systems by offering new options for storing fluctuating renewable energies, excess quantities of which so far are sent to pumped storage plants or underground cavities.

But it will take many years to reach this point. Bayer's vision also must be seen in the long term: eco-friendly plastics containing virtually no petroleum. For which mostly alternative sources are used. Bio-based fuels, for instance – and of course carbon dioxide, which is well on its way to assuming a new role as something useful and no longer merely a burden on the climate. ❑

Give us energy policy, not politics in energy

By Philippe Joubert
Executive Chair, Global Electricity Initiative

Our modern society could not exist without a reliable and affordable supply of electricity. It has taken over two hundred years to develop electricity supply infrastructure into its modern form. This development has brought about an unprecedented surge in the historical evolution of mankind. Electricity has become one of the most essential components of our basic human needs.

Demand for electricity continues to rise around the world, and it is expected to continue growing for decades to come. Even in many mature economies where every citizen has access to electricity, demand growth outpaces the growth in GDP, as the majority of new technologies and modern devices coming to market need electricity.

At the same time, approximately 1.2 billion people in the world, or roughly a sixth of the total population, do not have access to electricity. The majority of these people live in rural areas of developing countries, far from transmission networks. In addition, another billion people living in the poor suburbs of large cities in developing countries do not have any or reliable electricity supplies. These figures, plus the future growth in demand coming from the increase in the world population, will present significant challenge for the producers of electricity.

Moreover, the complexity of the situation is aggravated further by the increasing number of new regulations, requirements and constraints which are being introduced around the world, mostly in the environmental field or in the acceptance of new technology.

The pressure on the utilities to supply electricity at the lowest cost possible is also growing, as electricity prices play a fundamental role in the competitiveness of national economies.

Increasing emissions and climate change

Today human influence on earth's rising temperature is no longer a subject for debate, as the world is already witnessing consequences of temperature rises due to the exponential increase of CO_2 concentration in the atmosphere. If nothing different is done, emissions will go on rising; even the recent economic crisis, followed by a sluggish economic growth in many countries, has only marginally decreased the overall emission levels.

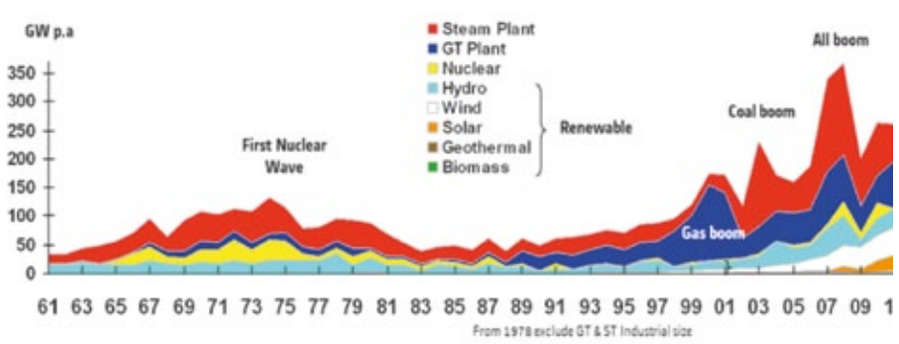
Electricity production and heat generation together account for roughly 40 per cent of global CO_2 emissions, according to the International Energy Agency. In 2011, global energy-related CO_2 emissions increased by 3.2 per cent, which is a higher rate than the average annual increase of 2.5 per cent recorded over the last ten years. In the same year, also total global emissions reached a record high of 31.2Gt CO_2.

A significant share of the growth in emissions over the last two decades can be attributed to the expanding use of coal mainly in China and India, but not only there. Other countries, for example Germany, Eastern European and East Asian economies, are also heavily relying on cheap coal. In 2012, coal accounted for the bulk (71 per cent) of additional global CO_2 emissions followed by oil (17 per cent) and natural gas (12 per cent).

Even more worrying is the prospect of new capacity additions in the next few years. More than 1.4 million MW of coal-fired capacity based on 1,200 new coal-fired power plants in 59 countries could potentially be built. China and India could build more than 500,000 MW each. These are impressive numbers, and even if only a part of these projects is completed, this would represent a massive increase in emissions.

Because of the important role the energy systems and electricity sector are playing, both for the economic and social development and for the environment, electricity utilities are

Power plants in GW p.a. and by fuel in the last 50 years



Source: Alstom

faced with an increasing number of challenges, often with conflicting priorities. The industry landscape is also showing increasing uncertainties. Competition, technological advancement, stakeholder expectations, financing and investment decisions in evolving regulatory contexts are just a few of the issues that are being dealt with, apart from climate change. Utility CEOs often receive conflicting messages from regulators and from customers. Moreover signals from the financial markets do not leave much space for making true long-term, strategic business decisions.

The "raison d'être" of the electricity sector is to supply sustainable, affordable and safe electricity, with the lowest impact on the environment. The deployment of alternative, lower-carbon and carbon-free, climate-resilient technologies and more efficient processes in the use of electricity are already happening across the globe. Despite increasing uncertainties and the risk of stranded assets, significant investments have been made, and continue to be made, to reduce the climate impacts of the sector. But more can be done, above all faster and on a larger scale.

The Global Electricity Initiative

This is where the Global Electricity Initiative (GEI) comes in. Three of the largest industry-based sustainability networks in the world: the World Energy Council (WEC), the World Business Council for Sustainable Development (WBCSD) and the Global Sustainable Electricity Partnership (GSEP) have joined forces to facilitate and accelerate the transition to environmentally acceptable, economically affordable and universally available electricity. For the first time, leaders from the global electricity sector will share a worldwide forum and discuss their experiences, views and visions. The roots of WEC, which hosts the Secretary of GEI, can be traced back to 1923 when the leaders of the electricity industry held a conference in London to discuss and plan how to rebuild the European electricity supply infrastructure destroyed during the First World War. This was the beginning of the World Power Conference which over the years became the World Energy Council and the World Energy Congress.

The objective of the GEI is to identify and highlight a significant contribution that progressive electricity utilities are making to ensure a sustainable future with access to electricity for all people. GEI will showcase the early voluntary action taken at the operational level and record the progress made.

The GEI will use the collective expertise and experience of the participating utilities to magnify and expand worldwide the effort that is being made to achieve economically efficient and environmentally effective solutions to climate change and other sustainability goals, while responding to the increasing demand for electricity.

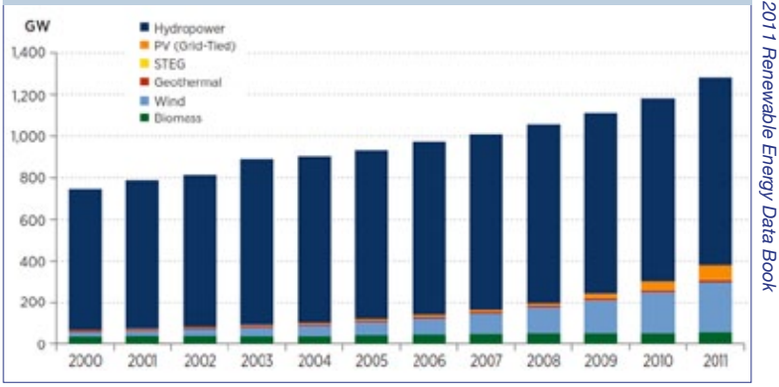
It is important to note that on the operational level progress is being made, regardless of the slowness of international negotiations and constantly changing operational framework conditions. The GEI will present its first key findings at the 22nd World Energy Congress in Daegu in October 2013.

Lower-carbon and carbon-free technologies

The path to clean power will have to go first through the currently available low-carbon technologies, including nuclear. Today, renewable energy is largely a domestic source of energy, although some proportion of biofuels and other bioenergy is traded internationally. When bioenergy displaces imported fuels, it contributes to greater national energy security and directly reduces import bills and thus improves the balance of payments. Energy often accounts for a significant percentage of GDP in many importing countries, and therefore minimising energy bills can produce sizeable benefits to the national economy.

In terms of technologies, as the graph below shows, hydro is still the largest provider of renewables, despite steady growth of wind.

Renewable Power



Source: U.S. Department of Energy 2011 Renewable Energy Data Book

A General Electric employee assembles a component for a gas turbine at the company's factory in Belfort, France

After using all the potential non CO_2 technologies, then the systems will have to capitalise on all possible efficiency gains.

These gains, plus the use of renewable energy, will still not be sufficient to ensure an adequate response to the demand generated by economic and social development needs.

Conventional power plants will still be required, and they will be carrying the brunt of the load for decades. State-of-the art technologies such as combined-cycle gas turbines and efficient coal plants are expected to continue coming online in large numbers. This is why Carbon Capture Storage/Carbon Capture Use and Storage technologies are now recognised as one of the solutions by most observers, as they allow fossil-fired plants to provide baseload electricity with practically no emissions.

As in the past, all the technologies will be used in the future to generate power. In this area there is no "silver bullet" solution.

The choice of the best solution is neither obvious, nor easy. In many countries, governments have not yet laid down legal conditions and regulations that would allow businesses to make the sound and sustainable long-term decisions needed to develop and scale-up possible solutions. The real cost of electricity generation and distribution is still often hidden behind subsidies, unrealistic carbon prices and schemes distorting market pricing.

In the last ten years, utilities around the world both in developed and developing countries have developed innovative solutions. More cost-effective lower-carbon and carbon-free technologies are now available and they allow utilities secure supply whilst addressing carbon emissions. The industry could achieve much more if there were stable regulatory conditions and realistic and transparent pricing system.

Similar to the first Power Conference in 1923, which united the industry to deal efficiently and timely with the post-war crisis in the electricity sector, GEI aims to bring together today's Global Industry Leaders and help communicate a sense of urgency and the need for action now to face the Trilemma issues. This means providing reliable electricity safely and at an affordable cost while respecting environmental constraints.

It is time to bring in realistic enegry policies and remove politics from energy. Join us in building the first global electricity industry leaders' community! ❑

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THE NATIONAL GAS COMPANY OF TRINIDAD AND TOBAGO LIMITED

The cooperative quest to provide Universal electricity access

By Jim Rogers
Chairman, Duke Energy

"This thing will bring us opportunity," the woman said, pointing a finger toward a concrete bunker in the river on the horizon. She held a tightly swaddled baby. Both of their cheeks were pink from the brisk wind that scraped across the Andes in the remote village of Cochico, Argentina.

The woman and I had arrived at the river that day for the same reason, to dedicate the community's first electric power plant. But our journeys could not have been further apart. I couldn't help but think that this distance – a giant gulf of mobility and opportunity that separated that woman's life experience from mine – might be made narrower for her children by the electricity that will flow off that river.

This year marked my twenty-fifth and final year as the CEO of a publicly traded utility. The driving mission of my career has been to move our industry in the US toward a cleaner future without compromising economic growth. Reliable, affordable, and clean electricity is a tough challenge, and one to which many talented people in the private, public, and nonprofit sectors have dedicated their lives work.

An equally massive challenge – and opportunity – exists in the parts of the world without electricity access. According to the United Nations, more than 1.3 billion people live without access to electricity.

The vast majority of these people live in rural areas that are not connected to an electric grid. I intend to focus the next chapter of my career on finding creative, public and private solutions to electrify these parts of the world.

I am approaching this work as a student. No one has cracked the code on how to create universal access to electricity in a cost effective way, and each country has its own unique characteristics that must be understood and respected.

Nevertheless, there is a valuable perspective that utilities in developed markets can bring to developing nations. That is why Duke Energy helped lead the effort to build a micro hydro plant in Cochico as one of the energy access projects of the Global Sustainable Electricity Partnership (GSEP). It is also why GSEP, a consortium of 13 of the world's largest utilities, is working to create a fund to catalyse new sustainable energy investment.

I had the privilege of serving as the GSEP chairman over the last year, when we completed the micro hydro plant in Cochico. That experience motivated our fellow GSEP utilities to ask a larger question of what we could do on a global scale to advance universal electricity access.

While our Cochico project was financed philanthropically with grants, the experience deepened our appreciation for the importance of finding viable commercial solutions. I believe that a substantial degree of private investment is the only way to motivate the scale of development and construction that is necessary to provide power to 1.3 billion people.

Children at the dedication of the Cochico micro hydro plant

GSEP is exploring ways to create a catalyst fund to help bridge the gap in public and private markets to fund distributed and grid-tied electricity infrastructure projects in developing countries. Each participating GSEP utility could provide capital and technical advisory support to the fund, which will seek additional capital and insurance from multinational institutions such as the World Bank.

A catalyst fund under such a structure could provide capital that is more patient than traditional private sector infrastructure funds, which are not present in many of these emerging markets. GSEP utilities might work with host nation utilities and developers to help build

their capacity. The fund may invest opportunistically in both innovative businesses and more traditional project development. We do not have all the answers. We need and welcome input to help shape this effort.

One thing is certain: we must be pragmatic. Efforts to spur energy infrastructure investment in impoverished nations have occurred with limited success throughout my career. I believe the opportunity to establish such a fund can work now for three reasons: cost reductions, technological advancement, and economic growth.

GSEP Executive Director Martin Provost, Duke Energy Chairman and CEO Jim Rogers, Neuquén Province Governor Jorge Sapag and team at the Dedication Ceremony

On the cost side, the rapid decline in the price of wind and solar construction in the past five years has been a surprise to many industry veterans. The cost of solar modules and wind turbines dropped a staggering 80 per cent and 29 per cent, respectively, in the past five years.

At their prevailing cost, wind and solar can compete with traditional generation sources in many economies, particularly nations with grids that are strong enough to support intermittent power, and where the levelised cost of electricity is above 20 cents a kilowatt hour. That price is about twice the average cost of electricity in the United States.

Turning to technology, cost declines have been even more precipitous with recent advances in battery technology. Battery technology is the "holy grail" for universal energy access because there are many geographies such as Cochico where it may never be cost effective to extend the national grid. At Duke Energy, we are running seven advanced utility-scale battery demonstrations, including one in Texas with the largest grid-connected battery in the United States. Advances in cellular technology are equally significant for improving energy access. The World Bank estimates that 75 per cent of the world's population has access to a cell phone.

Emerging business models in sub-Saharan Africa are enabling mobile payments for household distributed generation. This development helps address the key challenge of ensuring payment for services in developing countries. I believe the pace of technological development for distributed generation will advance far beyond conventional expectations, particularly when catalysed by funds such as the one GSEP is considering.

Lastly, consider where the majority of economic growth is likely to occur in the 21st century. It is not likely to be in mature, developed economies. The preponderance of growth will likely occur in often resource-abundant developing nations. Fortunately for the world's poor, it has already started. This year the World Bank assessed the economic growth rate of developing nations at 5.4 per cent.

A challenge is that just as electricity access enables economic growth, prosperity enables additional investment in power infrastructure. In the business community in the US, we often refer to this dilemma as a "chicken or the egg" problem. It is a reference to the ancient parable that questioned what arrived first: the chicken or the egg? Economic development or energy infrastructure?

The chicken or the egg question may never be solved. I believe our energy question, however, has an answer. Energy access is a precursor to economic growth. We need more patient capital, more technological advancement, more replicable business models, and more bold thinking and doing to create that access.

The woman in Cochico was right. Electricity brings opportunities. We are gathered here in Korea for the World Energy Congress. We are all students. Surely we can solve this. What can you do? What can we do together? ❑

Shale Gas: Will it ever become a global success story?

By Elena Nekhaev
Director of Programmes, World Energy Council

The energy sector has gone through significant changes during the past few years. One of the major consequences of these changes is the increased instability and uncertainty about the future. If a few years ago, the main concern was "peak oil" and the assumed insufficiency of energy resources in the long term, today it is rather the increasing number of technological choices and the difficulties in picking the right solution. The increasing number of national and international regulations and treaties makes the choices even more complicated. This is not to forget the currently estimated 1.2 billion people around the world who still lack access to commercial energy, despite the easing pressures on energy resources due to new discoveries, resource reassessments and improving efficiencies. The rapidly growing demand for energy all over the world clearly indicates that all technologies and fuels are needed to meet this demand, be it coal, oil, nuclear, hydro and other renewables or shale gas. As it happens, shale gas can also help secure further deployment of wind power, as gas is often used to back up wind capacity when the wind is not blowing.

The recent revolution in the energy sector which began in the United States and was caused by the development and wide deployment of fracking technology used to extract shale gas, produced spectacular results in terms of price reductions of natural gas prices. It has changed business models, project financing schemes and the mindsets of top executives all over the world. Many countries have begun prospecting and exploratory activities looking for gas shales, and many of them have found significant resources which could change the structure and performance of their energy industries. However, more often than not they have also found unexpected hostility from the population concerned about potential – though unconfirmed – threats to the environment or safety in producing areas. It is worth noting that in the US the main shale gas activities are taking place in sparsely populated areas, and have so far not lead to significant public protests. The situation is totally different in many European countries which have gas shale potential but are also densely populated with a fairly well-informed citizenry.

Energy is one of the most essential social and economic needs. Therefore, any developments in the energy sector should be taken seriously, as most of them have a wider economic and social impact. To build the wind turbine several hundred tonnes of steel and concrete are needed. This will help keep the domestic industries going. Shale gas can provide several economic benefits. It is going to create a lot of jobs, boost tax revenues and relax the dependence on gas imports. In addition, the availability of shale gas will depress gas prices. Even if it has no major impact on prices it will still bring benefits to tax revenues, jobs and the balance of payments.

Shale gas resource base and current developments

It is believed that the shale gas resource base is both large and wide-spread around the world. However, the resource has not yet been quantified on a national level in the majority of countries. The most credible studies put the global shale gas resource endowment at about 16,110 trillion cubic feet (tcf) or 456 trillion cubic metres (tcm). It is assumed that nearly 40 per cent of this endowment would be eventually recoverable. The US and the CIS countries of the former Soviet Union together account for over 60 per cent of the total estimate. European reserves, on the other hand, are not very impressive at slightly over 7 per cent of the global reserves, and China and India on current estimates hardly reach a 2 per cent share each.

It should be emphasised that these are best estimates available today and they can change significantly when proper assessments will be performed. The US provides an enlightening case study. In 2007, US shale gas resource base was estimated at 21.7 tcf, and only a year later it jumped up to 32.8 tcf. At the end of 2008, shale gas accounted for 13.4 per cent of US proved reserves of natural gas, compared with 9.1 per cent at the end of 2007.

How does fracking work? The process combines horizontal drilling with hydraulic fracturing. In this procedure, a well is sunk to a depth somewhat less than that of a known shale gas deposit and then gradually deviated until the drill-bit is running horizontally through the shale bed. Once drilling has been completed, the rock surrounding the horizontal bore is perforated in a number of places and artificial fracturing induced by the high-pressure injection of water combined with special additives and sand – called a proppant – to keep the fracture open.

Pad drilling is another emerging technology, where multiple wells are drilled and completed from a single location. This minimises the need for roads and reduces the overall footprint of production, especially important in populated areas or farmland and other environmentally sensitive areas. It also allows for a higher level of sophistication in material handling.

Economics and markets

At present, only a few dozen gas shales have properly assessed production potentials, and most of those are in North America. The initial capital investment requirement related to exploitation of shale gas is significant. In addition, considerable investment is required for processing, transport and distribution of shale gas. Nevertheless, even if capital costs may be significant, shale formations may still be worth exploiting for both financial and strategic reasons.

Large international oil companies (IOCs) seem to believe in the long-term economics of shale gas, as ExxonMobil, Total, Shell, CNPC, Reliance Industries and others have acquired significant stakes in shale gas resources in North America. These acquisitions, which will require further investments over a period of several years, demonstrate the value the oil industry places on the future of shale gas. The increasing participation of oil majors in North American shale gas exploitation brings positive implications for the use of best practices and technologies in drilling and processing, which will make the exploitation of shale gas cleaner (poor casing practices by small exploration companies has been the cause of much of the challenging environmental issues). Furthermore, the IOCs will most likely lead exploration activities worldwide.

While work on shale gas has, to date, been very largely concentrated in North America, and especially the US, other parts of the world are now following suit, and preliminary resource assessments are being conducted in a number of countries and regions.

What the overall assessment demonstrates

The emergence of shale gas as a potentially major source of energy has been accompanied by a flurry of publicity, both for and against further development of shale gas. The identified benefits of shale gas include:

- Potentially enormous resource base;
- Lower carbon emissions than from other fossil fuels;
- Applicability of the technology throughout the world;
- Improved diversity and security of supply for gas-importing countries;
- Extension of production in some existing gas fields and opening-up of new fields.

On the other hand, the drawbacks include:

- Uncertainty over costs and affordability;
- Questions about the environmental acceptability of the technology;
- Poor reporting of decline rates;
- Potential shortages of equipment;
- Local opposition to shale gas development.

Shale gas will not dramatically change the energy sector of any country, as it is only one of the components in the complicated structure of national energy value chains. But it is certainly a significant factor which should be properly assessed in the development of national energy policies. ❑

A well drilling rig works in the eastern plains of Colorado to reach the Niobrara Shale formation

The role of oil and gas in promoting development

By Renato Bertani
President, World Petroleum Council

For several past millennia, civilisation derived its energy mostly from wood and from human and animal labour. With the advent of the industrial revolution, growth of the global population and higher per capita consumption of goods and services, new sources of energy were required at unprecedented pace and scale.

The solution rested on the abundance of fossil fuels, plentiful around the globe, which have been stored by nature in geologic strata for many millions of years. Initially based mostly on coal and, from the middle of the 1900s, increasingly on oil and natural gas, fossil fuels currently account for more than 80 per cent of the global primary energy supply.

150 Years of energy delivery

The petroleum industry has so far been able to find and develop both the oil and natural gas resources that, except for brief disruptions caused by natural disasters or political unrest, met the market demands in an affordable and reliable manner. Furthermore, in spite of increasing demand and production, annual reserve additions have consistently been above depletion, thus resulting in a steady growth of the world's reserve base of both oil and natural gas.

The world oil reserves, according the latest BP Statistical Review, reached 1.65 trillion barrels at the end of 2011. It is important to notice that this now includes substantial volumes of extra heavy oils from Venezuela and Canada, which are now deemed technically and economically recoverable due to technological developments and the current oil price level. Other important new oil plays, like the pre-salt offshore Brazil and, more recently Angola, and shale and other ultra-low permeability oil reservoirs, will certainly add significant volumes to the global oil reserve base in the near future.

Even though the historic data are not very precise, it is estimated that the world consumed its first trillion barrels of oil (tnbo) the year of 2000. At that time the remaining reserves were assessed at 1.25 tnbo, with estimated remaining total resources to be discovered and developed of another 1 tnbo. Remakably, just over a decade later the world consumed an additional 0.4 tnbo and yet total reserves grew by another 0.4 tnbo. Furthermore, the most recent estimates indicate that remaining resources of about 1.7 tnbo are still to be discovered and developed, not including the non-conventional hydrocarbon plays. Three main factors made this possible: new technologies in seismic, drilling and reservoir management, massive allocation of capital to exploration and development of new plays and, most importantly, innovative approaches to finding and developing oil resources in ever more complex geologic settings and harsher operational environments.

Natural gas evolved in a similar way. While the world consumption increased by a factor of 2.3 times in the last 30 years, in the same period natural gas reserves grew by a factor of 2.56, to a total of 7,360 trillion cubic feet (tcf) at the end of 2011. And this does not take into account the potential resources of undeveloped gas shales, which contain producible resources, according to some estimates, of over 6,000 tcf in the US only.

Future oil and natural gas supply challenges

Projecting future energy demand is a very complex exercise. Many factors influence consumption trends, among them population and economic growth, improving living standards and per capita consumption, regulatory requirements and technological developments. Nevertheless, projections prepared by various research entities coincide in two main conclusions: steady growth of energy demand and continuation of fossil fuels, particularly oil and natural gas, as the main components of the global energy matrix. The International Energy Agency, in its latest World Energy Outlook 2012, projects a 30 per cent increase in global energy demand from 2010 until 2035, with most of the consumption growth occurring in the developing countries.

Even though it has been demonstrated that the reserves and resources are available, bringing them on stream in order to meet future demand of oil and natural gas poses huge challenges, and opportunities.

In a recent study the Energy Information Administration of the US Department of Energy projected a steady growth of the consumption of liquid fuels reaching, in their base case, approximately 112 million barrels a day (mb/d) in 2040 with the most significant supply growth coming from non-OPEC countries. Non conventional liquids, including gas-to-liquids (GTL), coal-to-liquids (CTL) and biofuels, would still remain minor sources although steadily increasing as well.

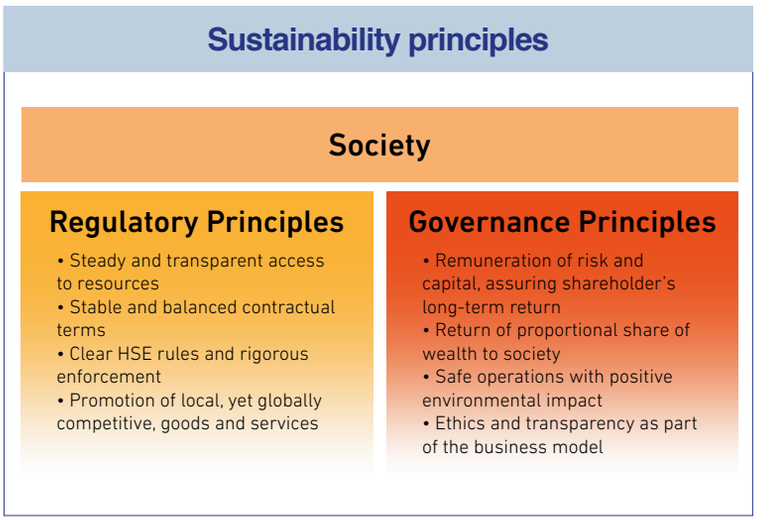
The main challenge is not only to meet the demand from incremental consumption but also to offset the inevitable decline of the currently producing reservoirs. Even at fairly conservative decline rates of 2-3.5 per cent per year the industry will have to bring on stream an additional 35 to 50 mb/d just to compensate for current reservoir depletion.

A significant amount of new liquid fuels production will

most certainly come from existing reservoirs through advanced oil recovery and reservoir management new technologies. Shale oil and natural gas liquids will also increase significantly with the expansion of the development of gas shales, particularly in the US.

There is no question that the oil reserves and potential resources are sufficient to meet the market demand for the next several decades. However, delivering sustainable production in the long term will demand huge sums of capital, constant technological advances and innovative approaches to exploration and development.

Natural gas demand is also expected to continue growing at a steady rate, particularly in developing countries. As in oil, reserves and resources are plentiful to meet the demand, but bringing additional production on stream will also require deployment of huge amounts of capital, innovation and technology.



Of particular relevance to natural gas developments is that they require huge investments in pipelines or in industrial Liquefied Natural Gas or GTL plants and, in the case of shale gas, enormous numbers of wells. And planning for such large and long term investments is extremely challenging in view of market and regulatory uncertainties. A good example of such uncertainties is the complete reversal of the supply/demand scenario that occurred in the USA in the short period of less than ten years where, with the advent of the shale gas revolution, the balance changed from a domestic market being significantly dependent on LNG and GTL imports to self sufficiency and most likely a net exporter.

Future sustainable supply of oil and natural gas

In the last 20 years, resource availability analyses have more or less oscillated between resource scarcity theories (the "peak oil" view) and the total substitution before resources are depleted (the "stone age ended before the end of the stones" view). In all probability, the long-term energy supply balance will be in between these extremes, with economic and environmental constraints dictating a gradual transition out of the fossil fuel era.

Meanwhile and for the foreseeable future, innovative approaches, new technological developments and huge capital allocations will continue ensuring the discovery, development and production of oil and natural gas to ensure the world's economic growth.

More than ever, though, the long-term sustainability of the petroleum industry requires that the objectives of all stakeholders involved should be balanced and satisfied.

From an holistic perspective the petroleum industry may be characterised as an economic activity where several stakeholders, including governments, regulators, oil and services companies and their shareholders, must achieve their goals while earning from society the right to perform their activities in the long term.

In order to earn such rights, certain key sustainability principles must be delivered by all those involved in a balanced and consistent way. Two main groups of sustainability principles can be identified:

- Regulatory Principles: a set of rules, practices and conditions which must be transparent, stable and rigorously enforced, applicable to all stakeholders involved in the industry, designed to promote a fair sharing of the wealth and the people's wellbeing;
- Governance Principles: a set of policies, practices and conditions which must be implemented by stakeholders while performing their activities, designed to maximise results while meeting the expectation of all stakeholders affected by the industry.

In conclusion, the petroleum industry has huge challenges to continue finding and developing new oil and natural gas reserves, in a profitable and sustainable way. In the long term these challenges represent just as big opportunities for those players that allocate their resources, capital and human, to the wellbeing of all of their stakeholders. ❑

Nuclear power in the aftermath of Fukushima

By Luis Echávarri
Director-General, OECD Nuclear Energy Agency

The 22nd WEC Congress, to be held this year in Daegu, Korea, is a great opportunity to highlight the evolution in the world's energy sector, to look at the aspirations of our societies and to analyse the challenges that lie ahead, while identifying solutions. This necessary stock-taking is very relevant for all energies, and particularly for nuclear energy, which provides around 16 per cent of world electricity supply and more than 20 per cent in the OECD countries.

The OECD Nuclear Energy Agency (NEA) has, for more than 50 years already, been helping its member countries that use or are planning to use nuclear power to identify through international co-operation the best practices in nuclear safety, protection of the environment and competitiveness, and is particularly involved in the analysis of these practices in the aftermath of the Fukushima Daiichi accident.

The use of electricity has always been associated with the social and economic development of societies, as it contributes to the welfare of present and future generations. Despite the impressive development of the use of electricity in the 20th century and the beginning of the 21st, well over one billion people still have very limited access to electricity, and understandably aspire to change that situation. We therefore need to be prepared to meet a continuous increase in electricity demand during this century, while at the same time protecting the environment from corresponding detrimental effects, especially climate change.

The first priority is, logically, an efficient use of electricity, rationalising consumption, followed by the development of those energy sources that do not emit greenhouse gases, which constitute one of the major threats to the planet's environment. Among these sources, nuclear power has historically been a very important contributor to both security of electricity supply, providing a baseload source of energy, and to reducing CO_2 emissions. In its role as a baseload source of energy, especially in the OECD countries where new hydropower projects are very limited, it is directly competing with coal and gas, which are both significant emitters of CO_2. In our efforts to move towards lower-carbon economies, one could see nuclear power playing an even more significant role in the production of electricity in the years to come. While feasible, it is important to first look at the challenges that lie ahead for this energy source.

Challenges associated with nuclear power

The first condition for maintaining and further developing nuclear power is social acceptance and support, along with the corresponding political support. Many societies, and foremost that of Japan, have been significantly impacted by the Fukushima Daiichi nuclear power plant accident. As is widely known, the accident did not have its origins in the plant itself, but was the consequence of a seismic event followed by a tsunami, both of unprecedented levels, that killed thousands of inhabitants. While the nuclear power plant accident did not have any significant physical health effects for the population, it has disrupted the lives of thousands of citizens and greatly impacted the collective psyche of Japanese society.

Although the specific impact that this accident will have on the operation of the Japanese fleet of reactors is still being debated, it has already led to changes in the nuclear energy policies of such countries as Belgium, Germany, Switzerland and Italy, which have decided to progressively abandon this energy source or not to reintroduce its use. However, far more countries have maintained their policies, including in many cases the further development of nuclear power: Canada, China, the Czech Republic, Finland, France, Hungary, India, Korea, Russia, the Slovak Republic, Sweden, the United Kingdom, the United States and others with experience in nuclear power are looking to new developments, and countries such as Poland, Saudi Arabia, Turkey, the United Arab Emirates and Vietnam are taking significant steps to obtain access to this source of energy for the first time. In all those pursuing the nuclear option, there is a clear consideration that accidents such as those at Fukushima Daiichi can be avoided.

In fact, nuclear safety is a prerequisite for the use of nuclear power. The Nuclear Energy Agency has been very active in analysing, with the best experts from the member countries and other collaborating countries, the safety lessons learnt from this accident. It is making this analysis available to the public through a report which highlights the main lessons learnt and the additional work to be carried out in the future.

Analyses have concluded that the safety level of operating plants is appropriate, and while enhancements, especially those related to better protection against extreme natural events, will be gradually implemented, no immediate shutdowns are required. Since it is necessary to be prepared for the unexpected and accidents can never be completely ruled out, prevention and mitigation of accidents, both design-basis and beyond-design-basis, should be analysed in a new light considering that mother nature can create events much larger than was thought. Access to power and

to means of cooling under all circumstances are crucial for defence against severe accidents.

The prime responsibility for nuclear safety remains with the operator, and the role of the national nuclear regulator is essential in ensuring that appropriate regulations are established and enforced, taking into account the international efforts that address the lessons learnt from this accident. More results of analyses and of the international research that is starting to be launched will be incorporated into new regulations as more information becomes available.

Emergency planning, both onsite and offsite as well as at the national and international levels, should be reinforced along with the capacity to promptly provide information during crises. It is also important to incorporate into the analysis not only prevention against adverse health effects, but also against large societal impacts.

In addition to societal/political support and nuclear safety, there are other factors that will affect the future of nuclear power. They are country- or region-specific and have to be appropriately addressed to attract investment in this sector. The availability and competitiveness of alternative baseload energy sources are key as, in many cases, market forces will be at play. In many countries, the economic and financial crisis is affecting electricity demand, and in some cases is even reducing it. It is also having an impact on the possibility to obtain affordable financing. A stable framework for investments in nuclear power, including from the safety regulation perspective, is crucial when it comes to deciding to launch a nuclear power project, as it determines the risk of the return on such investments which are capital-intensive and have long periods of amortisation. Another variable that could be a determining factor for deciding on the investment is whether the country in question has a levy or a limitation on CO_2 emissions.

Finally, an important factor for the future of nuclear power is the efficiency of the industry itself, especially in the construction phase. The nuclear technologies currently available tend to be for large amounts of installed capacity and require a very significant commitment in financial terms. Thus, the final cost of the kWh also depends on how well construction is managed to schedule and budget.

Conclusions

Looking into the future, although the energy sector is faced with some uncertainties, the characteristics of nuclear power, with safe and clean technologies, makes it very attractive for industrialised countries as well as for developing countries that consider industrialisation to be an important objective in their social and economic development. In contrast with other energy sources, nuclear power is mainly based on science and technology, and is an asset based on human capital far more than the availability of natural resources. Of course uranium is required, but it plays a very minor role in terms of cost, is readily available in largely sufficient quantities, and with the new technologies that are being developed, could potentially ensure supply for centuries to come.

In order to continue using and developing this energy source in a rational way, it is fundamental to recognise the importance of societal support. This support cannot be taken for granted, and largely depends on how industries, regulators and governments are perceived to control nuclear energy in terms of safety and protection of the environment. It is therefore essential that societies receive adequate information in a transparent way, so that reasoned and informed decisions can be made with confidence. ❑

An important factor for the future of nuclear is the efficiency of the industry itself

Our challenges since the Fukushima nuclear accident

By Naomi Hirose
President, Tokyo Electric Power Company

First of all, on behalf of Tokyo Electric Power Company (TEPCO), I would like to extend my deepest appreciation for the immeasurable support received from all over the world in assisting us with the restoration from the accident at the Fukushima Daiichi Nuclear Power Station on 11th March 2011, and the subsequent reactor decommissioning work.

We are now doing our best to fulfill all of our responsibilities for the accident and achieve the revitalisation of Fukushima, measures which are essential to TEPCO's reform and restoration efforts. To this end, we will put forth our utmost efforts into compensation payouts, decommissioning, decontamination and the revitalisation of Fukushima, while achieving a stable power supply and thorough business streamlining.

Accident overview and recovery work

At the moment the earthquake, which was one of the largest ever recorded in Japan (M9.0), struck on 11 March 2011, the nuclear fission chain reaction was stopped by an automatic shutdown with all control rods inserted at Units 1 to 3, which were then in operation. The emergency generator started up after the off-site power was lost due to the impact of the earthquake. However, emergency power then became unavailable, with the exception of Unit 6, due to flooding by the subsequent tsunami, which was also one of the largest in history. Eventually, all cooling functions of Units 1 to 3 were lost. Alternative water injection using fire engines was conducted as an on the spot measure, but consequently, there remained a certain period of time where water could not be injected into the reactors in Units 1 to 3. This damaged the fuel cladding, which led to the generation of a substantial amount of hydrogen due to a chemical reaction with the steam. Subsequently, in Units 1 and 3, explosions, which appeared to be caused by hydrogen leakage from each of the Primary Containment Vessels (PCV), destroyed the upper structures of their respective reactor buildings.

Units 1 to 3 have now been in a cold shut-down condition since December 2011. We are planning to remove the spent fuel from Unit 4's pool from this November. This is earlier than the previous plan. The removal process is expected to be completed by the end of 2014. We have been treating the accumulated water, which contains highly concentrated radioactive materials, in the Central Radioactive Waste Treatment Facility. Treatment is carried out taking into account the storage situation and the transfer of Accumulated Water Storage Facilities. The contaminated water continues to increase, and this has become a major issue for us in terms of maintaining the plant's condition and performing decommissioning work.

Steel frame for fuel removal at Unit 4 of Fukushima Daiichi Nucler Power Station

On 26 August 2013, TEPCO established the "Contaminated Water & Tank Countermeasure Division" to reinforce the fundamental measures we are taking. In addition to intensive use of the company's own resources, TEPCO has been employing the advice, expertise and know-how of both domestic and international experts. We have been making every effort to resolve this problem as the highest priority management matter.

Impact of the nuclear shutdown and new safety standards

Following the accident, other nuclear power stations in Japan that were undergoing periodic inspections were sequentially shut down. As of July 2013, 48 of the 50 nuclear reactors in Japan have been shut down. As a result, dependence on thermal power generation, especially LNG, has significantly increased. Therefore, the financial situation of Japanese utilities has worsened due to the increase in fuel costs. Japan ran a trade deficit in 2011 for the first time in 31 years and the deficit expanded to 6.9 trillion yen in 2012. The reduction of fuel costs is a pressing issue. Since the ratio of thermal power in the generation mix has increased, CO_2 emission intensities in 2011 worsened by approximately 20 per cent, compared with the situation in 2010, prior to the Great Earthquake. The shutdown of nuclear power stations has had a considerable impact on global warming.

The nuclear accident led the former ruling party, the Democratic Party of Japan, to move ahead with cabinet approval of the "Innovative Strategy for Energy and the Environment" in September 2012, stating that it would be possible to manage Japan's power supply without nuclear power by the 2030s. In contrast, after the change of administration to the Liberal Democratic Party in December 2012, Prime Minister Shinzo Abe expressed his intention to restart "nuclear power plants whose safety has been confirmed." This shows that the "Zero Nuclear Energy" mindset has been set aside, and that a movement to restart the nuclear power plants is now in place.

The Nuclear Regulation Authority (NRA) in Japan released new safety standards for light-water reactor nuclear plants in July 2013. They are to be applied in order to assess restart or new construction requests. The New Standards consist of compulsory measures for severe accidents, such as vent filters, important anti-seismic buildings, power sources and so on, together with preparations for multiple countermeasures in the event of a maximum scale earthquake and tsunami.

It is extremely important to restart nuclear power plants approved by the NRA to serve as the base load of Japan's power supply. To achieve this end, it is necessary not only to enforce safety measures to meet the New Safety Standards, but also to obtain the understanding of the local communities and society. Therefore, we will do our best to rebuild trust and to win support from the local communities

Flood barrier wall at Unit 1 of Kashiwazaki-Kiriwa Nuclear Power Station

and society by steadily implementing safety measures and complying with the new safety standards.

Challenges on nuclear reform

In response to the accident at Fukushima, we strongly desire to be a nuclear power plant operator with the world's highest levels of safety awareness, engineering capabilities and risk communication ability with society. Thus, we established the "Nuclear Reform Special Task Force," directly under the president, last September in order to reform TEPCO's safety culture, disaster prevention measures, risk/crisis control protocols, information disclosure, and risk communication methods. At the same time, we established the "Nuclear Reform Monitoring Committee," comprised of Dr Dale Klein, former Chairman of the US Nuclear Regulatory Commission, and other Japanese and foreign experts. The committee functions as an advisory organisation, monitoring our progress and implementation of reforms from a purely external point of view.

In March of this year, we developed the "Nuclear Safety Reform Plan," which includes lessons and countermeasures relating to the strengthening of facilities, and their operation and management. For instance, with regard to the facility countermeasures, every safety stage of Defence in Depth (D in D) will be implemented, so that serious situations will be more easily prevented even if external events exceed design base assumptions. High-pressure injection systems are to be strengthened to prepare for the event of a Station Black Out (SBO) and design requirements of Primary Containment Vessels (PCV) are to be defined.

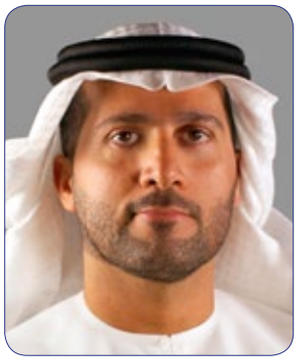
As a management enhancement, we established the "Nuclear Safety Oversight Office" in May of this year to improve oversight and support management by assisting the TEPCO directors in decision making. This is an internal regulatory organisation directly under the board of directors. The head of the office is Dr. John Crofts, former Director in charge of security assurance of the United Kingdom Atomic Energy Authority. We have also enhanced our D in D abilities, by reviewing work processes and organising an appropriate working environment to effectively promote the improvement of processes. With regard to the enhancement of our risk communication activities, as there was a disconnect between our way of thinking and the standards accepted by society, we established the "Social Communication Office" (SC office), directly under the president, in April of this year. The function of the SC office is to enhance risk communication activities and resolve our organisational issues, by promoting an improvement of our corporate culture and risk communication in compliance with social standards. It is also intended to provide the necessary direction to internal organisations in order to improve information disclosure. The SC office is comprised of approximately 24 "risk communicators," who undertake communications with those outside the company from a social perspective. Furthermore, in emulation of the Incident Command System (ICS), which serves as a standardised emergency response structure in the U.S., we reorganised the emergency nuclear disaster prevention organisations at power plants and our Head Office.

Realising the "Intensive Reform Implementation Action Plan"

In accordance with the "Management Policy towards Restoration" established in November of last year, we recognise that TEPCO's reforms begin by facing up to the Fukushima accident. To this end, we have established our new mission to "fulfill all of our responsibilities for the accident and realise the world's highest standards of safety while achieving a stable power supply in a competitive environment." At the same time, we will realise the "Intensive Reform Implementation Action Plan" based on the Management Policy.

The "FY 2013 Business Operation Policy" summarises the measures to be intensively implemented in FY 2013 and 2014 and sets down the implementation plans for the following four intensive measures, and the steps towards achieving the 71 points detailed in the Action Plan. They include measures towards the "revitalisation of Fukushima"; nuclear safety measures; thorough cost reduction and management to ensure survival; and management reforms via the introduction of the in-house company system.

In terms of building a revenue base towards restoration for the re-born TEPCO, we will proceed not only with domestic projects, such as framework development for the mass introduction of renewable energy, network utilisation environment, and total solutions as customer services, but also with our fuel businesses and overseas projects. For instance, we aim to triple the profit from IPP project investments and double the sales from our overseas consulting business by 2020. Based on the "FY 2013 Business Operation Policy," management will dedicate all of its efforts towards the implementation of thorough corporate reforms and to achieving our new mission. ❑



Planning for safe, reliable, efficient and sustainable baseload electricity

By Mohammed Al-Hammadi
Chief Executive Officer, Emirates Nuclear Energy Corporation

While the global public debate on electricity production is focused on the future of intermittent electricity-producing technologies, the electricity sector continues to struggle with the challenge of providing safe, reliable and sustainable baseload electricity on a long-term basis.

Baseload electricity is the backbone of a nation's economic and social growth. It provides stability so that entrepreneurs, citizens and governments around the world can construct the economic sectors of growth. It enables advanced technology and communications, and empowers agriculture, industry and the services sector.

Without a stable and long-term planned baseload infrastructure, energy policy makers face higher levels of energy insecurity, creating perilous imbalances. There is no growth without continued electrical power, and no government across the world wants to face the social and economic damage of electrical blackouts.

Just last year, two massive power shortages in two consecutive days left hundreds of millions of people without electricity or water across northern and eastern India, paralysing one of the emerging world's economic powers. We will likely witness an increasing amount if blackouts across nations around the world, mostly due to poor energy policy making and the non-existence of reliable baseload electricity.

As stakeholders of the global energy debate, we must accept our responsibility as enablers of growth and come together during the World Energy Congress to address the challenges of providing safe and reliable baseload electricity through a careful balance between cost, energy security, affordability and environmental impact.

There is an ample consensus that all forms of electricity-producing technologies must be considered to power the growth of nations around the world. However, energy portfolios need to become long-term oriented and balance assessment of the short-term gains of cheaper forms of baseload electricity with their long-term impact.

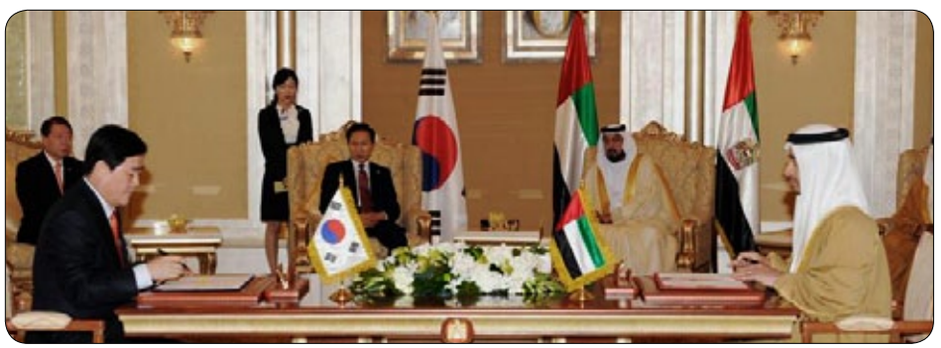
To do so, we must face the facts and have an honest debate about how and where our sector must evolve. The facts are:

- The electricity, heating and cooling sector is the highest contributor of greenhouse gas emissions in the world. It emits a quarter of the world's total emissions, nearly double the emissions of the transportation sector.
- Over the next 40 to 60 years, coal will provide the vast majority of the world's baseload electricity. Since the start of the 21st century, coal has been the fastest-growing global energy source. Nearly 1,199 coal-fired plants with an installed capacity of 1,401,268 MW are being proposed globally, even in Europe.
- Consequently, the electricity sector will continue to be the highest contributor of greenhouse gas emissions over the next decades. From an electricity production perspective, the decisions that energy policy makers make today will only be visible in the next 20 to 40 years, when the lifecycle of current power plants comes to an end.
- Clean baseload electricity generation, such as hydro or nuclear are proven technologies that play a critical role in providing sustainable baseload electricity. This, along with extensive research and development other forms of baseload technologies, will prove critical to improve the sustainability targets of the electricity sector for the next generation.

These facts highlight that this next decade will be crucial for the choices that the energy sector must take. Energy policy makers must protect their national interest and continue to provide baseload electricity. However, low-cost electricity can only be one of the factors in making this decision: energy security, social equity and sustainability must also be taken into account in the energy equation.

The impact of the decisions we make today will only become apparent over the next 20 to 40 years. Think of how the world will look in 40 years in the context of this data, and use the World Energy Congress as a platform to improve energy policy and planning. ❑

Korea has won a US$40 billion contract to build and operate four reactors for the UAE



Interest in nuclear power steady despite Fukushima

By Yukiya Amano
Director General, International Atomic Energy Agency

In June this year, participants from 89 countries attended an international ministerial conference on nuclear power in the 21st century in St Petersburg, Russia. In their Concluding Statement, they recognised "that nuclear power remains an important option for many countries to improve energy security, reduce the impact of volatile fossil fuels prices and mitigate the effects of climate change, despite the accident at the Fukushima Daiichi Nuclear Power Station."

That represents a good summary of the state of play for nuclear power, more than two years after the world's worst nuclear accident since Chernobyl.

After the Chernobyl accident in 1986, nuclear power entered a period of stagnation. That did not happen in the aftermath of the devastating earthquake and tsunami which knocked out Japan's Fukushima Daiichi plant in March 2011.

In fact, construction of new nuclear power plants continued. Around 70 new nuclear power reactors are being built at the moment, in addition to more than 430 already in operation throughout the world. Most of the growth is taking place in Asia.

Existing users such as China, India, Russia and the Republic of Korea have significant expansion plans. The United Arab Emirates, the first new country in 27 years to launch a nuclear power programme, is presently building two reactors. Bangladesh, Jordan, Nigeria, Turkey and Vietnam are among countries which have decided to introduce nuclear power.

So it is clear that nuclear power will have an important part to play in Securing Tomorrow's Energy Today, to quote the theme of the 22nd World Energy Congress. To meet that challenge, it will be necessary to tap all available sources of energy. As the St Petersburg Concluding Statement noted, "nuclear power, as a stable baseload source of electricity in an era of ever-increasing global energy demands, complements other energy sources, including renewables."

I believe that the number one challenge for the future of nuclear power is safety. We need to ensure that the most robust levels of nuclear safety are in place at every nuclear power plant in the world. Operators, regulators and governments must show an unwavering commitment to the principle of "Safety First."

Since Fukushima Daiichi, effective steps have been taken to make nuclear power plants safer everywhere. I see this myself when I visit nuclear power plants throughout the world. Protective anti-flood walls are being raised, extra backup electricity generators are being installed and emergency supplies of water for cooling are being put in place.

Public confidence in the safety of nuclear power was deeply shaken by the Fukushima Daiichi accident. We have made progress in the past two years towards winning back that confidence. The swift and comprehensive international response to the accident has helped. IAEA member states agreed a Nuclear Safety Action Plan within a few months and implementation began immediately. But this is no reason for complacency.

Openness and transparency on the part of plant operators, regulators and governments are essential for restoring and maintaining public confidence. It is important to be honest about the possible risks and problems associated with nuclear power – as with any modern technology – as well as the benefits.

Waste disposal is often cited as one of the major problems facing nuclear power. Of course, the problem of waste is not unique to the nuclear sector. Other forms of electricity generation, such as coal, generate large quantities of waste. They also cause substantial CO_2 emissions, which nuclear power does not.

The high cost of building a nuclear power plant is seen by some as an obstacle to future development. Nuclear power plants are expensive to build, but once they are up and running, they are relatively inexpensive to operate throughout a life cycle of 30 or 40 years – or even longer. A number of innovative new financing models have been developed. Other creative approaches to the high start-up costs of nuclear power are likely to emerge in the coming years.

So what is the role of the International Atomic Energy Agency in all this? The statutory objective of the IAEA is to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."

We do not attempt to influence any country in its decision whether or not to use nuclear power. But if countries decide to add nuclear power to their energy mix, our role is to help them do it safely, securely and sustainably. We accompany both experienced users and newcomers at every stage of their nuclear journey. We establish global nuclear safety standards and security guidance. However, responsibility for ensuring the highest standards of nuclear safety and security lies with each individual country.

The IAEA also provides practical assistance in many areas, from energy planning to site selection, legal and regulatory matters and technical training, all the way through to plant decommissioning. A key aspect of

the IAEA's work is preventing the proliferation of nuclear weapons. Member states conclude safeguards agreements with the Agency under which we have the right, and the obligation, to verify that all nuclear material is being used for exclusively peaceful purposes. IAEA safeguards are now implemented in nearly 180 States, the great majority of which fully comply with their safeguards obligations. There are problems with just a few countries.

It is also important to ensure that nuclear and other radioactive materials do not fall into the hands of terrorists and criminals. In July this year, the IAEA hosted an international conference on nuclear security at ministerial level in Vienna, which considered ways of strengthening the global nuclear security framework.

Non-power applications of nuclear technology, made available with the assistance of the IAEA, bring real benefits to developing countries in medicine, industry, agriculture and other areas. For example, we help countries to increase food production by using nuclear techniques to develop robust new varieties of crops. We work to improve access to clean drinking water and to combat deadly animal diseases such as foot-and-mouth. We provide training, expertise and equipment to developing countries so they can build comprehensive cancer control programmes.

Nuclear technology offers many benefits to humankind. I expect it to play an increasing role in all our lives in coming decades. I also believe that nuclear power will make a significant and growing contribution to sustainable development. ❑

APEC acts to lower the cost of environmentally-friendly imports

By Timothy J. Richards
Managing Director, Energy Policy, General Electric

At the Asia Pacific Economic Partnership (APEC) leaders meeting in 2012, APEC nations committed to reduce and cap their tariffs on 54 environmentally-friendly products at five per cent. Over half of these items are energy-related.

This action by APEC members, which represents 54 per cent of world GDP and 44 per cent of global trade, is a tangible international endorsement of the principle that trade liberalisation can contribute simultaneously to economic growth and to environmental sustainability. It therefore starts a new chapter in the debate about the role of trade and the environment – a debate that until recently was dominated by a view in many environmental circles that trade rules represent a threat to environmental protection measures.

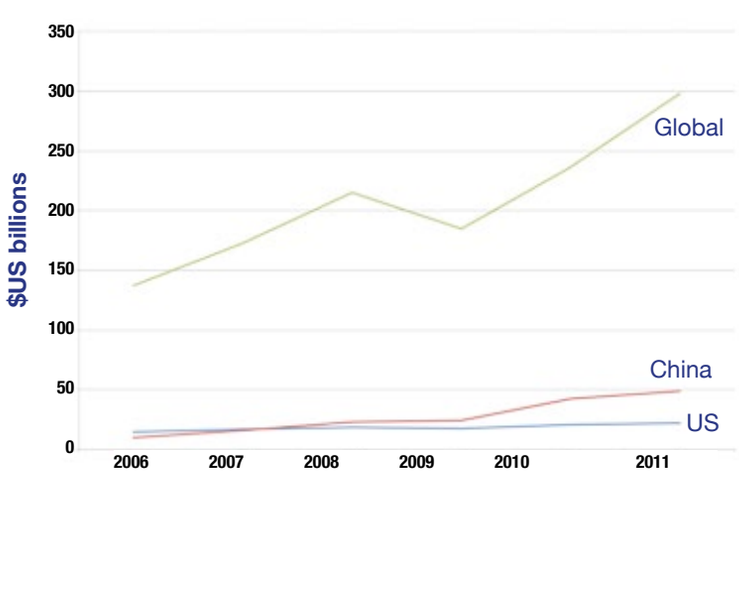
Tariffs, or customs duties, are taxes that nations apply to imported products, thereby adding an additional cost to those products and usually increasing their price in the importing country. Since the Second World War, governments have pursued the successful reduction of tariffs and other barriers to trade within international bodies such as the World Trade Organisation (WTO). The primary objectives of trade barrier reduction are to spur global economic growth and reduce international tensions through greater integration.

The APEC action is rooted in this policy framework as well as national energy and environmental policies. Many APEC members, for instance, aim to increase the use of renewable energy as a percentage of total electricity generation. Because the cost of electricity from wind, solar and other newly-constructed renewable energy projects is initially higher than that from existing fossil fuel plants, reducing the cost of renewable energy technologies so that market forces can propel them to widespread application is almost always a fundamental goal of national policy. Programmes to reduce renewable energy costs include government-funded research, tax incentives, and low-cost loans. APEC members have added tariff reduction to that list of policy measures.

In almost all cases, construction of a clean energy project involves the importation of some equipment and parts. By capping tariffs on those products, APEC nations will immediately reduce the cost of such projects and make them more competitive. Few other government actions offer such a clear and immediate impact.

In addition, tariff reduction makes it easier for environmentally-friendly products to be manufactured in higher volumes and sold globally, thereby offering longer- term cost-reduction through economies of scale and attracting additional investment into the sector. The result will be to generate the most total jobs globally, including new construction, professional and service jobs in every location where projects are built. Even for goods trade, the benefits are likely to be distributed widely among countries. As Chart 1 indicates, exports of environmental goods (in this case, as defined by the US Congressional Research Service) are already growing. China and the US together account for only about a quarter of those exports. Among APEC countries, Vietnam is already a major exporter of wind turbine generators.

Chart 1: Environmental goods exports



Source: US International Trade Commission Dataweb, Congressional Research Service

APEC has acted first to create a trade programme designed to facilitate environmentally-friendly projects. Many other organisations, however, are or have been engaged in similar efforts. In fact, negotiations to reduce or eliminate tariffs on environmentally-friendly goods have been part of World Trade Organisation talks since the launch of the Doha Round of trade negotiations in 2001. Several G8 declarations have also endorsed this approach. Today, with the Doha Round largely inactive, countries are turning increasingly to bilateral and regional free trade agreements, and future versions of those agreements are likely to contain provisions to promote trade in environmentally-friendly products and services.

The World Energy Council (WEC) has played a role in promoting these principles. In 2009, the WEC published a report[1] on energy-related trade rules that highlighted the advantages of eliminating tariffs and other trade barriers on environmental and other energy-related products. Subsequently, in 2010, WEC experts from utilities, ministries and technology companies assessed six types of environmentally-friendly energy projects[2] and identified the most important technologies and products that are utilised in those projects. The WEC then submitted this list of products to the World Trade Organisation in order to support WTO negotiations. Many of the products identified by WEC in that 2010 submission are now included on the APEC list of 54 environmentally-friendly products.

It is important to recognise that, as significant as APEC's action is in setting a precedent, it is also highly limited. In the context of the original Doha Round goals and the 2009 WEC recommendations, APEC's move covers only a fraction of the total field. The APEC decision deals only with tariffs on products. It does not address non-tariff barriers, barriers to investment, or barriers to services trade. Services, for instance, represent a large and growing percentage of energy-related trade, most of which is environmentally-friendly.

Even within the realm of tariffs, the APEC action limits tariffs to 5 per cent rather than eliminating them, and covers only 54 products. The 2009 WEC list had over 110 products, and many more items have been considered in the WTO negotiating groups. Furthermore, although APEC includes some of the largest and wealthiest economies in the world, the APEC decision naturally applies only to the 21 APEC members, not to all 159 members of the WTO. It is among developing countries (mostly not APEC members), in fact, that tariffs on environmentally-friendly products are highest (see Chart 2).

Finally, APEC members will undertake their commitments on an honour system. Unlike the WTO and most free trade agreements (FTAs), there is no APEC process to formally "bind" tariffs at the agreed level and no dispute settlement process should an APEC member later raise its tariffs above five per cent. ❑

The author greatly appreciates the contributions of Chloe Hartwell, who produced the tables and graphs for this article.

[1] *Trade and Investment Rules for Energy World Energy Council 2009*

[2] *The six types of projects examined by the WEC are:*
a. Energy efficiency in power distribution and plant-level consumption;
b. Carbon capture and storage;
c. Renewable energy generation (solar, wind, hydro);
d. Nuclear power;
e. Natural gas for power generation and other uses; and
f. Flare gas reduction.

Chart 2: Bound and applied tariffs on environmental goods (%AVE)

	Importer				
	ACP*	BIC*	Developing	OECD	WTO
Bound tariffs					
ACP*	44.9	27.6	25.7	2.5	15.5
BIC*	41.8	31.7	24.1	2.4	7
Developing	41.3	16.3	24.1	2.3	7.8
OECD	38.7	12.2	23.5	3.0	9.5
WTO	40.0	13.7	23.7	2.7	8.7
Applied tariffs**					
ACP*	10.7	12.1	7.9	0.4	4.8
BIC*	11.7	14.1	5.5	1.7	2.7
Developing	11.4	8.5	5.8	0.6	2.2
OECD	8.1	8.5	4	1.9	3.3
WTO	9.6	8.8	4.5	1.6	3.0

*ACP – African, Caribbean and Pacific Countries, BIC – Brazil India and China
** Applied tariff as used in this context refers to both applied tariffs on an MFN basis and applied preferential tariffs depending on whether the trading partner is awarded preferences or not. It also assumes a full utilization of preferences.
Source: UNEP Policy Brief, June 6 2012

Renewable energy investment: A pause for breath?

By Angus McCrone
Chief Editor, Bloomberg New Energy Finance

"History does not follow straight lines. And neither does the future," remarked Alvin Toffler, author of The Future Shock. His topic, in an interview with the Chinese People's Daily in 2006, was China itself. But in 2013, those same words might apply just as well to the transition of the world energy system.

For eight years up to 2011, global investment in renewable energy enjoyed a steep upswing. Yes, there was a minor, temporary setback in 2009, in the teeth of the financial crisis, but the trend was powerfully upwards - from US$40 billion in 2004 to US$279 billion in 2011.

However, in 2012, there was a meaningful bend in that line for the first time. Investment in so-called "new renewables" that exclude large hydro-electric projects of more than 50MW fell back 12 per cent to US$244 billion. It is too early to be confident about the likely figure for 2013, but data from Bloomberg New Energy Finance for the first half of this year suggest that it will, again, fall short of the 2011 record and could well be lower than the shrunken 2012 total.

World investment in renewable energy has indeed flown into a bit of an air pocket. The question is whether the resulting weakening of the dollar figures since 2011's record marks global disillusionment with the low-carbon transition at a time of economic difficulty in many countries - or whether it just shows the merit of Toffler's observation, in other words that even trends with strong momentum unfold in zig-zags as exuberance gives way to consolidation and then to re-acceleration.

Part of the answer lies buried in the numbers themselves. Two big things are evident when you dig deep. The first is that even though dollar investment fell in 2012 from the record of the previous year, the amount of renewable power capacity added to the world electricity generating system did not. In fact, 2012 was a record year for commissioning of both wind power (48.4GW worldwide) and solar photovoltaics (30.5GW). Altogether, renewable power capacity excluding large hydro accounted for 41.6 per cent of all generating capacity added last year, up from 36.3 per cent in 2011 and the highest figure ever.

The explanation is that technology costs have fallen sharply. Onshore wind turbine prices per MW dropped by some 25 per cent from their peak in 2009 to early 2012. Average PV solar system prices worldwide fell by 30-40 per cent between 2011 and 2012 alone, the lower end of this range relating to residential systems and the upper end to utility-scale solar parks.

The second thing that emerges is that a big swing in the geographical balance of investment is taking place. In 2004, some 80 per cent of world investment in renewable energy was in developed economies and only 20 per cent in developing economies. Even in 2011, the balance was 66 per cent in developed and 34 per cent in developing. But last year, this shifted to 54 per cent in developed economies and 46 per cent in developing countries. While investment in the former fell sharply, from US$186 billion in 2011 to US$132 billion in 2012, outlays in the latter increased for the eighth successive year, this time from US$94 billion to US$112 billion.

The two halves of the global economy were seeing very different trends in 2012. In developed countries, governments were reducing incentives for renewable energy deployment, partly in response to those cost improvements but also to protect the public finances or shield consumers from excessive increases in their electricity bills. Subsidies were cut in Italy, Germany and the UK, they were taken off the table entirely in Spain, and in the US, two important federal incentives expired late in 2011 and a third one looked likely to expire at the end of 2012 (although in the end, it was extended for another year). All this created uncertainty in some of the busiest markets for wind and solar deployment of recent years.

Meanwhile, in developing nations, the hunger for additional power capacity as economies grow, and the reduced cost of renewables, are continuing to drive investment. Last year, China was by far the largest investor in renewable power and fuels, at US$66.6 billion, up 22 per cent on the previous year, but there were also totals of between US$1 billion and US$10 billion from India, Brazil, South Africa, Morocco, Kenya, Mexico, Thailand and Turkey. Other countries such as Chile, Peru and Ethiopia grew spending and threatened to break into that 10-figure club for dollar investment in the years ahead.

However, it would be wrong to suggest that all of the underlying news behind the headline investment numbers is good. Policy uncertainty in key European markets such as Germany, France and the UK has been slow to dissipate, and some countries – such as Spain, Bulgaria and Romania - have inflicted serious damage on investor confidence by cutting the revenues available even for existing renewable energy plants – so-called "retroactive cuts". Meanwhile, the plunge in carbon prices in the European Union Emissions Trading Scheme since 2008 has eroded one of the

supports for low-carbon generation. In the US, the advent of low-priced shale gas has damped the appetite for new wind projects by reducing the value of power purchase agreements available to developers. Also, there was a spurt in US investment back in 2011 before the expiry of two incentive programmes hatched in the Obama economic stimulus of 2009. Those incentives will not return, although others (the Production Tax Credit for wind and Investment Tax Credit for solar) continue. In India, the temporary withdrawal of key incentives for wind power development has slowed activity.

The evidence so far in 2013 is that, with a couple of notable exceptions such as solar development in Japan and China, investment in renewables is not bouncing back from the 2012 setback. In fact, in the first two quarters of this year, overall outlays were US$93.8 billion, down 18 per cent on the same period of 2012 and 29 per cent down on the first half of 2011.

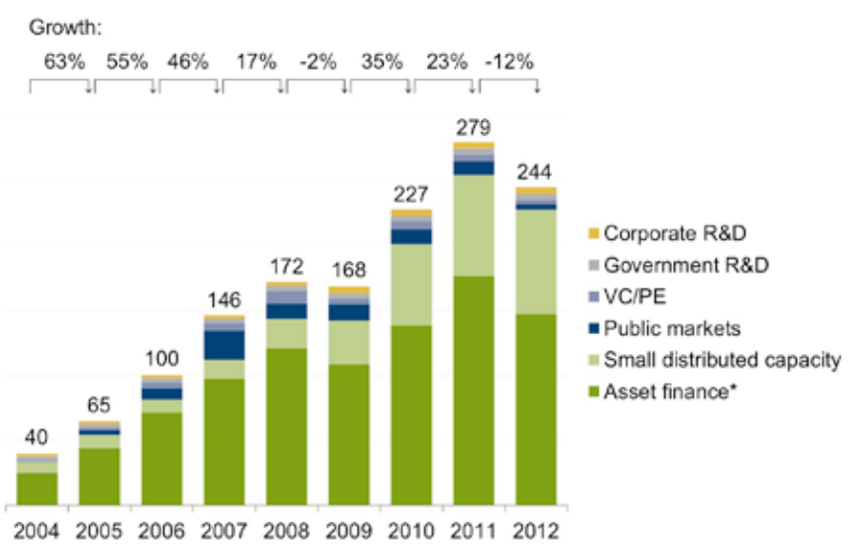
On the bright side, the second quarter of 2013 showed some improvement on the first, with investment up 22 per cent, but it was still 16 per cent down on the second quarter of 2012. There were some highlights, such as a recovery in US activity, helped by the US$2.5 billion financing of the 681MW SunPower Solar Star PV plant in California by MidAmerican Energy; continuing strong investment in Japan, particularly in small-scale solar; and US$2.5 billion of financings in South Africa, including US$395 million for the 134MW Cennergi Amakhala Emoyeni wind farm in the Eastern Cape.

But perhaps the most notable ray of light was coming from what has been clean energy's darkest corner in the last few years – the public stock markets. After a boom in clean energy share prices in the years up to late 2007, there was a painful crash during the recession and then a prolonged period of underperformance compared to wider market indices such as the S&P 500. By 25 July 2012, the WilderHill New Energy Global Innovation Index, or NEX, which tracks the performance of 98 specialist stocks, was down 78 per cent from its peak.

That proved the low, at least for quite a while, and there then ensued an impressive rally, the NEX rebounding more than 50 per cent to a short-term peak in May this year. There were much bigger increases for some of the most battered renewable energy stocks – turbine market leader Vestas Wind Systems, for instance, up 224 per cent between 25 July 2012 and early July this year, solar manufacturers SunPower and SunEdison up 453 per cent and 380 per cent respectively, Spanish wind turbine maker Gamesa up 329 per cent, US thin-film solar specialist First Solar up 223 per cent, solar glass maker China Sinyes Solar Technologies up 206 per cent.

Investors on public stock markets appeared to be taking the view that the worst of the over-capacity in wind and solar manufacturing chains, and perhaps the worst of the uncertainty about future demand, was past. After a period of distress for renewable energy manufacturers and many bankruptcies in solar, notably those of Solyndra of the US, Q-Cells of Germany and Suntech of China, it has been a bold call. As with all stock market rallies, it started not when investors felt confident but when they felt deeply gloomy. ❑

Global new investment in renewable energy by asset class, 2004-2012 (US$bn)



**Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals*

The role of the insurance sector in climate change mitigation

By Agostino Galvagni
Chief Executive Officer, Swiss Re Corporate Solutions

Both the energy and insurance industries are heavily affected by the increasing concentration of greenhouse gases in the atmosphere. In the case of the energy industry, the political decision-making directed at reducing greenhouse gas emissions has fundamentally changed the markets. In Europe, for example, targets set for the development of renewable energy resources and the related subsidy-driven boom in solar and wind power generation have affected the profitability of fossil fuel power plants. In the case of the insurance industry, natural catastrophe losses have increased significantly (see graph below) and – assuming this trend will continue – there is the risk that insurance coverage may become unaffordable for certain coastal areas. Hence, both industry sectors are keenly interested in climate change mitigation. What follows is a closer look into the role of insurance in fostering the development of renewable energy.

Annual investments in renewable energy have risen from US$33 billion in 2004 to US$211 billion in 2010. This trend is likely to continue: Bloomberg New Energy Finance (BNEF) estimates that the annual investments in renewable energy will reach US$ 450 billion by 2030. This view is also confirmed by a recent survey conducted by the Economist Intelligence Unit, in which 61 per cent of power companies reported that renewable power production will become highly significant within the next three years.

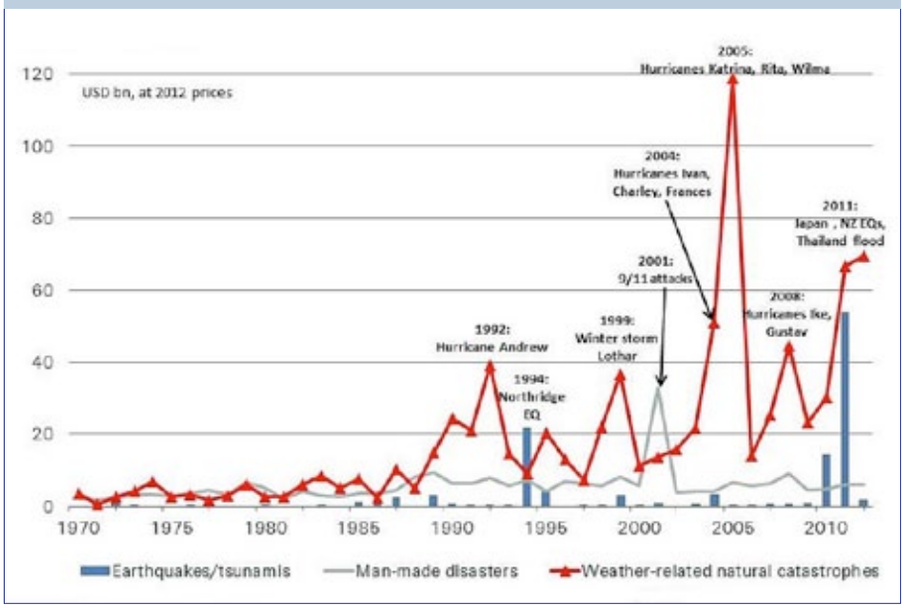
Renewable energy is a vital asset in the efforts to reduce carbon emissions and mitigate climate change. The publication "*Building a Sustainable Energy Future*"[1], authored by Swiss Re and partners from the public and private sector, shows that low-carbon technologies contributed 23 per cent to the global power supply mix in 2010, while fossil fuels accounted for 77 per cent. With this outlook for substantial investments in renewable energy, this gap will be further reduced.

The insurance sector has a key role to play in supporting the further growth of renewable energy. Not surprisingly, the demand for construction and operational risk coverage grows in line with investments into renewable energy assets and installed capacity, respectively. But a recent study by BNEF, commissioned by Swiss Re Corporate Solutions, revealed further interesting dynamics:

Firstly, there is an increasing need to finance renewable energy assets through debt from institutional investors (such as insurers), who are looking for a long-term, stable yield. Their risk appetite differs from that of current investors (such as utilities, private equity). Institutional investors commonly allocate only five per cent of their assets to so-called alternative investments, a class encompassing renewable energy projects, while typically reserving about 40 per cent for bonds. To allow institutional investors to provide debt financing at scale, it therefore becomes important to shape the risk/return profile of renewable energy investments, such that they can be considered bond-type investments. This can be achieved through de-risking the cashflow volatility of renewable energy assets.

A volatile cashflow pattern can be split into a safer and a less-safe part. The latter can be hedged in insurance or derivatives markets. For a share of the return in the form of a premium, risk takers can put boundaries on the cashflow volatility. In the example of a wind farm, this would mean putting a floor on the power production through a contract that pays the owner or the lender when

Insured catastrophe losses 1970-2012



the wind fails to materialise or production suffers from a shortfall due to other insurable causes. Investors benefitting from that protection would be willing to fund projects that generate uncertain cashflows because they are protected when that flow goes against them. Potentially, this could attract enough new investments to make a real difference in closing the funding gap in renewables financing.

Secondly, there are prevailing weaknesses in the insurance coverage during the construction phase of renewable energy projects, mainly relating to project downtimes (e.g. wave heights interrupting off-shore construction). Currently, these risks are dealt with as part of negotiated contracts amongst investors, developers, construction companies and manufacturers, but they are often not explicitly assessed, nor are they insured. However, project delays significantly reduce the expected returns on investment. It is essential that the insurance industry addresses these risks despite their complexity.

Construction contracts need to deal explicitly with this "shut down" risk, for example, by setting terms that assume an agreed number of shut-in days, defined as critical days, triggered when the waves are too high and/or the wind is too strong for vessels to operate and construction to proceed. To cover the days that exceed contractually agreed thresholds, insurance protection would be secured and also included in the contract. By putting this cost into the contract, the parties fix an element that would otherwise be variable, and the insurer takes over the risk of unpredictable weather events causing delays.

While the reserves for project downtimes currently built into construction contracts are difficult to assess, it is fair to assume that explicit pricing for insurance will increase transparency and reduce overall project costs. This would be a welcome benefit in view of the substantial investment required to build the numerous offshore wind farms that are currently in project planning stages.

A final dynamic to be highlighted pertains to grid regions with a substantial share of renewable power capacity, where production volatility has an impact on all market participants. In such regions (e.g. Germany and neighbouring countries) traders and grid operators are faced with very low and sometimes even negative power prices, as well as high production volatility and related issues of balancing the grid. In markets with fixed feed-in tariffs, the burden of low power prices and balancing the grid is imposed upon thermal power generators, making it increasingly difficult for them to operate profitably.

These rules for energy uptake are in the process of changing, and regulators will be working to make the costs more open and explicitly enforced. The parties who bear the balancing costs will have an interest in managing the cost of intermittent renewable energy production. Regulators currently face a dilemma of energy source prioritisation. Thermal power generation capacity stands uneconomically idle when the grid predominantly takes on wind power. However, power generation from other fuel sources is still needed to ensure stable power supply, available in all weather conditions. There is therefore a need for products or market designs that balance the playing field while still allowing renewable energy to be prioritised.

Insurance can de-risk both the construction phase of projects, which suffers from delays due to inclement weather or physical accidents, as well as the operational phase, which is exposed to the volatility of the natural energy resource's availability (i.e. sunshine, wind), fluctuating energy prices in the market, and physical damage of the power generation components. During the construction phase, Construction and Erection All Risk covers can be enhanced through complementary solutions addressing project downtimes and delays in start-up, both of which can materially affect expected return on investments. During the operational phase, Property Damage covers can be complemented by solutions addressing the monthly and annual variability in power production. Reducing the uncertainty surrounding start-up and operating variability is a key pre-requisite for attracting and unlocking the institutional investments needed to fund future renewable energy assets. Finally, there will be a range of insurance-type derivatives available for addressing volume and price risks, to assist traders in managing the supply volatility and related market risks in grid areas with a significant share of renewable energy supply.

In summary, we can draw the following conclusions. The generation capacity from renewable sources of energy will continue to grow significantly. For funding these assets, developers and utilities will increasingly rely on institutional investors, in order to reach the US$ 450 billion of investments expected annually by 2030. Insurers have a dual role to play, acting both as lenders but also as risk moderators, shaping the profile of income streams, such that projects are attractive for institutional investors who require a long-term, stable yield. ❑

[1] *www.swissre.com/sustainable_energy_future*

‘Can do’ versus ‘Can’t do’: A matter of attitude

By Brian Statham, Chairman, South African National Energy Association and Chair of the WEC Studies Committee

During my career of some 40 exciting years in the energy sector I have been fortunate to visit some amazing places all around the world and to meet and talk with some very interesting people. These experiences have enriched my life beyond measure.

These opportunities have been in environments of opulent extravagance and abject poverty and I remain surprised that after so many years of scientific and technological achievement we have still only managed to provide some two thirds of the world’s people with formal energy services.

When considering rural energy poverty, especially in Africa, we have to be sensitive to the geographic and demographic context. Community villages are quite small and they are widely dispersed across this vast continent. It is very difficult to make an economic case for grid connection; either through a power line or through a pipeline. The distances are too great and the market size of the village is too small. Therefore connection by means of network extension is unlikely to happen any time soon. A potential solution is off-grid stand-alone energy supply. However, these villages are often in remote locations with difficult access. This creates difficulties during the construction phase for any supply option but will also be a challenge for maintenance and feedstock supply during the operational phase. We should also be aware that the skills available in the village will be limited. People with the ability to thrive in a more sophisticated environment will have migrated to towns and cities in search of a better life.

When I talk to business people about addressing the challenge of energy poverty I hear of so many reasons why it can’t be done. The size of these projects is too small to be interesting to financiers. The likely payback periods are too long and the returns too low to merit consideration. The risk premium associated with working in remote and developing areas is so expensive that the project can never be bankable. The size of the energy system will be orders of magnitude too small to be matched to the technologies and products in use today. The economies of scale are simply not present in these projects; neither from a financing nor from a technological point of view. Bringing energy to impoverished communities cannot be done by the private sector; this is a matter for the public sector.

When sitting down to write this article there are two specific experiences that are in the forefront of my mind and which lead me to question whether we, the so-called leaders in the energy sector, are really heading down a path towards global sustainable energy systems.

The first example is a visit to a rural community in southern China. A biomass digester had been provided to the village by the local authorities. The villages were themselves responsible for the operation and maintenance of the system. They were also responsible for the distribution of the gas and the collection of payments. The village committee elected to run the system had developed a scheme whereby consumers could pay for the gas in currency, or in kilograms of feedstock delivered to the bio-digester, or in hours of labour at the bio-digester. This innovative approach greatly extended the ability of the villagers to have access to the service. The villagers were very positive about the system and they were all committed to developing the community.

The second example is a visit to an informal settlement [squatter camp] on the outskirts of Johannesburg. The average size of these “homes” is 3m x 3m. This shanty town has electricity supply and the residents qualify for the government ‘free basic electricity’ grant of 50kWh per month. One man uses this energy almost exclusively to heat a soldering iron as he repairs mobile phones, televisions and other electrical devices. A lady supervises neighbours’ children after school and uses a small television set to show them educational programmes while they do their homework. Another uses a basic sewing machine to do all manner of repairs and alterations to threadbare clothes.

What it means to have a ‘can do’ attitude

A significant aspect of these examples is the manner in which the energy is paid for and used. The conventional wisdom is that the first priorities of any effort to alleviate energy poverty should be lighting, heating and cooking. Heating and cooking are relatively energy-intensive, demand a robust energy supply and do little, or nothing, to improve the economic sustainability of the community. In these examples what the residents valued most were television, telephone, power for tools, internet connectivity and then lighting. Heating, cooking and refrigeration were not top priorities. It seems there are more important forces at work here.

It is really a question of sustainability of the household unit and the community. The most important driver is the legitimate aspiration of people to have the means to improve their quality of life. For this to happen their priorities are economic activity, communication, education and health.

Most important, though, is the stimulus of economic activity. If economic activity does not happen then none of

the other potential benefits of commercial energy supply can be sustained.

Access to television provides a number of important benefits. Firstly it provides information which allows people to become more aware of the world around them and to identify opportunities to improve their circumstances; both social and economic. Television is also an important medium for education. This can happen informally through people watching the standard range of programmes but, and perhaps more importantly, television can be used to broadcast formal education materials as an integral part of distance education schemes. Television can contribute to health and nutrition awareness and it is also possible to provide training for first-line healthcare providers in the community.

Telephones, particularly mobile cellular phones, provide the opportunity to communicate by voice and text. Apart from the obvious social and security benefits of enhanced communication within the family and the community, mobile telephony is a significant enabler of enhanced commercial and economic activity. Wherever there is cellular telephony coverage it is also possible to deliver internet connectivity. This is the ultimate step in enabling people to become economically and socially connected.

To solve these problems we have to take a giant leap into the future and invert our thinking from “Big is Beautiful” to “Local is Lovely”. Instead of trying to extend the existing grid we need to start from the bottom with wind, solar and biomass stand-alone systems and slowly connect and enlarge these to match increasing energy demand. The challenge to the suppliers of such systems is to develop them in economic units in the 200-500 kW range. The technology has to be robust enough to require a minimum amount of maintenance and it has to be such that operation and maintenance can be carried out by the people in the village. Many will argue that such systems will not provide uninterrupted energy and that there will have to be back-up supply. My contention is that for a village that currently has no modern energy supply, an electricity or gas supply that is available 60 per cent of the time is a small miracle. An intelligent mix of wind and solar will improve the availability and the biogas system can be used for backup. Such integrated systems should certainly be capable of providing sufficient energy to power electronic services. Such services could initially be provided at a community centre facility or school and could later be dispersed to individual dwellings as economic activity increases and families are able to afford them.

I suggest it is we, the bankers and the developers, the designers and the manufacturers who are preventing universal access to energy. It is we who have all the physical and intellectual resources, but who lack the vital emotional resources of courage and faith and who are locked down in our risk-averse, protectionist and ‘can’t-do’ paradigms that are preventing global energy transformation.

In both of the above examples the people I spoke with do not concern themselves with feasibility studies; with business plans; with mission statements; with performance objectives. They are driven by a powerful belief that they can make a positive difference to those around them and then they simply roll up their sleeves and start working for change. They don’t allow themselves to be constrained by future uncertainties such as where the funds will come from. They forge ahead and tackle each obstacle as and when it arises. They demonstrate incredible courage and a willingness to work within the community, believing that if they make a positive contribution to the community they will find the necessary resources for the next step.

I have come to realise that most of the great innovators – whether social, economic, political or technical – had demonstrated a similar clarity of intent and the vaguest of plans of how to get there, but were all powered by a rock-solid ‘can do’ attitude. Think about it – please. ❑

Solar Voltaic used to pump water out the ground, Oasis Salal, Bahr el Ghazal, Chad

Unlocking a clean energy future for Asia: Challenges and opportunities

By Takehiko Nakao
President, Asian Development Bank

Over the past decade, Asia has made huge strides in economic growth and poverty reduction, with the region (excluding Australia and New Zealand) accounting for 28.3 per cent of global gross domestic product (GDP) in 2011. According to recent Asian Development Bank (ADB) estimates, this figure could rise to 44 per cent by 2035 based on annual average growth of 6 per cent for the region.

While ongoing economic growth is expected to see developing Asia's share of the world's energy consumption rise from 34 per cent in 2010 to over 50 per cent by 2035, most of the increase in consumption will come from fossil fuels. This will lead to an emission level of greenhouse gases of about 20 billion tonnes out of a total global cap of between 22 billion and 30 billion tonnes which is the threshold to avoid a catastrophic tipping point in the climate system. Clearly, this level of emissions is not sustainable for the planet. Asia needs to change its development paradigm to use less energy per unit output, thereby requiring less primary energy overall, as well as to generate more renewable energy within that lowered energy requirement scenario, in order to further limit greenhouse gas emissions.

Also problematic is the ability of the region to deliver power to all. Despite impressive economic growth, some 600 million people in the Asia-Pacific region still lack access to electricity. If the policies of governments in developing Asia do not focus on affordable access, then around 330 million Asians could still be without electricity in 2035.

The challenge for Asia, therefore, is twofold. We must fuel the region's continued economic growth to increase living standards, by engaging in an energy strategy that is low-carbon and environmentally sustainable. At the same time, to make growth sustainable and beneficial to all, Asia must increase its energy access investments. Asia can do this only by embracing the three "I"s – to become more innovative, inclusive, and integrated.

Innovation requires an enabling environment which encourages the public and private sectors to grow and use their creativity and resources to support technology development and new jobs. ADB's contribution to innovation involves the "Finance++" model – i.e., finance, plus leverage, plus knowledge. We offer loans and grants to support renewable energy and energy efficiency projects, and we seek to leverage finance from external sources, primarily the private sector. The ADB also shares its knowledge with regional stakeholders, drawing on its experience in designing and implementing a range of clean energy projects.

In India's Rajasthan state, for example, the ADB provided US$103 million to help finance a 100 megawatt (MW) concentrating solar power plant, with the aim of demonstrating the feasibility and operational performance of such projects for Asia. In Viet Nam, the ADB is providing US$74 million to fund thousands of biogas plants of varying sizes which will convert agricultural and rural household waste into biogas and bio-slurry. In the People's Republic of China, the ADB is helping bus operators shift their fleets to cleaner fuels and technology, including compressed natural gas, liquefied natural gas, and electric and hybrid buses. All these examples show the ADB's desire to support emerging technologies which can sharply reduce harmful environmental impacts and deliver long-term economic savings.

To meet the goal of inclusiveness, there is a need to expand overall energy access in the region, and to facilitate a shift to cleaner, modern energy as demand rises. Nearly half of the world's people without electricity live in Asia, as do the majority of people who rely on traditional fuels such as wood, charcoal, and dung.

The ADB's Energy for All Partnership, launched in 2009, has already benefited 67 million people and is on track to provide access to modern energy for 100 million by 2015. It brings together the private sector, financial institutions, governments, and non-government organisations to scale up investments in energy access through better knowledge management, capacity building, and project development.

Integration calls for a stronger regional focus, with the end goal of creating a pan-Asia energy market. To this end, the ADB is supporting the development of cross-border energy markets and infrastructure connectivity through its regional power coordinating programmes which have already established a number of cross-border interconnections. "Smart" grids which integrate renewables into the electricity system could also help to optimise the use of intermittent resources like solar and wind, and the ADB is facilitating investments in this area. Integration also requires global resources and solutions to be mobilised for local action. With its rapidly increasing integration into the global supply chains, Asia is today both a recipient as well as a donor of both ideas and resources. The ADB, through its external networks, seeks to bring global knowledge and resources to create and adapt technologies and processes to solve Asian problems. At the same time, the best practices of

Asia have been shared with regions that are following Asia in the development curve.

In 2008, the ADB set a target of US$2 billion in annual clean energy investments by 2013. This target was met two years ahead of schedule in 2011, with investments rising to US$2.3 billion in 2012. About 59 per cent of the investments went to renewables and 41 per cent to energy efficiency measures.

Energy efficiency, with its least-cost, low-carbon potential for meeting regional power needs, is an area where Asia has substantial scope to make gains. The ADB estimates that a 1-4 per cent investment in energy efficiency – as a share of overall energy sector investment – can meet as much as 25 per cent of the projected increase in primary energy consumption in developing Asian countries by 2030. For this reason, the ADB is looking to ramp up its assistance, with a focus on demand-side interventions which reduce energy use at the point of final consumption across the residential, commercial, industrial, and public sectors. Examples include switching to more energy-efficient lighting and appliances, optimising industrial and manufacturing processes, and green building construction and renovation practices.

To drive energy efficiency activities forward, the ADB aims to enhance its technical support capacity. The bank will establish and fund a pool of energy efficiency experts under a technical assistance project, whose knowledge will help to facilitate energy efficiency interventions in developing member countries.

Next steps

The 21st century has the potential to become the Asian Century if clean energy is strategically tackled. Along with support for specific technologies and resources, we must design whole systems which capture the next level of energy savings and environmental gains. This task is especially vital in Asia's fast-growing cities, and implies a shift to mixed-use urban development, public transit and more efficient vehicles, and improved infrastructure to maximise efficiencies in buildings and in industry. Such investments, however, require an urgent shift in planning, and may necessitate additional public finance for the higher upfront capital and maintenance costs.

But for clean energy to advance significantly, we must confront the issue of fossil fuel subsidies. The ADB is now working to evaluate macro and micro impacts of removing fossil fuel subsidies in developing Asia. Such knowledge could help countries develop action plans to support the gradual withdrawal of fossil fuel subsidies as appropriate social protection measures are established. This could help level the playing field for clean energy uptake.

To establish a more effective enabling environment for clean energy, the ADB advises governments on the creation of national energy policy frameworks which support the sector's development. The bank sees a need for policy models which address the high upfront costs of some renewable energy projects, as well as transaction costs which often hinder investments in dispersed energy efficiency projects. Progress here can enhance the commercial viability of such investments.

In financing, the ADB sees an increased need for more leveraging of bilateral official sources of finance, private sector finance, and public-private partnerships. A notable example of ADB success in attracting leveraged funds is the Clean Energy Financing Partnership Facility. As of the end of 2012, it had a leverage ratio of 1:21, with US$72.3 million in cumulative commitments, resulting in the mobilisation of US$1.6 billion in clean energy investments. Another example is the Asia Solar Energy Initiative through which the ADB is looking to provide US$2.25 billion in finance, and to leverage an additional US$6.75 billion for solar power investments.

No time to waste

The need for bolder action to reduce greenhouse gas emissions was recently highlighted by sobering news from the scientific community. According to the World Meteorological Organisation, observed concentrations of carbon dioxide (CO_2) have reached 400 parts per million (ppm) at a number of Global Atmosphere Watch stations. As suggested by the US National Oceanic and Atmospheric Administration, the rate of increase now observed in global average CO_2 is 100 times faster than the increase that occurred at the close of the last ice age.

As countries throughout the world confront the threat of climate change, the challenge for the Asia and Pacific region is to transition to a low-carbon development pathway, in ways that are sustainable and secure the region's long-term economic prosperity.

In Asia, the ADB is committed to investments and approaches that deliver this outcome, and simultaneously lift millions out of poverty. It is a challenge worthy of our best efforts, and the time to act is now. ❑

Empowering women through energy programmes and initiatives

By Elizabeth Dipuo Peters
Former Energy Minister, Republic of South Africa

The Department of Energy (DoE) has embarked on several interventions to improve the lives of women in terms of job creation, decent work and sustainable livelihoods, and funding mechanisms for increasing opportunities for women's economic empowerment.

Towards this end, the DoE facilitates road shows as well as initiatives that facilitate training and information sharing for women in energy. Examples of these initiatives includes the Women in Oil and Energy (WOESA) workshops that have taken place in KwaZulu-Natal, Northern Cape, and Gauteng provinces, in which women are informed of existing business ventures and opportunities within the energy sector, as well as mechanisms for financial support and capacity building. Going forward, it is also envisaged that this venture will reach out to women in the most rural areas and provinces not yet covered.

Among the most prominent initiatives in this programme involves solar water heater geysers, in which women can participate in the installation, maintenance, and actual making of the geysers themselves. The recent audit of the 'Liquid Fuel Charter', which provides the framework for the empowerment of Historically Disadvantaged South Africans in the liquid fuels sector, also aims to provide opportunities for women within the petroleum value chain. The Liquid Fuels Charter provides women with the opportunity to grow their stake in this well established industry. Yet the current low up-take of these opportunities – as stated in the audit – is of concern to the DoE, which is looking at ways of improving the situation.

In addition to the programmes referred to, the department also recognises the importance of continuing to strengthen relations with sector partners such as Women in Nuclear South Africa (WINSA). This facilitates the acquisition of research information necessary for planning appropriate measures to realise the vision and mission of WINSA; maintains a database of all women in the various nuclear related fields; links in with the worldwide association of Women in Nuclear and contributes to public information through participation in global WIN activities.

In the quest to ensure universal access to energy that is affordable safe and cleaner, the Department of Energy has undertaken a study of India's programme for training women solar panel engineers, and training on a South African version of this is due to commence in the near future. This will be followed by a pilot and roll out of this training and job creation programme to rural women.

In August 2011, the Department of Energy launched the South African chapter of the Clean Energy Education and Empowerment Initiative for Women (C3-E) with our sector partners among the private sector, institutions of learning and research, business and NGOs. This is an initiative of the international Clean Energy Ministerial (CEM) forum. Through this initiative, the Department seeks to empower women of all ages to participate in the clean energy sector through business and professional networking, mentorship, coaching, training and clean energy ambassadorships.

According to the Clean Energy Ministerial forum, there is a well-documented gender gap in the clean energy professions, as well as in the broader science and technology fields. The numbers vary among countries and within sectors of clean energy (technology, policy, and investment, because clean energy is inherently cross-disciplinary), but it is broadly the case that more could be done to take advantage of women's potential contributions toward the clean energy questions of the future. There is also a business case for gender diversity; studies show that organisations' outcomes qualitatively improve when the leadership is composed of at least 30 percent of each gender.

Through the C3-E initiative, bursaries have been committed for girls to pursue studies in the fields of science, technology, engineering and mathematics (known as STEM). The areas of primary interest for DoE sponsored bursaries are specifically in clean energy. The steering committee and working groups on education, women empowerment, research and innovation, communication marketing and branding have developed a plan to implement integrated clean energy empowerment and education initiatives targeted at, and led by women.

Mentoring and shadowing of girls through the 'Technogirl' programme is implemented through involvement of our state owned entities and petroleum companies. In our attempt to address the challenge of scarce skills in STEM with our partners the Department continues to host the annual Learners Focus Week which is a career guidance and information session for Grade 9-12 learners from all provinces focusing specifically on the energy sector.

The Department also reaffirms its commitment to effective implementation of the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), the Beijing Declaration and Platform for Action, and meeting the Millennium Development Goals. This will be done by increasing skills development and training of young people, with a focus on girls in science and maths, and the provision of opportunities for employment and business for women in decision making positions in the energy sector. ❑

Reshaping China's sustainable energy strategy

By Changhua Wu
Greater China Director, The Climate Group

Energy is a critical pillar of any economy. Secure energy supply, clean energy production and consumption, and efficient energy use are among the most important factors to support economic growth. The world's second largest economy, China has to address the energy puzzle well in order to achieve its economic growth ambition, which is by 2020 to achieve another doubling of its economy over the 2010 level and guarantee a doubling of per capita GDP during the same period of time. A country constrained severely by energy resources, which rely heavily on coal, China faces a daunting challenge in sustainable development.

China's economic engine relies on rapid industrialisation and urbanisation and has been fueled by continual increase in energy use. China's economic growth is built upon heavy industries, including chemical industries, which are energy intensive. Industrial sectors in many regions in the country account for nearly three-quarters of local energy consumption. This further increases the burden to secure energy supply. In 2012, China's total energy consumption reached 3.62 billion tons of standard coal equivalent (tce), an increase of nearly 1.5 times from 1.46 billion tce in 2000. And energy consumption per capita reaches 2.68 tce, a level slightly higher than the world average (2.5tce) (Fig.1). China is now the world's largest energy producer and consumer.

Efficiency is one of highest priorities to address the energy security concern. During the period of 2006-2010 (the 11th Five-Year Plan period), China's energy efficiency improved by 19.1 per cent, as the average annual growth rate in total energy consumption remained at 6.6 per cent, and economic growth was in double digits. The recent global financial crisis and weak global economic recovery has hit the Chinese economy very hard. With economic growth dropping to 7.8 per cent in 2012, the annual energy consumption growth dropped to 4 per cent. If this trend holds, China's total energy consumption is expected to exceed 5 billion tce in 2020.

A fossil fuel-dominated energy structure, plus continued high-energy consumption has presented huge environmental concerns and challenges in tackling climate change. Air pollution has been spreading to most of the country, causing serious health concerns and social worries. Water scarcity in the northern part of China poses problems to fossil fuel production.

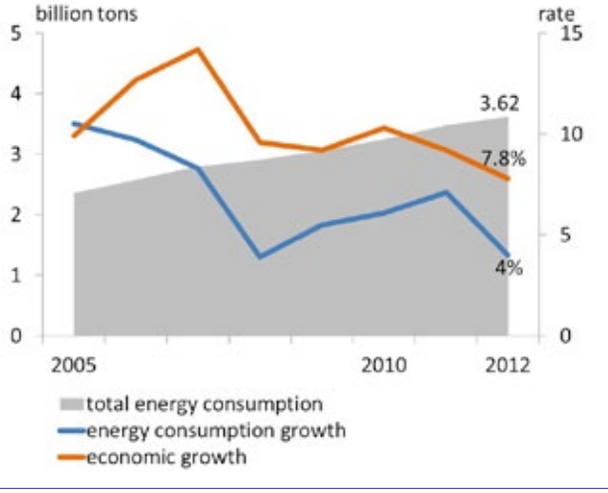
Great attention has been paid to sustainable energy development in China. While continuing its efforts to enhance energy efficiency and saving, the Chinese government has been setting clear policy targets, signaling to the business community and society that clean and renewable energy is the future of China's energy development. Strong incentives are given to drive technological innovation and to attract capital flows towards those priority sectors. Energy pricing instruments and energy-efficient labeling are in place to drive market demand for clean energy and environmentally-friendly products and services.

The first decade of the 21st century has witnessed a huge jump of investment in clean energy production and energy efficiency. Over six trillion RMB was invested in China's fixed-assets investment in the energy industry during this decade. And this has resulted in largely improved energy production capacity, outstanding improvement in energy efficiency, clean coal power generation and production of non-fossil energy sources (particularly renewable energy).

Optimising towards cleaner energy

Reducing reliance on fossil fuels while having a secure energy supply continues to be a national energy strategic priority in China. In 2006, China set mandatory targets to improve energy efficiency and grow alternative energy, particularly renewable energy. A 20 per cent energy efficiency target and a 10 per cent alternative energy target were put in place for this five-year period between 2006 and 2010. In 2011, after reviewing its experience, national government

Figure 1: China's total energy consumption ups and downs in line with its economic growth



Source: National Bureau of Statistics of China

set more ambitious targets to achieve energy efficiency and renewable energy development in the 12th Five-Year Plan (2011-2015), including a 16 per cent energy efficiency target, 17 per cent carbon intensity reduction target by 2015, and 15 per cent renewable energy target by 2020. The outcome has been impressive. The share of natural gas in China's primary energy use rose from 2.2 per cent in 2000 to 5.4 per cent in 2012, a rise of 3.2 percentage points. The share of hydropower and nuclear power rose from 6.4 to 9.6 per cent. The progress of China's energy structure optimisation is significant (Fig.2).

Renewable energy has been progressing, far exceeding the plan. As of the end of 2012, China's installed hydropower capacity stood at 249 million kilowatts, ranking first in the world, and accounting for more than 20 per cent of the world's total. Installed wind power capacity amounted to 62.66 million kilowatts, a quarter of the world's total, also the first in the world. Utilisation of solar thermal energy covers more than 217 million square metres, accounting for three-quarters of the world's total capacity. In addition, utilisation of solar photovoltaic and biomass is also developing rapidly. Driven by solar power feed-in tariff policy in 2011-2012, explosive growth of solar photovoltaic pushed new installations up to 4 million kilowatts in 2012 alone, reaching a cumulative installed capacity of 7 million kilowatts. In the meantime, China's installed biomass power generation capacity reached 8.7 million kilowatts and 50 million rural households have built biogas digesters.

Capturing the biggest efficiency potential

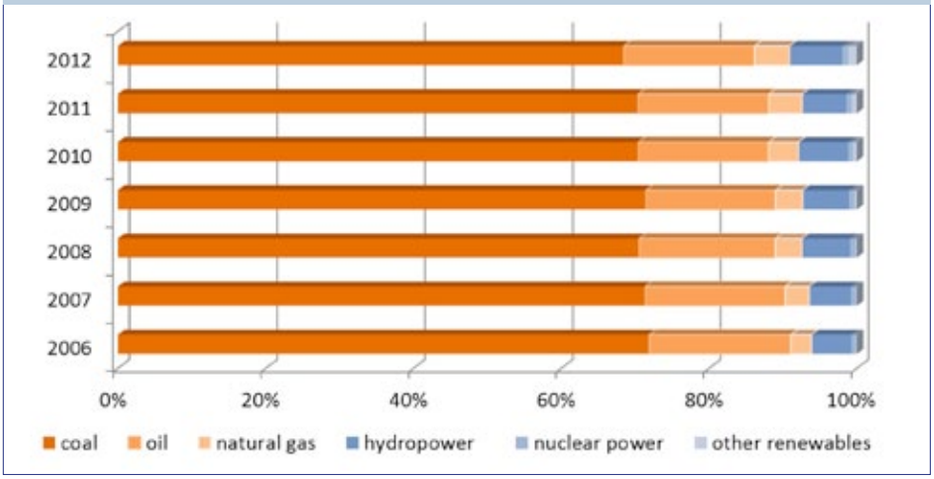
Energy saving and energy efficiency is the most cost-effective solution to energy security in China. How to capture the biggest energy efficiency potential has been a major task for policy makers. Increasingly restrictive laws, regulations and standards are required to regulate the market and give the market a clear policy signal in favour of efficiency and saving. Market-based instruments, including taxation, pricing and trading, are put in place to incentivise the development of the energy efficiency market. Innovation chases after incentives, which attracts investment. All this comes together to drive the scale-up of the deployment of products and services that are labeled as energy-efficient.

China's achievements have been very significant. The energy consumption per unit of GDP in 2012 achieved a drop of 24.2 per cent from the level of 2005, saving about 800 million tce. The implementation of a series of energy policy initiatives has definitely accelerated the shift of China's economic growth pattern. It has also played an important role in economic restructuring and industrial technology advancement. In the meantime, the general public's awareness of energy conservation continues to rise.

China is on track to decouple economic growth and energy consumption. An average annual growth rate of 6.6 per cent in China's energy consumption supported the national annual growth rate of 10.9 per cent during 2006- 2011. The energy consumption elasticity coefficient fell from the highest ratio of 1.6 during the 10th Five-Year Plan period (2001-2005) down to 0.5 in 2012. This trend will continue with further enhanced efforts and policy incentives in this decade.

Restructuring industry continues to be part of the strategy. The government has taken aggressive measures to phase out outdated production capacity that consumes lots of energy while emitting lots of pollution. When new capacity is installed, highly energy-efficient performance is required for power generation and industrial production. At national and local level, strategic emerging industries have been identified to lead China's clean industrial revolution. Energy efficiency and environmental protection, new

Figure 2: China's energy structure optimisation



Source: National Bureau of Statistics of China; BP statistical review of world energy

energy vehicles, and high-end manufacturing are given strong policy and subsidy support.

China today has some of the world's largest energy consuming industrial sectors, such as cement, iron and steel, ethylene and ammonia, besides coal and power generation. China is also the world's workshop in manufacturing low-end consumer products. Today, China has narrowed the gap in energy efficiency compared with that in some industrialised countries.

Continued improvement of energy efficiency and an increasingly cleaner energy structure has generated co-benefits in urban air quality and pubic health. It is well recognised that technological advance and innovation are key to improving energy efficiency. And we have witnessed a continuous progress in energy technology in China, especially in clean coal technologies, such as supercritical and ultra-supercritical power generation equipment, to the extent that China has started to lead in some clean coal technological areas.

China's dependence on imported energy resources has been increasing over the last two decades. This has caused considerable concern about energy security. To feed its fast-spinning economic engine, China has extended its reach to international markets for energy supply. More than 60 per cent of China's oil comes from international markets, and gradually dependence on natural gas imports is stepping up too. How to create an international context to improve China's energy security has become a major topic for decision-makers to figure out.

Challenges to sustainable energy development

Despite impressive achievements in security of energy supply, improvement of energy efficiency and development of renewable energy, China still faces a series of challenges to overcome. These can be highlighted as follows:

- The clean energy revolution has so far not been able to catch up with the continued rapid growth of energy demand fueled by the growth agenda. As a result, coal or fossil fuels continue to be the dominant source of energy in China;
- Environmental pollution from fossil fuel burning has worsened, causing increasing public health and social concerns in large parts of the country;
- Carbon dioxide emissions continue to grow and have made China the largest emitter in the world. Emissions per capita are also growing too, resulting in increasing pressure for emission reduction from the international community;
- Increasing reliance on oil and gas imports presents a severe challenge to energy security;
- China lags behind in core energy technologies, requiring further enhanced capability and capacity in innovation;
- China needs to overcome the barriers that slow down the widespread deployment of renewable energy.

Identifying opportunities for sustainable energy development

Policy incentives, if set well, create opportunities. In the past decade, the Chinese government has integrated energy reduction into its national five-year Plan and long-term development strategy. China has revised its "Energy Conservation Law", issued a "Renewable Energy Law", revised the regulatory system, developed a series of departmental regulations, and introduced pricing, taxation and other supporting policies. China has also made a commitment to the international community that by 2020 its carbon dioxide emissions per unit of GDP will be reduced by 40-45 per cent below that of 2005, and the proportion of non-fossil fuels in total primary energy consumption will reach up to 15 per cent.

Learning by doing has been the mode of policy experimentation in China. A wealth of experience is generated from a large number of pilot and demonstration projects to explore how to develop an energy system in a sustainable manner. A total of 178 nationwide projects, spread across 28 provinces, cities and regions, have been carried out. In 2009, China conducted energy-saving and new energy vehicle pilot projects in Beijing, Shanghai, Chongqing and 13 other cities. In 2010, China launched national low-carbon provincial and city pilot projects in eight selected cities and five provinces. Carbon trading piloting under cap-and-trade schemes is now carried out in two provinces and five cities. In addition, China is constructing solar thermal power generation pilot projects in appropriate areas such as Inner Mongolia, Gansu, Qinghai, Xinjiang, and Tibet provinces.

All these efforts and policy experimentation have increased the level of experience and confidence among policy-makers in China, continuing its journey towards a cleaner and sustainable energy future. It has also laid a solid foundation for China to set more ambitious targets towards capping its total coal consumption and greenhouse gas emissions in the coming decade. ❑

Article co-written by Yi Wang (Deputy Director-General of the Institute of Policy and Management of the Chinese Academy of Sciences), Handuo Cai (Research Manager, The Climate Group).

Marrying gas to renewables: Potential and problems

By Jean-François Cirelli
Vice Chairman and President, GDF Suez; President, Eurogas

Gas and renewables go very well together because they complement their strengths and they compensate for each other's weaknesses.

Let us consider the strengths and weaknesses of gas first: Gas is the lowest emitter of carbon dioxide (and other emissions) amongst the fossil fuels. Replacing coal-fired power stations with gas-fired power stations saves up to 50 per cent of emissions. Moreover, combined-cycle gas turbines are highly efficient. They reach fuel efficiencies of over 60 per cent, and combining them with the recovery of input fuel energy as usable heat (CHP) can lead to overall plant efficiency of around 90 per cent. Gas-fired power stations can be started up and ramped up and down rather quickly. Their construction phase is short, costs are low, and public acceptance issues are rare.

In principle, this description should make gas attractive, standing on its own. Let's look at the success story of the United States: More gas (as well as renewables and energy efficiency), less coal, lower energy costs and lower emissions. So what are the weaknesses of gas? Public opinion, particularly in the European Union, is very much in favour of renewables. The determining factors for the popularity of an energy source are no longer just security of supply, a competitive price and the most cost-efficient way of reducing carbon dioxide emissions. There is a strong desire for a high market share of renewable energy sources. Furthermore, in the longer term, the fact needs to be addressed that gas still emits carbon dioxide. This should be done by carbon capture and storage (CCS). If a truly positive framework is created for CCS, the weakness will turn into a strength, with gas continuing to form an alternative and increasing the diversity of low-carbon energy. Biogas is another avenue to address carbon dioxide emissions from gas. And finally, using excess electricity from renewable sources to produce hydrogen and synthetic methane (power-to-gas) is not just another option for gas but also a good example of the interface between gas and renewables.

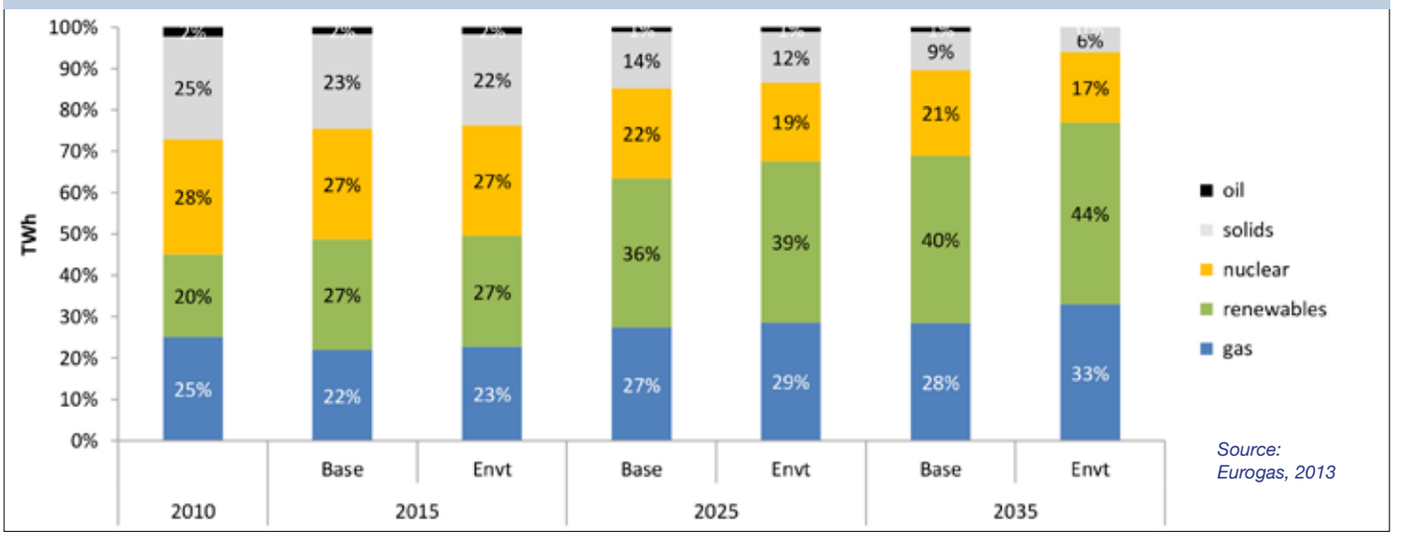
GDF Suez's onshore wind farm/gas-fired power plant at Combigolfe, near Marseilles

Photo: GDF Suez / Jamain Pierre

This leads us to the strengths and weaknesses of renewable energy sources. Leaving the discussion on biofuels to one side, their strengths are obvious: they do not produce carbon dioxide emissions, apart from those generated through the construction, transport and assembly of equipment. Renewable sources, such as wind and solar, suffer from the weakness of variable weather and hours of light and darkness. Large-scale energy storage is still an area for development, and there are limits to interconnection, including public opinion issues, and demand-side response because persuading consumers to adapt their energy consumption to availability rather than need or habit is difficult and still a long time coming. Moreover, despite the cost reductions that have already been achieved for some renewable technologies, globally they remain highly subsidised. Lack of a competitive environment for renewables has driven up the retail price of electricity in several EU Member States, much to the dissatisfaction of consumers.

Paradoxically, whilst the share of renewable energy sources has increased, so has the share of coal in some EU Member States, largely offsetting or even surpassing, in the case of Germany, the volume of carbon dioxide emissions saved by energy efficiency and renewables. The cheap coal not consumed in the US, thanks to domestic shale gas production, has been readily absorbed by the EU market where climate policy has not been able to prevent this from happening. At the same time, highly-efficient gas-fired power stations have become uneconomic, need to be mothballed or closed, and security of electricity supply is under threat due to the high share of electricity from variable renewable sources. Subsidisation of renewable energy sources and price regulation have contributed further to this situation. This is why some Member States are considering capacity remuneration mechanisms that reward the availability of

Power generation mix: Environmental case



power generation capacity rather than letting the energy-only market work via demand and supply.

Such developments can be avoided or be less pronounced if energy and climate policies are turned in such a way that competitiveness, security of supply and carbon dioxide reductions go hand in hand. Eurogas has recently calculated the outlook for power generation to 2035 in the EU based on the continuation of current policies favouring renewables in the energy mix (illustrated above).

The figure shows that gas and renewables will be able to grow together. The share of renewables will overtake the share of gas in 2015 and will rise steeply. Coal will be displaced throughout the whole period. In the more environmentally sensitive countries, these developments will be faster and stronger.

The current framework for energy and climate policies in the EU should therefore be adapted as soon as possible so as to provide a predictable environment encouraging cost-efficient low-carbon investment, including in gas solutions.

By the way, gas is not only an attractive fuel in power generation. It also performs well in heating and in transport. As a stand-alone fuel, gas is an ideal replacement for higher-carbon fuels. In transport, the gas can be delivered and stored as both CNG and LNG, the latter being ideal in shipping and trucks. But in heating and transport, too, gas can easily be combined with renewable energy sources in hybrid solutions.

A decarbonisation pathway should be technology-neutral to ensure that, whatever the need, the most cost-efficient solution wins and new technology replaces outdated technology. A meaningful economy-wide greenhouse gas reduction target is necessary, as well as a robust emissions trading system in which the price of carbon dioxide influences the choice of low-carbon energy over higher-carbon energy. Under such a system, the strengths of renewable energy sources will pay out without the need for subsidies. Conventional as well as unconventional gas resources, exploited at the highest safety and environmental standards, should not be left in the ground but made available to increase supply and diversity. Capacity remuneration mechanisms can be an effective means to address security of electricity supply where current market distortions cannot be removed quickly enough. Research, development and demonstration of low-carbon solutions should be strongly supported, again in a technology-neutral way.

There is no doubt that the potential for marrying gas to renewables is large and can be fully realised. Together they can provide a diverse and flexible energy mix for a competitive and secure low-carbon energy system. The energy industry is ready to do so, but needs to be reassured by a predictable policy framework that its investments will not be in vain. The sooner this is done, the sooner the tide can turn and extra costs can be avoided. ❑

Focussing on Latin America's energy development needs

By Enrique García Rodríguez
President, Development Bank of Latin America (CAF)

More than four decades ago, CAF was set up as a small financial institution by six countries from the Andean sub-region. Through the years it has become a leading Latin American multilateral development bank, expanded to 18 countries (16 belonging to the region plus Spain and Portugal). During the last five years it has approved operations in the amount of US$47 billion and today it is one of the principal sources of multilateral financing for Latin America and the main source for infrastructure and energy development.

The substantial increase in its operations has made possible the financing of initiatives considered strategic by its shareholder countries, as well as those initiatives that strengthen regional integration. Based on a comprehensive development agenda, the Institution works hand in hand with countries to give them support, not only through loans and other financial products, but also through advisory services, sharing with them the knowledge and expertise attained over the last 40 years.

Thus CAF's comprehensive development agenda seeks to achieve sustainable and good quality growth, fostering social inclusion and reducing inequality, while respecting cultural diversity and protecting the environment.

Without a doubt, macroeconomic stability is a necessary condition for everything else to work. But it is not enough if structural changes based on the transformation of the manufacturing base of the country are not also introduced. This implies a transition from a development model that emphasises exploitation of raw materials to one that incorporates technology and innovation to create added value and, consequently, better jobs, better salaries and a better quality of life.

From CAF's perspective, this transition requires, in turn, intelligent international integration; the strengthening of the quality and transparency of institutions, and investment in all forms of capital, including physical infrastructure, social and natural capital.

CAF's approach to energy is derived from these directives and principles, as well as from its unique condition of being a development bank *of* Latin America and *for* Latin America, with an important and growing role in the promotion of the region's social and economic development.

These guidelines are aligned with CAF's effort to produce a catalytic effect, through mobilisation of financial resources, organised along strategic lines of action to support countries in energy matters.

Latin America has an abundance of energy resources, both renewable and other, which makes the region especially attractive for investment. However, its energy resources are distributed unevenly among its countries and sub-regions. Regional integration and source diversification, therefore, are important issues in this context. There are important achievements in regional integration. The electrical interconnection, for example, in 20 years has experienced a growth from 500 MW to 5,000 MW. But there is still a lot more to be done in integration.

To give an idea of its energy achievements, challenges and potential, Latin America has 20 per cent of the world's proven oil reserves, four per cent of its natural gas reserves and two per cent of its coal reserves. Venezuela, Mexico and Brazil are the leaders in oil production; Bolivia and Peru in gas; and Colombia in coal.

Half of Latin American electricity output is hydroelectricity. Hydroelectric energy is dominant in most countries, with a total of around 320 GW of installed power, and its development potential is still high. It has been estimated that only 23 per cent of overall potential has been developed, but environmental considerations may hinder its exploitation.

The region has one of the cleanest energy mixes in the world, having, besides hydroelectric energy, great potential in other renewable sources. Biomass is highly relevant in Brazil, both in transportation and in the electricity sector. According to some estimates, the biomass cogeneration potential in Brazil would be enough to feed half of the required increase in the country's generation power for the next ten years. Other countries like Uruguay, Ecuador and Colombia have also shown significant advances in biomass development.

Wind energy has recently been experiencing tremendous growth, led by Brazil, with the execution of successful lease auctions. Mexico and Uruguay have also announced major projects in this area. Other countries may follow their lead. Very conservative forecasts estimate that the wind potential is around 330 GW.

Solar energy has high potential for the medium- and long-term potential, but is still little used. Cost reduction would increase its usage, starting especially in remote and isolated communities and spreading later to cities.

Geothermal energy has been used primarily in Central American countries, but also shows potential in countries such as Bolivia and Chile. Nuclear power, especially new generation reactors, can in the future assume central importance in some countries.

In summary, hydroelectricity, natural gas and oil will be, in the medium term, the driving force of energy supply expansion. The new renewable sources, led by biomass and wind, will gain increasing significance. It is important to stress that no single energy source will solve the energy expansion needs. Access to energy services is good in the region, although not in the rural areas of some countries. So, universal coverage and quality remain a major challenge.

Multiple forecasts indicate that the region faces growing energy demand. Energy demand grew by 31.36 per cent during 1990-2000, and 34.23 per cent during the decade of 2000-2010. Given this situation, there is a need for several countries within the region to increase their energy supply, especially in electricity, natural gas and petroleum products. The region will require significant investment in energy infrastructure over the next 20 years of between US$1-2 trillion, according to some estimates. Various sources of funding will be needed. Social policies, regulation and tariffs should be coordinated to attend to the payment capacity of users. In the case of subsidies, transparency and targeting resources to specific segments of the population should be promoted. The energy issue also plays an important role in environmental challenges, where it appears both as part of the problem and as part of the solution.

CAF's proactive role in energy

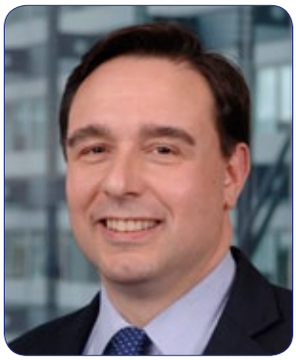
CAF has reserved an important role for the energy sector in its projects and investments. Over the last 15 years, CAF has approved 135 projects, for a total of US$11.6 billion dollars. In many Latin American countries, CAF is the main financial source for the sector and, overall, it is the main multilateral source of energy financing in the region.

In CAF's portfolio, energy projects are in excess of almost US$5 billion dollars, which represents around 28 per cent of its total portfolio. Around 50 per cent of the projects are related to electrical generation, among these projects the majority (65 per cent) are for renewable energy sources, with hydropower in the lead.

According to CAF's forecasts, based on national energy development plans and investment announcements from the private sector, the region requires around US$71 billion dollars a year in energy infrastructure investment. Within this total the oil sector demands a yearly amount of around US$39 billion dollars, followed by US$26 billion for gas and US$6 billion for the electricity sector.

These increasing requirements of energy supply underline the relevance of a development bank with CAF's credibility. The use of its resources, based on its knowledge of the energy situation of Latin American countries, anticipating demands without imposing an agenda, and stimulating, whenever possible, regional integration, are, in a nutshell, CAF's main challenges in this field. ❑

Half of Latin America's electricity is hydroelectricity



Promoting a private sector approach to sustainability

By Riccardo Puliti
Managing Director for Energy and Natural Resources, EBRD

It might be difficult to imagine that Mongolia, sitting on one of the world's largest reserves of coal, would bother investing in wind farms. And yet the country's first wind farm – and also the first private generator in the country – has just started producing electricity.

The world of energy changes daily. In this whirlwind climate, how can an institution like the EBRD formulate an energy policy for the next five years? The answer is by sticking to principles that will remain relevant, whatever the new energy fad, and being inventive in how we follow these principles.

In 2012, the WEC highlighted the "trilemma" facing the energy sector: security, affordability and sustainability of energy supply. A country needs to ensure a stable supply of energy at a price which keeps its citizens warm and its industries competitive, and which does not ruin the country or planet for their children. The EBRD's way of responding to this trilemma is rooted in our mandate: to promote market-oriented economies and private sector participation. We believe that private sector companies can find an optimal balance of security, affordability and sustainability, and in this article I will talk about EBRD-financed projects that demonstrate this balance.

But first, some words about the EBRD's energy portfolio and strategy.

Over the last seven years, the Bank has invested approximately €8.3 billion in the energy sector. Of this, €2 billion went to renewable energy generators, including the two largest wind farms in Turkey, the first ever wind farm in Mongolia, and recently the first solar project for the EBRD, near Vinnytsya in Ukraine. Under our Sustainable Energy Initiative we have invested over €11 billion since 2006, helping countless businesses and families save energy.

We also support smart distribution grids, transmission lines and generators, which are required to back up intermittent renewables. Under the Sustainable Energy Initiative we help raise energy efficiency and safety standards in the energy and other sectors.

We also always look for projects which will help our countries of operations diversify their energy supply; two examples are the financing of underground gas storage in Serbia, and the first Liquefied Natural Gas plant in emerging Europe, on Poland's Baltic coast.

Importantly, the EBRD is not only a financier, but also an enabler in the energy sector. We engage in policy dialogue and provide technical cooperation. For example, we supported Kazakhstan in developing its power market structure, legislation and framework conditions to incentivise renewable energy. We did similar work in Ukraine, where we supported the drafting of legislation for renewable feed-in tariffs. In the Western Balkans the EBRD supported the development of a regional power market.

The EBRD invested in building Mongolia's first ever wind farm at Salkhit

Photos: Newcom

The new EBRD energy strategy will set out the Bank's role in the energy sector for the period 2014-18. It is clear that we will be operating in a new environment. Over the last several years we have seen significant policy shifts on nuclear energy right around the world, while we have seen dramatic growth in US unconventional oil and gas production. Climate change has become an ever more pressing concern, but CO_2

prices in carbon markets remain very low. The global growth of renewables has brought both innovation as well as technical challenges (including issues such as pricing, grid, reliability of supply and the legal environment). The global crisis has squeezed money for infrastructure. In this new reality we will provide even more support to private sector companies looking for solutions to the trilemma of security, sustainability and affordability.

All three of these issues are at play in Turkey. Imported hydrocarbons – on which this sixth largest energy market in Europe relies – lead to high electricity prices and a current account deficit. We believe the answer to that issue is more efficient use of fossil fuels and an increase in domestic renewables generation. A recent EBRD loan financed the building of a state-of-the-art CCGT (combined-cycle gas turbine) plant in Kirikkale, outside the capital, Ankara. The plant will use the newest technology, and will boast the lowest carbon emission factor of any fossil fuel power plant in Turkey, and among the best in the world. The project, which includes replacing some old lignite coal units, is expected to cut carbon emissions by 1.5 million tonnes of CO_2 annually. The plant will also be very flexible and will therefore have the capacity to support renewables generation.

Another excellent example of the private sector leading the way in finding an answer to the energy trilemma is Mongolia's first wind farm, Salkhit. The wind farm, located 70 km from Ulaanbaatar, went on-stream in June, and will eventually provide about five per cent of the country's electricity needs. To fully appreciate this achievement it needs to be understood that Mongolia has not built any new power generators for decades. Salkhit is not only the first commercial wind farm and the first privately owned power generator in Mongolia, but it is also the first generator of any kind that has been constructed since the fall of communism. The idea for the project was conceived by the local technology holding company, Newcom. The EBRD provided some early equity to the project, and last year it attracted an impressive US$ 122 million from the Bank and other financiers for the construction of the massive wind farm. Mongolia is experiencing rapid growth, but it is starved for energy, which it must import, with blackouts regularly affecting businesses and homes. The EBRD stands ready to support new power generation projects throughout the country.

And of course energy security is very important for the EBRD region, where countries are often tied to a single source of gas. When we financed the first LNG terminal in Poland – in fact the first LNG terminal in eastern Europe – the main goal was to enable Poland to diversify both the sources and routes of its gas supply (currently it gets about 70 per cent of its gas from Russia via pipelines). The terminal on the Baltic coast – a €700 million project to which the EBRD contributed €75 million equivalent in Polish zloty – will be able to re-gasify enough liquefied gas to supply 5 billion cubic metres per annum, or a third of the country's consumption. Over the past four years, the EBRD has also consistently worked on energy security issues in eastern Europe, and has invested more than €600 million in strategic underground gas storage and distribution in the region.

It can be seen that the EBRD has found many different ways to support private sector companies as well as governments in finding the best possible answer to the energy trilemma. Our new energy strategy will define further ways for us to continue this work in the ever-changing energy environment. ❑

Finished in 2013, Salkhit will provide 5 per cent of Mongolia's electricity

Changing prospects for Russian oil and gas

By Dr Tatiana Mitrova, Head of Oil and Gas Department
Energy Research Institute of the Russian Academy of Sciences

Russia is one of the world leaders as far as crude oil and natural gas production are concerned and it plays the key role in the international hydrocarbons trade. In 2000-2010, the country had been dynamically raising its exports – oil exports grew by 70 per cent, while gas exports increased by 15 per cent during the same period. Oil production increased by more than a half and exceeded 500 million tons per year, annual gas production increased by 10 per cent. The revenues from oil and gas exports reached more than a quarter of Russia's GDP and amounted to one-third of the country's budget.

Now, however, the Russian oil and gas industry is entering a new stage of its development. These changes are the result of the coincidence of several factors: the global economic crisis and the demand slowdown in domestic and foreign markets, the US shale revolution, increased supply of hydrocarbons, the depletion of the Soviet era's cheap fields and the necessity to explore new hard-to-reach and expensive-to-develop oil and gas provinces. As a result, the oil and gas industry is going through a difficult transition period, the success of which would define not only Russia's position in the global energy market, but also its economic welfare.

Changing external environment

The new *Global and Russian Energy Outlook up to 2040*, prepared by the Energy Research Institute of the Russian Academy of Sciences (ERI RAS), assesses how recent global energy market trends affect Russia's energy sector and economy. The situation is really becoming less favourable:

- The consumption of primary energy in the world will increase by 1.1 per cent per year on average between 2010 and 2040, which is significantly slower than the growth in energy consumption seen for the last 30 years. OECD countries (the most mature and lucrative markets) will only increase their energy consumption by 3 per cent by 2040.
- The development of the world's energy trade will continue against the background of North America's growing self-sufficiency, due to unconventional oil and gas resources.
- Different types of unconventional liquids will cover more than 70 per cent of the incremental supply on the liquid fuels market. Unconventional oil (shale oil, tar sands oil, etc.) will reach up to 16 per cent of total production and dramatically change the entire structure of the global oil trade and pricing.
- Further expansion of unconventional gas production is expected, which by 2040 might account for 15 per cent of world gas production.
- By 2040, LNG will provide for nearly 60 per cent of the inter-regional gas trade. New major players in the LNG market will emerge (the USA and Canada; Australia and East Africa), which could significantly affect traditional pipeline exporters like Russia.
- The European market, which is key for Russia, is in stagnation with a clear decline in the consumption of liquid fuels and gas. The reduction in the domestic production volumes in Europe would undoubtedly require increased imports, but this increase will be at a much slower pace than before.
- The focus of the energy consumption growth is shifting to Asia, whose markets are very specific and where Russia lacks infrastructure and experience in commercial contact.
- There is an increased competition among the suppliers of the regional markets.

These transformations in world hydrocarbon markets bring extra risks for Russia's economy and energy sector. Russia will be more sensitive to negative market fluctuations – reduced demand, increased supply and, especially, price volatility. High costs and the current tax system hamper the competitiveness of Russian energy resources in external markets. The problem is not one of resource availability or production potential, but related to the above-ground factors: costs and taxes. It is the first time the Russian energy sector has to work under such difficult conditions.

According to the ERI RAS estimates, the potential decrease in revenues from gas exports – and even more, those from oil exports – could reduce the contribution of hydrocarbon exports to GDP by a third. Strong multiplier effects peculiar to these industries, and a decrease in the flow of foreign capital, might significantly enhance the impact of this decrease in export earnings, and reduce the development of the economy by one per cent per year.

Changing internal situation

The domestic market is undergoing dramatic changes as well. On the one hand, the slower development of the national economy leads to the inhibition of industrial production and domestic energy demand. On the other hand, the Russian oil and gas sector is now coming to the point of exhausting the capacities created in Soviet times. Most Russian production is based on the discoveries made during the Soviet era – 90 per cent of Russia's current oil oil is from fields discovered prior to 1998.

The situation is aggravated by the fact that newly-

discovered oil fields are located mostly in remote areas with severe climatic conditions and other difficulties. Therefore, significant investments are required to develop them. Further, the production dynamics would depend largely on companies' ability to introduce new fields into operation in due time and the pace of introducing state-of-the-art technologies to maintain production levels at existing fields.

For the Russian oil industry, the major challenge is the big decline in the production rates in the existing oil fields. In the 2000s, the pace of this decline significantly increased, reaching an annual rate of 11 per cent. To maintain the production volumes, it is necessary to constantly introduce new fields into development. In the recent past, this was achieved by the development of such fields as the Vankor, Talakan, and Verhnechonsk fields. However, to overcome this natural annual production decline in the future, it is necessary to introduce 3-4 fields into operation, each of them equal to the Vankor field in size.

In these conditions, one of the main ways to maintain the level of oil production in Russia would be the increase in oil recovery from the existing fields. Currently, the country's recovery factor of 20 per cent puts Russia well behind such countries as the US (43 per cent) or Norway (50 per cent). A recovery rate raised to these levels would add significant reserves, which furthermore are located in areas with existing infrastructure. However, the use of tertiary oil recovery techniques is not cost-effective under the existing tax regime.

The development of stranded oil reserves (in the first place – the Bazhenov shale oil) and the Arctic shelf may also contribute to the stable production. However, these are long-term projects, which would not pay off before the end of the 2020s. They would also require the development of major technological competencies, greater involvement of foreign partners, as well as creating a favourable regulatory environment (low taxes and ease of access) that are currently not in place.

The gas sector undoubtedly has capacities for sustainable production growth. The resource base is trouble-proof and sufficient to meet the domestic and export demands. But the main hindering factor here is the demand. The gas sector, like the oil industry, currently faces a rapid decline in production from existing fields, and to compensate for its falling volumes, it will be necessary to develop new huge and expensive fields in Eastern Siberia (Chayanda, Kovykta, new fields in Sakhalin) and in the Arctic (Yamal, Shtokman).

How can Russia cope with these challenges?

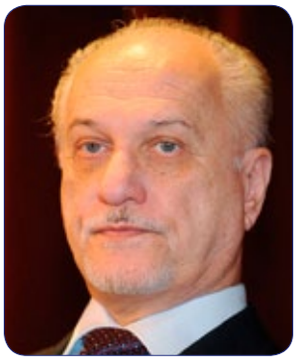
A truly effective means of countering external challenges would be a dramatic increase in both the investment efficiency of the Russian energy sector and in the energy efficiency of the economy as a whole. Russia has unique potentialities in respect of both these courses of action. Indeed, the Russian energy sector has already undertaken huge capital investments, which will grow in accordance with approved plans to reach an unprecedented 6-7 per cent of GDP (the global average is about 1.3-1.5 per cent of GDP). However, Russia's national economy has one of the world's lowest ratios of GDP output per unit of consumed energy (three times less than the global average). The elimination of such wastage is becoming critical now.

Another chance to increase competitiveness of the Russian oil and gas sector is a radical reduction in the costs of investment projects, together with a thorough evaluation of their cost-effectiveness and potential risks. It is necessary to rank all investment projects and reject or postpone the implementation of inefficient ones. This is confirmed by the results of work done by foreign and Russian experts, who analysed the cost of domestic energy projects, showing that they were typically several times more expensive compared to similar projects elsewhere, while those projects that were completed were underutilised for years.

Not surprisingly, even official scenarios of the Energy Strategy, produced in 2009, predict just a slight increase in energy exports by 2020, followed by stagnation and decline in total export volumes. According to the Energy Strategy, the volume of oil and petroleum product exports will fall, while gas exports (especially LNG) will rise, gas production will exceed 900 bcm per year by 2030 and oil production will stabilise at close to current volumes – 500m tons per year.

According to the ERI RAS estimates, due to external constraints, Russian oil exports would only grow slightly over the next decade and reach their peak in 2020-2025. Afterwards they would face a sharp decline, if the country were not to adopt major tax reforms, review the priority of projects and introduce strict cost control. By 2030, oil production could be 15 per cent lower than in 2010.

The gas sector is expected to show steady production growth, albeit at a slower pace than previously predicted. By 2030, production would rise by 20 per cent, and export volumes by 12 per cent (mostly, towards Asia). However, even with these more modest production and export volumes, Russia will remain the world's largest hydrocarbon supplier. ❑



Re-launching Iraq's energy sector

By Dr Hussain Al-Shahristani
Deputy Prime Minister for Energy, Republic of Iraq

Iraq's overall economy is closely linked to the performance of its energy sector. Both have suffered from 40 years of intermittent warfare and international sanctions. About 90 per cent of the federal government revenues come from oil exports. Therefore Iraq's prosperity depends on a sustained revival of oil production and prudent use of the wealth it creates.

Iraq today has oil and gas reserves that rank among the world's largest, yet the infrastructure, needed to take advantage of these resources, is inadequate, industries that depend on these resources are not yet developed, and Iraq's electric power system is unable to meet demand.

All the components of Iraq's energy sector, upstream and downstream oil, natural gas, power and linked industries need to be developed in a coherent, sustainable and environmentally-friendly manner to meet domestic energy needs, foster growth of a diversified national economy, improve the standard of living of Iraqi citizens, create employment, and position Iraq as a major player in global energy markets.

The upstream oil sector

In the last four years, Iraq has taken major steps to increase oil and gas production. Most importantly, the federal government has awarded 12 technical service contracts through highly transparent and competitive international bids received from several international oil companies.

The issue of Iraq's future sustained production capacity was a subject of a thorough study both by the Ministry of Oil, field operators and international consultants. Many factors were examined both technical and economic and a range of production profiles were considered from 'high' at 13.5 million barrels a day (mb/d), through 'medium' at 9 mb/d and 'low' at 6.0 mb/d. The 'medium' scenario of 9 mb/d to be reached by 2020 and sustained for 20 years was chosen, since it met the five strategic objectives that were put for the energy sector: energy security; government value maximization; economic diversification; employment generation; and environment sustainability.

The downstream oil sector

The downstream oil sector comprises three broad activities: commercializing crude oil for export; refining crude oil into oil products for domestic use and export; and distributing refined oil products to domestic customers.

Iraq has contracted to build 5 singe point mooring terminals (SPMs) and associate sea lines, and to rehabilitate its two oil export terminals in the northern Gulf to enhance its export capacity from the south to 6 mb/d by 2014, as the Asian market is expected to show largest growth in demand and offer Iraq the highest return.

SPM terminals are floating buoys that can service tankers moored farther away from the Gulf coast, and they will give Iraq more export capacity, in particular the ability to increase shipments from the country's southern oil fields.

We are also considering building a new system of pipelines to the Mediterranean across Syria and to the Red Sea through Jordan, in addition to the existing 1 mb/d pipeline across Turkey. This will provide flexibility to manoeuvre by pumping oil from the south all the way to the Mediterranean.

Also in order to avoid compromising our recognised brands of light crude oil from Kirkuk and Basra, we plan to segregate the heavier grades of crude oil that will be tapped as production increases, and build separate pipelines and export facilities for the light and heavy crudes.

Oil refining sector

Approximately 20 per cent of Iraq's current crude production is refined into products for domestic consumption. Iraq has major refineries in three locations with aggregate design capacity totaling 900,000 barrels a day (b/d), but the components of demand and production are not aligned. The Iraqi refineries produce far more fuel oil than Iraq can consume, and the excess is simply blended back into crude oil. On the other hand, these refineries produce less gasoline, gas oil and liquefied petroleum gas than needed domestically resulting in substantial import requirements.

The rising demand for high quality refined products represents a challenge to the energy sector. To address this shortage, four new refineries with total capacity of 750,000 b/d are planned to be built. The Ministry of Oil has already invested in front end engineering design (FEED) work for these refineries to define the needs in terms of size, crude and products specifications and the degree of complexity of each refinery. These refineries are offered for investments with substantial incentives under Investment in Refinery Law No. 64 and the Investment Law No. 13.

The natural gas sector

Iraq estimates that it holds approximately 3 trillion standard cubic metres (tscm) of natural gas reserves which makes

it the twelfth largest holder of conventional gas reserves in the world. Large areas of the country with good potential for gas have not been explored. With this additional potential, Iraq's total gas reserves could be as high as 7.5 tscm, placing Iraq among the world's top five holders of conventional gas reserves.

As we ramp up crude oil production, associated gas production will increase as well. The newly established Basra Gas Co. is tasked with the collection and processing of most of the gas that will be made available from the three major oil fields in the south of Iraq with the objective to minimize, and eventually stop, flaring. All new oil fields under development will have facilities to process, compress and transport the associated gas and no flaring is allowed under technical service contracts that were signed with the international oil companies.

The demand for natural gas is expected to increase significantly for power generation and also chemical industries such as the petrochemicals and fertilisers which shall use gas as a feedstock. In the long term, Iraq aims to become a natural gas exporter once the domestic demand is satisfied and we start witnessing excess production capacity from both associated and non-associated gas. In the coming months, there will be a bid round targeting exploration for free or non-associated gas with more attractive terms than in the previous rounds.

The power sector

Iraq suffers from shortage of electricity due to the large gap between supply and demand due to low production base after the fall the old regime and rising demand with annual growth rate of 10 per cent. The shortage imposes major costs on the economy due to lost production time, damage to capital assets from power interruption and an inability to carry on normal commercial process on a reliable schedule, in addition to imposing hardship on the citizens.

This shortage is due to a variety of system deficiencies, and the first step taken to overcome that was signing contracts to add 40 new plants which will be built and put into operation by 2015 adding some 20 GW of production capacity to the existing 10 GW. Most of the new plants are gas turbines and the next step shall be upgrading them to combined cycle which will add another 8 GW.

We also intend to encourage the private sector to operate as independent power producers to keep pace with demand growth which is expected to grow at 10 per cent annually.

The linked industries

Six industries have been chosen to be simultaneously developed in our energy development strategy. These include: petrochemicals, fertilisers, steel, aluminium, cement, and bricks. Each of these industries consumes large quantities of energy in the form of power, or heating fuel in the production processes, and two of these industries (petrochemicals and fertilisers) require large quantities of natural gas components (methane and ethane) as feedstock.

Today these six industries are underdeveloped and most of Iraq's demands are met through imports. With Iraq's energy resources and potential these industries can be quickly developed to meet all of Iraq's needs and enter the export market.

For the petrochemicals, the domestic demand is 200,000 tons per year which is almost entirely imported. Under our National Energy Strategy Plan, substantial investment will be made in petrochemicals, bringing total capacity to about 16 million tons per annum (mtpa) by 2030, or an increase of 80 times.

As for fertilisers, Iraq has three fertiliser plants with a combined utilised capacity of 0.3 mtpa, which is about half of Iraq's domestic demand for fertilisers. This plan is to increase fertiliser capacity to about 6 mtpa by 2030 to meet global rising demand which is estimated to expand at 5 per cent annually for the coming 20 years.

Institutional reforms

Iraq's energy sector requires fundamental institutional reform and the institutional challenges fall into two time-frames: short term and medium to long term. For the short term, the paramount challenges concern implementation of the field development plans agreed with the international oil companies by streamlining bureaucratic procedures.

For the medium to long term, Iraq's energy sector needs to adopt institutional reforms that are needed to oversee lasting growth and value creation by legislating new Hydrocarbon Law and re-establishing the Iraqi National Oil Company to operate as a commercial entity overseeing oil production and marketing.

As Iraq implements its National Energy Strategy Plan and re-launches its energy sector, it will emerge as a major producer of oil, gas and petrochemicals, and the world can count on it as long-term dependable supplier of these products. ❑

Standardisation, serialisation and international development of third generation nuclear power

By Wang Binghua
Chairman, State Nuclear Power Technology Corporation of China

In China, the important role of nuclear power is not only demonstrated in optimising energy structure, ensuring energy supply, and combating climate change, but also in accelerating technological innovation, promoting industrial modernisation and stimulation of economic growth. After the Fukushima accident, the Chinese government continues to adhere to the principle of "efficient development of nuclear power on the basis of ensuring safety." Following nuclear safety inspections, research and studies for a year and a half, in 2012 the Chinese government issued a national plan for nuclear power safety development and clarified the future size, safety standards and technology choice of China's nuclear power programme. The plan has three key points. First, by 2020 China will have 58 GW capacity installed and another 30 GW under construction. Second, new nuclear power projects will comply with the world's highest safety standards. All new-build needs to meet 'Gen III' nuclear power safety standards. Third, on the basis of the introduced AP1000 technology, the main technology choice for new nuclear power projects should be passive safety Gen III nuclear power technology.

China's endeavour to develop safe and efficient nuclear power is important for world nuclear power development at large. The State Nuclear Power Technology Corporation (SNPTC), as the main entity responsible for introducing, assimilating and re-innovating Gen III nuclear power technology, would like to share with the world three messages on China's Gen III nuclear power development model:

First, we will adhere to standardisation. Standardisation is an effective way to improve nuclear safety and economics. In China's nuclear power construction process, the government nuclear safety regulators, owners and operators, equipment suppliers, construction and installation businesses and operation service providers generally want to have a standardised design model.

On the basis of the introduction of AP1000 technology and construction of self-reliance supporting projects (Sanmen Unit 1&2, Haiyang Unit 1&2), China's domestic AP1000 standard design has been formed. The follow-on development will be continuously upgrading and the level of standardisation will be constantly improved following the principle of "develop one updated design after building a number of projects, and develop another updated design after building another batch of projects."

The Chinese government department in charge of nuclear power and nuclear safety regulators gives policy support for nuclear power projects adopting a uniform standard design. China's nuclear power industry will build a unified standard Gen III passive nuclear power plant design platform to share standard design results and improve standard design jointly.

Second, we will adhere to nuclear power development in series. On the basis of the introduction of AP1000 technology and the construction of domestic AP1000 units, China will also provide "large" (LPP) and "small" (SMR) models to meet different customer needs and different nuclear power plant site conditions.

Development of large passive nuclear models is mainly based on the following considerations: quality nuclear power plant resources are becoming scarce; development of new nuclear power plant sites will be under increasing public pressure; large nuclear power plant units boast lower construction cost and better economics. Currently, development of large Gen III passive nuclear power plants (CAP1400/CAP1700) has been listed in China's national major science and technology programme. Development of small passive modular reactors (SMRs) is mainly based on flexibility and mobility of the layout, construction, transportation of this model, as well as the special needs for small-capacity power grid in remote areas.

Third, we will adhere to international development. China's self reliant development of nuclear power is an open, cooperative, inclusive and win-win system. Continuous and lasting cooperation with the technology originator is a business concept that SNPTC always upholds.

China's AP1000 self-reliance supporting projects and CAP1400 demonstration project is a cooperative project for multiple parties, including Sino-US companies and enterprises in South Korea, Japan, Italy, Spain, Germany and other countries. Currently, on the basis of existing cooperation, the parties are expanding cooperation in joint research and development of nuclear power technology, joint development of international market and building global supply chain, promoting nuclear power industrial standards. These partnerships will provide opportunities for international partners' in-depth and continuous participation in the Chinese market and common upgrading of the competitiveness in the global market.

Meanwhile, the SNPTC will continue to share its industrialisation experience, to strengthen technical and marketing cooperation and to realise common development of nuclear power with global peers and developing countries. ❑

The final word

By Marie-José Nadeau
Chair, WEC and Secretary General, Hydro-Québec

Every three years, the World Energy Congress brings together people involved in energy from across the globe. Daegu 2013 is no exception, with specialists and stakeholders from more than 80 nations representing all activities of the energy sector. The number of participants and their range of interests reflect the continuing, indeed growing, importance of World Energy Council and its premier event, the World Energy Congress.

Despite the multiplication in recent years of international and multilateral fora in which energy and the environment are discussed, few, if any, match WEC as a non-partisan platform at which stakeholders from the world of energy can discuss future challenges and contribute to the development of sustainable solutions. WEC's unique structure, based on 93 Member Committees, allows it to reach out to every element of the energy equation, from generation to end use, technology development and environmental mitigation.

Over recent years, the World Energy Council (WEC) has witnessed a major change in the way the organisation functions. From being primarily a platform for discussion, it has emerged as a major player in the global debate through the publication of comprehensive and wide-ranging reports that can have a tangible impact on energy policy in all five continents.

Much of that pivotal evolution is owed to Pierre Gadonneix, under whose tenure as chair many of these changes have taken place. Over the past six years, Pierre has shown remarkable leadership and vision, in the process transforming World Energy Council from an organisation where policy is discussed to one where policy orientations are formulated and suggested to national governments. The fact that WEC was invited to join the United Nations' Sustainable Energy for All (UNSE4ALL) initiative highlights the organisation's growing prestige and influence.

WEC's triennial Congresses have helped to cement the organisation's global reach. Its Congress in Rome in 2007, held during a period marked by a major enlargement of the European Union, cemented WEC's role in the continent. The subsequent Congress in Montreal in 2010 resulted in renewed vigour in Member Committee activity in both North and South America, as well as a record attendance by African delegates. Of course, Asia has always been a key WEC constituent and this Congress in Daegu will doubtlessly lead to a greater focus on Asian energy, especially in the light of the appointment of my colleague David Kim from Korea as Co-Chair of World Energy Council. Looking ahead, the Istanbul World Energy Congress of 2016, at the crossroads between Europe and Asia, will certainly help WEC make new inroads in emerging regional energy hubs in Central Asia.

Increased complexity

WEC studies paint a picture of increasing complexity in the world of energy. For a start, one can see the impact of technological breakthroughs and innovation on not just the production of energy but also its conservation. However, there is increasing awareness of the effect the energy sector has on climate change, whose effects may threaten energy infrastructures which may in turn cause global geo-political instability. World population growth, economic development and changing demographic trends raise questions about access to affordable and secure energy supplies. And, finally, energy is no longer the domain of governments and specialists. There is increasing public awareness and sensitivity towards complex energy issues. In short, energy is now a complex global issue of concern to all and at the top of the public agenda.

Responding to a triple challenge

Energy has always been a valuable commodity, not just providing for basic human needs but also the base for economic growth. A single light bulb in a village in India, under which a child can do her or his homework, has as much value as a high-voltage connection supplying a major industrial unit in a developed country. Today's energy prices not only reflect that value but they also highlight the challenges for energy producers and consumers and the need to incorporate the costs of energy production and use to the environment.

We cannot allow the current global economic stagnation and consequent slow growth in energy consumption to distract us from the long-term challenge. Demographics and population growth alone will result in major challenges in terms of energy access and energy security. It is widely recognised that the world cannot continue with a business as usual scenario. Indeed, it is clear that the world recognises this and that a transformation of the energy sector is already underway. This transformation is neither linear nor uniform as each country responds to its respective reality.

But as we move towards a more sustainable energy future, it is clear that the world is facing a triple challenge that WEC describes as the 'energy trilemma', namely the need to create a policy framework that simultaneously delivers secure, affordable, and environmentally sustainable energy. Energy security, energy access, and environmental

sustainability are the three pillars of this 'energy trilemma'. Each of the three elements is vital to a healthy economic and social development of a country on the long term.

WEC recognises that each country has its own view on the relative importance of each element in the world energy trilemma equation. While all countries are right to focus on energy security as a critical factor to fuel economic growth and social cohesion, there is more variability when it comes to energy access and affordability, the energy equity pillar, and even more so for the environmental sustainability pillar.

The key strength of WEC's role is its total neutrality. The Trilemma Report does not pass judgement but provides an objective toolkit for policymakers, in the form of the Energy Sustainability Index. The Index provides public and private stakeholders with the opportunity to evaluate and benchmark their country against others in order to help policymakers identify areas where action needs be taken in line with their national priorities.

The Future Landscape

National governments and policymakers have a clear role to play in shaping how their respective energy systems evolve. However, they have to work within the constraints of certain fundamentals, not least energy availability. WEC's World Energy Scenarios gives a truly realistic indication of what the future energy landscape could look like. It gives policymakers an extra tool to plan for a sustainable energy future.

WEC's World Energy Scenarios shows that by 2050 fossil fuels will still play a crucial role in the global energy mix. Coal is also going to play an increasingly important role in the long run, especially for power generation in China and India, the two most rapidly growing energy consumers in the decades leading to 2050. Natural gas production, especially from unconventional sources, will continue to grow and account for an increasing proportion of the energy mix.

The age of oil is far from dead. Oil will continue to remain dominant as a transport fuel and we expect to see an increase in importance of unconventional energy sources – in particular oil sands, and oil shale. For its part, nuclear energy is unlikely to grow at anywhere near the levels seen in previous decades. WEC anticipates a large increase in the share of renewables, mainly in solar photovoltaic energy and hydro globally.

As the global population grows and energy consumption rises, WEC's World Energy Scenarios show that energy efficiency and energy conservation are absolutely crucial in ensuring that demand does not outstrip supply. However, the report warns that both require a change in the mind set of consumers and have cost implications across industries. As a result, growing amounts of capital will be required to finance energy efficiency measures. Typically, investments in this area can take time before they are paid off.

Electric mobility will take longer than expected to make an impact on energy demand – at the earliest after 2030. The Report warns that policy makers need to undertake an even greater effort to promote the share of renewables in electricity production, which is not increasing enough to ensure environmental sustainability in the long run.

Despite growing energy demand and continued dependence on fossil fuels, the future is not necessarily disastrous for the planet and its environment. WEC believes that a reduction in greenhouse gas emissions is possible in the second half of the scenario period, if strong global agreements and the implementation of cost-efficient market instruments like emissions trading within a cap and trade system are put in place sooner rather than later.

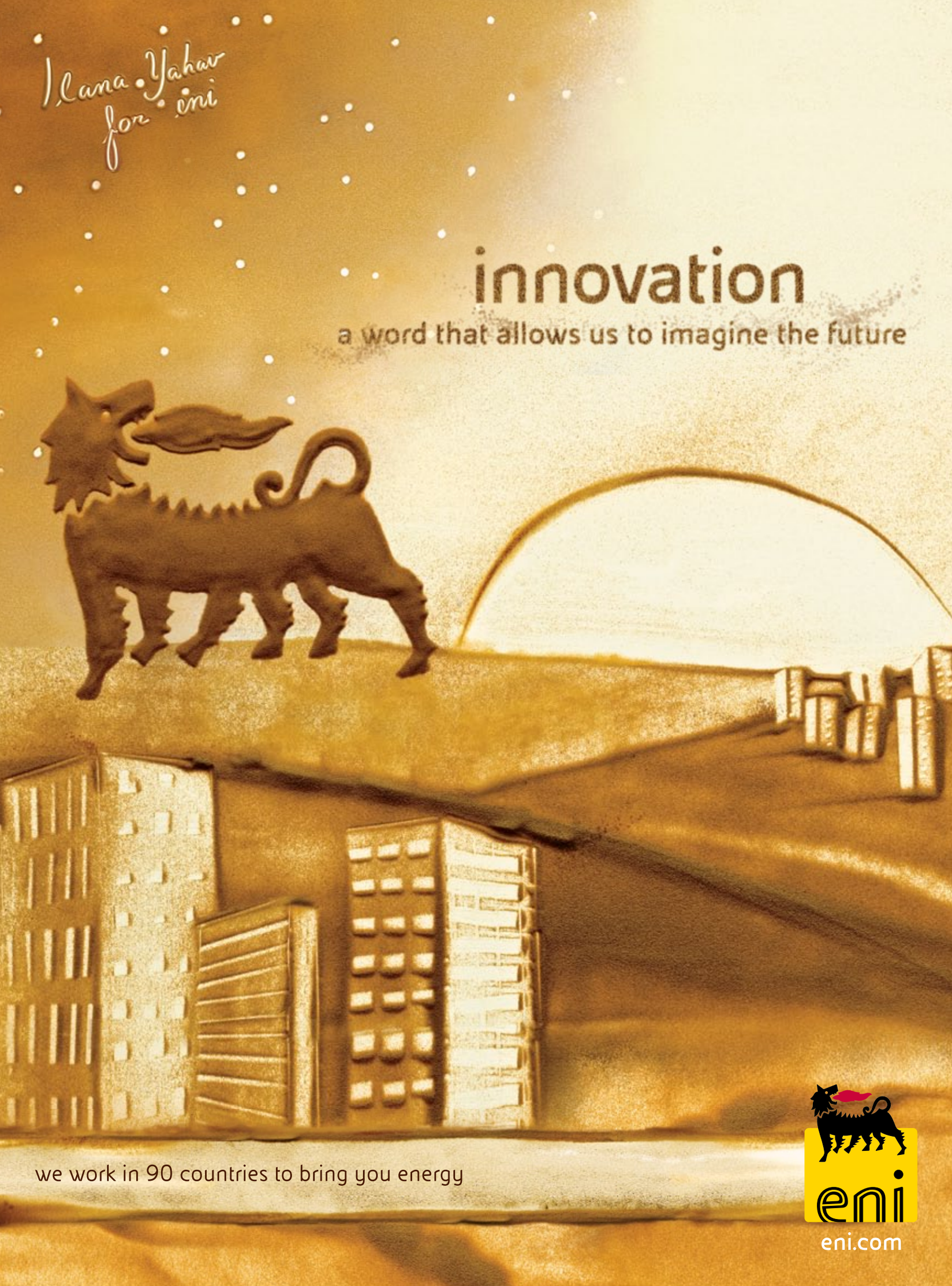
A Stark Warning

WEC World Energy Scenarios indicate that these large reductions in CO_2 are possible if and when governments take concrete action and industry players and markets are given the right incentives to provide suitable technological solutions to achieve this. However, current signals indicate that the global economy is not on track to meet the 450ppm target. We need to work harder.

WEC's World Energy Scenarios offer a stark warning to politicians: the time for short termism is over. A holistic long-term view of the energy sector is required to address these energy challenges up to 2050 and beyond. Critical uncertainties remain, especially with regard to CCS and the scalability of energy storage technologies. In this complex scenario, governments play a crucial role in determining and establishing frameworks for markets to function. Industries and markets need to provide efficient solutions.

The Way Forward

Daegu 2013 is a landmark event at which all these issues are being discussed. Of course, discussion is not enough. We need our participants – ministers, CEOs and experts – to leave us not just with concrete ideas to implement at home but fired with the necessary enthusiasm to make the tangible and lasting changes that are required for a sustainable energy future. ❑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