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

World Energy Insight 2012

Official Publication of the World Energy Council to mark the World Energy Leaders' Summit, Istanbul, 2012







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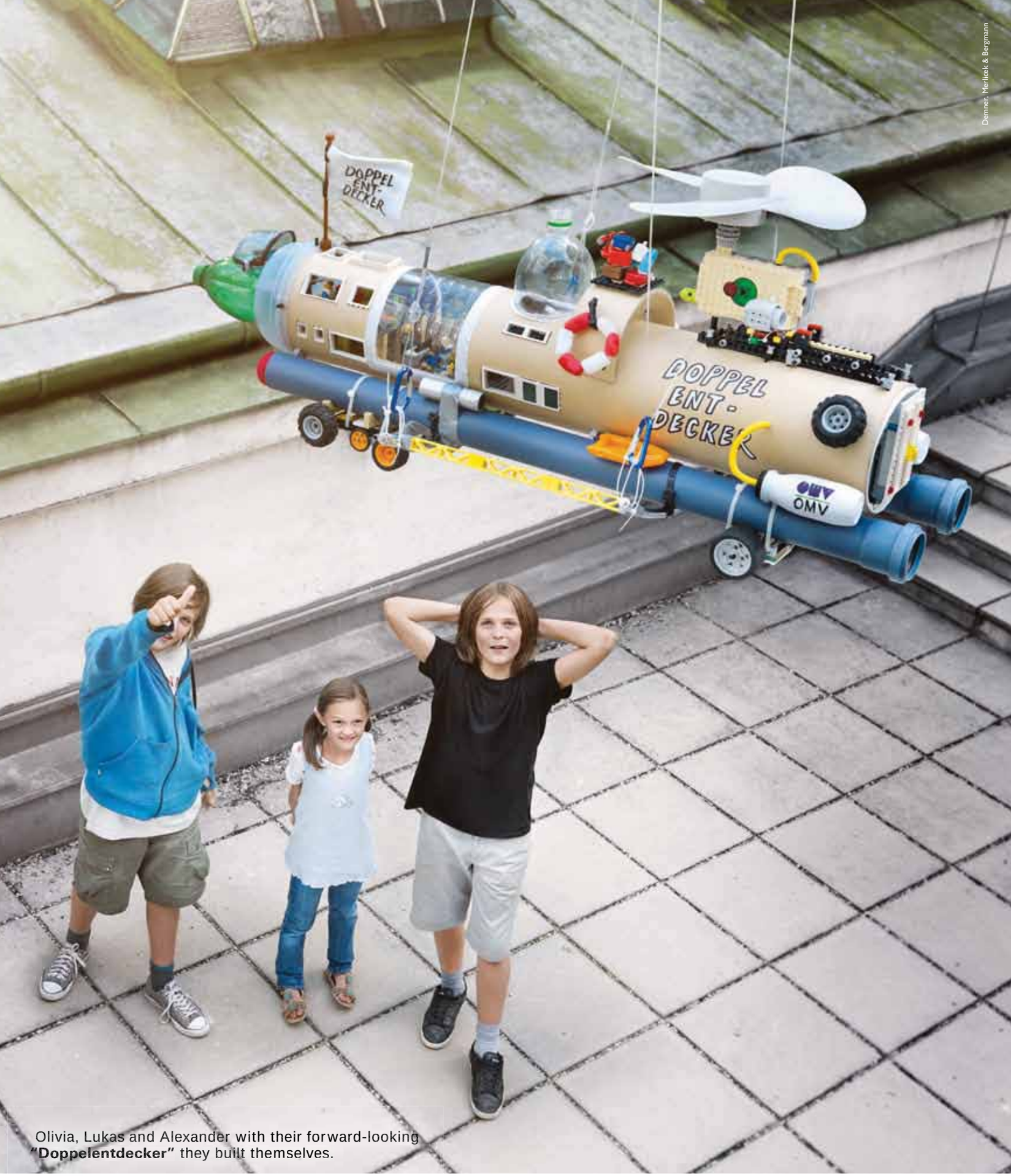

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Contents

Putting energy at the heart of the development debate

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

It is a pleasure for me to contribute to this Istanbul WELS edition of *World Energy Insight*, the World Energy Council's official publication for our energy leaders' community, providing key insights and strategic views on the global agenda.

As we produced the last edition of this publication for our Executive Assembly in Algeria last year, the pace of change in the energy sector was clearly increasing year on year. A publication such as this is therefore important for our community, as it provides us with an opportunity to take stock, to stand back and consider the progress that has been made in the last 6 to 12 months.

The state of the energy world: An assessment of the last 6 months' progress

As we look to address the issue of climate change, both our *Policies for the Future: 2011 Assessment of Country Energy and Climate Policies* report, launched in November, and the outcome of the COP 17 meeting in Durban last December, confirmed the on-going relevance and increasing urgency of finding solutions to what WEC calls the "energy trilemma". This trilemma implies meeting at the same time the challenges of growing energy demand or energy security, the protection of the environment and especially preventing climate change, and the fight against energy poverty to provide a socially equitable energy system.

The "Durban Platform for Enhanced Action" agreement reached at the COP 17 meeting in South Africa is promising, even though some major countries like Canada have left the process because it prolongs the Kyoto Protocol until 2017. This agreement will help shape the future negotiations, which above all will require countries to set targets for cutting carbon emissions by 2020, including the new big emitters such as China and India. This is the first time that practically the whole world will be in a race towards a low-carbon economy, with huge implications for the energy sector worldwide.

Nevertheless, starting in 2020 means the global community will fail to meet the challenge of keeping the global temperature increase to under +2°C by 2050. This is all the more concerning as we are already on track towards a rise of +6°C. Indeed, as our *Global Transport Scenario 2050* testifies, world transportation is still very much carbonised and this will continue to be the case for the foreseeable future. The reason is that there is still no mature alternative fuel to oil at a time when transportation, be it aviation or ground transportation, is increasingly growing internationally, driven by double-digit growth in emerging countries. What is more striking is that even with the oil price reaching more than US$110 per barrel last March, oil demand grew steadily in 2011 and will continue to grow.

On the energy poverty front, the UN Secretary-General, Ban Ki-moon, rightly reminded us in his January 2012 wakeup call in Abu Dhabi that the global population is still growing, and this increases the pressure on social equity in the energy sector. There is a real risk that 2 billion people could be excluded from the opportunities presented by access to energy. WEC, as a truly international organisation, is committed to the development of energy for the greatest benefit of all. We have an on-going commitment in our local and regional programmes aimed at relieving energy poverty. We have publically committed ourselves to the UN's "International Year of Sustainable Energy for All". I believe that WEC has a tangible role to play in promoting the objectives of this initiative and can play a leadership role in the coming years. Initiatives like our *Village Inventory* study will be significant and studies aimed at finding ways to propose smarter and innovative regulations for energy in cities, and especially megacities, will be key in relation to addressing energy poverty. We are uniquely placed to support the UN as the Secretary-General seeks to include energy in the development debate.

In respect of demand and economic growth, we continue to see that the uncertainties keep growing. The crisis in Syria that is putting the price of oil at record levels in March 2012, and the debt crisis in Europe that is threatening the whole development of the region, are two of the many economic uncertainties that are freezing investments decisions and policy changes. As WEC stated in our annual *Assessment of Country Energy and Climate Policies* and *Global Transport Scenarios 2050* study, the energy sector needs long-term vision. When the market, fraught with uncertainties, cannot bring this vision, it is the role of policy makers to provide it. Growing awareness of the energy trilemma will hopefully bring policy makers to deliver more visionary and practical regulations.

Existing paths towards improvement

As countries seek to find the right balance in the energy trilemma we have seen that many governments have reviewed their plans for the utilisation of nuclear in the energy mix. Our perspectives report, *Nuclear Energy One Year After*

Fukushima, was published on the first anniversary of the Great North East Japan Earthquake and is educational. It shows that 50 countries are still building, operating or considering nuclear, many of those being "newcomers", and that 60 reactors are currently under construction, 20 in China alone, with the majority being in emerging countries. I believe this means two things: first, that climate change is considered as a real threat and that countries envisage nuclear as an efficient means to contribute to curbing climate change, and second, the same countries believe in safe nuclear energy, and are willing to strengthen nuclear safety through reinvigorated international governance.

At the same time, we cannot stress enough the need for the world to develop new renewable sources of energy. To meet the energy supply challenge, Europe, the US and China have developed wind power on a large scale, cumulating in up to 238 GW of installed capacity worldwide, with 97 GW in Europe, including 29 GW in Germany alone. The use of photovoltaic panels to harness the energy from the sun is growing rapidly, reaching 67 GW of installed capacity worldwide, of which 25 GW will be in Germany, and approximately 4 GW in the USA and China each. These energies are destined to account for an increasingly large share of the world's total mix, provided that they are exploited in countries that have good potential. To ensure that they reach their potential, they will need to get closer to grid parity without subsidy, and the intermittency and storage issues will need to be fully resolved. I believe this is possible with targeted R&D efforts, the right incentives and a clear policy direction.

The world is also endeavouring to exploit the new unconventional resources to relieve the pressure on energy security. However, after recent debates regarding the safety conditions in respect of the exploitation of unconventional sources of energy in Europe, Canada and the United States, we see that 2 states in the USA have decided to impose a moratorium on exploitation. There is clearly further dialogue required in this area and WEC stands ready to play its part in this process. Indeed, two years after the Deepwater Horizon oil spill we were reminded of the inherent dangers in providing all forms of energy with the accident on 28th March 2012 on the Elgin-Franklin platform in the North Sea. Fortunately loss of life was averted in this instance. However, efforts must continue to ensure the safe exploitation of fossil fuels, be they conventional or unconventional.

Yet, building new infrastructure for power generation or for safer energy exploitation bears an ever growing cost. Underlying much of the debate is the need to finance the huge amounts of investment required to secure the provision of energy from clean and safe supply sources. Albeit another positive outcome of the COP 17 meeting in Durban was the agreement to the format and governing principles of the Green Climate Fund (GCF), a US$100bn annual fund to support developing countries. Now, efforts must be redirected into securing finance for the fund. During COP17, Germany and Denmark led the way in committing €55m for fast-track finance to be available to the fund from 2012. But the world must go further. As our *Assessment of Country Energy and Climate Policies* report underlines, in the current situation financing will happen only if investments are rightly made according to the inherent value of the technologies, and thus contribute to keeping costs in check.

What else needs to be done? Where else can WEC drive its efforts?

It is clear that the promotion of international trade in relation to energy goods and services would be enhanced by a specific

Almost 40 per cent of Turkey's annual exports go to fund energy imports

framework. Such a framework would allow developing countries to access clean technologies, while ensuring competition and appropriately rewarding innovation in the sector. To help further this debate we produced a report, *Rules of Trade – Energy Sector Environmental Innovation* which was presented at the COP17 meeting and to the World Trade Organisation (WTO), which was discussed during a meeting I had in March 2012 with Pascal Lamy, the WTO's Director General in Geneva. I believe that the three principles contained in this report (list of energy goods and services, principles for intellectual property rights and border tax adjustment in the energy sector) provide a sound basis to further this debate. WEC is now committed with the WTO to engage in a dialogue with all relevant parties on how to develop energy trade in a sustainable way.

As the speed of change in the global energy sector continues to increase, the relevance of WEC has never been more apparent. WEC's community of leaders and practitioners provides a unique platform for governments, private and state corporations, academia, NGOs and energy-related stakeholders to engage in neutral dialogue to promote an affordable, stable and environmentally sensitive energy system for the greatest benefit of all. We will build on our collaborations with organisations such as the WTO and the UN to encourage a clearer dialogue for sustainable energy. Our latest partnership with the World Water Council (WWC), which was agreed in March 2012 at the World Water Forum, will provide a renewed understanding of the tensions inherent in the energy-water nexus and WEC is committed with the WWC to enhance mutual knowledge and mutual works. Lastly, WEC is fully committed to engage with all countries in the debate on how concretely to enhance the safety of all energies.

These are stimulating times, and as the UN Secretary-General has recognised, WEC continues to provide leadership for the energy sector. As governments and industry explore how to best address the energy trilemma we will work through our extensive member network to facilitate the energy policy dialogue. Our 2012 Assessment of country energy and climate policies report will extensively "open the floor" to questions and suggestions from the industry leaders. This will lead to our 2013 report which will give the opportunity to government leaders to respond and build concrete solutions. This is the real dialogue that WEC convenes to help the energy community together build a more sustainable future. ❑

Global and regional issues: The energy challenges for the future

By Christoph Frei,
Secretary General, World Energy Council

As the population of the world continues to grow past the 7 billion mark, the demand for energy is becoming an ever more critical challenge for the world's energy leaders. Governments are looking for sustainable solutions that provide the most competitive energy supplies from secure sources, whilst at the same time trying to balance the long-term, and in some cases, short-term needs of the environment. Companies and state enterprises are seeking the most efficient solutions to meet the needs of shareholders and the national treasury to support growth. Innovators are looking at the latest trends that will enable them to capitalise on developing markets and the public simply want access to energy so that they can go about their business and prosper. These are the challenges that the World Energy Council addresses every day.

I am in the fortunate position of being able to assess the world's energy priorities and to call upon the support of its most extensive and influential network of energy leaders. This privileged position enables me to better understand the challenges that face all facets of our community as they seek to meet the demands of what we identify as the "energy trilemma". Building on the combined knowledge of our network and the insight captured in our annual *World Energy Issues Monitor,* we have now been able to develop this work to better understand the critical uncertainties affecting the energy sector on a regional basis. This is an important development in our process to better serve the WEC membership whilst also providing a unique insight for policy-makers and industry alike.

Looking at this global assessment over the past three years of our survey, the one item that has remained a constant is concern over climate framework. This statement can sometimes lead us to think that the world shares the same priorities. This is not the case; different regions have different priorities.

It is therefore important to develop our methodology so that we can conduct more detailed analyses of our different regions. Through the outstanding support that we have received from our members we are now able to offer this unique insight into what keeps energy leaders awake at night. This work not only guides the WEC work programme, to ensure that the organisation correctly responds to the needs of our community, but also provides a valuable insight for policymakers and strategists.

So what are the differing challenges?

While climate framework continues to be of high importance for Asia, Europe, Latin America and the Caribbean, and North America, it is seen more as a source of uncertainty in Africa where energy prices are seen as having the highest impact.

Africa

In Africa, energy poverty is more prominent than in any other regions due to the high level of social poverty and the low access to modern energy. About 70 per cent of Sub-Saharan Africa's (SSA) population (and 58 per cent of Africa's population) lack access to electricity, while some 80 per cent of SSA's population without access to electricity live in rural areas. Among all the regions Africa shows the highest interest in the energy-water nexus. There is an expressed concern that if dry cooling is not implemented at power plants, then there will not be enough water to sustain the current population plus cooling for the region's power plant.

Conversely, large-scale hydro is seen as an important asset for Africa and holds great potential for development, but its further development and exploitation requires huge amount of investment, suitable social and environmental framework, political stability and bold economic reforms. It could take time to address all these challenges and to make development happen in a sustainable way. Solar is also viewed with great interest as the prices of photovoltaics continue to fall.

Asia

Asian countries, especially emerging economies, have experienced increasing demand for electricity as a result of rapid economic growth. To meet the increasing demand, Asian economies are relying heavily upon coal and nuclear as their main energy sources.

Understandably, the impact of the events in Japan following the accident at the Fukushima Daiichi nuclear power plant, while having affected the world, are probably more directly felt in Asia. The fact that Japan has seen the equivalent of a 72 per cent decrease in nuclear power generation, taking into account installed nuclear capacity, has led to other issues. To replace this supply, Japan has raised liquefied natural gas (LNG) imports, spending an estimated US$6bn on increased additional gas imports in 2011. LNG imports to Japan were up 28.2 per cent year

on year in January 2012 and, according to the Institute of Energy Economics of Japan and the Japanese Ministry of Finance, Japanese LNG imports in 2011 were 12 per cent higher than in 2010. This understandably brings the issue of energy security to the front for Asia.

Europe

In Europe, climate framework is clearly an important issue, but it has also become clear that Europe is globally in a rather isolated position and it will be very difficult to convince other regions to follow a similar climate agenda. Weaker economic activity has led to dramatically lower greenhouse gas emissions, driving down carbon prices for emissions trading, and our survey suggests that carbon prices will continue to decrease. Indeed, new EU data suggests that emissions fell 2.6 per cent last year, prompting carbon prices to fall to a record low of just over €6 a tonne, in line with our analysis.

Energy infrastructure, including regional interconnection, is an important agenda for Europe. However, progress in areas such as large-scale, high-voltage transmission projects have been delayed by a lack of regulatory coherence. Transmission bottleneck issues could become more serious in future. The lack of an effective carbon market and a stagnating economy raise uncertainty regarding the future of technologies. In order to reach higher shares of green electricity there is a need for proper integration of renewables. So this strong need for new infrastructure is up against an economic situation that is currently a stress to investment.

Latin America and the Caribbean

Transforming energy wealth into social development and reducing energy poverty is key to the region. Energy subsidies for demand side in particular are important for developing countries as they are seen to help guarantee access of energy for low-income people. Energy price concerns grow bigger as they could slow down economic development, since we expect energy demand to increase on one hand while we see the influence of MENA dynamics on the other. This region is the only region that has little doubt about the future of biofuels.

North America

Energy issues are becoming extremely challenged in the North American region. We see that nuclear is both a source of high uncertainty and high impact. With 104 reactors operating in the United States, accounting for 20 per cent of America's electricity output, and two new reactors having been given the go-ahead, nuclear will remain significant for the area. Middle East dynamics are an important issue to the North American region as we now see coming to the fore with the impact of oil price on the United States' political landscape.

Unconventionals are critical to the agenda in terms of their abundance and impact on energy prices. Shale gas, oil sands, fracking and tight oil have transformed North America's energy outlook. Shale gas plays an important role in the global energy market as its global production will increase to 30 per cent by 2030, and 70 per cent of this will come from the US and Canada. As for oil sands, their environmental acceptability, including pipeline construction, will be the key element for their timely development and even the creation of a new market. However, as was highlighted at our regional event in Houston last year, without agreement the Canadian government will look to new, emerging markets such as China. With the anticipated penetration of photovoltaic and wind energy into the grid and the much anticipated advent of the smart grid, the impact of electric storage may grow even bigger for the region.

Looking to the future

It is important to note that as China becomes the world's number-one energy consumer there is a distinct shift in the energy landscape from OECD to non-OECD countries. The growth in the utilisation of nuclear power, for example, is mainly driven by non-OECD countries – the very countries that are seeing ever-rising energy demand. Of the 63 nuclear power plants currently being built worldwide, 39 are being built in non-OECD countries, including 26 in China, 10 in Russia and 7 in India. This demand shift will have a clear impact on the use of all energies in the future.

The demand growth is striking when we look at the transport sector. Our *Global Transport Scenarios 2050* report highlighted that even under the two extreme scenarios of "Freeway" (FW) and "Tollway" (TW), over the next four decades the non-OECD countries demand for transport fuels is expected to exceed that of the OECD countries by 2025 at the latest, as shown in figure 1.

Transport fuel demand in the next forty years will come mainly from developing countries such as China and India, where demand will grow by 200 per cent to 300 per cent. In contrast, the transport fuel demand for the developed countries will drop by up to 20 per cent, mainly due to

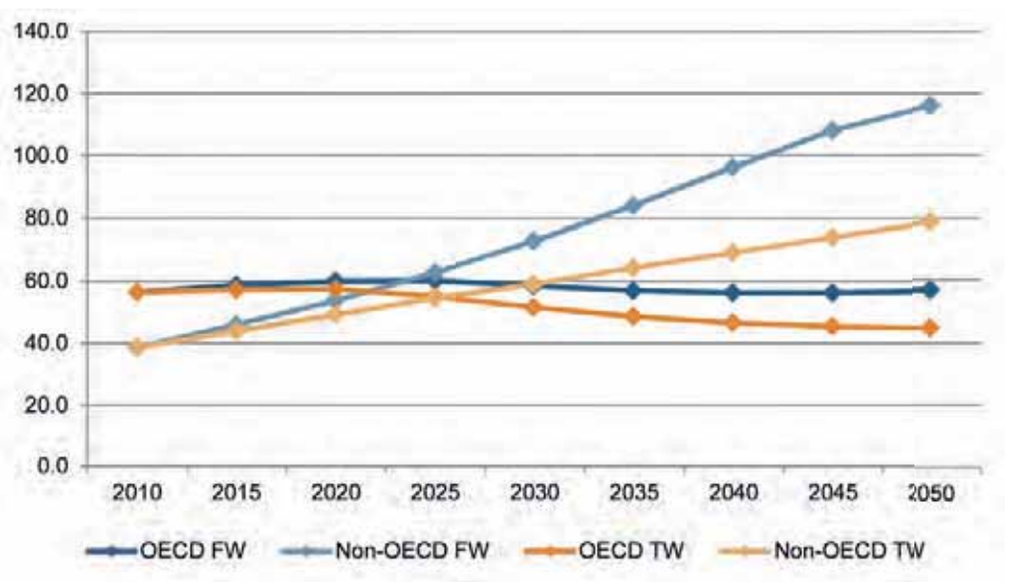
increased efficiencies. While the overall transport sector represents a quarter of total CO_2 emissions, our scenarios show that CO_2 emissions from transport could be up to 79 per cent higher in 2050. However, with clear policies that empower governments, the public and the private sector to intervene, we could limit this increase to 16 per cent. This is a clear challenge and one that will be very difficult to address.

Oil could fuel more than 80 per cent of the global transport sector for the next 40 years due to strong demand growth from the heavy duty sector, shipping and air traffic. By 2050 our report projects that global fuel demand in all transport modes could increase by 30 per cent to 82 per cent compared to 2010 levels. The impact of clear policies will have a significant effect on the projected technology mix, with the "Tollway" scenario leading to a greatly diversified landscape, as seen in our infograph on the following page.

Balancing the "energy trilemma"

As we look to the future the challenges are great but the rewards are equally as tangible. WEC is building partnerships with organisations such as the United Nations, the World Water Council and others to help secure a sustainable energy future. We are creating processes anchored around our events programme that will help policy makers address the issues associated with the energy trilemma. The enduring objective of overcoming the energy trilemma provides the opportunity to have a long-term view of a balanced energy strategy within a country. From a pure investment point of view, the trilemma is increasingly being seen as a way to evaluate risks. Investors will establish a country's energy risk profile by assessing the balance between the three dimensions of the trilemma. Imbalances in the trilemma can lead to opposition in one dimension, which eventually lead to policy changes that can undermine projects. Therefore, clear and transparent energy policies that will at the same time justify the necessary short term trade-offs between the different dimensions and ensure a long- term balance between social equity, energy security and environmental impact mitigation will ultimately secure the highest degree of investor confidence. ❑

Figure 1: Fuel demand for OECD and non-OECD countries



Fuel demand in all transport

The modelling results show that over the next four decades the non-OECD countries demand for transport fuels is expected to exceed that of the OECD countries by 2025 in Tollway, and earlier than 2025 in Freeway.

WORLD ENERGY COUNCIL **Global Transport Scenarios 2050**

Next forty years of potential developments in global transport fuels and technology systems on the basis of two distinct scenarios: **"Freeway" and "Tollway".**

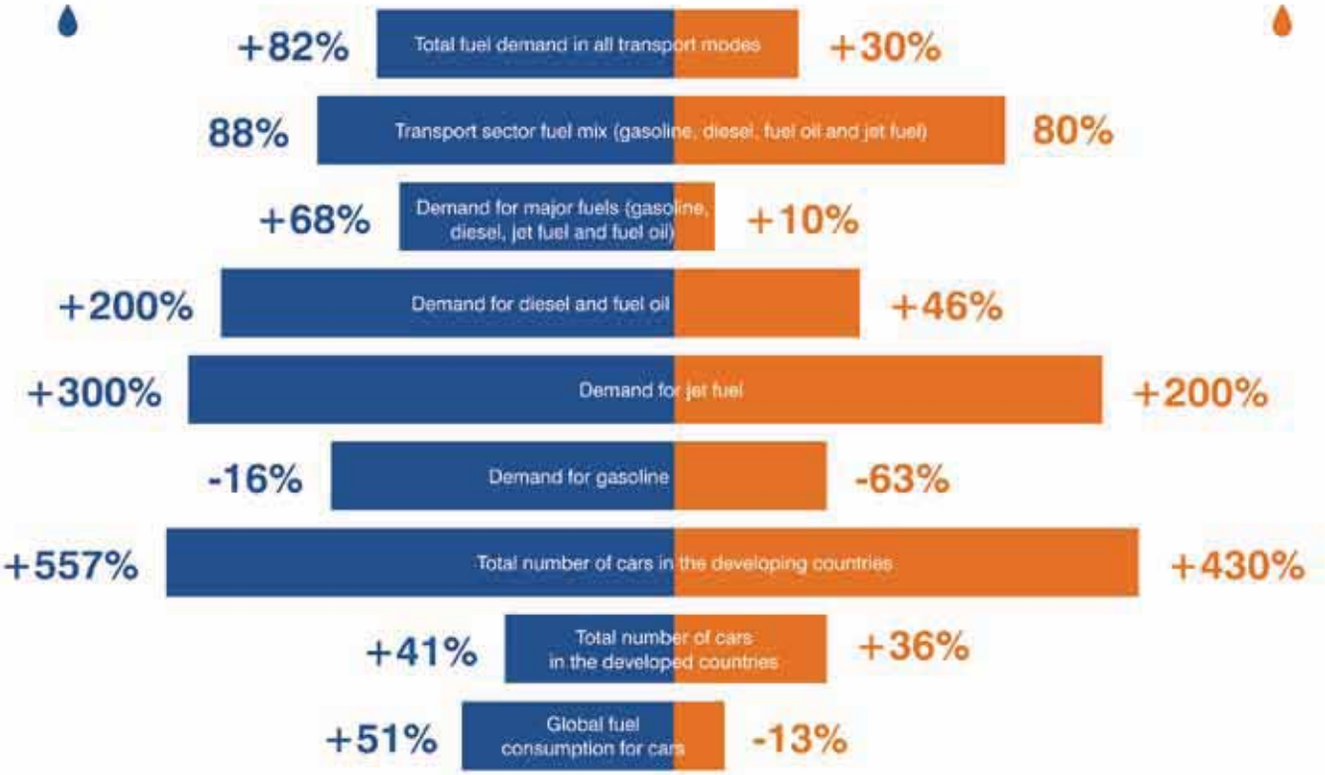
FREEWAY

The "Freeway" scenario envisages a world where pure market forces prevail to create a climate for open global competition.

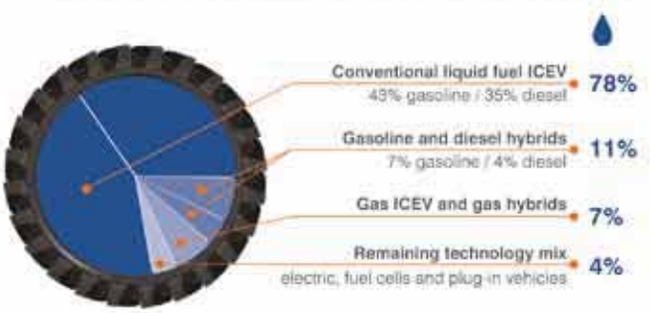
TOLLWAY

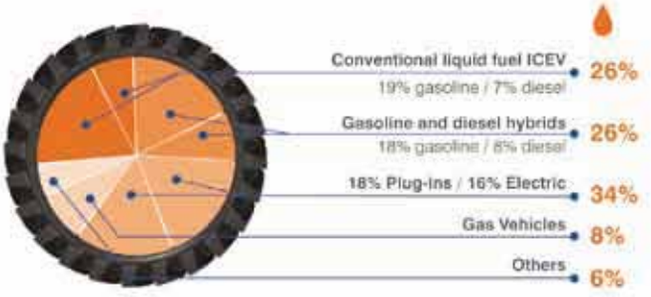
The "Tollway" scenario describes a regulated world where governments intervene in markets to promote technology solutions and infrastructure development.

FUEL DEMAND



TECHNOLOGY MIX





CO_2 EMISSIONS

36% increase in CO_2 emissions from cars

79% increase in CO_2 emissions from all transport

46% drop in CO_2 emissions from cars

16% increase in CO_2 emissions from all transport

Increase in CO_2 car emissions come from emerging non-OECD markets, especially Asia (India by seven-fold and China by more than eight-fold). Reductions expected in OECD countries (US will drop by about 38%).

Most reductions in CO_2 car emissions are expected from OECD markets (i.e., US and Western Europe drop by about 80%). Increase expected in non-OECD countries, especially Asia (India by about four-fold and China by three-fold).

Turkey: At the energy crossroads of Europe and Asia

Interview with Taner Yıldız,
Minister of Energy and Natural Resources, Turkey

Turkey's aspiration to be a regional energy hub has been widely discussed in the context of natural gas. How do recent developments – on the pipeline side, the rise of unconventionals, the 'Arab Spring' and the situation vis-a-vis Iran – affect this agenda?
There is no doubt that recent events between Iran and EU countries affect the gas supply and security situation for everybody. Iran has issued threats that it could close the Strait of Hormuz, reminding the world that it could cause oil prices to spike if the US or Israel attacks. In the light of this, the outlook is uncertain for both exporting and importing countries. But from our point of view, we are determined to be a regional energy hub by virtue of our strategic and geopolitical position. We will continue to expand our endeavours in respect of the transportation of Caspian, Middle Eastern and Central Asian energy resources to Europe and world markets. Turkey will make every effort to develop new projects through bilateral cooperation to increase prosperity and enhance peace in the region.

The country's ambitions have been less widely discussed in the context of renewables, in particular Central Asia's tremendous wind potential. What are Turkey's plans with regard to becoming a renewable energy hub?
Turkey is rich in terms of renewable resources. In geothermal energy resources, for instance, Turkey ranks first in Europe and seventh in the world. As for wind energy, a rapid increase in terms of installed capacity – from 20 MW in 2002 to 1800 MW today – has taken place. With our ongoing projects and those in the pipeline, Turkey's wind energy capacity will most likely demonstrate further rapid and sharp increases. With a 132 per cent increase from 2008 to 2009 in installed wind capacity, Turkey is ranked second after Mexico according to the World Wind Industry Association. We believe that renewable energy resources will ultimately be the most important resources for all countries which is why we plan to increase the share of renewables in our energy mix to 30 per cent by the time of the 100th anniversary of the establishment of the Republic of Turkey, in 2023.

How has the Fukushima disaster, and its political ramifications in countries such as Germany, affected Turkey's nuclear plans?
Making use of safe, low-cost and environmentally-friendly energy resources remains the focus of our development strategy. Turkey's first nuclear power plant will be built by the Russians at Akkuyu, near the southern port city of Mersin. The second nuclear plant, slated for the Sinop region on Turkey's Black Sea coast, is still up for grabs. Turkey has launched an ambitious nuclear programme. We aim to meet the country's energy needs sustainably. We will take all precautions needed in the light of the Fukushima disaster but will continue to show our determination to develop nuclear power. In this context we intend to set up two nuclear plants, which will meet ten per cent of Turkey's energy demand until 2023.

How does the present economic uncertainty – in particular the eurozone situation – affect financing for clean energy infrastructure? What is Turkey doing in terms of its policy framework to ensure its attractiveness to investors?
Our aim is for Turkey to become a key destination for clean energy investments in the future. The Turkish government is ready to take on the challenge of climate change, and to take the necessary steps to promote the development of clean energy. Turkey has enacted its first renewable energy

Only 40 per cent of Turkey's hydraulic potential has so far been developed

law and revised it during our present government period. In this way, we support investors in hydroelectric power, wind, solar and other forms of clean energy.

What would be the preferred model to finance nuclear energy in Turkey?
Nuclear power plant constitutes one of our biggest investments, amounting to 20 billion dollars. In the past, many alternative investment models and methods of tendering have been tried but none has been successful. In the case of Akkuyu, we undertook negotiations with those countries that have the capability to build Nuclear facilities, and as a result we signed an intergovernmental Nuclear power plant agreement with Russia. We are planning to apply the 'build, own and operate' system. This is the first such model to be applied anywhere in the world. Our second plant is now in progress and we are in discussions with a number of countries in this regard.

Turkey's geothermal capacity is the largest in Europe

How important is the Istanbul World Energy Leaders Summit for Turkey and what do you hope it will achieve?
I very much appreciate the organisation of the World Energy Leaders Summit (WELS) in Turkey, enabling as it does an ongoing high-level dialogue on critical issues affecting the energy world. I believe that the Summit will be beneficial for all participants. Everybody will discuss the problems facing the energy sector and try to find solutions, at both a regional and international level.

How would you describe the relationship between the Ministry and the WEC Member Committee in Turkey? How useful has WEC's global network and information/research capability been in shaping the country's energy policy?
We have a good relationship with the WEC committee here in Turkey. As a government, we have adopted an open dialogue mechanism with all parts of the energy sector and listen to the suggestions and recommendations which they voice. In this sense, we follow the activities of the Turkish WEC Committee and are supportive of its activities.

How is Turkey supporting the UN's International Year of Sustainable Energy for All?
We must all change the way we use energy. Increasing the energy efficiency of our economies is an absolute necessity. We must also move rapidly towards a more diverse, sustainable set of energy resources. This move depends on the aggressive development and deployment of more sustainable energy sources.

For this reason, the UN's Sustainable Energy Year is a good motivation for us all. We have a responsibility to make energy more efficient, accessible and sustainable in order to reduce poverty all over the world. We support for UN's endeavour in this respect.

What are the most successful investment models for energy currently operating in Turkey?
There are many international energy projects operating successfully in Turkey, such as the Baku-Tbilisi-Ceyhan (BTC) and Iraq-Turkey pipeline projects. We encourage investors in renewables and local energy resources, such as hydroelectric power, wind, solar and geothermal energy. In this way, we have successfully fostered projects which assist in reducing the country's current account deficit. ❑

Challenges and opportunities for the Turkish energy sector

By Ömer Ünver,
Secretary General, WEC Turkish Member Committee

Turkey, the sixth largest economy in Europe, is also a major consumer of energy. Economic growth in recent years has been outstanding, with GDP growing at approximately 9 per cent, strongly correlating with total primary energy consumption. Historic trends suggest that with sustained economic growth, energy consumption, and in particular electricity consumption, will increase at a similar pace to GDP.

In the coming decade, primary energy consumption is estimated to increase by around 4 per cent per annum.

Electricity consumption to 2020 is estimated to increase in the range of 6.7 per cent (low) to 7.5 per cent (high).

The capital investment required to meet this growth in energy consumption, in the period 2010 to 2030, is estimated at between US$225-280 billion.

The characteristics of the Turkish Energy Sector can be summarised as:

- High increase in absolute energy consumption;
- High dependence on imported energy;
- Energy intensive industrial consumption.

These characteristics represent the primary challenges for the Turkish Energy Sector. The need to address these challenges is intrinsically important to the development of the Turkish economy and if not adequately addressed will have a serious impact upon economic expansion.

Around 90 per cent of primary energy consumption in Turkey is attributable to fossil fuels. This statistic provides a backdrop for the development of renewable energy, which offers the benefit of reducing greenhouse gas emissions, whilst also reducing the soaring dependence on imported energy, predominantly in the form of oil and natural gas.

In Turkey only 40 per cent of the hydraulic potential, (in the form of hydro-electric power stations), has been developed, which leaves around 85 billion kWh/year of electricity generation potential for future development.

At present, there is around 1600 MW of wind generation capacity in Turkey. There is material opportunity for this installed capacity to be increased in the coming decades. The challenge of connecting wind turbines in remote locations to the grid transmission system represents one of the primary technical and financial challenges. To realise the potential of wind generation (and also solar), will require strong political and regulatory support to oblige the grid administration to modernise and invest in its system, to allow for the connection of renewable generation facilities.

I do not want to speculate on the potential of solar power in Turkey. However, the Aegean, Mediterranean and South Eastern parts of Turkey look especially promising. The legislative and regulatory steps to promote solar power have been completed, however there remain economic barriers which will require both technical advances and a further reduction in the cost of solar panels.

Turkey has a material lignite reserve of over 11 billion tonnes. The lignite is of low calorific value and high in ash and moisture content, nevertheless, at present there is over 8000 MW of lignite generation capacity installed in Turkey. There are economically viable options for increasing the capacity of power generation fuelled by domestic lignite. It is estimated that with the new discoveries of lignite, over 10,000 MW of additional electricity generation capacity (generating approximately 70 billion kWh/yr) can be added to the existing 53,000 MW of total installed generation capacity.

In summary, with the projected and potential additional investments which utilise domestic resources, Turkey has the opportunity to meet a large proportion of its increasing energy demand with a reduced reliance on imported oil and natural gas.

With timely and proficient implementation of generation technologies utilising Turkey's natural resources, the high dependence on energy imports may decrease dramatically.

It is worth noting that Turkey's 2011 cost of imported energy was over US$54 billion. This figure means that close to 40 per cent of Turkey's annual exports are utilised to fund energy imports. This dramatic figure, which has been noted by policy- and decision-makers, will mean that future policies will trend towards the development of generation technologies using indigenous energy resources, which can achieve supply security and sustainability.

The high energy intensity of Turkey, which presents a further dilemma of energy utilisation, is expected to decrease considerably following new legislation and regulations which have been implemented in recent years. Considering that every ten years in Turkey, primary energy consumption increases by 50 per cent and electricity usage by approximately 100 per cent, the vast investment required to meet demand is a major concern.

Although the financial challenge to fund the estimated growth in energy consumption to 2030 is very material, (US$225-280 billion), there remains solid optimism that economic growth will continue, providing tremendous opportunity for the future of energy and for power project development in this country. ❑

Improving energy efficiency in emerging economies

By Kandeh K. Yumkella, Chair, UN-Energy and
Director-General, United Nations Industrial Development Organisation

Energy is everything. It powers human progress. From job generation to economic competitiveness, from strengthening security to empowering women, energy is the great integrator: it cuts across all sectors and lies at the heart of all countries' core interests. Now more than ever, the world needs to ensure that the benefits of modern energy are available to all and that energy is provided as cleanly and efficiently as possible. This is a matter of equity, first and foremost, but it is also an issue of urgent practical importance – this is the impetus for the UN Secretary-General's new Sustainable Energy for All (SE4All) Initiative.

This initiative is launched in a time of great economic uncertainty, growing inequity, rapid urbanisation, and high youth unemployment. It is also a time where there is emerging consensus on the need to act cohesively towards global issues such as climate change and sustainable development. How we capture these opportunities for wealth and job creation, for education and local manufacturing will be the key to unlock any real revolution. Three linked objectives underpin the goal of achieving Sustainable Energy for All by 2030:

- Ensuring universal access to modern energy services;
- Doubling the rate of improvement in energy efficiency;
- Doubling the share of renewable energy in the global energy mix.

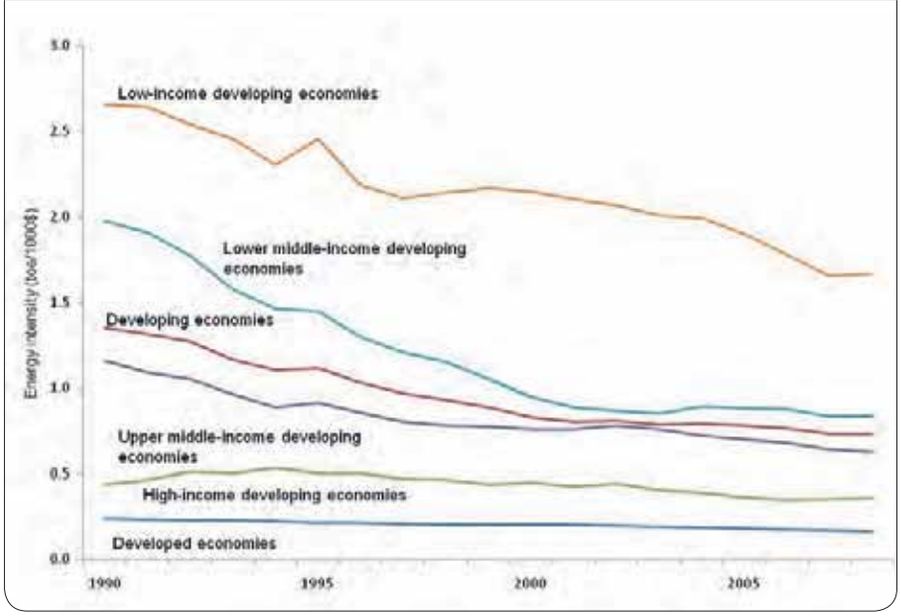
These three objectives are mutually reinforcing. As an example, increased efficiency in the production and use of electricity relieves strained power grids, allowing them to stretch further and reach more households and businesses. The alternative – unconstrained expansion of today's conventional fossil fuel-based energy systems – would lock in a long-term infrastructure commitment to an unsustainable emissions path for the world's climate.

Efficiency at the heart of energy policy

I want to focus on aspects of energy efficiency (EE) – and specifically on industrial EE in this short paper. To that end, I allude to the results of UNIDO's 2012 Industrial Development Report. Energy efficiency is a foundation of any good energy policy – and a pillar of the concepts of both "Green Economy" and "Green Industry". The economic, security, and environmental benefits of energy efficiency (EE) have been recognised for decades. Governments worldwide are designing and implementing policies and regulations to foster the development and use of energy saving technologies and systems. Firms too are changing approaches to manufacturing, considering new business models, and embracing the benefits of EE. Utilities are playing a leadership role in creating awareness, developing technologies and systems, and designing incentives to enhance energy efficient behaviour. While EE has gained growing momentum and the pace of progress has improved in the recent past, major work remains to be done and substantial environmental and economic benefits are still to be captured. This is particularly true for developing countries, which are lagging behind with regard to energy efficiency and productivity, as energy intensity profiles show (Figure 1).

Developing countries experienced an annual 2.3 per cent annual growth in total energy consumption over 1990-2008, which is more than 2.5 times the 0.9 per cent in developed countries. A key driver of the differences in growth of energy

Figure 1: Energy intensity over time between income levels



consumption between developed and developing countries is the disparity between developing countries' 0.6 per cent annual rise in industry's share of energy consumption and developed countries' 0.7 per cent annual decline. Manufacturing industry spends some US$1 trillion a year on energy, 55 per cent of it in developing countries. Manufacturing is the largest energy user sector globally, accounting for around 31 per cent of total global energy consumption since the early 1990s. In 2008, per capita industrial energy consumption in developing countries was 29 per cent of that in developed countries. Around 76 per cent of industrial energy was used to power manufacturing processes while the remainder was used as feedstock to those production processes.

Growth in industrial energy use would have been much higher over 1990-2008 but for reductions in industrial energy intensity. Global industrial energy intensity dropped some 26 per cent over 1990–2008, most of which was achieved during the 1990s. Since the year 2000 energy intensity has stabilised at around 0.35 tonnes of oil equivalent (toe) per US$1,000 of manufacturing value added (in 2000 US$). Since 1990, industrial energy intensity has fallen globally at an average annual rate of 1.7 per cent. Developed economies have the lowest level of industrial energy intensity, followed by high income and upper middle-income developing economies and – further behind – by lower middle income and low income developing economies. On average, over the period 1990–2008, energy intensity in developed countries was around 0.2 toe per US$1,000 of MVA while in low-income developing countries was 2.2 toe per US$1,000 of MVA. As an example of how the differences between economies manifest, in the Republic of Korea and the US, structural change accounts for more than two-thirds of the decline in industrial energy intensity. In China, India and Russia improvements in technology have been the main driver of reductions in energy intensity.

Table 1: Technical savings potential from industrial EE improvements (%)

Sector and product	Developed countries	Developing countries
Process sectors		
Petroleum refineries	10-15	70
Chemical and petrochemical		
Steam cracking (excluding feedstock)	20-25	25-30
Ammonia	11	25
Methanol	9	14
Non-ferrous minerals		
Alumina production	35	50
Aluminium smelters	5-10	5
Other aluminium	5-10	5
Copper smelters		45-50
Zinc	16	46
Iron and steel	10	30
Non-metallic minerals		
Cement	20	25
Lime		
Glass	30-35	40
Ceramics		
Combined sectors		
Pulp and paper	25	20
Textile		
Spinning	10	20
Weaving		
Food and beverages	25	40
Other sectors	10-15	25-30
Total	15	30-35
Excluding feedstock	15-20	30-35

Despite the significant achievements, large technical and economic potential for energy efficiency improvements persists in developing as well as developed countries. It has been estimated that industry globally could reduce its energy consumption by up to 26 per cent (IEA, 2008) through worldwide deployment of best available technologies and demonstrated best practices, including policies. Table 1 provides a snapshot of such untapped potential, highlighting the difference between Developed and Developing economies.

It is clear that while efforts must continue to promote and pursue new technological breakthroughs and solutions,

stronger support is provided for faster worldwide uptake of current best available technologies and practices, which would improve energy efficiency and productivity, ultimately reducing energy intensity. As an example, motor systems are a largely untapped, cost-effective source of industrial energy-efficiency savings that could be realised with existing technologies. Energy management systems (EnMS) and standards are another example of well proven best available technology and policy best practice. Energy efficiency in industry is achieved and sustained through changes in how energy is managed on a daily basis rather than through simple installation of new technologies. A systematic approach and top management engagement are required. National programmes hinged on the implementation of energy management system standards in EU countries showed that enterprises that implemented EnMS more than doubled their annual energy intensity reduction rate compared to enterprises without EnMS.

But major transitions in energy technologies can take decades and entail massive investments. Access to finance is bound to remain among the principal barriers to the full implementation of EE technologies and practices. This financing gap and the associated barriers are well documented. Today there are a suite of well understood, targeted and innovative financial policies and measures which policy makers can draw on. The data show a clear positive trend of new investment in EE, with an average growth rate of 28 per cent between 2004-2009. Still, the finance sectors in developing countries are often not familiar with the technical details of EE projects, and the scale is often too small to be handled directly by international financial institutions.

Despite the growing trend of EE investments, especially in developing countries and emerging markets, many financially profitable EE projects remain un-implemented. UNIDO conducted a survey of 357 manufacturing companies in 25 developing countries inquiring about their EE practices and investments. The survey found that the EE investment decision making process is driven by a traditional payback approach: more than 90 per cent of surveyed firms in developing economies used simple payback rules to assess the financial viability of EE projects, with an average payback period of 23 months. This reinforces the notion of large existing potential at low cost.

But while there has been growing recognition by industry that energy is a manageable production cost and a competitiveness/strategic factor, the majority of firms, especially in developing countries, remain largely unaware of and unable to seize these opportunities. The improvement in addressing the remaining barriers towards effective energy efficiency implementation requires sustained efforts to create enabling institutional, financial and industrial settings. Strong government and regulatory support is crucial to the success of some schemes. The international community has an important role to play in the endeavour. UNIDO's Industrial Development Report was developed to help underpin this action. ❑

Developing countries continue to lag behind with regard to energy efficiency

1. The incremental gain ranged from 1 per cent up to 5-6 per cent in certain cases, with an average of 1.5-2.0 per cent on annual basis (Gudbjerg et al, 2009). It had to be mentioned that such incremental reductions were achieved by large companies that already paid attention to energy consumption and had some energy efficiency programs in place. The experience of the USA confirms these results, showing also that in companies totally new to energy management average energy efficiency gains in the first 1-2 years can range between 10-20 per cent.

2. Bloomberg New Energy Finance

Enabling a renewable future for India

By Farooq Abdullah,
Minister of New and Renewable Energy, India

We live in strange times. The optimism and hope of a better world is often tempered by the difficult realities of conflict, economic stress and shortages. While technology has made human progress almost inevitable, the heavy demands that prosperity places on our natural resources has also driven home the lessons of restraint, cooperation and respect for nature. Nowhere is this more apparent than in the field of energy. The increasing demand for energy that has developed in the recent past has been constrained by rapidly diminishing conventional sources such as oil and coal. To further add to the problems of increased demand and constrained supply, there are serious questions about pursuing a fossil fuel-led growth strategy.

Globally, nearly 70 per cent of electricity today is generated from fossil fuels; as a result, electricity accounts for about 40 per cent of global energy-related green house gas emissions; these emissions are expected to grow by 58 per cent by 2030. Scientists believe that a temperature rise above 2°-2.5°C risks serious and intolerable consequences. The Intergovernmental Panel on Climate Change (IPCC) predicts that with rising temperatures, the frequency of heat waves, droughts, and heavy rainfall events will very likely increase. This in turn will seriously affect agriculture, forests, water resources, industry, human health and settlements.

The world will therefore have to work together towards new and alternative ways to decouple economic development from traditional energy consumption. And the core solution will be technologies that reduce carbon emissions per unit of energy. This is why, while striving to bridge its energy deficit, the world must necessarily increase the share of clean, sustainable, new and renewable energy sources. Whether or not renewable energy completely replaces fossil fuel, we must all work together to develop renewable energy to its fullest potential.

What about India? How far have we moved on the path of sustainable development? India is endowed with a substantial renewable energy resource base. Recent estimates indicate that a potential of over 2000 GW of electric power capacity exists from wind energy alone. Solar photovoltaic and solar thermal energy has the potential to generate around 50 MW per square km of area. Small hydro and biomass could add another 40 GW of capacity. Furthermore, there exists significant potential from decentralised distributed applications.

How far have we moved ahead in realising this potential? India today stands among the top five countries of the world in terms of renewable energy capacity. We have an installed base of over 24 GW, which is around 12 per cent of India's total power generation capacity and contributes over 6 per cent to the electricity mix. This represents an almost 400 per cent increase in the past 5 years. Investment in renewables grew by 25 per cent last year alone. A recent E&Y study ranked India among the top 5 countries of the world in attracting renewable energy investments in the country. The Indian National Action Plan on Climate Change mandates an increase in the share of renewable power in the electricity mix to 15 per cent by the year 2020. The action plan of the Ministry of New and Renewable Energy aims at achieving a target of around 72 GW of renewable power including 20 GW solar capacity by 2022.

While the significance of renewable energy from the twin perspectives of energy security and environmental sustainability is usually well appreciated, what is often overlooked is its capacity to usher in energy access. In its decentralised or standalone avatar renewable energy is the most appropriate, scalable, speedy and viable solution for providing power to thousands of villages and hamlets. By providing energy access to the most disadvantaged and remote communities, renewable energy has become one of the biggest drivers of inclusive growth.

Already, around 9000 villages in different part of the country have been meeting electricity needs through off-grid renewable energy systems. Entrepreneur-based market-led systems are being evolved to provide renewable energy-based electricity for lighting and motive power applications in some of the remotest and poorest areas. Kilowatt-sized systems are being used to provide reliable power to run computers, televisions and provide e-connectivity to otherwise far-flung and poor areas. In many tribal and forest areas solar power is not only lighting up remote hamlets but also trying to bring about a convergence in forest conservation, education and rural development efforts. In other areas, energy-entrepreneurs are experimenting with generation of electricity and its local distribution through use of locally available rice-husk. Each of these endeavours is an effort at energy access for the poorest and the remotest. We in government are trying to encourage rural entrepreneurship and make it easier for poor citizens to access these services through policy and financial interventions including preferential tariffs and a combination of capital subsidy, soft loans and interest subvention.

Renewable energy applications have the great advantage of meeting decentralised needs other than rural electrification too. By doing so, they mitigate the consequences of power shortage by providing solutions at the consumption point. Over 25 GW of power is currently generated by diesel. Over 1 million tonnes of furnace oil is used annually for meeting incremental process-heat requirements. Solar energy can save both by acting as heat as well as power source. With oil prices going up and solar prices coming down, the tipping point is approaching for large-scale off-grid development. Quite naturally, industries facing power shortage, telecom towers using diesel, and agricultural pump sets using diesel, large kitchens using LPG are promising candidates for this effort. All these applications have the potential of saving hundreds of thousands of litres of diesel, kerosene and cooking gas annually. They will spawn new financial and business models as well as an acceptance of service delivery in a distributed manner that supports local entrepreneurs with low-cost funds.

In January 2010, the Government of India launched the Jawaharlal Nehru National Solar Mission (JNNSM). This is a unique and ambitious Mission that aims to facilitate the deployment of 20,000 MW of grid-connected solar energy being deployed in India by 2022 and 1100 MW by 2013 itself. By leveraging domestic and foreign investments, the Mission framework will facilitate and provide the foundation for the private sector to participate and to engage in research & development, and manufacturing & deployment. Within less than two years of its launch, the Mission has succeeded in catalysing the installation of around 500 MW capacity solar power projects in the country. One of the major achievements of the Mission is a significant reduction in solar power tariff, and the offered tariff has now fallen by over 30 per cent to an average of 17 US$ cents per kilowatt-hour. This steep decline in solar power tariff affirms the Mission's aim to achieve grid parity in the shortest possible timeframe.

Despite the strong push for solar energy, wind energy continues to contribute significantly to our renewable energy matrix. With over 16 GW installed capacity, India competes globally in manufacturing and deployment and occupies the fifth position in the world. Our policy framework in wind energy generation is extremely investor-friendly. An attractive feed-in tariff, supportive regulatory regime, and fiscal and promotional incentives provide a strong foundation for the growth of the sector. Our latest decision to incentivise generation of power by a generation-based incentive will help create a level playing field between foreign and domestic investors and attract more investments in this sector.

India's wind sector is the world's 5th largest with over 16 GW of installed capacity

Biomass, which is a carbon-neutral fuel source of energy, holds considerable promise for India. Our surplus biomass material is estimated to be about 150 million tonnes; this could potentially be used to generate about 16 GW of power. Apart from providing relief from power shortages, power projects based on biomass would generate employment in our rural areas. They could also help the stabilisation of the electricity grid in such areas. We are working towards a National Bio-energy Mission. This mission will which will help devise a policy and regulatory environment to provide a predictable incentive structure for rapid and large-scale

capital investment in biomass energy applications and encourage development of rural enterprises for project development and sustainable operation of bioenergy systems.

The challenge before us in the renewable energy sector, generally and in India, particularly is to reduce the per-unit cost of renewable energy. Hence, there is a continuous need to innovate, to increase efficiencies, ensure cost reductions and low material consumption, increased recycling and extended technical lifetimes. All these innovations can only result from better research and indigenous technologies. This is why, research and development in renewable energy is such a major area of action. I firmly believe that we need a whole new ecosystem involving business, academia and government in a symbiotic research effort.

A related challenge is reducing import dependence and development of indigenous technology and/or technology transfer. The currently skewed global distribution of intellectual property rights as well as the unaffordably high costs of imported technology acts as a barrier to the speedier indigenisation of renewable energy technologies. India looks to create partnerships between IPR holders and local technology expertise. Establishing targeted international collaborations among industry, academia and the private sector continues to be a challenge as well as a priority.

With increased volumes, handling intermittency of renewable power, particularly from solar and wind, pose another set of challenges. These call for planning for a balancing of power systems, developing hybrid systems, improvements in forecasting technology, creating an efficient and resilient renewable power transmission infrastructure and development of storage technologies. Globally, development of storage technologies has not been in line with wind and solar technology developments. This area requires learning from international experiences and targeted international collaboration.

All deployment, development and research require financing. Gearing up the banking sector to finance renewables in large numbers and develop a suitable mechanism for risk mitigation or sharing is another key challenge. Innovative financing strategies are required – micro credit or micro-lending for energy access and targeted project credits and equity/debt financing.

With increasing deployment levels, ensuring availability of appropriately skilled manpower is another challenge. Although efforts have been made in this direction and a number of academic institutions, industrial training institutes etc have been involved, involving industry in a big way would be required.

The challenge for India is gigantic and exciting. We can set history on a hopeful course – away from poverty and despair, and towards development and dignity. We have made considerable progress on our own, but we still have miles to go. My vision is to see that every Indian has access to clean energy, reliably and affordably. Today's technology provides us this opportunity. It is for us to rise together to take advantage of these opportunities and translate to reality the vision of a better world for all mankind. ❑

This article is an edited and updated version of The Tenth Darbari Seth Memorial Lecture on A Renewable Future for India delivered by Dr Farooq Abdullah, Minister of New and Renewable Energy at The Energy and Research Institute(TERI), New Delhi, India.

India's solar tariff has fallen by over 30 per cent to an average of US¢17 per kW/h

Coal: A bet that could go either way?

By Fatih Birol,
Chief Economist, International Energy Agency

The global coal industry has experienced an incredible decade, with demand growth for this one fuel alone nearly matching the aggregate growth seen across gas, oil, nuclear and all forms of renewables – including hydro, wind biofuels, solar, etc (Figure 1). Even in percentage terms, growth in coal use over the decade outpaced growth in renewables, although this was a time of take-off for many and they started from a low base. The importance of coal in the global energy mix is now the highest since 1971. It remains the backbone of electricity generation and has been the fuel underpinning the rapid industrialisation of emerging economies, helping to lift hundreds of millions of people out of energy poverty.

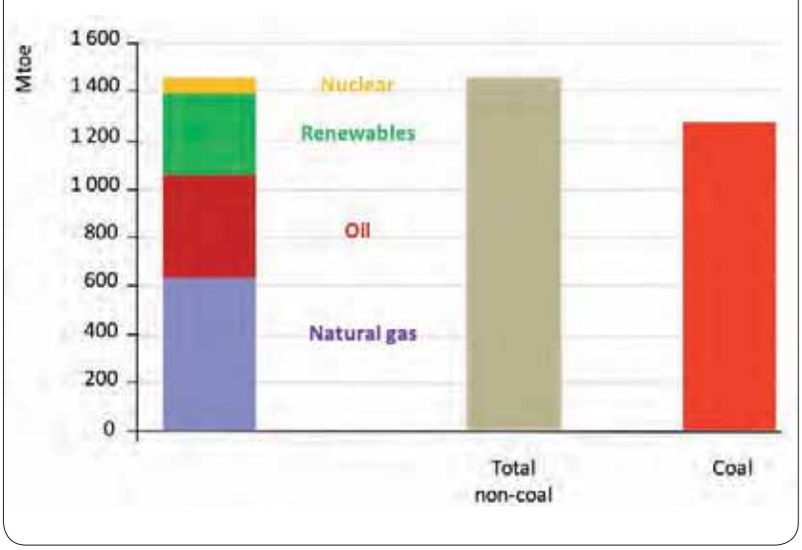
But, when looking to the horizon, many questions remain and the outlook may well have some uncertainties. This is because coal is a carbon-intensive fuel and the environmental consequences of its use can be significant, especially if it is used inefficiently and without effective emissions and waste control technologies. Government decisions reflecting their judgements as to the balance between the relevant social, economic and environmental considerations, particularly their success in encouraging the development and deployment of clean coal technologies, are crucial to the future pattern of coal demand.

This is reflected by the wide difference in projections for coal demand across the three scenarios presented in the IEA's *World Energy Outlook 2011* (Figure 2). Maintaining current policies would see coal use rise by a further 65 per cent by 2035, overtaking oil as the largest fuel in the global energy mix. In the central scenario for the Outlook – in which recent government policy commitments are assumed to be implemented in a cautious manner even if they are not yet backed up by firm measures – global coal use rises for the next ten years, but then levels off to finish 25 per cent above current levels. In the 450 Scenario, which assumes much stronger policies to achieve the goal of limiting the long-term global temperature increase to 2°C, coal demand peaks before 2020 and then falls sharply.

One factor, however, is constant: non-OECD Asia, especially China and India, are set to dominate the global picture of future coal use, whatever its level. China is by far the world's biggest coal producer and has massive resources. Its consumption of coal is almost half of global demand and its Five-Year Plan for 2011 to 2015, which aims to reduce the energy and carbon intensity of the economy, will be a determining factor for world coal markets. China has long been a net exporter of coal, so the speed and magnitude of its emergence as a net importer in 2009 – which in some ways could be seen as analogous to Saudi Arabia becoming an oil importer – had a major impact on traded coal markets. It contributed to rising prices and new investment in exporting countries, including Australia, Indonesia, Russia and Mongolia. But it would take only a relatively small shift in domestic demand or supply for China to become a net-exporter again, competing for markets against the countries that are now investing to supply its needs.

India – currently the third-largest coal user worldwide behind China and the United States – is likely to see continued rapid expansion in coal demand in the absence of radical policy change. India's coal use, which increased by about 80 per cent between 2000 and 2010, is expected to more than double by 2035 as it displaces the United States as the world's second-largest coal consumer. Over 60 per cent of the rise comes from the power sector, reflecting the enormous latent demand for electricity across the subcontinent. Consequently, India is poised to become the

Figure 1: Growth in world energy demand, 2000-2001



Source: World Energy Outlook 2011

world's biggest importer of coal soon after 2020, as rapid demand growth is likely to outstrip domestic supply. In other words, India is set to become the new China as far as coal imports are concerned.

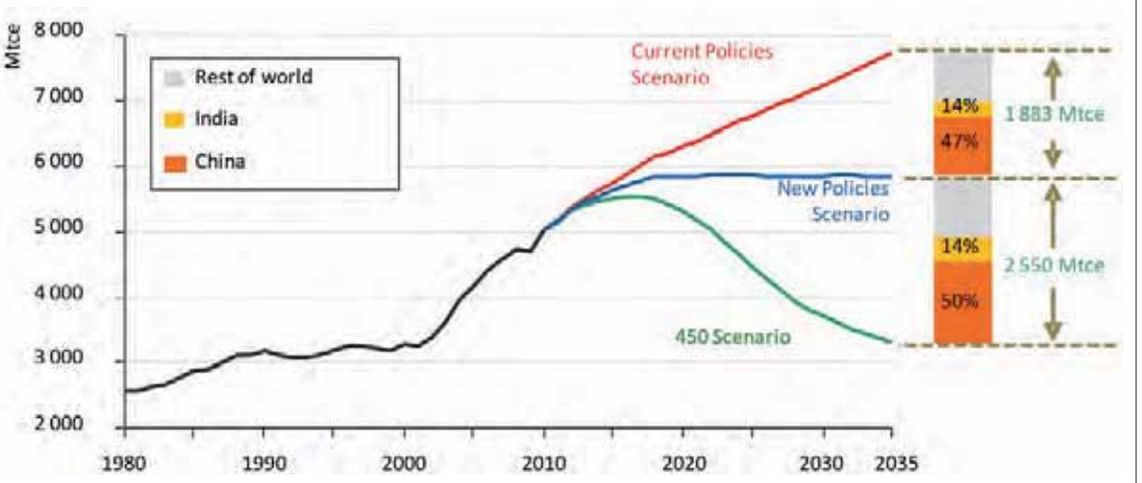
So it is clear that energy and environmental policy will play a decisive role in future coal use. In some countries, its use may be deliberately encouraged for economic, social or energy security reasons. For instance, if action were taken to provide electricity access by 2030 to the 1.3 billion people in the world without it today, coal would be expected to account for more than half of the fuel required to provide additional on-grid connections. In other countries, policies may be designed to encourage switching away from coal to more environmentally benign or lower carbon sources, such as through air quality regulations or carbon penalties. While a global agreement on carbon pricing has been elusive, a growing number of countries are taking steps to put a price on carbon emissions, including China where there are several pilot schemes underway.

In terms of technology, the widespread deployment of more efficient coal-fired power plants is an essential first step for the longer term use of coal. This needs to be a high priority, especially where power plant fleets are being rapidly expanded. If the global average level of efficiency of coal-fired power plants were 5 per cent higher than expected, such an accelerated move towards more efficient technologies would lower global carbon dioxide emissions from the power sector by 8 per cent. In reality, the penetration of the most efficient coal-fired power generation technologies is constrained by barriers such as financing, the absence of a carbon price and technical considerations.

In the longer term, the deployment of carbon capture and storage (CCS) technology on a significant scale is another potential "game-changer" for coal. If widely deployed, CCS technology could potentially reconcile the continued widespread use of coal with the need to reduce carbon dioxide emissions. While the technology exists to capture, transport and permanently store these emissions in geological formations, it has yet to be demonstrated on a large scale in the power and industrial sectors and so costs remain uncertain. The current picture is still one in which many legal, regulatory and economic issues need to be resolved. The experience yet to be gained from the operation of large-scale demonstration projects will be critical to driving down the costs and reducing efficiency losses and, hence, the prospects for widespread deployment of CCS.

Taken together, the widespread adoption of more efficient coal power plants and of CCS would help secure the position of coal in our future energy mix and make an important contribution to tackling climate change. But without these technologies, the world will need to move gradually away from coal towards low-carbon technologies, seeing global coal demand and coal's share of the energy mix decline in the process. ❑

Figure 2: World primary coal demand by region and scenario



Source: World Energy Outlook 2011

Energising Africa with renewables

By Adnan Amin,
Director-General, International Renewable Energy Agency (IRENA)

To meet its growing demand, Africa has an urgent need to raise the level of investment in its power sector. The region currently has 147 GW of installed capacity, a level comparable to the capacity China installs in two years. Capacity is concentrated in the North and South of the continent. In sub-Saharan Africa, average per capita electricity consumption is 153 kWh/year equivalent to just 6 per cent of the global average. Nearly 600 million African citizens lack access to electricity. Electricity blackouts occur on a daily basis in many African countries, in many cases causing people and enterprises to rely on expensive diesel power generation to meet their electricity needs, costing some African economies between 1 per cent and 5 per cent of GDP annually.

At the same time, Africa's population and economic growth rates are amongst the highest in the world. Out of the ten fastest-growing economies in 2010, six are in sub-Saharan Africa. As a result, the continent will need to add around 250 GW of capacity between now and 2030 to meet demand growth.

Africa faces a unique opportunity as nearly two-thirds of this additional capacity has yet to be built. The continent can benefit from the recent technology improvements and cost reductions in renewable power generation technologies, to leapfrog the development path taken by industrialised countries and move directly to a renewable-based system.

Governments in Africa now consider renewable energy as a core element of their energy strategy to provide access to millions of citizens whilst contributing to energy security and climate change mitigation (IRENA, 2011). This is part of a global trend. Renewable power generation is now the fastest growing sector of the energy mix and accounts for almost a fifth of all electricity produced worldwide.

A key feature of many renewable power supply options is their capability to operate economically at small scale. This is a very attractive feature in situations, such as are found in most parts of Africa, where there is no established grid. Furthermore, the costs of renewable energy technologies have come down significantly in the past decade, to the point where they can often compete with fossil fuels without subsidies. An analysis by the European Commission suggests that an optimal mix to meet Africa's demand growth would consist of approximately one third grid expansion, one third mini-grids and one third off-grid systems.

Africa is endowed with vast untapped renewable energy resources that can provide electricity for all at an affordable cost. The potential for hydropower is estimated around 150 GW, spread over the major river basins. Wind power potential in the north east, north west, south and certain elevated spots in the Sahara and Sahel areas is among the best in the world. Solar resources are excellent everywhere except in the rainforest zone, where biomass resources offer an attractive alternative option. The East African rift valley offers interesting opportunities for geothermal energy. However, there is no "one size fits all" solution for Africa's needs and the optimum mix varies by power pool, by country and even on a smaller spatial scale (Figure 1).

Opinion is divided on Africa's potential for energy crops, which will depend on the future increase of agricultural productivity, population growth, changing food consumption patterns, and on net lifecycle greenhouse gas (GHG) emission reductions. There is general agreement that significant quantities of agricultural waste residues are available that can be used. Countries such as Mozambique have significant unused land suitable for bioenergy production. Achieving the necessary economies of scale and overcoming the logistical challenges while meeting sustainability criteria such as lifecycle GHG reductions, including land use change as well as social standards, will be critical for a successful deployment of biofuels in Africa (IEA, 2010).

Although Africa's potential for renewables is relatively well known, precise assessments are needed to provide the basis for bankable generation projects. Accurate data are not currently available for many project locations. Improving the resource dataset is therefore a priority. IRENA has been working on new datasets for wind, solar and biomass for all African countries and bankable wind data for Namibia. The Agency is also coordinating global efforts to develop a Global Solar and Wind Atlas, through the Clean Energy Ministerial (CEM) process and the UN Sustainable Energy for All Initiative (SE4ALL).

Access to technology is another key issue affecting Africa's uptake of renewable energy. The importation of equipment is often hampered by taxation and the lack of a sizeable market, which drives up cost. IRENA analysis shows that project costs in Africa are higher than in other parts of the world. Projects often need to encompass enabling infrastructure because equipment is imported. Financing costs are high because of perceived risk and the opportunity cost of capital. Moreover, international development projects tend to incur substantial transaction costs. Although local production of equipment is currently

limited in many African countries, IRENA analysis suggests that the local content in projects could rise to 45-80 per cent, depending on the technology, which should help reduce costs (IRENA, 2012). One of the key benefits of an industrialisation strategy through renewable energy is its potential to create jobs and benefit many sectors of society, in contrast to fossil fuels exports, which risk crowding out other economic activity.

Renewables can therefore bring new income sources to African nations. In North Africa, the Desertec Industrial Initiative aims to install 100 GW capacity by 2050 to export electricity to the European market. Morocco, so far the only African country with a powerline connection with Europe, has been chosen as the first location to develop a 500 MW Concentrated Solar Plant as part of the Desertec Initiative.

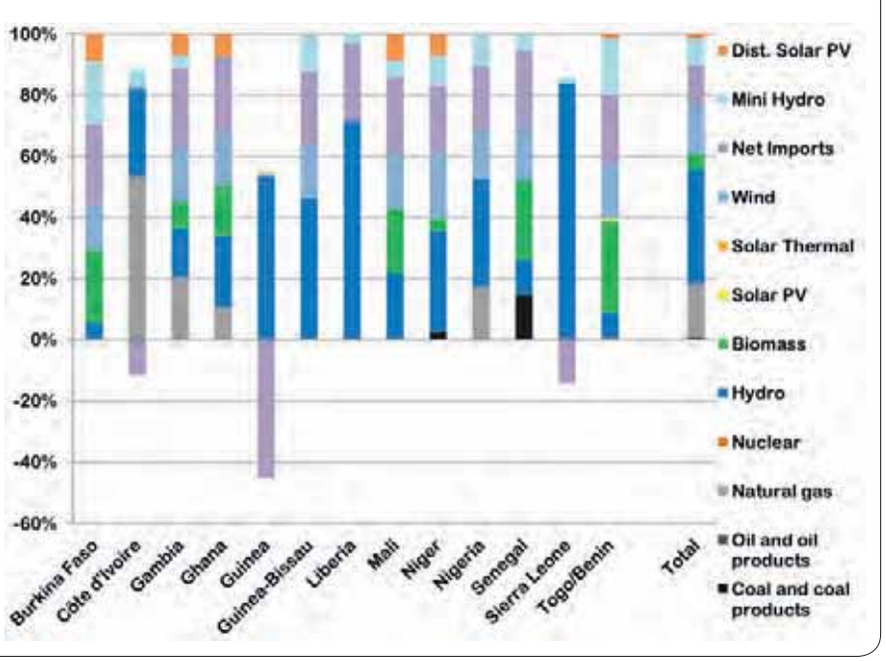
The magnitude of the investments required is such that governments will need public-private partnerships in order to scale up investment in generation capacity. While access rates are improving in some countries, the business environment and policy framework are still not sufficiently robust to attract the level of private investment required to install the additional 250 GW by 2030. In many countries electricity is subsidised and sold at prices below production cost. The result is that utilities lack capital that is sorely needed for investments.

The development of clear and stable policy frameworks is essential to enable the private sector to invest with confidence. IRENA has recently instigated a new country-driven process – the Renewables Readiness Assessment (RRA) – which assesses national policy frameworks and gives a measure of a country's readiness to adopt renewables with recommendations for policy adjustments. To date Mozambique and Senegal have been assessed under the RRA process and a regional roll-out in the ECOWAS region will follow during 2012 (IRENA, 2012).

Adoption of renewable energy offers Africa other advantages for end-use sectors, such as cooking, transportation and industry, which can enjoy similar or even higher benefits. Traditional solid biomass in rural areas and charcoal use in cities currently dominates energy end-use in sub-Saharan Africa. Traditional biomass presents a number of challenges such as its health impacts, increasing scarcity, and inconvenience of use. A mix of LPG, efficient cooking stoves, biogas and advanced liquid biofuels is emerging as a viable solution. Governments should give priority to providing economically viable alternatives, while at the same time encouraging a more sustainable use of traditional biomass. Cities should be a priority, where costly charcoal use dominates and alternatives can be economically viable today.

In conclusion, Africa stands at a crossroads with the opportunity to build a modern renewable energy-based economy across the continent. While upfront investment costs may be higher, renewable energy use will generate significant benefits that outweigh costs in the medium to long term. The critical challenge for African governments is the establishment of robust policy frameworks that will make this energy revolution possible. ❑

Figure 1: Electricity production mix in the Renewable Scenario by country and fuel in the ECOWAS power pool, 2030



Water, energy: The same shock, the same battle

By Loïc Fauchon,
President, World Water Council

While motorists worldwide, eyes riveted on the petrol pump, wait impatiently for good news from the Straits of Hormuz and the Libyan shores, do those same motorists, as French citizens, pay attention to the lowering of the Nile's water level or the filling in of Iguaçu's lake? Yet water and energy, it's the same shock and the same battle.

Today, water and energy are interdependent resources. This question must be given a place within public debate. We can be pleased that it was at at the heart of discussions during the 6th World Water Forum, which gathered from 12-17 March all those who wish to advance the cause of water and of energy.

On the demand side, it is the same disadvantaged populations that lack access to drinking water and to electricity: surely 2 billion people, if not more, not to mention sanitation. But water and energy are crucial for human, economic and social development. They are necessary for fulfilling basic needs for a decent life; without water and energy, there is no food, no health, and no education.

Water and energy demands are both continuously increasing. Every twelve years there are one billion more inhabitants, overwhelming mega-cities that are growing like mushrooms and that are potential health bombs, with evolution in climate confusing political leaders' and citizens' actions. All these realities negatively impact the management of essential resources, becoming more and more rare.

Urgency knocks at the door; it is real and proven. For the medium-term needs are huge. By 2050, we are expecting to double energy production and experience a 50 per cent increase in water demand. If we do not act, if we do not create new offers, and if we do not drastically regulate demand, tensions will degenerate into conflicts.

Water and energy, common approaches

Because they are interdependent, both energy and water require regular dialogue and the sharing of experiences and solutions so as to generate more efficient and cost-effective ways of using these two resources in the future.

To do so, professionals from both fields must work together towards better knowledge and regular and sustainable support for issues that are common concerns for both water and energy. It is for this reason that, during the 6th World Water Forum, the World Energy Council and the World Water Council announced their intention to cooperate at the international level to promote greater energy efficiency in the management of water resources, to make known and enhance the necessary contribution of energy to the water sector and to facilitate cross-sector dialogue.

Without drastic regulation, water shortages could soon give rise to conflicts

Additionally, a common demand regulation approach is also needed in both sectors. Over the last century, governments, political and financial authorities have strived to increase the offer through new infrastructure and more equipment, so as to improve access to water and electricity for all sorts of uses.

This policy of "offer at any price" that often resulted in subsidised costs for water and energy much lower than actual market prices, globally encouraged waste and overconsumption.

This policy of unprotected increases in offer and lack of harmonious resource management has very clearly shown its limitations.

It is not only that the era of easy water is over, but the era of easy energy as well. Tomorrow, we will have to consume less, to consume "better" so as to respond to Mankind's expectations, while respecting Nature.

Mobilising for investments and good governance

Many countries are also confronted with a severe lack of financial resources to secure their future energy and water supply. For water, energy is a pre-requisite and the survival of a part of future generations depends on the answer to this question. Today, the international community must reflect on, propose and pursue solutions to answer those challenges.

To accomplish this, it is necessary for the political world to impose that part of the energy for water, necessary for the poorest and most disadvantaged countries and populations, be made available at a sustainably low cost, so as to spare us a scenario where the soaring price of a barrel would inevitably result in the lack of access to water in the African bush or in Asian slums.

Could we also imagine a type of moratorium on price increases, a solution which would aim to neutralise part of the price or its recent or future increases?

Another possibility: use a specific fuel to produce the energy needed for water. This solution can be compared to what existed or exists in several European countries for so-called "domestic" diesel for use by farmers, fishermen or taxi drivers.

Another idea consists of the creation of a specific tax on petroleum products, to be discussed with oil-producing countries that would agree to support and invest in a special fund, directly in the poorest countries, dedicated only to water.

Those are just a few examples of potential solutions. Another is more of a global concern and could increase joint recognition for both water and energy needs. Before the Copenhagen Summit, the World Water Council asked to add water to the famous "energy-climate" package. Today, with the upcoming Doha Summit, it's more pertinent than ever. We believe that the future of energy cannot be written without that of water.

The world needs a "water-energy" package, with climate change as a backdrop. For us, the water community, this idea is translated by the establishment of a "World Fund for Rare Resources", supported institutionally, especially created to encourage energy production specifically for water.

Through these new solutions that stand out among so many others, we clearly see that water and energy are at the heart of the world's security for tomorrow.

This "Water Security" is one of a number of future strategic requirements, such as energy, nuclear and maritime security, in particular.

It is first of all human security, one that concerns basic needs: obtaining enough water (and energy) to feed and heal the planet's population. It is also economic security to produce goods and services in a fair and incentive-based environment. Finally, it is also environmental security to give back to nature the water that is necessary for the preservation of both biodiversity and the life of future generations.

It is thus that harmonious growth in the coming decades can be imagined. A "Blue Planet" or "Green Growth": the colour doesn't matter. What matters is the very nature, quality and lifespan of this growth. What matters is to know if, in the future, growth based on the best possible management of water and energy will be sufficient, fair and respectful of both man and nature. ❑

Global demand for water is expected to rise by 50 per cent by 2050

Africa: Coping with the challenge of climate change on the path to sustainable development

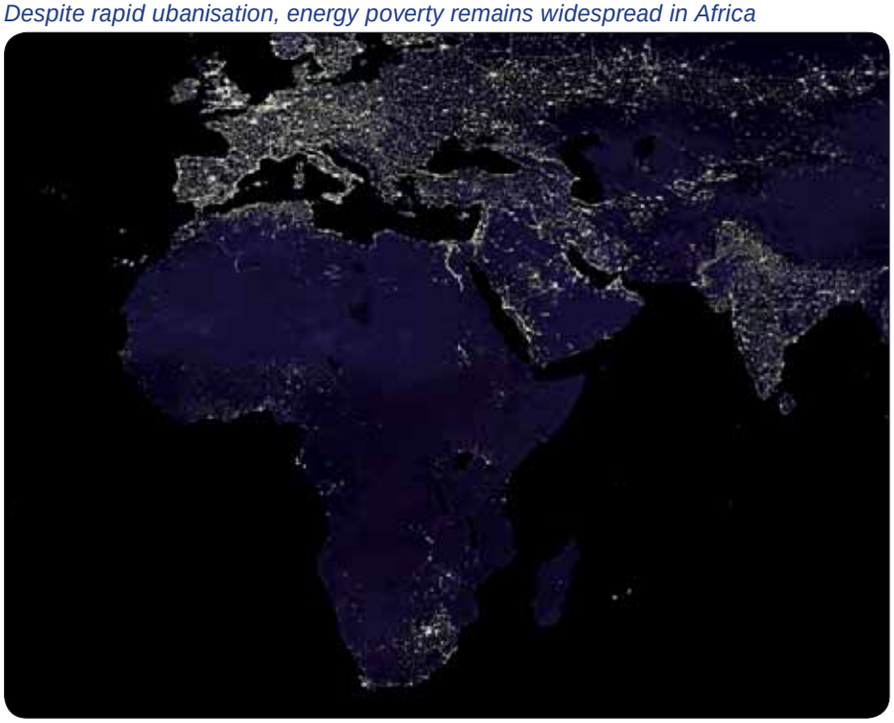
By Abubakar S. Sambo, Director General and CEO,
Energy Commission of Nigeria and Vice Chair, Africa, WEC

The UN has declared 2012 the International Year of Sustainable Energy for All. The issue of sustainable energy development is a key consideration for climate change mitigation and adaptation initiatives, and is an integral component of Africa's ability to achieve the inter-related economic, social and environmental aims of sustainable development. Nearly one third of the global population lacks access to sustainable, efficient energy services that are environmentally friendly. Climate is likely to affect everyone in one way or the other: from temperature rise, increased floods and change in rainfall patterns to the spread of diseases like cholera and malaria. The challenges that need to be overcome in sustainable development are enormous. As a continent, Africa is experiencing one of the fastest rates of urbanisation in the world, with Sub-Saharan Africa leading the way. By 2030 Africa will have about 760 million urban residents, more than the entire western hemisphere of today. And by 2050 the figure is expected to grow to about 1.2 billion. With more people moving to cities, the demand is increasing for sustainable development projects in energy and water, as well as healthcare. African countries are likely to be severely affected because of the already high levels of poverty and vulnerability. The impacts of environmental change on men and women are likely to be different due to their different roles and responsibilities.

Much of the focus of development interventions in Africa have been on energy use at community level. For example, many interventions have promoted the use of improved stoves, which end the drudgery of wood-fuel collection by women and children. The different impacts of climate change, international energy policies, and climate change mitigation activities on men and women have not been articulated or researched into properly at the national and regional levels. These impacts can play significant roles in mitigating climate change activities at the local level. Energy policies therefore need to be explored and addressed.

In the developing world, 1.3 billion people now live below the poverty threshold, 70 per cent of whom are women. Energy use is a yardstick for socio-economic development, and it is clear that energy poverty and inefficiency are widespread in Africa. Energy use is closely linked to a range of social issues: poverty alleviation, population growth, urbanisation, and lack of opportunities.

Despite rapid ubanisation, energy poverty remains widespread in Africa



Promoting sustainable energy in Africa

Major initiatives must be taken and scaled-up at all levels to make progress. The measures that should be embarked upon in Africa include:

Prioritising efficient institutional, regulatory and policy frameworks: African policy-makers should pay special consideration to policy measures which clarify the role of various stakeholders (public and private); improve the investment climate in general through more favourable legal and regulatory reforms; strengthen the role of independent energy regulatory bodies and lift barriers to the realisation of regional integration projects in energy. Co-opting women in making energy policies will enhance the promotion of sustainable energy and alleviate energy poverty in Africa.

Increasing financial flows towards the African energy sector: International development partners, including the UN, should enhance their role to support African Nations to undertake the necessary reforms conducive to a coherent, transparent and attractive investment framework and increase their advocacy and funding function to mobilise and significantly increase financial flow towards Africa for investment in energy projects. Commitments made to set the NEPAD energy initiatives as a priority for the continent, should be reinforced.

Improving the share of RE in the African energy mix: African governments should put in place coherent regulatory and policy frameworks that support the development of thriving markets for renewable energy technologies and recognise the important role of the private sector. This includes removing barriers; allowing fair competition in energy markets; and taking into account the concept of internalising external costs for all energy sources.

Promoting regional energy integration as a catalyst for development: The Regional Energy Commissions (RECs), with the support of international partners, should promote regional energy trade as an efficient means to reduce the uneven distribution of energy resources in Africa; reduce energy import cost burdens on most national economies; and increase the supply of secure and environmentally sustainable energy.

Linking rural energy development programmes to poverty reduction strategies and the achievement of the MDGs: International development partners, regional, sub-regional and national energy stakeholders should view the energy access problem as inseparable from poverty reduction efforts and economic growth strategies. They should, therefore, be willing to drastically increase their financial participation in the sector and assist in the development of key infrastructure that can sustain the minimum economic growth required to break the cycle of poverty and achieve the MDGs.

Promoting coordination and coherence among all international partners: More efforts must be made by all energy stakeholders, especially UN organisations, to create coherence, complementarities and effectiveness in energy policy initiatives in Africa. This can be achieved in the framework of a collaborative mechanism such as UN-Energy/Africa.

Conclusion

In conclusion, energy production and utilisation is the main source of greenhouse gases emissions and global warming and the solution lies in adopting clean, sustainable, alternative energy systems and strategies, which include behavioural changes, promoting of energy efficiency and conservation, expanded development of renewable energy resources, adaptation of clean and efficient fossil conversion technologies and nuclear fission and fusion.

Africa's GHG emissions are negligible when compared with global emissions, yet Africans are most vulnerable to the impacts of climate change, so we must start in our own ways to reduce emissions and clean our environment. ❑

Sub-Saharan Africa has the potential to be a leader in renewable energy

Facing up to the "energy trilemma": A Brazilian perspective

By Luciano Coutinho,
President, Brazilian Development Bank (BNDES)

Energy systems are the basis for developing our societies. The power and economic supremacy of social groups or countries depend heavily on the methods to generate, transform and use energy. Despite being a recent announcement, the trilemma between energy security, social equality and environmental impacts has been evident in several forms since the 19th century, when the Industrial Revolution transformed the landscape and the infrastructure of cities.

The accelerated dissemination of fossil fuels resulted in economic and social progress which was accompanied, for example, by the negative effects of unbreathable air in the surrounding areas of factories, as happened in Paris and London at that time. Sources of new energy were already a choice among the elements of the trilemma. We could say that the trade-offs between such elements were always inscribed in the nature of the way energy systems evolved.

Today, challenges posed by the energy trilemma have risen to a global scale. The energy sector has overcome enormous challenges, especially from a technological point of view, but we have reached the 21st century in an energy scenario that is associated with excessive social inequalities and generating negative environmental impacts. While previous evolution met specific needs, the ongoing challenge should be to meet multiple goals on a scale not achieved by former transformations. What steps can we take in the coming decades to implement green and socially-inclusive development in a scenario in which fossil fuel sources still predominate as the primary supply of energy?

In practical terms, the trilemma comprises several dilemmas. The way in which each nation establishes its policies and investments in energy depend on the characteristics of each country or region: availability of natural resources, income per capita, institutional and regulatory reach, existence of an industrial base and technological development.

For example, countries whose economies are focused on exporting energy tend to have higher levels of energy equality, with lower energy prices for the population. On the other hand, due to the scarce diversity in energy sources, long-term energy security may come under threat.

Countries with no abundant energy sources, which are generally heavy importers of energy, after presenting increased income per capita, have more difficulties in providing modern energy at competitive prices to the populace. For countries with higher income and lower energy sources, which generally have a small territory and population, mitigating environmental impact may be effective despite strong industrial companies in some sectors.

Developed and developing countries with extensive energy sources and strong existing or growing energy infrastructure tend to show a more harmonious balance between higher level of energy security, equality and accessibility to modern energy.

What can we learn from the many different examples around the world? First, there is no single solution when seeking sustainability in energy. While there is a certain level of inertia in the evolution of economic systems, the paths taken by developing countries do not necessarily have to be the same as those taken by more industrialised countries.

Second, in spite of the complexity of the energy trilemma and the weak articulation presented by the international community becoming hurdles for sustainable energy solutions, specific initiatives from several countries may be shared and assessed as national alternatives. Brazil is one of these countries and has experience that can be replicated in other regions around the world, namely:

Public Policies and Environmental Externalities: The strategy to expand the Brazilian energy grid is associated with the energy auctions for projects related to the National Interconnected System (SIN). The auctions guarantee predictability and stability and, coupled with the long-term Power Purchase Agreements, they make it feasible for private institutions to take part. In addition, the Brazilian Development Bank (BNDES) offers financing to raise other resources. The BNDES fosters renewable energy by offering attractive financing conditions, which increases the competitiveness of renewable energy in the energy auctions, thus reducing the market distortions caused by environmental externalities, as happened recently with the historic increase in wind energy projects in the country.

Universalisation: To make electricity available in regions where investments in distribution are not attractive, the federal government launched the Electricity for All Programme. In the first nine years of the Programme, investments managed to reduce the numbers of those with no access to energy in the country to a mere 1.4 per cent of the population, one of the lowest rates among developing countries.

Mitigating the Environmental Impact of Hydroelectric Plants: To reduce the socio-environmental impact of hydro-electricity, which is an energy source with low greenhouse gas emissions (GGE) and which is of great importance to the energy security of the country, the socio-environmental

scale has become part of all new projects from their initial conception, when structural elements have not yet been defined. This approach enables the drastic reduction of negative impacts, such as a reduced number of flooded areas. Besides this, today, investments in economic and social development in municipalities surrounding the hydroelectric plants are much more significant.

Sustainable Biofuel Production: Brazilian ethanol has been deemed the most "carbon efficient" biofuel produced in the world. It can now be used in up to 84 per cent of the new cars manufactured in Brazil. So that expanding sugarcane production does not impact the production of foodstuffs and native forests, the Brazilian government established Sugarcane Agroecological Zoning, as the inhabited regions expanding their plantations are defined. Furthermore, this instrument has identified 65 million hectares in degraded areas that may be used to expand the sector (this is eight times the area of planted sugarcane today), which means that the growing production of Brazilian ethanol will not generate negative impacts related to the use of soil, thus maintaining its eminently sustainable nature.

Brazilian Labeling Programme: This is aimed at increasing the dissemination of more efficient machinery and equipment by establishing minimum technological standards for energy efficiency and providing information to consumers.

Facing the trade-offs of the energy trilemma has offered some new possibilities:

- Planning and governmental efforts are fundamental in establishing regulatory policies, fostering incentives and attracting private resources needed for investments in energy infrastructure, especially in renewable energy;
- With no advance in international coordinated support for energy sustainability, national efforts will remain isolated policies;
- The main focus of sustainability policies should be the least economically-developed countries and the lowest-income classes in all countries. Universalising access to electric power and modern sources of biomass should become a global target for the international community;
- Large-scale gains from specific energy areas should not restrain the search for more diverse sources, with the aim of increasing energy security and resilience in countries. A mix of national sources and imports should focus on guaranteeing a long-term energy supply;
- Establishing standards or technological paths for machinery, equipment and industrial processes should be flexible and varied, as well as adapted to the stage of development in each country so as to avoid excessive imbalance and technological dependence;
- Transition to an economy with lower carbon emissions requires new technological levels, investments and public administration. Additional costs of this transition for less developed countries should be distributed across temporary bases that are socially acceptable, in accordance with the capacity of more developed countries to collaborate;
- While they are important, market solutions to reduce carbon emissions, such as the cap-and-trade system and carbon tax, are not enough to foster the needed transformations. Establishing deeper commitment from the developed countries and the voluntary participation of the more advanced developing countries may bring about solutions that combine planning and the market;
- Incentives for researching, developing, demonstrating and disseminating low-carbon technologies require substantial financial resources and long-term foresight. Development banks the world over are capable of leveraging investments and are natural channels for foreseen international financial flows, such as the Green Climate Fund.

The capacity of the world in integrating isolated initiatives that contribute to the sustainability of the energy sector requires a change in society as a whole, and our capacity to implement such a change will only be revealed over the coming years. Natural tensions within and stemming from the energy trilemma will not be entirely overcome. But today there is a wide array of national experiences that can be of great value in making the related and difficult choices. ❑

Brazil's Itaipu hydro plant: The world's largest by generating capacity

Sustainable development through green energy and smart technology

By Joong-kyum Kim,
Chairman, WEC Daegu 2013 Organising Committee

In the quiet Scottish town of Greenock, one James Watt was born in 1736. In 1755, he moved to London where he found work as an apprentice mechanic for drainage systems. It is here that he invented the steam engine, a discovery whose importance would eventually lead to the onset of the Industrial Revolution. At the time, the era of fossil fuels was dawning, while the introduction of steam locomotives and railways capable of carrying loads quickly over distances allowed mass production to take place.

The invention of this innovative technology sent shockwaves around the world, and James Watt was declared the inventor of the day. From that time, competition for fossil fuels between countries led to the development of a mechanical civilisation through machinery and technology which would enrich the world.

Since the start of the industrial revolution, however, the development of fossil fuel-driven technology has had unexpected results. If we consider, for example, the world as a type of environmental clock, we stand today at 9:30 pm. Just a little over 2 hours remain until the Earth's life is over. A rise in the average global temperature of just 0.74°C has brought with it drought, flood and heat waves, resulting in ecological destruction and economic loss.

Added to this, the development of such technology has used up 85 per cent of the world's fossil fuels, thus resulting in an explosion in demand as the resource depletion crisis deepens. As a result of not having alternative energy sources, fossil fuel prices continue to rise and economic growth slows down. The unpleasant reality is that the depletion of fossil fuels is adding a great deal of confusion and inconvenience to our lives.

In this regard, technological innovation such as that during the time of James Watt is needed now to survive this crisis. There is much work to do to develop more of the technologies we have believed in until now, although not just in the area of the natural environment.

Emerging environmental issues and changes in the global energy market

Since the industrial revolution, growth-oriented industrialisation has brought with it concerns about the environment. From 1970, these issues have been the focus of the world's attention. Environmental regulations have been strengthened by over 175 international agreements which have had a tangible effect on both society and the economy.

As a response to changes in environmental regulations, the global energy market is rapidly evolving. Energy prices and volatility continue to rise, while competition for energy security has increased and intensified. In addition, improved efficiency as well as the development of green technology has increased demand for new programmes, and the portfolio of renewable energy is expanding. In this light, the development of smart grids and related technology, not to mention IT convergence, are now taking place. It can be said that interest in nuclear power, which has been the key alternative to fossil fuels, continues to grow even after the Fukushima nuclear accident which took place in Japan in 2010.

Reflecting this, the United States has recently announced plans to invest US$150 billion by 2020 in the renewable energy field, including green cars – a 15 per cent overall increase. The EU intends to focus on developing large-scale wind power and CCS projects, while in Eastern Europe there are plans to build 27 nuclear power plants by 2030. In order to initiate low-carbon and energy efficiency projects in urban areas, €80 million has been set aside. In Japan, the country's "Cool Earth 2050 Strategy" is a plan to promote greenhouse gas reductions to the tune of 60-80 per cent by 2050. China National Energy has announced a policy of limiting production and consumption of coal to 3.9 billion tonnes by 2015, and has expressed its desire to actively cooperate with international efforts on climate change.

As the spotlight shines on the green industry, new and renewable energy industries are also seeing an increase in investment. In 2011, despite the financial crisis and challenges seen in European countries, US$2.6 trillion was invested in these areas, a 5 per cent increase over the amount of investment made just one year earlier. The government of South Korea will continue to keep pace with global markets as it actively implements the country's "5-year Plan for Green Growth." In short, the domestic energy industry will continue to move quickly.

The power industry's current reality

Feeling the harsh reality of 'only the strongest survive,' global and domestic companies alike are working hard to evolve. In this light, the electric power industry is still dependent on fossil fuels, while so-called smokestack industries are now being treated as polluting industries.

If so, we must look at KEPCO's current appearance

from the inside out. In terms of scale of power generation, KEPCO stands in the global top 10. The company's annual sales have reached KRW 40 trillion, while the UAE's order of 4 KEPCO nuclear power plants has given a massive boost to Korea's largest government-owned enterprise. At first glance, it would appear that KEPCO is full of trees bearing fruit which is ripe for the picking.

Taking a deeper look, however, one would see that the reality was just the opposite. In fact, KEPCO has recorded a deficit for the past four years consecutively, while overseas sales have plateaued at a mere 3 per cent of total revenue. The proportion of thermal power generation at KEPCO in regard to overall power generation is 67 per cent, while the company accounts for 29 per cent of all of Korea's carbon dioxide emissions. In contrast, there is a very small level of development in renewable energies. Given this reality, KEPCO's growth can be represented by a stunted tree instead of one laden with fruit.

Vision and action plan

It is thus that the tree with stunted growth must have life breathed into it in order to continue growing. To this end, KEPCO has taken a penguin's perspective of being on a melting iceberg as we strive to establish new 'blue ocean' strategies.

Upon assuming my current position in September 2011, I set a target of KRW 180 trillion in annual sales by 2025, established a "Global Top Green & Smart Energy Pioneer" vision, and vowed to unite our employees to carry out this vision to the best of my ability.

To the end of realising a low-carbon society and seeing this vision through, the company has implemented a two-pronged approach. The first is the development of green energy and the second, the implementation of smart technology. Of course, the ultimate goal is the convergence of both.

Green energy development

Green energy should be interpreted as a concept which includes solar, wind and other natural power sources, as well as nuclear power, IGCC and CCS technology which can convert fossil fuels into sustainable energy.

KEPCO is focusing its core technology on offshore wind power development while simultaneously developing power generation from tidal currents and solar power. The company is also expanding its core data to develop a special purpose company geared toward overseas projects. Due to the currently low level of desalination technology, KEPCO is boosting collaboration efforts with world-class companies, conducting research and acquiring plant sites with the hope of establishing a demonstration plant capable of desalinating 10,000 tonnes of water per day by 2020.

Meanwhile, solar, geothermal and biotechnology have been designated as future strategic technologies for our company. Plans are being established to combine solar energy with heat energy technology to raise the commercial viability of photovoltaic power generation, connect available geothermal technology with overseas geothermal resource development plans to develop a feasible project model, and use waste as the feedstock for biogeneration to perform overseas verifications of 10 MW by 2018. Through the development of such green energies, we will be able to raise the ratio of domestic renewable (excluding hydro) from 2.3 per cent at present to 7.2 per cent by 2024.

In regard to nuclear energy on the domestic front, plans are in place to raise the total contribution of nuclear energy to the nation's power generation from 25 per cent at present to 32 per cent by 2024. Public-private partnerships between Korea and other countries will also be strengthened through investing in stakes of relevant companies and by providing value chain services for nuclear power plants around the world. For certain, the export and construction of additional nuclear plants will also lead to the expansion of green energy.

In addition, we have designated IGCC and CCS as growth engines and will work to expand these business areas overseas. Investment in R&D for IGCC technology will also increase. With the completion of construction on the Taean IGCC plant, KEPCO has raised its level of technology to 90 per cent, thus equipping the company with the ability to compete in the global market. In regard to CCS, a collaborative programme with KEPCO's group subsidiaries will be initiated to build a 500 MW integrated propulsion system by 2018.

As a result, through the development and expansion of green energy, the domestic and international power configuration currently centred on thermal power will switch to a low-carbon power mix better suited to address climate change.

Implementation of smart technology

As mentioned above, there is a need for the convergence of smart technology in order to distribute green energy to where it is needed. In regard to smart technology, in order to operate the technology for hardware such as smart grids, HVDC and superconductivity, and to combine green energy with smart technology, an efficient organisation, administration and human resources system must be established, while R&D activities must also include software technology.

Concerning the development of core hardware technology, namely smart grids and microgrids, KEPCO has made a significant level of investment which has enabled it to secure core technology in communications security solutions and control technology, and thus take the lead in the global market through a KEPCO-led consortium and demonstrations.

In light of the expected rapid growth in the HVDC and superconducting market, the company has plans to make aggressive R&D investment in this field in order to bring its advanced technology up to necessary levels. Following the introduction of this technology, we plan to increase the number of outside research personnel and establish an integrated work scheme with our subsidiaries to connect 2 GW of offshore wind power to the existing power grid.

In the long term, KEPCO has great interest in establishing a supergrid with a high-voltage capacity which will connect Russia, China, North Korea, South Korea and Japan. At present, this plan has been divided into three stages.

At the present time, green energy and the smart technology used to distribute it are being readied. Finally, it is now time to establish the global organisation and human resources needed for to manage this integrated smart software technology.

In order to ensure an effective global management structure capable of carrying out its vision, KEPCO will give independent governance functions to business units where each will receive respective targets and be assessed based on post-performance. Communication channels between the business units and our subsidiaries will be established to ensure the integrated management of this new structure.

In addition, a Corporate Centre will be established to monitor and manage each project and its respective risk, while plans are in place to analyse potential synergies for new business development.

In order to ensure sufficient 'smart' human resources, KEPCO is operating a Meister School as well as K-INGS, the world's first graduate school devoted solely to cultivating nuclear experts. The company is also developing talent through varied in-house training and education programmes to enhance the practical skills of its employees.

Blueprint and Closing Comments

Now, all the preparations are complete. All that is left to do is to take on the world, and indeed the world is on our doorstep. Today, KEPCO is set to achieve KRW 180 trillion in annual sales, 50 per cent of its total business coming from overseas projects and a capacity of 107 GW for Korea's domestic power plants, 71 GW of which will be from offshore. Green energy will account for 32 per cent of KEPCO's power ratio, all of which will transform the company into a global, eco-friendly top-level utility company.

The winds of change began to blow two centuries ago in a little town in Scotland called Greenock. Today, KEPCO stands ready to achieve the Butterfly Effect as it rides an even bigger wind. Time, like the leaves of autumn, is fleeting, and change means that nothing is certain and there is nothing to hold on to.

In other words, the sun's light does not work on its own. Instead, it requires a body which represents smart hardware technology, and a head formed by smart software technology. As a result, the sun can shine to make the world a better place.

It is time for us to stop lingering on negative thoughts, only acknowledging that technological advancements have failed to benefit the environment and regarding nature simply as good scenery. We need to act on giving back the beauty and joy that nature has given to us. It is crucial to find a way to exist together with nature without violating it. In light of this mission, KEPCO is seeking to combine smart energy technologies with James Watt's steam engine and to develop new environmentally-friendly growth engines for green energy. We believe this is the initial step to achieving our vision of becoming a "Global Top Green & Smart Energy Pioneer" and changing the world for a better future. ❑

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