
Renewable energy: potential and benefits for developing countries

*Proceedings of a conference organised by the
European Office of the Konrad-Adenauer-Stiftung
and the EastWest Institute*

Brussels, 28 February 2007

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Published in the framework of the project *Dialogue on Development Policy* at the European Office of the Konrad-Adenauer-Stiftung.

Responsible for publication: Dr. Peter Köppinger
Editorial coordinator: Denis Schrey
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Page layout: Eurocorrespondent.com Limited

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Printed in Germany. ISBN 978-3-88579-464-6

The Konrad-Adenauer-Stiftung

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Abbreviations

CERER	Centre for Studies and Research into Renewable Energy (Senegal)
CDM	Clean Development Mechanism
CHP	Combined heat and power
CO ₂	Carbon dioxide
DNES	Department of Non-conventional Energy (India)
ECOWAS	Economic Community of West African States
EU	European Union
EUR	Euro (currency)
FEMA	Forum of Energy Ministers of Africa
GEEREF	Global Energy Efficiency and Renewable Energy Fund
GHG	Greenhouse gas
IEA	International Energy Agency
JREC	Johannesburg Renewable Energy Coalition
KAS	Konrad-Adenauer-Stiftung
MDGs	Millennium Development Goals (UN)
MNRE	Ministry of New and Renewable Energy (India)
mtoe	Million tons of oil equivalent
NEF	New Energy Finance
NGO	Non-governmental organisation
ODA	Overseas development assistance
PEC	Primary energy consumption
ppm	Parts per million
REEEP	Renewable Energy and Energy Efficiency Partnership
SEFI	Sustainable Energy Finance Initiative
TERI	The Energy and Resources Institute (India)
UEMOA	Union Economique et Monétaire Ouest Africaine
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar

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Introduction

Anders Wijkman, MEP

Think big: the case for energy technology leapfrogging

The role of energy in development is crucial. Energy fuels economic growth and is therefore of paramount concern for all countries. But access to energy varies widely among countries. An estimated two billion people in the world lack access to modern energy carriers. As long as they have to rely on fuel wood and animal dung for their energy needs there will be no development. In fact, no country has been able to substantially reduce poverty without significantly increasing its use of energy, replacing human and animal labour with more efficient forms of energy.

Energy use in developing countries is closely linked to a range of social issues: poverty alleviation, education, health, population growth, employment, enterprise, communication, urbanisation and a lack of opportunities for women. To mention just a few examples: cooking with poorly vented stoves has significant health impacts, hundreds of millions of women and children spend several hours a day gathering firewood and carrying water for household needs; lack of electricity means inadequate lighting, limited communications and no access to refrigeration or to a whole host of labour-saving devices and income-generating opportunities. It follows that provision of modern energy services to the poor is a crucial prerequisite to meet the Millenium Development Goals (MDGs).

Energy is also strongly linked to the climate and the environment. Most current forms of energy generation and use cause environmental problems at local, regional and international levels, threatening the health and well-being of current and future generations. The health impacts from solid fuel used for cooking and heat are serious: an estimated two million premature deaths per year because of indoor air pollution.

Because of inefficient combustion the use of traditional biomass also adds significantly to global warming.

Finding ways to expand energy services, while addressing the environmental impacts associated with energy use, represents a critical challenge for humanity. Recent developments in countries like China and India, where energy production has increased significantly, demonstrate how difficult it is. Carbon emissions from these countries are rising rapidly. However, despite the many environmental problems related to energy production, numerous ‘win-win’ strategies exist that could simultaneously benefit the economy, the environment and human well-being.

Renewable energies have the important potential of allowing development and environmental challenges to be dealt with jointly. In recent years there has been a significant development of alternative energy technologies, both in terms of performance and cost reduction. Moreover, many developing countries are particularly well positioned when it comes to developing a new generation of energy technologies.

For example, simple technologies like solar water heaters, solar pasteurisers, wind pumps, improved cooking stoves, biomass briquettes, and biogas, have the potential to make a huge difference in securing modern energy services for the poor and to be an important step towards achieving the MDGs. On a broader level, grid-connected large-scale hydro plants and wind power have great potential to enable growth and development in developing countries, while not countering ongoing efforts to mitigate climate change and reduce greenhouse gas emissions.

The biofuels experience of Brazil, where the residue materials from sugar production are being used to produce ethanol, shows the great potential for modern biomass in the tropical countries. Combined heat and power (CHP), based on biomass, is another option that deserves serious attention. The same goes for the suggestion from the Club of Rome to make use of solar thermal power plants in the African deserts. The concept is simple. By using large-scale mirrors to concentrate the sun’s rays on a pipe, that heats up a liquid that can power conventional steam turbines, electricity can be produced and then fed into European networks.

Apart from development and environmental benefits, renewable energies have the potential to provide increased security and economic stability. Increased use of renewable energy sources would reduce dependence on expensive fossil fuel imports and would help many countries improve their balance of payments. Renewable energy projects can have a significant impact on job creation; the ethanol program in Brazil, for example,

has generated almost a million new jobs in rural areas.

While there are good renewables opportunities in many developing countries, we should be mindful of the fact that many renewable technologies still are relatively expensive. Costs have to come down and here development grants and soft loans could contribute substantially. In addition, as shown by the fuel versus food debate and the links between biofuels development and deforestation, some renewable energy sources may even contradict the attainment of other development goals. Sustainability criteria are badly needed, not least when it comes to biofuel production. It is also necessary to realise that fossil fuels will continue to be used quite extensively in the future, and that huge efforts to make these cleaner and more efficient are part of any successful attempt to combat climate change.

Nevertheless, the potential for renewables in poverty reduction, the fight against climate change and in working towards development goals, give cause for optimism among politicians, economists, environmentalists and investors around the world. On a global level, investment in renewable energy has seen an explosive increase during the past few years, doubling since 2004. A further 20 percent increase is expected for 2007 alone.

However, continued interest is largely dependent upon oil prices and, significantly, on governments creating the right frameworks to foster long-term business engagement. In addition, new financial mechanisms at international level are badly needed to drive down costs and overcome the many barriers to deployment. In other words, policy matters.

An important step needed to ensure that renewable as well as more efficient energy technologies actually benefit the poor, is a reform of the development agenda. In the past, national poverty strategies have given scant attention to the provision of modern energy services. Considering currently insufficient private investment, substantial overseas development assistance (ODA) grants and soft loans, directed towards capacity building, clean technology for power production and appropriate small-scale renewable energy technologies at village level, are absolutely crucial.

The development and transfer of clean and more efficient technology to the developing world is not without a cost. The Stern Review (*The Economics of Climate Change*) estimated that an extra USD 20-30 billion will be needed annually to fill the cost differential between conventional and low-carbon energy investments. Where will this extra money come from?

Some people point at the Clean Development Mechanism (CDM). But as currently designed, the CDM will not get us very far – at least not in the near and medium-term. Then there is the Global Environment Facility (GEF), but the funding it commands in the field of sustainable energy is very limited – only a few hundred million dollars per year. The EU recently launched The Global Energy Efficiency and Renewable Energy Fund (GEEREF). It is a worthy initiative but far too limited to make any real difference – an estimated EUR 75 million for the period 2007-2010.

We have to think big. There is desperate need for modern energy services all over the developing world. Black-outs are frequent in the modern sector and governments do what they can to expand electricity production. Most often they resort to fossil fuels, mainly coal. In the villages people seldom have alternatives to fuel wood and animal dung. If we want this to change, the priority must be given to large-scale deployment of efficient and low-carbon technologies. A technology fund in the range of USD 10 billion per year is badly needed.

Industrialised nations are ultimately responsible for the build-up of greenhouse gas (GHG) emissions in the atmosphere. We never had to take global warming into account when we modernised our own economies. We could rely on cheap oil. That is why we have a moral responsibility to act. The launching of a Technology Fund – to support investments in efficiency and clean technology – would make it possible for developing countries to avoid repeating many of the polluting mistakes made by industrialised countries. Technological leap-frogging would become a real possibility and developing countries could modernise their economies based on a far lower carbon footprint than otherwise.

Such a development ought to be in everybody's interest. What are we waiting for?

Introductory session

Introductory remarks

Dr Gerhard Wahlers

Energy and climate change: global challenges

This international conference '*Renewable energy – Potential and use for developing countries*' is the second conference hosted jointly by KAS and the US think tank, the EastWest Institute. It aims to continue the discussions on energy supply, following the first successful conference in the series held in Berlin in October 2006.

The first event brought together high profile experts from politics, business, science and NGOs to stimulate thinking and influence discussions on the topic of, '*Global security of resources*', on the eve of the double German presidency of the European Council and the G8.

The great global challenges of the next few years will be safeguarding our energy reserves and managing climate change. Experts agree that European oil and gas reserves, which are not very substantial, will be exhausted in the next few years. The dependency of European countries on imports will then rise from 75 percent to 90 percent for oil and from 45 to 70 percent for gas.

This dependency brings particular risks. A large proportion of known oil and gas reserves are situated in the Near East and Central Asia - regions that include politically unstable countries. Furthermore, oil and gas exporters are increasingly looking to exploit their strategic advantage to assert their own interests.

When it comes to shaping policies, it is ever more apparent that questions of energy policy are questions of power. This can be witnessed in Russia's disagreements about energy with Ukraine and Belarus, as well as in positions taken by the Iranian and Venezuelan Presidents.

Climate change is another issue of primary concern, which is increasingly linked to the energy debate in political discussions. The recently published first and second parts of the Intergovernmental Panel on Climate Change (IPCC) study concluded that global warming because of human activities has already begun and that it can only be slowed down, not prevented.

The recently published report by the British governmental adviser Sir Nicholas Stern has examined the already substantial economic costs of climate change. The phenomena of floods, drought, and water scarcity are impacting on industrialised countries, but also, first and foremost, on developing countries.

Climate change is an issue no country can ignore. However, unilateral activity to mitigate or adapt to it will only have a limited impact. If a country such as the United Kingdom was to reduce its emissions to zero, the energy saved would be quickly offset as a result of the economic growth in other parts of the world, such as China.

The warming of the atmosphere today is due to the greenhouse gases emitted by industrialised countries in the past. Even today, the African continent is responsible for only three percent of global carbon dioxide (CO₂) emissions; the same amount as Germany alone. North America is responsible for 30 percent of global emissions and the EU for 15 percent. The industrialised countries have primary responsibility for preventing further emissions and offering environmentally friendly technology to support third world economic development.

Awareness of renewable energy provides an important response to questions of energy security and climate change. Interestingly, the use of natural power is nothing new; humankind has centuries of experience of exploiting renewables as a source of energy. Wind and water have been used much longer than fossil fuels, which have only been exploited for the last 150-180 years.

Experts believe that renewables can contribute a large share of today's energy requirements – around 25 percent for Europe in the long term. This would bring the double advantage of securing energy supplies and reducing CO₂ emissions. An increase in the share of renewables in a country's energy mix can help in achieving independence from imported fossil fuels and from volatile world market prices.

Ten years ago, the EU set itself the goal to meet 10 percent of its energy needs through renewable energy by 2010, and 20 percent by 2020. The European Commission has spoken of a new industrial revolution in this context. Germany is well on schedule; in

2005, the share of environmentally friendly electricity had already surpassed 10 percent.

These figures show that it is possible to satisfy a far higher share of energy needs through renewables than is currently the case. Further efforts are needed worldwide to develop renewables and both developed and developing countries must contribute.

Introductory remarks

Ambassador Ortwin Hennig

Energy security is vital, not just for running the economies of developed countries, but also for providing the developing world with the means to lift itself out of poverty. Sustainable use of energy, and especially use of renewables, is a precondition for sustainable development and poverty reduction.

However, current energy scenarios for the 21st century look gloomy. Today's energy system cannot provide an adequate energy supply for those 1.6 billion people who live in energy poverty. A continuation of the current energy policy, relying on the extensive use of hydrocarbons, could lead to environmental catastrophes, which will seriously affect the poorest countries, and further increase income disparities between rich and poor.

The current debate on energy security therefore has to be broadened to include the potentially devastating impacts of high energy prices in a hydrocarbon-based global energy infrastructure and climate change. Extreme weather patterns will limit access to energy resources and changes in temperature will quickly change the pattern of global energy markets, creating new and very often negative relations of interdependence.

Developing countries need better access to stable and affordable energy supplies, as well as new technological solutions enabling efficient use of traditional and renewable energy sources. More consistent support for climate-friendly development on the basis of renewables in the countries of the South is needed. The same holds true for international assistance packages for developing countries involving technology-sharing and renewable energy.

We all need to save energy, improve on energy efficiency and focus on renewables. We

should act on a global level to promote renewable energy as well as energy saving and energy efficient technologies. It is in the common interest of both developing and developed countries to meet these challenges. The European Union and its member countries must be urged to promote renewable energy. They have the political, intellectual and technological capabilities and the resources, not just to steer the global debate on renewables, but also to drive global action.

Renewable energy is the best answer to energy poverty, it helps to reduce CO₂ emissions, slows down the negative global temperature trend and proposes a feasible model for sustainable energy strategies. Furthermore, it is not just a must, but also a business opportunity. In Germany, for example, it is estimated that the renewable energy sector has a EUR 16 billion turnover and has already created 170,000 jobs.

The EastWest Institute addressed some of these issues in a recently released energy policy paper. It called on leaders in government, business, the media and the energy community to respond to growing global fears about access to resources by rebuilding confidence in a set of global rules. A cooperative approach creating a truly international energy organisation with a broad mandate is needed to reconcile competing stakeholder interests.

Renewable energy: potential and benefits for developing countries

*Andris Piebalgs**

Energy and climate: Europe's approach

The timing of this conference is perfect. In mid-February 2007 the European Commission's energy package was discussed in the Energy Council, and energy was a key issue for discussion at the Spring European Council (March 2007). As you know, energy ranks amongst the top priorities on the European political agenda but it is only right that Europe – amidst the intensive discussions about Europe's own energy future – does not forget that the energy challenges are global and that we have to maintain a strong focus on the developing world. There is a genuine positive-sum game that can stem from increased collaboration between the EU and the developing world in the key field of energy. This could be one of the best instruments to get the developing world and the EU closer to each other.

The developing world presents one of the best windows of opportunity for the promotion and use of renewable energies. There is a real opportunity to be seized at many levels, at which the use and production of renewable energy can bring about positive benefits. Security of supply is a very important factor, the effects of which are increasingly noticeable. Renewables can also generate additional incomes and reduce expenses by preventing the building of polluting and maybe already obsolete grids and plants. Renewables may allow developing countries to leapfrog directly into a clean energy scenario, thereby avoiding actually what Europe is facing today: we have an existing grid, existing energy production, which will over time have to be replaced, and this costs a lot of money. So the developing world could jump from the present situation to a situation in which it doesn't need this obsolete and polluting

* Mr Piebalgs' presentation at the conference was given by Mr Roland Kovia.

infrastructure. Sustainable energy production also has an important role in achieving the Millennium Development Goals and meeting the Kyoto targets.

Sustainable energy is so important for developing countries for the following reasons:

Firstly, energy production and use has an important economic impact. Most developing countries - like Europe - are net importers of energy. Some of them have benefited from the increase in oil prices in recent years, but most have not, and have suffered as a result. A significant proportion of the revenues of developing countries, and of the development aid received, has been outweighed by the oil price increase. Yet, as energy consumers and producers, developing countries have a lot of catching up to do:

- 1.6 billion people in the developing world do not yet have access to electricity;
- 2.4 billion people use traditional biomass, such as wood or agricultural residues for cooking, heating, and other needs, often in an unsustainable manner, which runs counter to their own interests in terms of economic development and health.

Better access to sustainable energy services is necessary at macro level to foster economic growth, and at micro-level to stimulate businesses and income-generating activities. Small businesses, public buildings and homes need adequate energy for lighting, communication, water supply, heating and cooling. Streetlights, for example in Africa, are essential for safety at night.

Secondly, energy is important from an environmental viewpoint. Energy emissions represent 80 percent of total GHG emissions, contributing to global warming and making the trend towards natural disasters in many parts of the world worse. Following the Stern Review, and the February 2007 report of the Panel (IPCC) on climate change, there is no longer any real doubt that climate change is caused by human activity. As world energy demand is expected to rise by some 60 percent by 2030, (as seen in all the latest estimates, for example the World Energy Outlook published in October 2006) the pressure to find alternative and efficient energy sources as well as to save energy will only become greater. As the developing world is forecast to be hit hardest by climate change, it needs to embark upon this common endeavour to minimise the sources of risk. A concrete example: Nairobi, Kenya, was built at 1700 metres above sea level, because at the time there was no malaria at that height. If temperatures rise, malaria will return to Nairobi and other high plateaus, even in certain parts of Europe. Alongside conflict, governance issues, access to food and water, and diseases, the consequences of climate change could definitely rank amongst the most difficult challenges that the

developing world will have to face in the coming years. But something can still be done, notably through early investment and behavioural changes.

Investment climate

It is estimated that the rapid process of industrialisation in China, India and other energy-intensive transition economies, will need about EUR 250 billion in investments in new energy production per year for the next 30 years. The figures can be debated, but their range and scope gives an idea about the massive investment that is needed.

On the other hand, many renewable energy technologies are ready and are used extensively in some developing countries. China, alongside Germany, was the investment leader in new renewable energy capacity in 2005. We always talk about China as a matter of concern because of the massive creation of gas and coal plants. But it is also making efforts in terms of renewable energy production. India has surpassed the wind capacity of Denmark, which is a front runner in that field. Large scale investments by these emerging economies could drive the cost of producing renewable energy down considerably.

With increasing energy shortages and environmental concerns in mind, the wider use of renewable energy is more and more critical for a sustainable energy future. The Commission believes that we have to go beyond words and actively promote renewables. A need for investment to meet the expected growth in energy demand in developing countries, together with the imminent need to reduce greenhouse gas emissions must be a determining factor in the choice of national and regional energy mixes. In order to encourage a bigger share of these investments to be directed towards new and renewable energies, we must work together in intelligent partnerships to bring down the cost of new technologies and, generally speaking, to make them more available.

Ongoing EU initiatives

In recognition of the importance of clean and affordable energies for development, the Commission and EU Member States have jointly set up the EU Energy Initiative for Poverty Eradication and Sustainable Development. This was done in 2002, following the World Summit for Sustainable Development in Johannesburg. The initiative kicked off the policy dialogue with developing countries and other international energy initiatives, such as the Forum of Energy Ministers of Africa (FEMA), the Johannesburg Renewable Energy Coalition (JREC) and the Renewable Energy and Energy Efficiency Partnership (REEEP).

On the basis of the Brazzaville Ministerial meeting of October 2006, and of the 2005

European Consensus and EU Strategy for Africa adopted by heads of states, the Commission also intends to initiate the development of a comprehensive Africa-Europe Energy partnership as it is formally provided in the Communication on a new Energy Policy.

The EU Energy Initiative has already set up two specific frameworks for action:

- An ACP-EU Energy Facility was set up with EUR 220 million for co-funding energy-related projects.
- The COOPENER Programme also focuses on sustainable energy services to overcome poverty in developing countries, concentrating on strengthening local capabilities to use sustainable energy. It was launched in 2003 with a budget of EUR 17 Million until 2006, and will continue to be supported, under a different name.

Last but not least, a new EU Infrastructure Trust Fund for Africa has been set up with the European Investment Bank with an initial allocation of EUR 320 million. Part of the fund (which is massive, although not strictly limited to energy infrastructure) will be used for enabling access to sustainable and affordable energy services.

However, let's not be mistaken. What is coming from the donor community will not and should not be enough. It is important that the developing world itself contributes, in terms of political willingness to engage on that path. Developing countries are themselves in strong positions to promote the use of renewable energies due to abundant renewable resources, including wind, solar, geothermal, biomass, and hydro. Financial aid is only needed to give a kick-start to the process of creating the right framework and the momentum for renewable energies. One example comes from the Democratic Republic of Congo: the Inga Dam in its last phase, Inga III, would actually be able to give electricity to almost the whole continent. This shows that the developing world, in this case Africa, has the potential to produce its own renewable energy. Of course, some financial and political support is necessary, but the potential exists in concrete terms.

Amongst developing regions, Africa in particular offers a unique opportunity to use decentralised renewable energy technology in a competitive manner. It can by-pass the need for transmission grids and 'leap-frog' to a new generation of clean, local and low carbon energy sources and technologies – as already seen for mobile telecommunications. This is very revealing, for example in sub-Saharan Africa, hardly

any area had land lines. Now, everyone uses mobile phones. There was no grid, and today there is no need for landlines, except for Internet access, on a much more limited scale. The same could be done in the energy sector to bypass certain stages of development. This is a real "win-win" opportunity for collaboration between the EU and the developing world: to increase the penetration of clean renewable energy and to bring electrification to some of the world's poorest citizens. A special effort will be needed in sub-Saharan Africa, where rates of access to electricity are the lowest in the world. This will be a development priority for the EU.

Multilateral development institutions

Financial bodies must also be engaged. The G-8 summit at Gleneagles in 2005 asked international financial institutions to use their financing instruments to promote cleaner-energy and lower-carbon investments. The European Investment Bank and the European Bank for Reconstruction and Development both have specific sustainable energies programmes. These are strong instruments, which should be used, but they will not suffice without a global partnership between ourselves and the developing world.

Energy efficiency

I already mentioned energy efficiency. For Commissioner Piebalgs, this is one of the crucial policy areas on which he wants to work. It needs also to become a global priority as working on demand will make success on the supply side easier. This is an area where there is also a very large consensus, both at institutional and popular levels. This is an area that can bring the political and civil spheres closer to each other. It offers a win-win opportunity, because both spheres agree on the need for energy efficiency. Last October (2006), the Commission adopted an energy efficiency action plan that showed a potential energy saving in 2020 of over 20 percent of EU energy consumption (relative to present trends). But the Commission is also ready to propose going further than 20 percent, to 30 percent energy savings, if there is a larger consensus at international level. Some say that 20 percent is too ambitious, others say it is too little an effort, the European Parliament had advocated 25 percent reduction, but 20 percent is for the time being the figure on the table.

Renewable targets

The EU's own current target for renewable energy consumption is 12 percent by 2010. The Energy Package adopted by the Commission on 10 January 2007 proposes to give it a boost by advocating a longer term binding target of 20 percent by 2020. A separate binding target for a minimum biofuels share of 10 percent was also proposed for the transport sector, which presently almost fully relies on fossil fuels.

Member States are divided on whether the overall 20 percent target should be mandatory. We will continue to discuss this with Member States to ensure an agreement on a coherent and ambitious renewables policy in time for the European Council in March.

Developing countries could benefit from the EU's ambitious objectives, as it will boost trade, in particular for biofuels. Although our analysis shows that the 10 percent minimum share of biofuels could be achieved entirely through domestic production from the EU, this is both unlikely and undesirable. In practice, we see a significant role for biofuel imports from the developing world. We believe this is in the interests both of the EU and of developing countries. By creating new markets for developing countries' agriculture, it will have the potential to benefit poor people in rural areas.

Biofuels also have the potential to offer important benefits for the global environment. Most biofuels produced today are delivering these benefits, and we expect them to continue doing so. We recognise that some biofuel production methods can have perverse effects and should thus be corrected. For example, biofuels produced with very intensive production techniques or produced on drained wetlands are bad for the environment. Also, biofuels produced by clearing forest or other valuable ecosystems would contribute to substantial biodiversity damage and increase CO₂ accumulation in the atmosphere. It is essential therefore to ensure that such methods of production – whether used domestically in Europe or for imported biofuels – are not encouraged by Europe's biofuel policy.

Therefore, as announced on 10 January, the Commission intends to bring forward measures to tackle this problem of the perverse effects of some biofuel production.

Concluding remarks

Renewables can bring significant major benefits to developing countries. There is a real momentum to be seized here, because now is the time to do it. We must take action at international level to ensure that renewable energies play their role in poverty reduction and in improving living conditions for people. Concerted international action is also needed. Nobody will be able to do it alone, not ourselves, not the developing world, nor the industrial partners of Europe.

The Commission has already addressed these issues forcefully. The developing world is increasingly recognising that renewables offer good opportunities for sustainability and energy security. Commissioner Piebalgs is putting a very high emphasis on renewable energy, which matches with his willingness to do more for the developing world. These two subjects match perfectly, as far as his own political agenda is concerned.

Renewables and development: the German perspective

Dr Peter Paziorek

Germany's energy policy objectives

The main aims for energy policy in the German coalition agreement are energy saving, improvement of efficiency and renewable energies. Up to now, Germany has been able to implement the international agreements concerning CO₂ reduction. Of the 21 percent CO₂ emission reduction promised by 2012, Germany has already reached almost 19 percent. There is optimism that the target will be met, but there is also a recognition that the last two percentage points will be the most difficult to achieve.

People often ask to what extent the CO₂ reduction has been brought about by the economic collapse of the former GDR. The German government estimates that only just over half of the 19 percent reduction is due to economic change in the new *Länder*. The Western *Länder* have also independently contributed about eight or nine percent.

Energy saving and energy efficiency

Energy saving has become a very popular issue. The new coalition agreed a special subsidy programme for the refurbishment of buildings and this has succeeded in encouraging much investment. This has also meant that the population is benefiting from public money when taking energy efficiency initiatives.

Improvements in the energy efficiency of power plants would bring about the greatest savings. In Germany, 41 percent of CO₂ emissions are caused by the energy industry, compared with less than 20 percent by car traffic and a similar amount by the construction industry. Renovations costing approximately EUR 20 billion will soon be necessary and so power plant efficiency has been the subject of great debate. Germany is at a crossroads regarding efficiency improvement work as the decisions taken today will

have an impact over the next 20 years and there is still much debate.

It might seem strange from an environmental point of view that modern brown coal plants which have 20 percent higher CO₂ emissions than hard coal plants are still being subsidised. However, climate neutrality must also be seen in the context of the security of energy supplies. Brown coal plants have long-term prospects in Germany because there are large reserves in North Rhine Westphalia and they are the cheapest plants that Germany has. The government does not, therefore, foresee the phasing out of brown coal in the near future and so chooses rather to subsidise efforts to increase the efficiency of these plants from around 35 to 50 percent.

Renewables

The German coalition government agreement stipulates raising the share of renewables in electricity production to 12.5 percent by 2010. In fact, the development has been much more dynamic than was anticipated during the negotiations in late 2005, and Germany is very likely to achieve the target already this year; the current rate is nearly 12 percent and 12.5 percent will have been surpassed by a significant margin by 2010. Given this success, a new renewables target of 30 percent is being considered for the future.

Government subsidies have supported these developments, including for the use of biomass in producing electricity. When producers of renewable energy feed power into the grid they are paid at market price and these credits amount to EUR 4.5 billion. It would only cost EUR 2 billion to produce this power in conventional plants, so the economy is subsidising this development by EUR 2.5 billion.

The figures for heating are not so positive, with only 3-4 percent use of renewable energy. As well as the subsidies for heating installations on the basis of biomass, there are discussions on a possible law on heating to include incentives and financing possibilities. This would require agreement between the Ministries of Agriculture and the Environment and could aim to achieve an 18 to 20 percent share of renewables in the area of heating.

The coalition agreement lays down a 5.75 percent target for biofuels by 2010, but this target should perhaps also be raised to 20 percent by 2020. Further discussions are needed on this topic, in particular with the automobile industry, to see what other strategies are available, including the possible use of hydrogen.

The peaceful use of nuclear energy towards these aims has re-emerged as a highly

controversial topic. The coalition agreement states clearly that the phasing out of nuclear power should continue. However, whilst this is still accepted, the question arises whether extending the times of operation of nuclear power plants might not be used as a bridging mechanism to finance efforts towards a greater share of renewables and better energy saving strategies.

A broad discussion involving all stakeholders is needed in Germany to develop the energy concept to meet future challenges. The German government is currently in the process of preparing the third energy conference including participants from industry for the second half of 2007. It will look to make energy policy even more ambitious, consider how to make the best use of renewables and reflect on the question of nuclear energy.

International efforts

Germany broadly backs the Commission's vision and will work to achieve agreement in the forthcoming talks on the 20 percent renewables target. Chancellor Merkel has declared that she wishes to make use of the presidency both of the EU and the G8 to focus on energy and climate protection policy. She has the full support of the coalition parties for this plan.

Via the G8 process, instruments should be developed that link the issues of assisting developing countries and favouring action against climate change. Debate is needed on how to make full use of concrete instruments such as the global bioenergy partnership. Although there is broad agreement on principles, the details of implementation of several instruments need further clarification.

A follow-up process for Kyoto is needed. There is public controversy about the usefulness of such a process if important international partners such as the USA are not participating. Representatives of developing countries have also argued at many international conferences that the developed countries have been enjoying the benefits of using fossil fuels for over 150 years. Although they understand the calls for change, they also expect that developed countries take a lead in climate protection measures.

Another way of looking at this is that whoever brings climate protection forward will have an advantage in the long run, since it can be expected that climate protection policies will pay off. Nevertheless, countries are likely to face short-term losses of competitiveness if they are the first to make efforts. This is why an international climate protection regime is needed, to provide a suitable balance between the long and short terms. This would make it clear who bears which risks and costs in what relation, so

that the participating economies can anticipate which kinds of burdens and long term perspectives they will face.

An alternative approach was developed by the USA before it decided not to sign the Kyoto protocol in 1997. The USA steered the Kyoto negotiations towards flexible instruments to link the interests of developing and developed countries. The EU also now favours a relatively flexible approach, with an effective monitoring process, a good eco-balance and positive developmental consequences. However, such instruments can only be successful in the context of an international climate protection treaty, which allows investments to be made in developing countries in favour of climate protection and the benefits accounted for at home.

Germany will, therefore, be supporting those states that advocate for a follow-up protocol to Kyoto after 2012. It is irrelevant whether the word Kyoto will still be used for such a process or not; what is needed is a linkage of the interests of both developed and developing countries in international climate protection policy. This is a very important issue for the EU, where basic agreement must be turned into common positions.

Germany is in the process of implementing the second phase of the emissions trading rules agreed upon at EU level. For its Second National Allocation Plan, the German Parliament (Bundestag) will examine the possibilities for making links with the developing world. For example, industries could buy emissions certificates if they make sensible, climate-preserving investments there. Such emissions trading might also be made possible within Germany. This could mean, for example, that better land-use measures could be rewarded with emissions certificates. Pilot projects could then be undertaken in Germany, to provide examples of good practice.

Promoting sustainable energy

It is not enough to develop a legislative framework, but funds need to be provided as well. The Bundestag, in its function as budgetary authority and legislator, has decided not to cut energy research funding in the 2007 budget. In the agricultural budget alone, EUR 50 million is earmarked to support research and development. A significant market incentive programme also exists in the area of heating.

The Bundestag is debating whether global energy consumption will really quadruple up to 2050 and whether energy consumption in the developing countries will really grow much faster than in the developed countries. If that is the case, there are issues that need to be considered around the development of the bioenergy sector, including

biomass. Many researchers from the International Panel on Climate Change call for caution in extending the use of biomass in developing countries because it creates large amounts of CO₂, particularly when very simple usage techniques are applied.

There are many local crops in developing countries that could be used as fuels, but environmental standards need to be applied. The Bundestag has instructed the government to evaluate a certification system to ensure that imported herbal oils comply with high environmental standards. In many developing countries biogas is already in production, but mainly in small and poorly efficient installations. Therefore efforts need to be made, possibly through the promotion of new technologies, to ensure that biofuel production develops in an environmentally sustainable manner.

Germany also has problems with its 3,500 biogas plants only working at 40 percent efficiency. To improve this situation, plants could be installed close to industrial parks and the heat that is currently wasted could be harnessed to supply the surrounding industries. However, this requires funds for the initial investment in the necessary infrastructure, which is often lacking.

Germany is failing to meet its targets in cogeneration and so the government needs to analyse how to make better use of the heat by-product. The residue from fermentation processes also offers potential as a replacement for chemical fertilisers and can help reduce CO₂ emissions in agriculture. At the same time, questions of land allocation must be solved. All these experiences should help inform a strategy to also allow developing countries to make better use of biogas plants in a decentralised energy grid.

Procedures and concepts are needed to build a decentralised energy infrastructure. In spite of all the justified enthusiasm, bioenergy must be handled with caution and not be looked at in too one-sided a manner. Solar energy must be explored, especially in the world's 'sun belt' and the potential of wind energy for many coastal countries needs to be harnessed.

Crop breeding also offers great potential. Experiments were carried out in the 1980s to breed crops with a greater resistance to heat that could also be used as energy resources in dry regions of the earth. This research was sadly abandoned, but crop breeding has been enjoying great success in Germany by improving the performance of many plants. Of course, the possible contribution of genetic engineering here raises great controversy and the German Cabinet has only recently started to discuss a paper on these issues.

Furthermore, conflicts of interest in land use will arise. There are 13 million hectares of agricultural land in Germany; 1.6-1.7 million of these are used for bioenergy, but Ministry estimates suggest this might increase to 3-4 million hectares. Animal farming also requires a large amount of space, whilst the use of corn as a biogas increases its price and makes the feeding of animals more expensive. These conflicts will be addressed in the 2007 action plan for biomass, as asked for at EU level.

Conclusions

A broad approach is needed for aid to derive maximum benefit from renewable energy in developing countries. However, this linkage is only possible provided an international legal regime allows businesses to invest in developing countries and take that investment into account in their climate balance at home. For this to happen, international climate change conferences need to give international secretariats the means to make such calculations.

Germany is giving full support for the EU policies outlined here today. It is to be hoped that big advances will have been made by the end of 2007 and that these advances will also be of benefit to developing countries.

Introductory session

Questions and comments

Contribution from Christine Ortega, ambassador of the Philippines to Belgium, Luxembourg and the EU:

The Philippines has been looking at renewable sources of energy to overcome its dependence on oil, but these have always proved very expensive – solar and geothermal power - or politically difficult in the case of nuclear power. The rise in price of fossil fuels increases the need to promote energy security and it is positive that the EU is looking to promote renewable energy in the developing world. Programmes for partnership and cooperation with African countries were presented, but are there also programmes for Asian countries? There is a large market in a country like the Philippines with 85 million people, but new technology and investment is needed and the EU could perhaps play a role in promoting investment in renewable energy there.

Response from Roland Kovia

There are the following main possibilities for cooperation between Asia and the EU.

1. The Cooperation Agreements between the EU and Asian countries normally contain a section on energy and provide for the promotion of exchanges on energy.
2. Trade in technologies could be an area of mutual benefit to Asia and the EU; Asia has specific expertise which the EU would be interested in, so the commercial balance could be positive for Asia in this case.
3. It would be good to enter into an international agreement to bring a shared commitment to the higher 30 percent rate of renewable energy. This is an area which would open up further possibilities for exchange.

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4. Money can be put at the disposal of a certain number of countries, in the framework of certain EU and international programmes, for specific projects and the promotion of investment.

Resources are clearly limited and priority is given to the ACP countries, notably sub-Saharan Africa, because this is where needs are the greatest. However, these aspects should open up possibilities for a certain number of Asian countries such as the Philippines to access money and develop cooperation with the EU.

Response from Dr Peter Paziorek

There are clearly great opportunities for solar power in hot countries like the Philippines, but a substantial amount of financing is needed. Consideration also needs to be given to the grid and energy structure that is needed and the political stability in a given country that is necessary to secure foreign investment. This highlights the need for international agreements and a consideration of who finances what across the globe.

Contribution from Alberto Glender, Mexican Mission to the EU

The enthusiasm for biomass and biofuel is sending signals to the market that could create a very problematic export boom. It could have a perverse effect on land use, particularly in competing with other agricultural products that are a basis for human consumption. There is a danger of turning an energy production crisis into an agricultural problem. Global action is needed to bring in labelling and trade certification to cover standards in biofuel to protect the environment, food supplies and land use.

Contribution from Dr Peter Paziorek

Biofuels are a double-edged sword for Germany, as although farmers can broaden their market away from simply food production, countries like Brazil are capable of producing ethanol much more cheaply. Biofuels could also have an impact on the 'set-aside' areas that are a part of existing agricultural policy; if German farmers are not given the chance to adapt to the market, an opportunity might be lost for domestic agriculture. Nevertheless, production costs are lower in the developing world and Germany will not be able to make recourse to protectionism in WTO negotiations so German agriculture will have to bridge this gap in the next few years.

The land use issue is a big one; Germany is trying to develop solutions through the biomass action plan. In Mexico the issue has led to demonstrations and riots; the question of worldwide competition needs to be addressed. If price structures in the USA are changing, however, it might open up new possibilities for corn production in Mexico. In general, it is right that we should not be too euphoric about biofuels.

Contribution from Ella Stengler, European Federation of Waste Incineration Plants

Waste should be taken into consideration as an alternative source of energy. For developing countries this offers an environmentally sound way of processing waste and a useful source of energy.

The process is seen as CO₂-neutral as it saves the fuels that would have been used in traditional plants and is relatively inexpensive. In order to save one ton of CO₂, the waste-to-energy process costs EUR 7 to 12; for biomass the costs mount up to EUR 80; wind is more expensive still and for photovoltaic power it would cost more than EUR 1,000 to save a ton of CO₂.

Contribution from Roland Kovia

This proposal is a good one. Pilot projects in Africa have taken plastic bags, which are terrible for the environment, and incinerated them for energy production. Although these actions remain limited, it is an area that needs to be developed. There is a clear positive-sum game given the impact of waste on the environment and the possibility for energy production. Organisations working in this area can help institutions to focus on how to work effectively on this, for example in the effective allocation of resources in the context of the National Indicative Programmes.

Contribution from Dr Peter Paziorek

In my constituency in Germany waste has started to be used in the domestic cement industry in order to replace Belgian coal imports. Today, there are cement factories that replace 70 percent of hard coal with secondary raw materials. All this offers opportunities and waste must become a pillar of renewable energies, but care must also be undertaken to understand all the issues; if the process is not steered correctly, it could lead to considerable and dangerous environmental consequences.

Session one
The European Union's renewable energy policy:
between national/European interests and global
responsibilities

Renewables: problems, solutions and policies

Professor Stefan Krauter

The problem

After the Second World War, global energy consumption increased dramatically and most consumption was of fossil fuels such as coal, gas and oil. This led to an increase in the amount of carbon dioxide in the atmosphere and a measuring station was installed in Monaloa, Hawaii to permanently register the levels.

The station has seen considerable increases in carbon dioxide. Before the 1950s, there were around 320ppm (parts per million) and in the following fifty years levels increased above 380ppm. This may not sound very much, but it has a significant impact on the radiation exchange of planet earth with space.

A dramatic rise in temperatures has been seen, particularly in the last 20 years; overall global ground surface temperature has increased by more than one degree Celsius since the dawn of industrial production. Some people still argue that there is no causal link between the two, but records of the last 150,000 years show that global temperature changes and levels of carbon dioxide in the atmosphere are well synchronised over time.

Furthermore, the current level of carbon dioxide of 380ppm is an amount which is higher than any level found from the last 150 000 years. Given the time lag of 20 to 50 years between changes in carbon dioxide levels and changes in global temperature and the historical trends available to us, we can expect an increase not just of one degree, but of five.

Once more, although one degree might not seem a significant increase in global temperature, the effects are already being seen. Records from Rückversicherung, the

world's largest reinsurance company, show the total cost of damage caused by natural disasters was relatively stable until the end of the 1980s at around USD 12 to 15 billion per year. However, there has been a significant increase over the past 15 years; with hurricane Katrina, damages went up to over 200 billion dollars. These are the first apparent costs of climate change and there is more to come, as set out in the Stern Review on the Economics of Climate Change.

The alternative solutions

Evidence of the resources available to us shows that there are around 30 to 50 years of oil left, a bit less of gas, around 100 to 150 years of coal and even uranium is not infinite. It also tells us that the solar energy which the plant receives just during one year is substantially more than all known resources for the rest of time, amounting to 14,500 times more than the world's energy consumption during one year. So the potential is there, we just have to use it.

Taking a vision of the world if all the energy was supplied by photovoltaics models show that only about 15 percent of the area of the Sahara, where almost nobody lives, would need to be exploited. However, a big advantage of the technology is that it does not have to be centralised through big power plants; the generation can be spread out across the world. Individual people can even generate solar power in their own houses, on their mobile phones and so on.

Solar energy was already presented during the world fair in Paris in 1989. The technology has developed and photovoltaic panels look a bit different. Wind energy has also been used for thousands of years. There are ruins of wind converters in Afghanistan, which were used for more than 1,000 years with a vertical rotor. A new wind park has been installed in sand dunes in Fortaleza, Brazil

Even the oil company Shell believes that mineral oil production will decrease after 2020 whilst there will still be an increasing world energy demand. By the year 2040, they forecast that most of the energy generated or used on the planet will be from renewables. This means the challenge is not just to substitute existing energy production by renewables, but to also match the increase in demand.

The world's photovoltaic installation has developed to the point where there is now about 5.6 GW installed on the planet and this is increasing by 1,460 MW per year. The rate of growth of photovoltaic is the equivalent to one nuclear power plant every year, which is an astonishing development.

The carbon dioxide-reducing effect of introducing renewable energy is determined to a great extent by how 'dirty' the current means of energy generation are. A small solar power plant generating one kilowatt of energy would substitute about 6.8 tons of carbon dioxide in Germany and 9.8 tons in Brazil. However, even in Brazil, it depends where you substitute the energy. Connecting the solar energy to the grid would have less effect as there is a large proportion of hydro-electric energy in that mix. However, in the non-electrified zones, which receive their electricity from diesel generators, the carbon dioxide-reducing effect would be about three times greater than for the equivalent injection into the German grid.

Policies

Gross energy consumption was supposed to be made up of 10 percent renewables by 2010, now the target is 12 percent and 20 percent by 2020, which is quite feasible. If there was no decrease in consumption, this would lead to a reduction of 20 percent of carbon dioxide, which could be doubled through efforts to increase efficiency and save energy.

However, present emission levels show that the average US citizen emits about 20 tons of carbon dioxide a year, European citizens 10 tons and citizens of developing countries such as Brazil and China less than two tons per year. The reality of energy needs suggests that the participation of renewables would have to be 70 percent to meet levels of sustainability.

Some suggest meeting the growing energy needs through nuclear energy, but there are some severe disadvantages with that approach meaning it does not seem to be a real global solution to fight climate change. The waste treatment issue is a key one as it creates problems for the next tens of thousands years. Plutonium has a half-life of 15,000 years, meaning that only 50 percent of the radiation would be eliminated after this time and there is no physical process to improve this. These long-term costs are often ignored or underestimated. Furthermore, unlike other power plants, nuclear plants are not usually insured because insurance companies will not cover them.

There are also big political issues about which countries could be allowed to develop the technology to use nuclear power as can be seen in the case of Iran. In general, the greater political instability in many developing countries might also make nuclear power a more risky long-term option, not to mention the vulnerability to new terrorist or military threats, which was not considered when nuclear power programmes were set up in the 1970s.

Conclusion

There is no alternative to renewable energies. So far, people have been talking about and targeting 20 percent renewables to reduce emissions. However, considering the energy needed to set up new plants, the installation of additional energy storage and distribution infrastructure - so-called grey energy requirements – the result is that almost 100 percent renewables is necessary to reach a really sustainable level within the EU.

Limiting climate change: defining the challenge

Eric Tang

Restricting climate change

The challenge to meet the EU objective of limiting global temperature increase to 2°C is huge. To achieve it, global greenhouse gas emissions must peak before 2020 and then decrease significantly. Energy and industry emissions will have to be reduced by 25 percent by 2050 and agricultural emissions stay flat and then gradually decrease at a time when agricultural production will need to increase.

Overall deforestation can only continue for two decades because deforestation in developing countries is a major contributor to climate change. This will not be easy to achieve and even after such efforts, there would only be a 50 percent chance of meeting the 2°C target. Greenhouse gas emissions in developed countries would have to be cut by 30 percent compared to 1990 by 2020 whilst they are currently struggling to meet the more modest target of 8 percent in a context of rapid economic growth.

Nevertheless, it is technically and economically feasible to achieve the agreed target based on a series of complementary initiatives. Energy savings are a big part of the answer and the development of renewables is another. Further possibilities include the shift from coal to natural gas usage, nuclear power and carbon sequestration (storing emissions underground).

Energy efficiency and renewable energy

Energy efficiency is linked to the renewables issue because the use of traditional biomass in developing countries is inherently inefficient and one way of promoting the use of renewables is to improve their efficiency. The replacement of open fires with stoves of bricks and cast iron for cooking in Denmark saved the remaining forest there and improved the health of women and children. Similar initiatives could be foreseen in

developing countries to supply every house with an energy-efficient and reliable cooking stove and chimney.

Many people have realised the importance of increased energy efficiency and use of renewable energy and yet little is still being done. There are also no grounds for developed countries to preach to the developing world on renewables since OECD countries only get 13 percent of energy supplies from renewable sources, whilst the figure for the EU is only 7 percent.

Already today, 27 percent of energy supplies in developing countries come from renewable sources. The real challenge is to get developing countries to remain renewable, improve the sustainability of their renewable sources and increase the share of renewables. The 2°C target requires 40 percent renewables and this is asking a lot.

The physical potential for the development of substantial renewable energy supplies is present in developing countries. In fact, there is the potential for them to export energy to the developed world. The northern Sahara could supply a significant share of Europe's energy needs through solar thermal power and a super-grid of direct current. This is not necessarily cheap but nor would the costs be astronomical and it is a feasible approach given the right framework.

Some developing countries are developing renewables on a large scale. China is the country with the biggest solar water heater system and has a very impressive wind power programme. India has also made important progress. However, despite these efforts, the growth in use of fossil fuels in these countries is far outstripping the use of renewable energy sources.

Conflicts and constraints

The biggest constraint on the development of renewable energy supplies is the costs involved; there is no doubt that most renewables are more expensive than fossil fuels. It is not realistic to expect developing countries to opt for the more expensive option and so the challenge is to make renewables more affordable. A key here will be to help with the initial investment needed to set up renewable energy sources, which tend to be high, although the subsequent running costs are relatively low.

There are also conflicts that appear when the promotion of renewables is foreseen. Biofuels that could be used to run machinery could also be used to feed the world population. More bio-energy will require more water, putting further pressure on limited water resources. Fields of windmills for wind power can affect wildlife, particularly

if they are placed in corridors used by migrating birds. Also, continued use of biomass can result in deforestation, which in itself impacts directly on climate change.

Policy efforts

The best and most significant policy decision that the EU could make to achieve the 2°C target would be to adopt a 20 percent mandatory renewables target. Some say it is too costly and will impact on competitiveness, but only through a mandatory target will effective efforts be made to reduce costs and improve the reliability of renewables.

The Global Energy Efficiency and Renewable Energy Fund (GEEREF) set up by the European Commission and EU Member States is another key initiative to help cover the high initial investment costs of renewable energy sources. It is an innovative financing mechanism providing the initial capital for risky investments allowing for payback over a long timescale without prohibitive interest rates. The fund has a total of EUR112m, mostly provided by the Commission and Germany and is run by private fund managers with experience in developing and transition economies.

Progress can be made through the established methods to interlink developed world and developing world energy systems through emissions trading. The global carbon market and in particular the Clean Development Mechanism of the Kyoto Protocol offer important structures to reduce global emissions. These would allow developed countries to support renewable energy sources in the developing world to provide global gains.

It is essential, however to promote sustainable use of biofuels. Growing biofuels based on soya beans in a rainforest area would take 320 years to payback the loss from the rainforest; if grown on wetlands it would take 1200 years to offset the losses. It is therefore essential to plan biofuels in a sustainable way that does not impact negatively on the environment. The EU is setting up a system of common certification of biofuels to ensure sustainability.

Developing second and third generation biofuels based on biowaste is a good path to take. The EU Environment Agency shows that the total energy from biowaste in the EU is 60-70 million tons of oil equivalent (Mtoe) and yet the total sustainable resource is about 300 Mtoe. This means there is the potential to quadruple output in Europe without harming the environment, increasing the prices of agricultural products or taking too much raw material from industries such as paper. Overall energy use is 1700 Mtoe, so about 20 percent of energy consumption could be served by such second generation biomass.

Conclusion

As argued in the Stern Review on the Economics of Climate Change, the benefits of taking action and trying to achieve the target of limiting global temperature increase to 2°C are well above the costs involved. Renewable energy can be a significant part of the solution and 40 percent of energy supply in developing countries could and should be renewable by 2050.

It is essential to have a global agreement post-2012 and this needs to take into account mechanisms to ensure developing countries can finance investments in renewable energy and energy efficiency to not only remain renewable, but to become more renewable. Similarly, a mandatory 20 percent target in the EU is affordable needs to be introduced. Finally, policies need to ensure that the exploitation of biomass or other natural resources is done in a sustainable way.

Decarbonising the energy mix

Simon Worthington

Macro overview

Clearly, the key current issue is the need to decarbonise the current energy mix. In the next 50 years, seven gigatons of carbon need to be removed from the energy mix, so there is a need for solutions that provide energy without emitting carbon. BP and Princeton University have looked at a range of technologies available today that could provide material reductions based on the hope of finding seven technologies that could reduce carbon by one gigaton each.

Various measures were looked at to provide savings of one gigaton. Fuel switching by moving from coal to gas, carbon capturing sequestration (CCS), solar power and switching to biofuels – if the right routes are taken – could all provide such savings. This approach showed that there are a range of options and also that a lot of them need to be implemented to achieve the required reductions. The continued research also found more and more ways of reducing carbon emissions; there are now 22 or 23 forms of technology available today.

Since the technology is already available, the key missing ingredient is the right policy framework to make full use of these possibilities. A holistic approach is needed. For example, it is not enough to promote the use of palm oil as a fuel in Europe if that oil is being shipped to Europe from Indonesia, which then has to import coal from Australia to burn in its own power stations.

The use of biomass must be encouraged at source, rather than being shipped around. The available options also need to be made cheaper or subsidised in some way. One approach could be to introduce tariffs with some of the costs passed on to consumers who need to develop their understanding of the carbon impact of their consumption.

Micro projects

One cannot go to the developing world and tell people that solar panels are the answer. It is important to listen to the local requirements and try to attach an energy dimension onto the development initiatives that are taking place in a country. In Brazil, it was astounding to see how little coordination and awareness there was between the different initiatives taking place.

However, the biggest off-grid solar project in the world was carried out in the north-east of Brazil, where a government contract was won to put solar panels on 2000 schools. A Brazilian company experienced in grid extension was educated in installing solar systems and schools were then used as a showcase to promote the use of solar power elsewhere. Meetings held in schools after the installation showed local people, often including farmers the potential of the technology.

The cost side is clearly a huge issue at micro-level. People struggle to afford the rent on their housing, but at the same time they are typically buying diesel oil to fuel a generator in their house. This costs more than it would take to put a solar panel in and so there is a big need for education to show people that there are cleaner and - more importantly for the individuals - cheaper options out there.

The involvement of micro-credit agencies and development banks is essential to allow people to finance the initial investment involved in installing systems to generate renewable energy. Work has been carried out with these bodies in Brazil to bring the solar package within the scope of the existing financing mechanisms.

It can also be useful to set up ways to generate income to pay for the maintenance of the infrastructure. As an example of this, the project supplied films to schools using solar power so that they could have film nights and generate a little income to finance future batteries and maintenance.

The European Union's renewable energy policy: between national/European interests and global responsibilities

Questions and answers

Question from the floor

What will it take to get the second-generation biofuels industry going in Europe?

Response from Eric Tang

In theory, it will just take a good support scheme with the key being a certification system of biofuels that favours second generation biofuels. However, in practice it is much more complicated since it is not always easy to track how a load of biofuels has been produced, particularly in developing countries. The EU is currently working to create a common EU scheme to make trade between Member States possible and to set a global standard.

Response from Simon Worthington

If we cannot get to second generation biofuels, biofuels are a waste of time. Therefore, the key is to get to second generation as quickly as possible. It is not clear how long this will take, but a significant amount of research is needed to get there. There will be hurdles and challenges, for example around the use of genetically modified organisms, but tremendous progress is possible in countries like Brazil.

Session two
The potential and benefits of renewable energy
for developing countries

Global investment in the renewable energy sector

Eric Usher

Abstract

The renewable energy sector has become a multi-billion dollar industry and the most dynamic sector of the global energy market. Renewable energy technologies have a significant potential to mitigate global climate change, address regional and local environmental concerns, reduce poverty, and increase energy security. Globally installed capacity is expected to more than double over the next ten years, when it will begin to have a visible impact on the overall energy mix. This paper assesses how the renewable energy sub-sectors are developing in terms of investment trends and future outlook.

This paper is based on the work of the UNEP Sustainable Energy Finance Initiative (SEFI) and largely references a report, currently in draft form, commissioned from New Energy Finance Ltd¹. In 2007 SEFI and New Energy Finance are preparing to jointly publish a Global Renewable Energy Investment Outlook.

Introduction

The International Energy Agency forecasts that energy demand worldwide will grow by almost 60 percent by 2030². Investment in amounts never seen before will be required to develop and upgrade global energy infrastructure in order to keep pace with the surging demand.

The three trends of rising oil prices, energy security concerns and the growing environmental impacts of the current energy mix challenge the ability of governments, energy companies and financiers to deliver energy solutions that are sustainable in the long term and increase the attractiveness of alternatives to conventional fossil fuel-based energy sources.

Renewable energy and energy efficiency, the so-called sustainable energy options, now have the potential to play a key role in the global energy mix. The trends pointing towards increased growth of these new clean energy sectors has finally begun to translate into increased commercial investment in the sector.

Main discussion

Estimates from New Energy Finance (NEF) are that investment in clean energy worldwide has more than doubled in the last two years, from USD 27.5 billion in 2004 to USD 49.6 billion in 2005 and USD 70.9 billion in 2006.

According to International Energy Agency (IEA) estimates, generation of electricity by renewables including large hydro made up just 19.5 percent of the world total in 2004. The IEA's baseline figures see electricity generation by renewables, excluding hydro, expanding by 9.3 percent a year between 2004 and 2015. Current investment trends would seem to indicate that this projection underestimates sector growth.

The sharpest increases in investment flows into clean energy have come via venture capital and private equity, and through investment in public capital markets. NEF estimates are that venture capital and private equity investment in 2006 totaled USD 7.1 billion worldwide, an increase of 163 percent over 2005 levels. Investment via public markets increased almost as quickly, by 140 percent, to USD 10.3 billion, with the flow of initial public offerings of renewable energy companies particularly strong in the second quarter of 2006. Other categories of investment have also seen decent growth in 2006. Government and corporate research and development increased by 25 percent to USD 16.3 billion. The financing of clean energy infrastructure projects – termed asset financing – rose by 23 percent to USD 27.9 billion. Small scale projects increased from an estimated USD 7 billion in 2005 to USD 9.3 billion in 2006.

The ability of the markets to mobilise capital quickly behind new innovators is providing a counter-balance, or at least a fore-warning, to the obstinacy of energy sector incumbents. For instance, the solar photovoltaic market has seen the emergence of a new breed of pure-play technology leaders such as REC in Norway and Q-Cells in Germany³. The fact that today's market leaders mostly didn't exist a few years ago and that a healthy pipeline of new Initial Public Offerings is getting ready to follow on their heels is indicative of the rapidly changing dynamics of the whole clean energy sector. In line with solar, the European biofuels market is also gaining momentum after the strong take-off in the US, however market and project complexity is a barrier to faster uptake. Investor attention to wave and tidal energy is also growing faster than expected. The investor landscape is becoming more crowded, but more professional.

One impact of competition is that investor interest is internationalizing rapidly to places like China and India.

In the area of asset finance increasing competition in the on-shore wind debt markets has driven innovation in the banks with loans now going out 20 years on conventional project financings and new financial structures such as portfolio financing and turbine financing becoming more common. Risks are growing with the size of projects, leading in some cases to blockages and in others to new roles for different financial actors. Capital market solutions are becoming increasingly important and the rating agencies are now getting familiar with the sector through their first portfolio securitisations financed through the bond markets. Off-shore wind growth is slower, however the first limited recourse financings have now been arranged.

Debt providers are also moving into other technologies such as small hydro and biofuels, a sector where off-take agreements are no longer essential for project financing. In solar photovoltaic and solar thermal the first non-recourse transactions have taken place in Spain. Landfill gas and small-scale biogas is experiencing dynamic growth. The lack of financing solutions for exploration is still limiting growth of geothermal. A number of leading lenders are now also moving into private equity. These banks and others are also beginning to look beyond the confines of Europe and North America, although more slowly than the capital markets.

Investment in clean energy in 2006 was widely spread between the main sectors of biofuels, biomass and waste, solar and wind and variations existed in the types of financing most used. According to NEF estimates, over 50 percent of asset financing has gone to the wind sector. By contrast, when it came to venture capital and private equity investment in 2006, the largest recipient among the sectors was not wind but biofuels, which attracted USD 2.8 billion. In the public markets, solar was the largest recipient of investment, receiving USD 4.4 billion, with biofuels second at USD 2.5 billion.

Overall, adding together the venture capital and private equity, public markets and asset financing figures, wind came out as the most heavily invested sector in 2006, with USD 17.2 billion, followed by biofuels with USD 11.7 billion, solar with USD 7.2 billion and biomass and waste with USD 4.2 billion.

Conclusion

The year 2006 witnessed record investment in the renewable energy sector. The general consensus was that increasing technological maturity, growing staff expertise, and

better understanding of technology risk were key drivers behind this growth.

A look at renewable energy finance and investment reveals some key trends, including:

1. Investment in the clean energy sector has more than doubled in the last two years;
2. Current investment trends would seem to indicate that IEA projections underestimate clean energy sector growth;
3. The ability of the markets to mobilise capital quickly behind new innovators is providing a counter-balance, or at least a fore-warning, to the obstinacy of energy sector incumbents;
4. The investor and lender landscape is becoming more crowded but more professional. One impact of competition is that investor interest is internationalizing rapidly to emerging markets, and lenders are becoming more innovative with their financial structures and moving beyond wind to the other clean energy sectors;
5. In venture capital and private equity, most investors are gravitating towards larger more mature deals. There is a lack of seed and angel capital in the market;
6. On the stock markets the valuations of clean energy stocks are high, but are considered reasonable for such a high growth sector;
7. The US is leading the world in financing new technology development through VC and private equity; Europe, with its somewhat more mature industry, is leading in financing through public stock exchanges;
8. Investor focus is starting to shift to emerging markets, although mostly China and India. The opposite is also happening, with China and India being substantial net buyers of clean energy companies during 2006.

Renewable energy market growth is happening in almost all sectors, countries, and investment stages. In a few sectors the industry is facing bottlenecks, but when these open up, renewed growth will be seen. The growth of private finance and investment flows suggests that the renewable energy sector has become more than a transient spot on the edge of financiers' radar screens.

Overall, the clean energy sector has gone well beyond idealists to include serious

entrepreneurs. In the words of one renewables entrepreneur, “The face of the market has gone from long hair to business suits – it might be the same folks with the same values, but the appeal is different now.” Indeed, investors are feeling more and more comfortable committing capital for the long periods required by most projects in this sector, particularly as technologies mature, expertise increases, and risk management is better understood.

Notes

1. New Energy Finance, SEFI Report on Global Trends in Renewable Energy Investment 2006 (Draft), December 2006.
2. International Energy Agency, World Energy Outlook, 2005.
3. Sustainable Energy Finance Initiative, Zug Advisory Board Meeting Summary Report, September 2006.

An African view: renewables in Senegal

Professor Mamadou Mansour Kane

Introduction

The countries of the Economic Community of West African States (ECOWAS) and the West African Economic and Monetary Union (*Union Economique et Monétaire Ouest Africaine* – UEMOA), such as Senegal, are strongly aware that the Millennium Development Goals (MDGs) cannot be achieved by 2015 without at least half of the rural and periurban populations having access to modern energy supplies. They have therefore decided to carry out an ambitious regional policy to improve access.

Senegal has a population of around 12 million with three percent population growth. The lack of water and the unpredictability of rainfall in Senegal mean that there are significant regional differences in population numbers and demographic profile. There are strong regional differences in electricity supply and the poor performance and ageing of the electricity infrastructure are resulting in high electricity costs and frequent power cuts with knock-on effects on Senegalese businesses and economic and social development.

The energy profile of Senegal

Despite the fact that Senegal has hydroelectric potential and important local resources for the replacement of petrol products, the energy situation in the country – as with others of the sub-region - is characterised by weak consumption of commercial energy, low access to electricity and little use of renewable energy sources.

More than half of the national energy supply is provided by coal and wood coming from natural forests. The overexploitation of these forests is causing ecological disasters which could become irreparable. Renewable energy remains underused and marginal to the mainstream.

Commercial energy depends almost entirely on petrol and since Senegal is not a petrol producer, it is becoming increasingly dependent on imports: in 2004, petrol imports equalled 53 percent of the value of all its exports for the same year. Rising international petrol prices are therefore impacting significantly on Senegal's balance of trade. The limited storage capacity for petrol means that Senegal is not able to protect itself against any future supply problems.

Despite the Senegalese government's efforts to combat the negative impact of rising petrol prices on the national economy, the current energy profile is a significant challenge to the implementation of a coherent energy policy to facilitate the national Poverty Reduction and Accelerated Growth Strategies.

The potential for renewable energy in Senegal

One of the Senegal's major challenges as with other developing countries is increasing the supply of appropriate energy. Energy needs to become more accessible to large sections of the population, including the poor, vulnerable and those living in rural areas, and contribute more to the social and economic development of the country.

Renewable energy such as solar, hydro-electric, biomass and wind can make a significant contribution to fighting the problems caused by the consumption of fossil fuels which include the strategic dependence on petrol producers, high fossil fuel prices, pollution and greenhouse gas emissions.

Renewable energy sources could meet the demands of the dispersed rural population which have low energy needs and few resources whilst protecting the natural environment and promoting sustainable development.

Senegal has a significant and varied potential in renewable energy based on 3,000 hours of sun per year, wind speeds of around four metres per second between Saint-Louis and Dakar and on the coast, the Senegal and Gambia rivers, significant vegetal reserves and agricultural products and by-products.

A solar park covers power needs of around two megawatts including public and private lighting, schools, hospitals and water pumps. A wind atlas has been developed, evaluating the potential of wind power and several hundred thermal water heaters have been installed. The government is supplying farmers with about 250 million 'Jatropha' plants to encourage the cultivation of this plant to generate biofuels. The Senegal Sugar Company (*Compagnie Sucrière du Sénégal*) is developing a distillery to start the production of ethanol in a totally complementary way to its production of sugar.

The government has introduced a series of measures to promote the use of solar power, including the provisions of tax advantages, its promotion in the public market, the introduction of quality controls and control bodies and plans for the extended use of solar power in rural areas.

The Centre for Studies and Research into Renewable Energy (CERER) was created in April 1980 to study meteorological phenomena, research and development procedures to use solar or other weather-based power sources. It focused its work particularly on the conversion of energy from the sun into electricity via solar panels, the conversion of energy from the sun into heat to drive thermal power plants, wind power, energy saving, efficient use of biomass and water treatment.

It has realised projects introducing solar water heaters, solar-powered ovens - including in rural areas – solar lighting, quality controls and anaerobic digesters to produce biogas. Current projects include efforts to train technical researchers and political decision-makers in the promotion of micro-grids and renewable energy sources for the provision of electricity in developing countries. The project will assess rural energy needs and set up a prototype grid with partners from Spain, France and Senegal.

However, it is difficult to coordinate the necessary activities in Senegal to develop renewable energy sources fully. The initial investment needed is often prohibitively high with insufficient financing in place. There is a lack of both training to develop local expertise and strategy and resources for the maintenance and regulation of installed equipment.

Research bodies have not been adequately involved in developing projects and so there has been a lack of scientific evidence on which to base efforts. Similarly, local populations and the private sector are often insufficiently involved in the implementation of projects with a lack of awareness of the possibilities for progress. Typically the infrastructure is inadequate to generate sustained supplies to meet local needs.

Conclusion

Developing countries such as Senegal, which are not petrol producers, need to promote the use of renewable energy to ensure access for their population to modern, reliable energy supplies. This form of energy can play a key role in reducing poverty and promoting sustainable development.

Biofuels and sustainability: examples from Brazil

Professor Weber Antonio Neves Do Amaral

Biofuels in Brazil

Brazil is arguably the world's leading nation when it comes to biofuels. Brazil has been mass-producing biofuels since the mid-1980s. Bioethanol powered cars, or cars that can run on either petrol or bioethanol, now account for more than half of the new cars sold in Brazil. Tax incentives and policy have played a major part in this.

The Brazilian Centre for Biofuels contributes to the development of knowledge about biofuels in Brazil. The Centre is an independent think tank, focusing on technology transfer, developing contributions to policy-making, awareness raising and capacity building, research, and projects designed to mitigate the impact of greenhouse gases (GHGs).

Brazil recognises that it may have a significant global role to play because of several factors that are likely to support greater use of biofuels in the future. These factors include rising oil prices, the warming impact of GHGs, political goals – such as the objective in the US of reducing gasoline consumption by 20 percent in 10 years – and the greater cost effectiveness of biofuels resulting from deployment of new technology.

The Brazilian biofuels sector has a number of structural advantages. Brazil produces both bioethanol and biodiesel, with potential for biogas production. There is a long history of biofuel production, based on established technologies, and the sector is characterised by both long-established players and new entrants. The 2004 biofuels law in Brazil and other policy factors have encouraged the sector's development, with the national market providing a strong base for expansion into other markets. Oil-based chemicals production and ethanol chemistry can work side by side. There are few barriers to new products and production in terms of intellectual property rights.

Because of these different factors, Brazilian bioethanol production is done at low cost – Brazil produces bioethanol from sugar cane at a significantly lower cost than bioethanol produced from cassava, corn, wheat or sugar beet.

Brazil's headstart in biofuels is clear. In 2005, the biofuel share of total gasoline and diesel demand for transportation use was 37 percent in Brazil, compared to 2 percent in the US and China, and 1 percent in the EU. The share in Brazil is forecast to grow to 49 percent by 2015, compared to 7 percent in the EU, 6 percent in China, and 3 percent in the US.

The raw input for biofuel in Brazil is sugar cane. One hectare of sugar cane can produce 9000 litres of bioethanol, equivalent to 65 barrels of oil. Sugar cane production is concentrated in the south-east of Brazil, which produces 70 percent of the country's ethanol. Production in 2005 was 16 billion litres. There are 5.4 million hectares of land under sugar cane production in Brazil, with 72,000 growers involved. 334 mills and distilleries across Brazil produce both sugar and biofuel from the sugar cane. Other outputs include food and pharmaceutical products, and Brazil's ethanol sector is looking at a number of opportunities for future development, including biodiesel, bioplastics and carbon credits and offsets.

Critical issues for the sustainable production of biofuels

A number of crucial points can be identified in terms of future expansion of biofuels production in developing countries:

- The relative benefits of ethanol versus biodiesel, and the future developments and learning curve in these areas;
- The impact of crop production for biofuels on current and future land use patterns;
- The impact of crop production for biofuels on food production;
- Expansion of biofuels crop production into the fringes of the Amazon region and other sensitive areas – how much can biofuel crop production be expanded;
- Agricultural productivity and industrial productivity;
- Management practices – whether or not to burn for sugar cane harvesting;
- Water and nutrient use;
- Social impacts and concerns.

For sustainable biofuels production, it is necessary to integrate multiple players in the dialogue for sustainable production and expansion of sugar cane. Stakeholders include traders, biotech firms, consultants, lawyers and so on. Issues include site selection and management, legal aspects, installation design and technology, selection of sugar cane

varieties, construction, improving business processes, and crop genetics. All of these areas have potential environmental impacts that could undermine the benefits from biofuels.

One example of a factor that must be considered is vinasse, a by-product of ethanol production. Vinasse is a viscous, acidic substance, 12 litres of which are produced for every litre of ethanol. The acidity of vinasse can be limited by application of other substances.

This is one example of the need for new technology in the biofuels industry. New technologies are likely to greatly reduce the environmental impact of biofuel production by introducing second-generation biofuels.

Second-generation biofuels

Development of second-generation of biofuels will mean that fuel can be produced from a wider range of raw materials, including waste from pulp and paper mills, such as wood bark and wood chip, white water from paper machines, and other waste products. Hemicelluloses and carbohydrates can be extracted from wood chip and fermented to produce ethanol and methanol; other waste can be used to produce energy, which itself can be used to power ethanol plants.

Crops that can be used to produce biodiesel are also being looked at. These include soy, castor beans, sunflowers, and cotton. Brazil has the potential to produce a variety of crops that will be the raw material for biofuel production: palm oil from the north of the country; castor oil, soya and cotton from the north east and central areas; and crops such as rape seed and peanuts from the south.

To effectively harness this potential, food and energy production needs to become more integrated. Crop production needs to be sustainable, and to take account of other factors, such as the need to protect forests. Farmers must also be able to benefit and share in the investment in biofuels. For this, collaborative models must be developed, investment risk must be reduced through sound decision making, policy decisions from the international to local level must be coherent, and capacity and awareness must be built. These are the key areas for engaging developing countries in biofuels production.

India's energy mix

Dr. V.V.N. Kishore

Growing primary energy consumption

The world's primary energy consumption (PEC) has grown from about 6600 million tons of oil equivalent (mtoe) in 1980 to about 10,500 mtoe in 2005, a 60 percent increase. The present shares of oil and gas are 37 percent and 23 percent, followed by coal (28 percent), hydroelectric (6 percent) and nuclear (6 percent). Thus 88 percent of the world's primary energy consumption is from fossil fuels, which are depleting fast and are damaging the global environment. Both climate change and energy security concerns are at the core of many international debates and conventions at present, the chief one being the UNFCCC.

While the developed countries rely more on oil and natural gas, developing economies like China and India continue to use coal as a major source. In India, for example, coal has a 55 percent share in PEC, followed by oil (30 percent), natural gas (nine percent), nuclear (six percent) and hydro (one percent). As increasing dependency on imported oil can hamper development, there is a need to explore alternatives such as energy conservation and renewable energy. India embarked on a programme for renewable energy nearly two decades ago by establishing the Department of Non-conventional Energy (DNES), which later became a full-fledged ministry, currently named the Ministry of New and Renewable Energy (MNRE). Non-governmental agencies like the Energy and Resources Institute (TERI) and several academic institutes have initiated research and development and dissemination programmes concurrently.

Energy situation in India

The estimated coal resources in India are about 84,000 million tons, which are expected to last for 230 years. However, all coal reserves may not be economically exploitable and India has started importing coal. The oil and gas reserves are 5.4 billion barrels and

660 billion cubic metres respectively. The hydroelectric potential is 54,000 megawatts, out of which 32,326 megawatts has been harnessed so far.

The power generation capacity installed is 126, 294 megawatts, out of which 68,519 megawatts is from coal thermal plants, 32,326 megawatts from hydro, 12,690 megawatts from natural gas, 1,201 megawatts from oil and 3,360 megawatts from nuclear. Power from renewables is 8,198 megawatts, which is higher than nuclear. The electricity generation in 1997 was 329 terawatt-hours, which is likely to increase to 1,221 terawatt-hours by 2020 in a business-as-usual scenario. There is a significant demand-supply gap at present both in terms of installed capacity and energy.

Renewable energy potential

There is abundant solar radiation in India, with insolation levels of about 2,000 kilowatt-hours per square metre per year, which is among the highest in the world. The estimated potential is more than 50,000 megawatts of solar power. The resource potential for wind power is 45,000 megawatts. An estimated 420 million tons of biomass is produced every year, but most of it is being used inefficiently. The power generation potential from biomass is estimated to be 61,000 megawatts. Along with others such as small hydro and waste-to-energy, the gross potential for power generation from renewables is 183,000 megawatts.

Government policies for the promotion of renewables

India has a long tradition of promoting renewable energy. The 1970s saw biogas promotion as one point of the 20-point economic programme of the then Prime Minister Indira Gandhi. The current premier energy research institute, TERI, was founded in 1974 as a corporate, non-profit initiative. Currently there is a range of financial incentives provided by MNRE, including capital subsidies, soft loans, tax rebates and preferential tariffs for electricity from renewables. The Prime Minister has announced a target of a 10 percent share or 10,000 megawatts of renewables by 2012. Foreign investment in the renewable energy sector is strongly encouraged by allowing 100 percent equity participation.

As a result of such progressive policies, India's achievements in renewable energy have been substantial (see <http://mnes.nic.in>). India is fourth in the world in wind power capacity (6,070 megawatts) and second in family size biogas plants (3.9 million). Also, the solar water heating systems have reached a cumulative capacity of 1.5 million square metres. Solar-powered home lighting systems (providing about 300,000 kilowatt-peak), lanterns (about 460,000 kilowatt-peak) and village-level power plants (around 1,860 kilowatt-peak) have also become popular.

Bagasse- and biomass-based power plants have an aggregate generating capacity of about 1,038 megawatts at present. Small hydro power (less than 25 megawatts) installations now total about 1,850 megawatts. India is the current leader in small-scale biomass gasifier systems, both for thermal applications and small power plants (less than 100 kilowatts). A large variety of thermal applications include cooking, silk reeling, crop drying, textile dyeing, metal melting, bakeries and rubber making. The financing wing of MNRE has been quite successful in promoting renewable energy. Several research and academic institutes and many regional engineering colleges are actively contributing to research and education in renewable energy.

Future challenges

In spite of the impressive achievements, the contribution of renewable energy in the PEC is still quite small compared to the exploitable potential. While MNRE was quite successful in managing subsidy- and incentive-based programmes, it has not done well in promoting market-oriented programmes or goal-oriented research and development. It was also not very successful in launching or managing public-private partnerships. In view of the increasing global interests in renewable energy, there is a strong need to evolve progressive and efficient institutional structures and to create a favourable policy environment to promote research and development, public-private partnerships and international collaborations.

The potential and benefits of renewable energy for developing countries

Questions and answers

Question from Greg Austin, EastWest Institute

What are the opinions of the three speakers from the developed world about the degree of creativity, imagination and flair being shown in the developing world, and the transition that they experienced, especially India and Brazil?

Response from V.V.N. Kishore

There is a lot of innovation being demonstrated in the development of technology. Developed countries have shown a lot of imagination in developing wind power, for example. Wind power was known about for thousands of years, but improvements in harnessing it have mainly come through European research.

Response from Professor Weber Antonio Neves do Amaral

Brazil has been trying to develop biogas facilities. A programme was started around 30 years ago, but it didn't succeed well. Now we have new European biogas technologies. Are they better than the Indian ones? Probably not yet, but they probably have stronger retailers behind them. In terms of creativity there is a major bottleneck especially in the second generation of biofuels. There are very good examples from developed countries, that could be used specially for countries that have lignanine selosic materials available and don't know how to use them. Creativity and the transfer of that technology to developing countries is something we look forward to have access to, specially for subsaharian Africa. In Brazil it is happening slowly, but it is good for a lot of countries have a huge mass of biogas available.

Response from Professor Mamadou Mansour Kane

This question is very difficult. The most important thing is to reach a critical mass in

innovative fields. Innovation is born from critical mass. Alternatively, imported materials can be adapted to local conditions.

Question from Olga Johnson, Colombian Embassy in Brussels

In terms of biofuels, what are the main export markets for Brazil and India? In trading those products, are there any trade barriers, and what are those trade barriers?

Response from Professor Weber Antonio Neves do Amaral

Brazil exports ethanol and vegetable oil. Ethanol mainly goes to Europe and to the US, notwithstanding the tariff for exports of ethanol to the US, which stands at about 13 cents per litre. Europe has a tariff as well. There are some exports to Japan, but the largest market is the US, in particular specific states such as California and Florida. Florida has just launched an inter-American initiative on biofuels, which aims to increase the proportion of biofuels used for transport from 10 to 20 percent. The initiative is led by Jeb Bush. This is creating a market, although the US has not signed agreements such as the Kyoto Protocol. There is a huge potential market for biofuels in South East Asia; Japan is one country that may import more, but there are issues of logistics and a question of who will be the major player: the Brazilian petrol company or other players. These are the potential markets.

But there is a threat to Brazil's exports: Technical Barriers to Trade (TBT). Certification processes should not be discussed too early, before discussion of a set of criteria that can be used relating to sustainable and traceable biofuels. All players should be engaged in this discussion, or finding solutions will be difficult.

Conclusions

Dr Greg Austin

Policy recommendations

The link between renewable energy and socio-economic development is clear: the poorer a country, the more vulnerable it is to external shocks and price volatility. We need to mobilise the promotion of sustainable energy development on a global scale and suppress the negative effects of global climate change. To reach that point, global leaders must demonstrate political will and work together to change behavioral and investment patterns in the energy sector, and to devise pricing and investment incentives. We must actively promote renewable energy and energy saving/efficiency technologies such as hydropower, photovoltaic, biofuel, and wind power. Furthermore, we must ensure that multiple alternative energy scenarios fit a single policy framework. Finally, we need projects ‘on-the-ground’ that teach ways of adapting renewable technologies according to local conditions.

Promote sustainable power generation facilities with greater urgency

It is believed that up to 25 percent of global power generation capacities may come from renewable sources by the year 2020. This policy should be backed by concrete proposals, such as the EU’s recent decision for binding CO₂ emission limits, and targets for the use of renewable energy, both binding and non-binding. We must launch more international energy cooperation initiatives such as the Initiative for Poverty Eradication and Energy Efficiency, the Africa-EU Energy Partnership, and the ACP-EU Energy Fund.

Raise the stakes for CO₂ reduction

In order to keep the rise in global temperature within 2°C, we need to set higher markers to bring CO₂ emissions down by 70 percent by the year 2040. It has been shown that only by limiting CO₂ emissions to 3-5 tons per person per year will we be

able to sustain favorable global climate and temperature scenarios. Currently, the US emits an average of 20 tons of CO₂ per capita, per year. Europe emits 10 tons per capita, per year.

Measure the costs of the transition to the post-carbon era

The investment costs necessary to prevent the negative effects of climate change are estimated at an average 0.5 percent of global GDP, while the costs of inaction may be as high as 5-20 percent of GDP depending on the region. It is worth noting that low carbon energy is an efficient hedge against high oil prices. The share of renewable energy in the developing world is 27 percent, pointing to the high likelihood that these countries can lose their dependence on hydrocarbon fuels and directly switch to a post-carbon energy framework. Developed and emerging markets are equally interested in 'second generation' renewable power generation. For example, 'new generation' renewables represent only 2 percent of the global energy supply but account for 10 percent of energy-related investment. Some developing countries such as Brazil are already international leaders in a number of 'second generation' renewables such as biofuel.

Reduce 'energy poverty' in developing countries through the promotion of renewables and energy efficiency/saving technologies

Currently 1.6 billion people have no access to electricity and over 2.5 billion use traditional biomass for energy. Access to renewable energy will help developing countries meet UN Millennium Development Goals and move from traditional energy intensive scenarios.

International decision makers need to act together to expand the debate on energy security and to re-shape existing global energy frameworks. We urgently need an international legally binding agreement on climate change and renewables, and a framework based on universally accepted certification and ecological standards. Governments should collaborate with the private sector to devise solutions for waste management and mitigate the negative consequences of switching to renewables, such as perverse effects on land use linked to the extensive non-sustainable use of biofuels.