Fresh momentum for tackling global energy challenges

Continued use of current energy trends will have catastrophic consequences. The time for change is now, and the 450 Scenario has a plan to make that change

By Nobuo Tanaka, executive director, International Energy Agency

The 2010 G8 and G20 summits will be the first opportunities since Copenhagen for world leaders to inject fresh momentum into efforts to tackle climate change. Recent analysis from the International Energy Agency (IEA) provides grounds for both caution and optimism for these crucial discussions. It brings caution because if current trends in energy use continue, they could contribute to potentially catastrophic climate change and pose serious threats to global energy security. It brings optimism because there are cost-effective solutions to effect a rapid transformation to a more secure, reliable and environmentally sustainable energy system – and with enough common will, these are within reach.

These are the headline findings of the IEA's *World Energy Outlook 2009* (WEO). It shows that if policies do not change, primary energy demand will grow by 40 per cent by 2030, with a persistent dominance of fossil fuels – oil, gas and coal. Demand will come mainly from developing countries, particularly China, India and the Middle East, where economic and social development will require more transport, cooling and heating. At the same time, growing fossil fuel consumption will drive up global carbon dioxide emissions, pushing up the average global temperature by as much as 6°C. In such a scenario, 1.3 billion people will still live without electricity in 2030 – an unacceptable level of energy poverty.

But these trends are not set in stone. The WEO demonstrates that containing climate change will require a profound transformation of the energy sector. The '450 Scenario' contains an aggressive timetable of actions to limit the long-term concentration of greenhouse gases to 450 parts per million of carbon dioxide equivalent and keep the average global temperature rise to around 2°C above pre-industrial levels. To achieve this scenario, fossil fuel demand would need to peak by 2020, causing energy-related carbon dioxide emissions to peak and then decline to below today's level by 2030.

The bulk of the emissions reduction in the 450 Scenario is delivered by energy efficiency, accounting for more than half of total abatement by 2030. The social, economic, environmental and energy security benefits of energy efficiency are too large to be missed. Yet, experience shows that proper policy frameworks are needed to reap these benefits. Sharing best policy practices in energy efficiency must therefore remain a priority for international policy cooperation.

Low-carbon energy technologies also play a crucial role in the 450 Scenario. Around 60 per cent of global electricity production comes from low-carbon sources in 2030: renewables (37 per cent), nuclear (18 per cent) and carbon capture and storage (CCS) (5 per cent). Furthermore, a dramatic shift in car sales would be needed, with hybrids, plug-in hybrids and electric vehicles representing almost 60 per cent of sales in 2030, from just 1 per cent today. To jumpstart the wider deployment of these crucial technologies, the IEA is developing a series of low-carbon energy technology roadmaps that identify priority actions to guide environmental and energy decision makers.

This energy transformation will require unprecedented deployment of the technologies of today and tomorrow. The costs are not trivial – $10.5 trillion between today and 2030, with the annual cost reaching 1.1 per cent of global gross domestic product (GDP) by 2030. However, these clean energy investments more than pay for themselves through fuel savings. In industry, buildings and transport, $8.3 trillion of investment would save $8.6 trillion by 2030.

The energy security benefits of this lower demand could be profound. With existing demand trends, the world faces a peak in conventional oil production in about 2020. By contrast, global oil demand in the 450 Scenario is only 4 million barrels a day more in 2030 than today. Oil and gas import bills in the 450 Scenario in member countries of the Organisation for Economic Co-operation and Development in 2030 would be lower than in 2008.

The commitments under the Copenhagen Accord for reducing greenhouse gas emissions are an encouraging step toward turning the 450 Scenario into reality. However, ambitions to reduce emissions must be raised still higher: the IEA's preliminary analysis suggests that the current pledges – if fully implemented – would still be short of what is needed by 2020 to limit the rise in global temperature to 2°C.

To achieve the necessary cuts in greenhouse gas emissions, new technologies will be critical. Among these, CCS plays a crucial role. The IEA, together with the Carbon Sequestration Leadership Forum and the Global CCS Institute, will report to the Muskoka Summit on progress made on G8 recommendations for developing

> "Energy transformation will require unprecedented deployment of the technologies of today and tomorrow"

Beijing: developing countries such as China will see the biggest increase in energy demand in the coming years

From left: South Africa's president Thabo Mbeki, Brazil's president Luiz Inácio Lula da Silva, Mexico's president Felipe Calderón, China's president Hu Jintao and India's prime minister Manmohan Singh during the G8 Hokkaido-Toyako Summit. The leaders back the broad deployment of carbon capture and storage technologies

and commercialising CCS. Since 2008, there has been much progress, particularly with the development of legal and regulatory frameworks, the commissioning of CCS pilot plants and the continued learning from plants already in operation. However, for broad deployment, the construction and operation of large-scale CCS demonstration projects are critical.

Central to the report is an account of progress against the declaration made by the G8 leaders at the 2008 Hokkaido-Toyako Summit that they "strongly support the launching of 20 large-scale CCS demonstration projects globally by 2010, taking into account various national circumstances, with a view to beginning broad deployment of CCS by 2020". The IEA, with others, has developed criteria for qualifying to be one of those projects. Prior to the Hokkaido-Toyako Summit, four large-scale CCS demonstration projects were operating. By April 2010, just one additional large-scale project had fully satisfied the criteria and was proceeding to construction. However, imminent decisions from governments are expected, and would result in several projects meeting the criteria soon, notably in Canada, Norway and the United States. In addition, a significant number of projects will likely meet some, but not all, of the assessment criteria. As well as reporting progress, the IEA report will identify challenges yet to be overcome in achieving the deployment levels required both in 2020 and beyond.

Energy subsidy reform represents another important opportunity to help avoid the most severe consequences of climate change. This was highlighted by the G20 leaders at their Pittsburgh Summit in September 2009, when they committed to "rationalise and phase out over the medium term inefficient fossil fuel subsidies that encourage wasteful consumption". The G20 also called upon the IEA, OECD, the Organization of Petroleum Exporting Countries (OPEC) and the World Bank to prepare a joint report on energy subsidies and suggestions for the implementation of the G20 initiative. The IEA's input has underscored the global energy security, environmental and economic benefits of phasing out subsidies. It shows that fossil fuel consumption subsidies – which lower end-use prices, thereby encouraging increased and often inefficient or wasteful energy use – approached 1 per cent of global GDP in 2008. Phasing these subsidies out by 2020 would result in significant reductions in primary energy demand and carbon dioxide emissions, compared with a baseline at which subsidy rates remain unchanged.

To abolish energy subsidies is nonetheless far from straightforward or painless. The short-term costs on some groups of society can induce strong political opposition. Yet the desirability of a general shift toward more open markets and more cost-reflective pricing is no longer in debate. The results of the IEA's analysis support the arguments favouring continued and intensified reform alongside appropriate targeted assistance, safety nets and industrial restructuring packages.

> "Energy subsidy reform represents another important opportunity to help avoid the most severe consequences of climate change"

IEA analyses, such as on the 450 Scenario and on phasing out subsidies, have identified many of the practical measures that need to be taken within the energy sector to achieve ambitious climate goals while improving energy security. The next step is a strong political signal to drive these essential changes. The 2010 G8/G20 summits thus represent an invaluable opportunity to point to the kind of energy future that awaits the world. Whatever the outcomes, implementation of the commitments made at Muskoka and Toronto – or beyond – will remain key. For every year that passes, the window for action on emissions is lowered a little – and the costs of transforming the energy sector increase. ◆

Sowing the seeds of sustainable growth

GBEP gathers developed and developing countries in finding consensus-based paths to bioenergy for sustainable development

Modern bioenergy presents great opportunities for sustainable development and climate change mitigation. But it brings challenges too, some with international relevance. So, international co-operation is essential for building consensus on how to measure success in bioenergy and building capacity to help implement successful solutions. The Global Bioenergy Partnership (GBEP) has proved that a voluntary partnership of developed and developing countries and international organisations, informal enough to allow open discussion yet formal enough to yield meaningful results, is an effective and innovative vehicle for co-ordinated progress towards low-carbon, sustainable development.

In developing countries, switching from traditional to modern bioenergy can reduce death and disease from indoor air pollution, free women and children from collecting fuelwood and reduce deforestation. It can also cut dependence on imported fossil fuels, improving countries' foreign exchange balances and energy security. Furthermore, bioenergy can expand access to modern energy services and bring infrastructure such as roads, telecommunications, schools and health centres to poor rural areas. In such areas, bioenergy can increase the income of small-scale farmers, alleviating poverty and decreasing the gap between rich and poor. In urban centres, using biofuels in transport can improve air quality.

For developed countries, where the focus is on reviving economic growth and mitigating climate change, bioenergy can stimulate a green recovery, generating more jobs and fewer greenhouse gas emissions than fossil fuels. It can breathe life into rural economies and diversify the supply of imported fuels.

However, if not sustainably produced, bioenergy can place extra pressure on biodiversity, scarce water resources and food security. If land use is not well planned and enforced, increased deforestation, loss of peatlands and land degradation can occur and lead to an overall negative impact on climate change. Where land tenure is insecure, communities can be displaced and lose access to land and other natural resources.

Therefore, GBEP has developed an initial set of criteria and indicators for bioenergy to enable governments to determine whether they are seizing these opportunities for sustainable development and managing these challenges adequately. While distinguishing between "good" and "bad" bioenergy depends on a country's situation and priorities, this tool will help countries produce better bioenergy. The criteria and indicators were designed to be implemented in a range of countries, building the capacity of governments to monitor, interpret and respond to the environmental, social and economic impacts of their bioenergy production and use. Furthermore, GBEP will now move on to facilitate access to adequate financing, capacity building and technology co-operation for sustainable bioenergy.

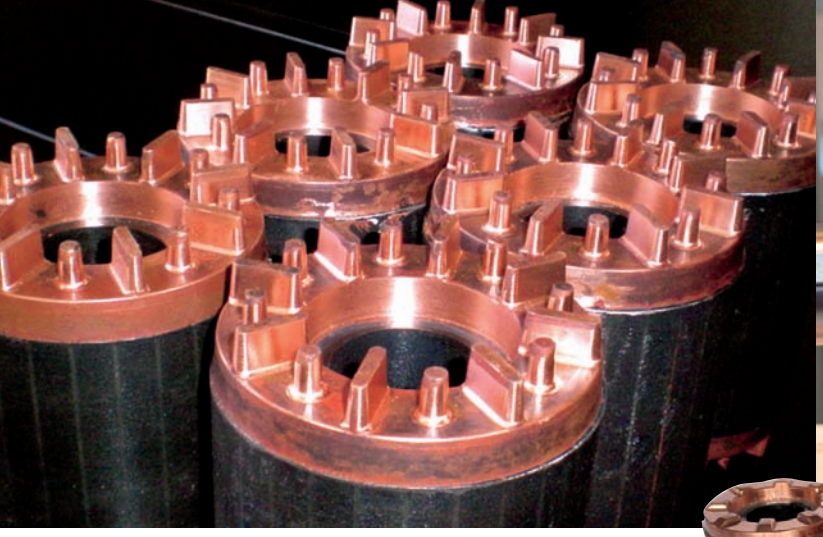
GBEP is an international initiative established to implement the commitment made by the G8 in 2005 to "support wider, cost-effective biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent".

GBEP brings together 29 partners and 30 observers from governments, international and UN organisations as well as private sector and civil society stakeholders to promote bioenergy for sustainable development. The Partnership is chaired by Corrado Clini, Director General of the Italian Ministry for the Environment Land and Sea, and co-chaired by Brazil. FAO hosts the GBEP Secretariat at its Rome headquarters, with the support of Italy.

Read more about GBEP at www.globalbioenergy.org

Working together for sustainable development

GBEP
Global Bioenergy Partnership



Energy-efficient motors: meaningful impact from an unexpected source

The responsible use of energy has become a foremost concern of industrialized and industrializing societies. How the nations of the world use energy today – and the decisions the leaders of these nations make about how it will be used tomorrow – will have profound effects worldwide. Every watt we save and every kilogram of CO_2 we do not emit helps to ensure a better future. The inherent challenges we face in making significant improvements in energy use in the short term are difficult, but certainly not insurmountable.

Meaningful achievements in energy efficiency can be made today. One area in particular – electric motors – offers significant opportunities to save energy and reduce our carbon footprint.

MOTORS (AND MOTOR-DRIVEN SYSTEMS) USE 40% OF ALL ELECTRICITY

Discussions on the efficient use of electricity often are limited to readily visible applications with relatively low impact. The responsible use of electricity needs to be at the core of energy-saving initiatives, and evidence of this abounds: compact fluorescent lights, high-energy-efficiency appliances, such as refrigerators and airconditioning units, etc. Any effort to save energy is a step in the right direction. Remarkably, one of the most significant uses of electricity has not been addressed aggressively by policy-makers globally to achieve maximum potential impact. That use is motors and motor-driven systems. The International Energy Agency (IEA) estimates motors in motor driven systems (e.g, pumps, fans, compressors) use as much as 40% of all electricity[1]. In the industrial sector, electricity consumption by motors account for as much as 60-70% of electricity demand.

SMALL IMPROVEMENTS CAN LEAD TO BIG IMPACTS

If by 2030, all the world's economies were to adopt best practices for motor-driven systems (for example: high-energy- efficiency of the motor itself, right-size motor selection, use of variable motor speed controls, power supply quality, etc.), ***electricity consumption would drop as much as 10% worldwide***. This is equivalent to 2,000 – 3,000 terawatt hours of electricity demand.

In addition, CO_2 emissions would be reduced by 1.3 – 1.8 gigatonnes. These are massive numbers, and some

[1] All statistics related to motors and motor-driven systems have been provided by the International Energy Agency (IEA) and the International Copper Association (ICA). As of this writing, these are preliminary and subject to further refinement.

perspective is in order. Let's start with 1.8 gigatonnes of carbon-dioxide. That is 1.8 billion tonnes.
These savings equate to:

- As much as three times the energy savings from phasing-out incandescent lights in favor of compact fluorescent bulbs, or CFLs.
- About 1.5 times the current emissions from the energy consumed by India, or Japan.
- CO_2 emissions from more than 500 coal-fired plants of 500 megawatts each.
- 75% of current U.S. demand for electricity.
- ***Twice*** the carbon savings of the Kyoto Protocol if ***all*** the signing countries met ***all*** of their targets.

MANDATORY MINIMUM ENERGY PERFORMANCE STANDARDS (MANDATORY MEPS) FOR MOTORS

The International Copper Association (ICA) has been a strong voice globally for the implementation of Mandatory Minimum Energy Performance Standards (Mandatory MEPS) for motors for many years. In 2002, only five countries had Mandatory MEPS. The story is different today. Through the concerted efforts of the International Energy Agency, United Nations, various other organizations, governments, and the ICA, 39 countries will have adopted some level of Mandatory MEPS for three-phase electric motors, by 2011. Motors in these countries account for about 20% of total global electricity demand. If the Mandatory MEPS in these 39 countries were raised to best-practice levels, savings could approach 200 million tonnes of CO_2 annually. If all countries adopted and enforced best practices for motors and for motor-driven systems, savings could reach 1.8 gigatonnes of CO_2.

BUSINESS CONSIDERATIONS

Utilities are promoting premium-efficiency motors as a customer service to help industries improve their competitiveness and to enhance environmental quality. Since most industries spend a significant percent (60-70%) of their electricity bill in powering motor loads, lowering operating and maintenance costs with premium-efficiency motors, coupled with typical payback periods of six months to three years for these products, makes premium-efficiency motors a sound investment. Energy-efficient and premium-efficiency motors have other benefits, too. These motors:

- Run cooler and better withstand voltage variations and harmonics than standard motors.
- Deliver higher power factors on average than their standard counterparts.
- Operate more quietly.
- Often are backed by extended manufacturers' warranties.

CONCLUSION

We encourage governments to adopt Mandatory MEPS in line with international best practices.

Charlie Sartain
Chief Executive, Xstrata Copper
Chairman, International Copper Association

Francis J. Kane
President,
International Copper Association

ABOUT THE ICA

The International Copper Association is the leading organization for the promotion and defense of copper products and markets worldwide. The ICA's 36 member companies represent a majority of the world's copper production, and also include ten of the world's largest copper and copper-alloy fabricators. The ICA global network comprises more than 350 project partners, which include industry, governments, multilaterals, and non-governmental organizations (NGOs). The ICA is headquartered in New York and maintains 31 offices on six continents, with activities in more than 60 countries.

Integrity, innovation, trust, credibility, commitment, empowerment, and passion are core values of the ICA. The ICA is dedicated to advancing copper as the material of choice for current markets and use in new applications based on its superior attributes, such as excellent heat and electrical conductivity. These include technical performance, aesthetic value, sustainable qualities, an essential role in human health and contributions to a higher standard of living. ICA's vision is to inform and inspire a global audience on the intrinsic value and benefits of copper through its role in safeguarding and improving health, developing and commercializing new technologies, and improving the quality of life.

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Courtesy of Clean Energy Council

The sources of clean energy

The technology needed to produce clean, renewable energy is out there. Progress has been made. But further investment and government action are needed to develop this technology further and ensure sustainable, clean energy sources for the future

By Matthew Warren, chief executive, Clean Energy Council

In the history of humanity, energy has been the code for growth. Energy has been used to power machines to make human efforts more productive. Finding and exploiting abundant and affordable energy have been the essential ingredients in the miracle of industrial development that has made lives safer, cleaner and better.

The world's fastest growing economy, China, knows this fundamental relationship only too well. New energy is the life blood transforming China's economy. The lives of millions of Chinese people are being changed every day. The scale of this extraordinary act of humanity is still being contemplated. It took the industrial revolution 100 years to lift 25 million Europeans out of poverty. China has done the same to 250 million people in a decade.

With this in mind, climate change and the need to decarbonise global energy poses a significant challenge. It threatens to impede not only the continued wealth and welfare of the world's most developed economies, but also to derail the remarkable progress made in recent times to address one of the world's most difficult problems – the problem of redressing the balance between rich and poor.

The answer to this problem is obvious: find reliable and affordable energy sources at scale that do not contribute to the Earth's oversupply of greenhouse gases. These energy supplies must also be used more efficiently and conventional energy markets must be released from the commercial straitjackets that have been placed on them for the past century. But fundamentally smart ways need to be found to harness the abundance of clean energy that exists today. And soon.

The question of the transformation is only one of convenience. Fossil fuels are serendipity incarnate. Every tank of gas we buy, every street light we see, is the result of millions of years of solar energy packed into the coal, oil and gas that power it. That energy density has made these fuels transportable and affordable. Cheap energy powered the stream trains that linked London to Liverpool and Chicago to Charlotte. It powered the steel mills of Europe, Japan and Korea. It powers the 600 million cars operating in the world today.

So now these carbon fuels need to be used to decarbonise energy, and to exploit the ingenuity and technology developed over the last fossil fuel century to find ways of extracting the plentiful but diffuse sources of clean energy on Earth.

It is entirely achievable, but unlikely to happen simply as a result of either sheer willpower or desperation. This suite of new clean energy technologies will be created from two fundamental policy principles. First, sufficient abundance needs to be created to drive ingenuity. Second, enough competition needs to be imposed on this abundance to drive efficiency. Renewable energy accounts for around 7 per cent of global energy supply not because it cannot deliver more, but rather because that request has not yet been made of it.

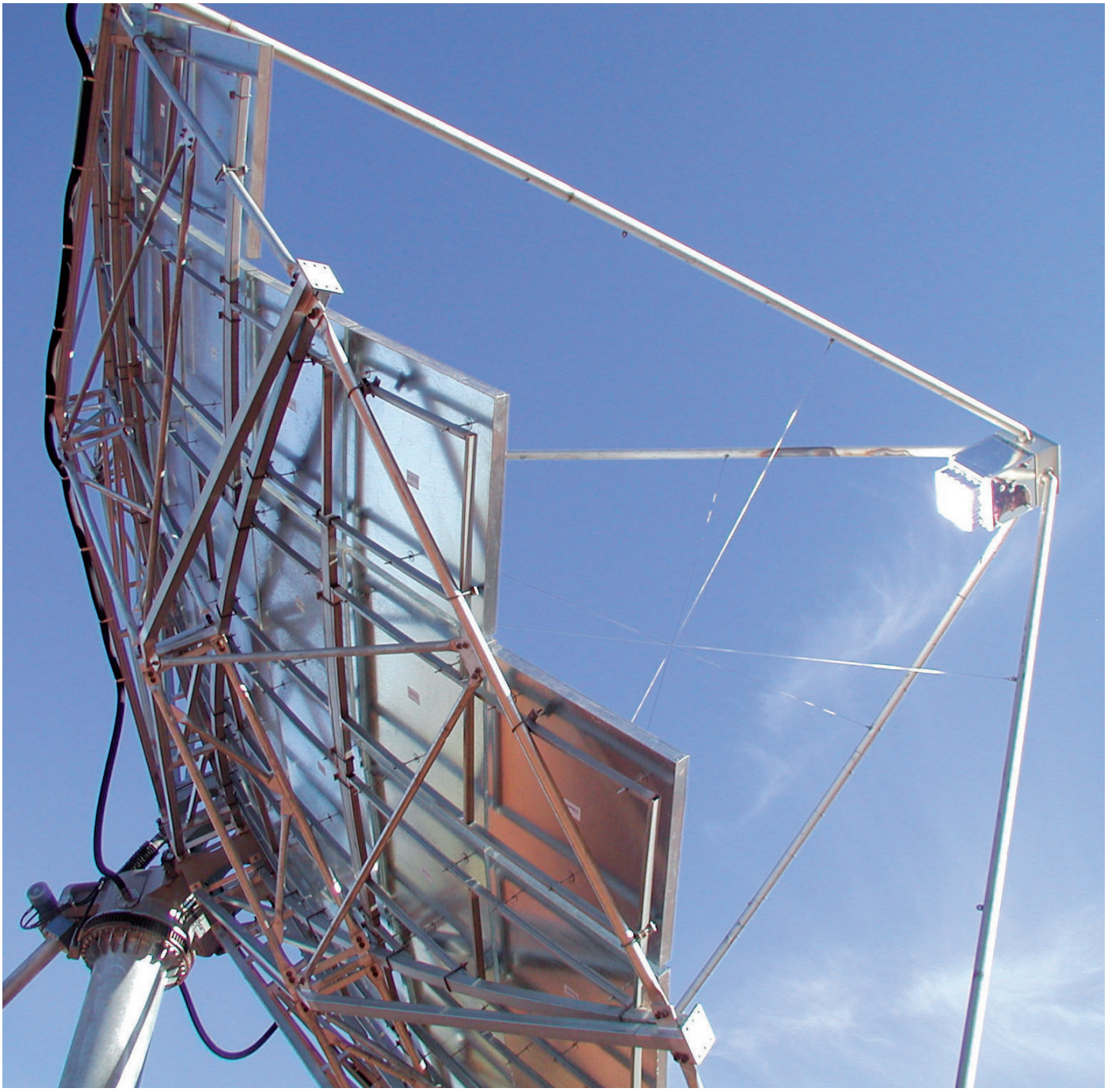
What is known already is that energy can be drawn from the rain and the wind with remarkable efficiency and at industrial scale. By the end of 2009 the total installed capacity for wind energy was 158.5 gigawatts (GW), with an annual growth rate of more than 30 per cent a year. Global hydro energy supply exceeds 800 GW. Photovoltaic solar energy has passed 5 GW of installed capacity globally with a 50 per cent per annum growth rate as costs continue to fall behind a massive scale-up of production.

> "In the all-important clean technology space, a generation of innovation is being crammed into a decade"

Sunshine is a rich but diffused source of energy. Large-scale solar technologies are looking at low-cost ways of concentrating this energy source to improve its efficiency at scale. There are 11 GW of large-scale solar projects under development globally in the United States, Spain and North Africa. Sunshine is also trapped in plant matter, which, when extracted as energy, delivers another 260 GW used as energy and heat.

Geothermal heat stores beneath the Earth's surface deliver around 38 GW of energy as electricity and heat, with enormous untapped potential. There are also hundreds of companies around the world working to safely and reliably harness the enormous energy potential in the Earth's ocean currents and tides.

So progress has begun. Investment in new clean energy generation in 2008 outstripped that in conventional



energy for the first time in history. The US-based Pew Charitable Trusts predicts a jump in total clean energy investment to around $200 billion in 2010, led by China, Britain, Germany and Spain.

There is a clear first-mover advantage for governments. Those economies that act early will enjoy the largest benefits. China has invested more than $30 billion in new clean energy generation during 2009 – almost twice as much as the US did.

In turn, those governments need to create the right conditions for investment in clean energy development and deployment to increase exponentially. In the long run, that will be delivered by an agreement on global greenhouse gas emissions. In the short run, that means sufficient regulatory certainty for investors to finance new clean energy projects.

In the all-important clean technology space, a generation of innovation is being crammed into a decade. That means faster cycles of success and failure, trials and errors. Investors ought to back these risky ventures with confidence – and recover their losses in the failures and recycle their capital in other ventures. Governments play a crucial role in installing that confidence and creating that abundance.

Clean energy is just like conventional resource extraction – only in reverse. The technologies to extract conventional resources already exist. The resources just need to be located. With renewables, the location of those resources is already known. It is now just a matter of optimising the technologies. But these new clean energy generation sources are not always conveniently located. Investment rules in grids and networks need to change too.

At the spring summit of the European Union in 2010, leaders officially endorsed the G20 as an alternative forum for reaching an agreement on emissions reduction. Inevitably, the leadership in clean energy innovation and investment will come from these 20 leading economies. ◆

Small-scale versus big-scale renewable energy investments: the path for developed countries versus developing countries*

Developed countries should focus on investments with a large impact, developing countries should focus on small-scale investments

Aad Groenenboom & Paul Nillesen, PricewaterhouseCoopers

The next decade brings us new and difficult challenges. But it also offers real opportunities to change the course of our economies and the impact of the environmental footprint we will leave behind. It also requires choices in investment focus between different countries.

We expect the renewables market to flourish as conventional sources such as oil and gas wane and the marginal cost of producing them rises. Over the longer term, this increase will enhance the competitive position of renewables and tip the balance in favour of these new technologies. At the same time, technological progress and economies of scale are driving down the initial investment costs of renewable technologies and increasing their efficiency.

Importantly, stakeholder pressure is acting as both carrot and stick, spurring investment in renewable sources. Renewable energy in particular, but sustainability in general, is now the credo for governments and businesses alike, as consumers are demanding environmentally friendly products and behaviour.

Renewable energy investments have suffered in the current economic crisis. However, increasing the level of investment could decrease our environmental footprint and boost our economies. Recent PwC analysis suggests that reaching the European targets alone will require substantial investments between 1.8 and 4 trillion Euros depending on the technology.

We identify two trends in the market for renewable energy. On the one hand there are large-scale renewable energy projects in development around the world, such as offshore windparks or concentrated solar power plants. These projects are reaching the scale and complexity of conventional power stations. On the other hand, there is a proliferation of small-scale, often local, renewables initiatives, such as households with heat pumps or PV panels on their roofs. At all levels in society a renewable revolution can be witnessed. Although both local initiatives and larger scale projects are necessary to realise the renewable transition, we see an important distinction in focus for developed countries and developing countries. This distinction should be accounted for in policy development and development aid between rich and poor countries.

There is a need for Constraint and Reduction to facilitate and achieve the renewable transition. The developing countries have relatively low per capita carbon intensity when compared to the more developed countries. Policy should be aimed at Constraining the carbon intensity of the less developed countries, whilst allowing economic growth and growth in prosperity. At the same time policies need to be developed to Reduce the carbon intensity of developed countries, whilst maintaining the social wealth that has been created by decades of economic growth.

This implies that the primary focus for developed countries should be on large-scale renewable energy initiatives that will help drive down the carbon intensity. The impact of these large-scale initiatives is likely to be far greater than smaller-scale individual measures. That is not to say that these should be neglected but rather the direction of scarce resources should be aimed at large-scale projects. Obviously this will require coordinated efforts between countries as those initiatives can be across borders.

For developing countries the focus should be on these small-scale, decentralised initiatives. Utilising these small-scale renewable energy solutions will allow the benefits of economic growth to be captured, whilst constraining the growth in carbon emissions. There is a unique chance to leapfrog conventional sources of energy and implement a fully renewable energy system. This leapfrogging is similar to the introduction of mobile telephone networks in many developing countries rather than expanding the traditional fixed line networks. In policy terms this implies that funds should be directed at facilitating this local decentralised transition.

Ultimately, linking these two approaches will boost both the market for large-scale solutions and allow innovation and development in locally-based technological solutions.

*connectedthinking

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Prosperity, energy and global warming – a policy dilemma

By Dr. John S. MacDonald, Chairman and CEO, Day4 Energy Inc.

Modern humans, at least those in developed economies, have had the privilege of living in a time of relative prosperity, when our quality of life has been the best it has ever been since our species first appeared on the Earth. The fundamental basis for this happy state of affairs has been the relatively easy availability of large quantities of affordable energy. The vast majority of this energy is created through the combustion of fossil fuels, energy sources that are depleting and becoming more difficult and expensive to find and exploit. This coupled with rising energy demands as more of the Earth's human inhabitants strive to gain a better life, is leading to increased volatility in energy prices and to their inevitable rise. Our modern energy supply is gradually becoming neither as inexpensive nor as plentiful as it once was. This will impact prosperity.

In addition, our climate is changing and increasing worldwide average temperature is an accepted fact. It is "unequivocal" in the words of the Intergovernmental Panel on Climate Change (IPCC). Careful modeling of climate phenomena and their trends has made it increasingly clear that today's dominant method of generating abundant cheap energy, is a significant contributor to the climate change we observe because of increased emissions of greenhouse gases (GHG's). Global warming is likely to cause many regions to become less inhabitable leading to further decreases in human prosperity. Climate change is therefore not a good thing with respect to our being able to sustain human prosperity at its current levels in the developed world, let alone enable the developing economies to realize their aspirations.

Thus the two major threats to the prosperity of modern civilization, depleting energy sources and climate change, are intimately intertwined. Sober reflection on this state of affairs leads to the conclusion that *today's level of prosperity based on the way we presently derive our energy is unsustainable*. This clearly threatens our future prosperity, and is the essence of the dilemma we face.

Our dilemma is a policy dilemma

What can we do to sustain the level of prosperity we have achieved in the developed world and then propagate this achievement

into the less developed portion of our human family who quite appropriately aspire to increase their prosperity to the level of the developed economies? If we simply reduce GHG emissions, we threaten the short-term availability of the energy supply. If we carry on with "business as usual" energy prices will increase anyway and we will continue to aggravate the warming trend in the global climate with unpredictable consequences.

This simple analysis reveals that unlocking this dilemma cannot be successfully accomplished by dealing with the energy situation and climate change in isolation. *They must be tackled together as parts of a single complex threat*. The failure of the recent Copenhagen Conference on Climate Change illustrates the futility of trying to address one of these issues in isolation.

What is the key to unlocking the dilemma?

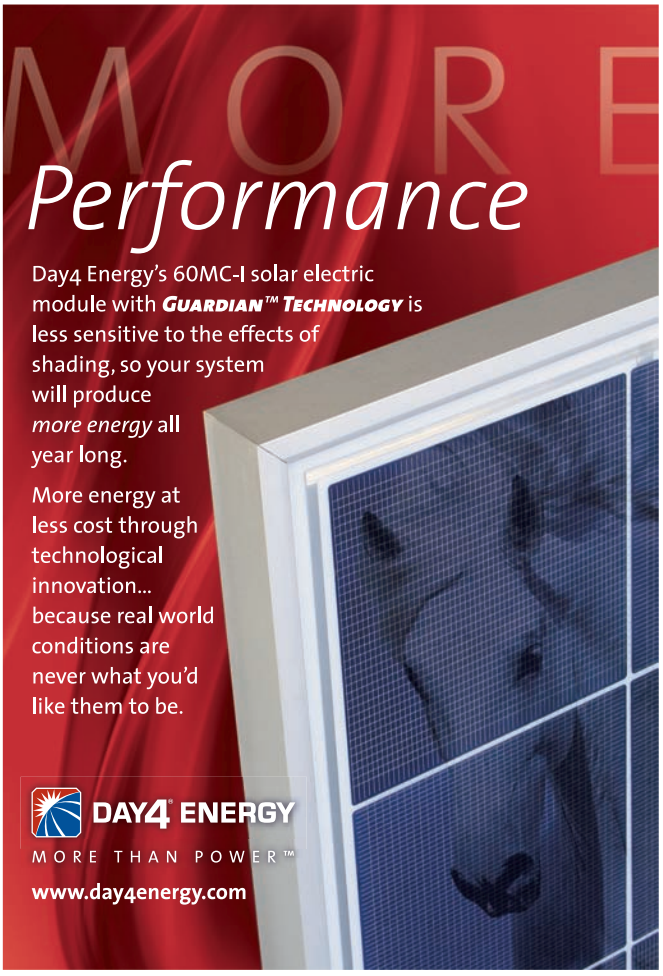
That key is Renewable Energy Technology because it simultaneously addresses energy supply/demand and climate change. *It addresses both threats to our continued prosperity*. Renewable energy sources are, by definition, inexhaustible. That can deal with the supply issue. As demand increases we will have to develop better, smarter and cheaper means of harnessing renewable energy sources but there is no fundamental barrier to doing that. Renewable energy sources are secure, the fuel is generally free and not a significant factor in advancing global warming.

Renewable energy in its current state is an infant industry. In spite of this, however, its technologies are well understood and the majority of them are at or near the commercial level of development. The challenge now is to develop policies that will lead to renewable energy sources entering the mainstream of the energy system. These technologies are, in most regions of the globe, still not cost competitive with existing mainstream energy sources and are generally regarded as a peripheral curiosity. The development of the renewable energy industry is still at a very early stage, and it is generally accepted that to develop to the point where it is competitive as a mainstream energy source will require subsidization, a concept that is no stranger to the traditional fossil fuel based energy industry.

At Day4 Energy we have set a goal to move our particular renewable energy technology (solar photovoltaics) to cost parity as quickly as possible through technological innovation. We are making good progress and in our experience so far it has become very clear to us that a performance-based subsidy is by far the most effective policy tool yet conceived as a mechanism to move renewable energy technology to the point where we can begin to realize a viable solution to the energy/climate change dilemma. Subsidy mechanisms based on capital rebates and tax schemes are far less effective in stimulating the innovation necessary to achieve the goal of unlocking the dilemma.

The most well known performance-based subsidy mechanism is the Feed-In-Tariff (FIT) introduced in Germany a decade ago. As a company dedicated to using our skills at technological advancement to realize the generation of solar energy at competitive prices we, at Day4 Energy, find that operating in regions that use FIT subsidies provides the degree of incentive necessary to keep us on the right path to achieve cost parity. This is due to the essential characteristics of the FIT. The subsidy is supported by the ratepayer, not the taxpayer, which creates a business transaction where an investor makes a deal to provide renewable energy to an electrical utility in return for a stable price regime and an acceptable return on investment for an extended period of time. In this way, private capital is attracted to the task of developing more efficient, effective and reliable renewable energy sources. As the technology improves and its costs reduce, so does the subsidy until it ultimately disappears. The pressure to innovate is unrelenting because the competitive advantage of a supplier such as Day4 Energy rests on our ability to provide reliable technology that delivers the most energy at the lowest possible cost thereby providing the investor with the highest possible return together with the assurance that the system will perform for many decades. While our focus at Day4 Energy is on solar generation systems, these same principles apply equally well to all forms of renewable energy.

There is a degree of urgency to all of this. The challenge is not as simple as replacing conventional fossil-based energy sources with renewable ones. The characteristics of renewable energy sources will require considerable modifications to the transmission, distribution and control infrastructure compared to the system we currently have. This will be an enormous undertaking. It will take much time, and given the uncertainties in both the consequences of the global warming threat and the timing of increasing prices for conventional energy, there is no time to waste. The time to start is now. Bold leadership will be required. Let us hope it is forthcoming.



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Beyond fossil fuels: how the G8 and G20 summits can help

By enhancing the work of the International Energy Agency, and encouraging emerging economies to join, the G8 and G20 can help reduce the world's fossil fuel consumption

By Dries Lesage, University of Ghent

Despite the disappointing results of last year's Copenhagen climate change conference, the world still needs to move rapidly to a climate-friendly energy system. Ambitious, globally agreed and binding targets to reduce carbon dioxide emissions are imperative.

Yet Copenhagen demonstrated that this goal is hard to achieve in the short term. It must be supplemented by other strategies, of which stepping up international collaboration on energy efficiency and clean energy appears to be a promising one. Such collaboration should not be seen as opposed to the Kyoto approach of binding emission targets. On the contrary, intensified policy and technology collaboration will likely pave the way for stronger reduction targets. Moreover, the numerous meetings between energy officials from advanced and emerging economies may contribute to mutual trust and understanding. One lesson learned from the difficult post-Kyoto talks is that a gap remains between international climate and energy policy. Only a small amount of the climate debate is dedicated to what enhanced energy cooperation could achieve. The upcoming G8 and G20 summits could make a huge difference on this front.

Apart from useful work in reducing national subsidies for fossil fuels, energy is not yet a prominent theme on the G20 agenda, which focuses on macroeconomic and financial issues. In contrast, the G8 has long engaged in the climate/energy debate. It has been a priority since the 2005 Gleneagles Summit, and has figured on the agenda of all subsequent summits. However, energy is not a priority theme for the June 2010 Muskoka Summit and no energy ministerial has been held. Consequently the useful mechanism of iteration, which can enhance national compliance and G8 effectiveness, has been lost. Moreover, the G8 has not produced a breakthrough on emission reduction targets. It has also had little interesting to say about climate finance.

Yet the G8 has been helpful in ultimately bringing the climate-sceptic former US president George W. Bush on board, pushing forward an 80 per cent reduction target by 2050 for industrialised countries and achieving global acceptance of the principle that global warming should not exceed 2°C compared to pre-industrial levels. More important, but less publicised, is the G8's contribution to technological collaboration on energy efficiency and clean energy, particularly between G8 countries and major emerging economies. Since Gleneagles, the G8 has boosted the work of the International Energy Agency (IEA) on sustainable energy, as well as its outreach efforts. And in 2009, the G8, the European Union, China, India, Brazil, Mexico and Korea founded the International Partnership on Energy Efficiency Cooperation (IPEEC). Open to all interested countries, the IPEEC will promote

energy efficiency worldwide and facilitate the exchange of information and best practices.

But the work is far from done. More than ever, G8 and G20 summits are key in providing the necessary leadership for a complex, multidimensional and urgent issue such as energy, while being sensitive to the interests of non-members. The June 2010 summits have a good chance to become historic ones, by pushing forward a few initiatives already underway and departing from an institutional infrastructure already in place. The rise of Brazil, Russia, India and China and other non-western energy consumers has made it increasingly difficult for the IEA to coordinate strategic oil reserves and work on sustainable energy. The G8 and G20 can help more major emerging economies become members of the IEA. US secretary of state Hillary Clinton and IEA executive director Nobuo Tanaka have already spoken in favour of expanding membership to countries such as China and India. This endeavour should become a foreign policy priority for all IEA member states and major emerging economies.

To be sure, some intricate, practical and legal difficulties must still be sorted out, but that is exactly what leaders' summits are for. The full engagement of the major emerging economies in the IEA will amply benefit both sides. Leaders and their sherpas could take the 2010 summits as opportunities to convince their colleagues of the advantages of becoming a member of the IEA. As an organisation of very important consumers, the IEA could coordinate the shift to a world economy beyond fossil fuels – but only if it is more attuned to today's increasingly multi-polar world.

Meanwhile, the G8 and G20 can take other actions as well. In 2010, they could create the international low-carbon energy technology platform already proposed by the IEA. The proliferation of technological initiatives could be better streamlined, the agendas of energy officials worldwide lightened, duplication of work avoided and remaining gaps better identified. Furthermore, if the IEA assumes a higher profile regarding low-carbon energy strategies, its regular budget must be increased. Relatively small amounts of money would allow this institution to adapt to the 21st century, which would effectively serve the strategic interests of member states. The G8 should take the lead in this. The G8 and G20 could also endorse, both politically and financially, the International Renewable Energy Agency (IRENA), another new multilateral institution headquartered in Abu Dhabi.

> "Less publicised is the G8's contribution to technological collaboration on energy efficiency and clean energy"

However, strengthening and creating multilateral institutions does not relieve the G8 and G20 of their overall political responsibility in keeping global energy governance moving forward.[1] These bodies are well placed to do strategic thinking on energy, to establish linkages between distinct issue areas (for example between energy and development) and to give necessary impetus to the machinery of multilateral institutions. In other words, the leaders must remain committed. Indeed, the energy agenda should shift from the G8 to the G20, as the latter represents more than 75 per cent of global energy consumption and almost 80 per cent of carbon dioxide emissions from fuel combustion. It is, therefore, highly relevant for future summits to discuss the coordination of domestic policies related to energy efficiency and clean energy, to complement the official climate framework of the United Nations.◆

[1] *See* Global Energy Governance in a Multipolar World, *by Dries Lesage, Thijs Van de Graaf and Kirsten Westphal (Ashgate, 2010).*

OPG's Beck Generating Complex in Niagara Falls has a capacity of 2089 MW

Ontario Power Generation: Public Power in Ontario

Ontario is a big province, about twice the size of Texas, with complex energy requirements, lots of industry, a vibrant commercial sector, and a customer base that wants clean, sustainable electricity.

Ontario Power Generation (OPG) supplies about two-thirds of the province's electricity.

The fact that we're publicly owned is central to our role, and has shaped not just the company we've become, but the province of Ontario itself.

Publicly-owned power

Ontario has a proud history of publicly-owned electricity generation. OPG's predecessor company, Ontario Hydro, pioneered both public ownership in this sector and also developed the enormous water resources of Niagara Falls.

By electrifying this province, Ontario Hydro helped transform Ontario from an agrarian province into the industrial heartland of Canada. It also went on to build Canada's first commercial nuclear plants, which are still operating today.

As all members of the G8 and G20 can appreciate, electrification equals industrial development equals rising wealth and prosperity. Electricity is the foundation of a modern economy.

Today, OPG has a generating capacity of 21,279 megawatts. We own and operate three nuclear stations, five fossil-fuelled stations, 65 hydroelectric stations, and two wind turbines.

OPG's plants can be found the length and breadth of Ontario, and we maintain a close relationship with all our site communities. This is an essential part of operating a sustainable, future-oriented business.

A pioneering environmental course

And in that broader public interest, OPG is setting a pioneering course. Already, nearly 90 per cent of the electricity we produce comes from nuclear and hydroelectric stations that are virtually free of emissions contributing to smog and climate change.

At OPG, we see ourselves as a significant enabler of environmental change. Accordingly, we are transforming our mixed generation base of hydro, nuclear and coal, into a much cleaner portfolio. The company is looking at repowering our coal-fired stations to cleaner alternative fuels, including wood and agricultural biomass, and natural gas. If successful, our biomass efforts could create an entirely new industry in Ontario.

"Our move off coal is one of the most significant initiatives to combat climate change in North America."
Tom Mitchell

Our move off coal is one of the most significant initiatives to combat climate change in North America.

Greening the province

We also believe in promoting biodiversity. Since 2000, OPG has planted nearly four million native trees and shrubs. That's been a significant investment in carbon sequestration and habitat revitalization. Twelve of our plant sites have been certified by the Wildlife Habitat Council for exemplary habitat enhancement programs.

Not only will the trees we've planted offset nearly two million tonnes of carbon dioxide over their lifetimes, OPG's nuclear plants have made their contribution too. In the last 10 years, our nuclear plants have spared the environment more than 470 million tonnes of CO_2 – that's equivalent to taking 13 million cars off the road over the same period.

OPG and the economy

G8/G20 participants come together annually to discuss economic matters. OPG's contributions to Ontario's economy are significant. We employ 12,000 people and every cent of our net income remains here in this province to the benefit of all Ontarians.

A responsible nuclear operator

As a major operator of nuclear plants, we've had notable success. In 2008, four of the top five performing CANDU units in the world were OPG units. Three of those units are from our Darlington station, which also won an important award for operational excellence from the Institute of Nuclear Power Operations. OPG is currently planning for the refurbishment of this station.

The question of nuclear waste management is one that concerns all countries with nuclear operations. OPG is responsible for the cradle-to-grave management of its nuclear plants, and we have well-developed plans to deal with nuclear waste. At three locations in Ontario: in Kincardine, and east of Toronto at our Pickering and Darlington plants, we have major nuclear waste management facilities. We control every gram of used nuclear fuel that we have ever produced. We know where it is, how much of it we have, and we monitor it constantly.

To deal with the long-term costs of managing our nuclear waste and nuclear plant decommissioning, OPG has created a $10 billion dedicated fund. And at Canada's federal level there is an effective cross-country consultative process being developed for the long-term storage of used nuclear fuel. OPG is closely involved.

Hydroelectricity and our future

The original foundation of the Ontario's electricity was based on water power. Hydroelectricity continues to offer new renewable energy supply opportunities. OPG is currently building, or proposing to build projects in northern Ontario that will add about 600 MW of new hydropower to Ontario's supply. In southern Ontario, we're building a 10.2 kilometre tunnel under the city of Niagara Falls to help our Niagara stations generate more electricity. When finished, the tunnel will have a lifespan of about 100 years.

OPG is a leader in biodiversity and has been honoured by the Wildlife Habitat Council

All over the world, where hydroelectric projects proceed, there are potential effects on indigenous populations. OPG's approach to new hydroelectric is firmly rooted in principles of respect, partnership, economic opportunity, and sustainable development. The Aboriginal people who live and work in the vicinity of our northern projects are full partners, and share in their benefits. For instance, we opened our new Lac Seul/Obishikokaang Waasiganikewigamig Generating Station last year. Through a partnership agreement between OPG and the Lac Seul First Nation, they have a 25 per cent equity stake in the plant. OPG is also negotiating other agreements with First Nations as we plan future hydroelectric developments in Ontario's North. This is a key element of our approach to operating a sustainable enterprise.

Through our many initiatives across the province, OPG's goal is to be increasingly recognized for delivering clean, reliable electricity in a manner that is safe, efficient and that benefits the people of Ontario.

I welcome all Summit participants to Ontario, and hope your discussions are fruitful.

Tom Mitchell, President and CEO of Ontario Power Generation

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Harnessing renewable energy

Energy security relies on increased investment in renewable energy research and technology. The G8 and G20 must promote and support these investments

By Victoria Panova, Department of International Relations and Foreign Policy of Russia, MGIMO-University

It has become increasingly evident that energy security is not possible without highly diversified energy sources and, therefore, the full-scale introduction of renewables. The share of renewables in the global fuel and energy balance currently remains below 7 per cent, excluding traditional biomass. According to most forecasts, this figure will only reach about 10 per cent by 2030. Thus, fossil fuels will remain a dominant feature of the mid- and long-term energy mix.

The recent global economic crisis led to a general decrease in energy consumption and reduced levels of investment in the sector in general. It also led to the postponement or cancellation of many renewable energy projects. Thus there is a risk of less investment to develop renewables without substantial government support. This would in turn lead to long-term difficulties in reaching the target of 10 per cent market share for renewables and the transition to a low carbon economy. Meanwhile, interest in wind energy has been increasing, with many companies such as Ibedrola, CEZ, Enel and Blackstone Group engaging in large projects and acquisitions, and Mainstream Renewable Power and Andes Group mounting joint investment projects.

Harnessing renewable energy: an uneasy path

Renewable energy sources – those that can be replenished quickly – include biomass, hydro power, wind, solar, geothermal, sea (tide and wave, ocean, salinity gradient, sea biomass) and other types of power.

Today, with the volatility of hydrocarbon prices, which remain in the upper part of their price range, combined with long-standing anxiety about the eventual depletion of hydrocarbons, as well as about the damage to the Earth's ecosystem, renewable energy can play a more prominent part in the total fuel and energy balance in the long term. Nevertheless, this cannot happen simply by the stroke of a magic wand. Any increase in renewable production would require several steps at the national and international levels, as well as with business.

Renewables also offer a potentially valuable solution in climate change mitigation. The International Energy Agency (IEA) estimates that increased use of renewables would account for 20 per cent of carbon dioxide savings. Biofuels used in transport accounts for another 3 per cent. However, this transition would require a "hybrid policy approach", which would include national policies, sectoral agreements and cap-and-trade systems with the participation of all the countries with "common but differentiated responsibilities".

Another important step to increase the use of renewables is significant investment, which should amount to $5.5 trillion over the next two decades. As much as half of the total projected investment in renewables will likely come from electricity.

Nevertheless, obstacles remain. They include the high cost of renewable energy technology, the lack of state support or subsidies, the interaction between food security and the development of biofuels, limited skilled labour and policymaking capacity, insufficient investment and a sceptical attitude toward the commercial viability of renewable energy.

Yet harnessing renewable energy is an important step in strengthening energy security, increasing the sustainability of energy development and maintaining ecological balance. There is still a considerable lack of research and transparency on the issue. A recent study, conducted by the European Commission on the use of biofuels, shows that the current policy of the European Union – for example, the target of 10 per cent of all road transport fuel coming from biofuels by 2020, or expanding agriculture to grow crops for biofuels – becomes increasingly unsustainable and leads instead to further deforestation, increased greenhouse gas emissions and degradation of the environment. Meanwhile, the IEA urges further expansion of biofuels, in part because only "around 1 per cent" of total agricultural land is used, there is the "potential to expand".

An Ibedrola wind farm in Murcia, Spain: despite reduced investment in the renewable energy sector, wind power projects are on the rise

International mechanisms foster sustainable energy development

One of the reasons behind the creation of the G7 as an informal mechanism for coordination in the 1970s was the need to respond to the energy security challenge as a result of the rise and assertion of energy producers in the developing countries of the Gulf. Today, with globalisation even more advanced, interdependence is not just a slogan but a reality. Hydrocarbons, with all the attendant problems regarding price, availability and so on, are gradually ceasing to be the panacea in global economic development. More and more attention is being devoted by the original G7 countries, together with their new partners – Russia, the G5 or Heiligendamm L'Aquila Process partners of Brazil, China, India, Mexico and South Africa – to the promotion of new sources of energy for sustainable global economic development and wellbeing.

Thus the issue of energy has always been on the G7/8 agenda. This includes the price of hydrocarbons and the security and stability of supply, evolving into environmental and nuclear safety questions, and then returning to oil. Although questions of diversification have always been part of the general discussion on energy, the issue of renewables, although always present, never emerged as a major priority. As G8 chair in 2006, Russia focused on energy security, but its partners prefer to make climate change a priority (with Canada's 2010 chair not breaking the tradition).

Alternative and renewable sources of energy have always occupied a secondary place on the G8 agenda. At the 2000 Okinawa Summit, the leaders agreed to create a task force on renewable energy, but it never produced visible results and existed only for one year. More recently, the 2007 Heiligendamm Process focused on energy and energy efficiency as one of it's four topics. But even then, it only touched indirectly on renewables. The new G20 leaders'-

> "The G8 and G20 should promote high-level political guarantees in stimulating investments and development projects in renewables"

level meetings, kick-started in 2008 by the financial and economic crisis, primarily deal with issues closely related to the world coming out of the current economic crisis.

Nevertheless, renewable energy offers ways for more sustainable and environmentally friendly economic development. It is important for the G8 and G20 members to take the lead in this area by adopting the following recommendations.

The leaders must provide the political will to support national and international research facilities and development along with increased financing to conduct research on all types of energy resources and their potential pluses and minuses.

The leaders should also create a new body or expand the mandate of the existing ones (such as the International Renewable Energy Agency or the United Nations Environmental Programme), not to limit them to the exchange of information, but also to provide for joint research on the comparison of natural advantages of specific types of renewable sources in different geographic areas, with further skilled support for providing best policies for introducing renewable technologies. They should also create international programmes to share best practices and advanced technologies with poor countries.

The G8 and G20 should promote and provide high-level political guarantees in attracting the private sector and stimulating investments and development projects in renewables.

The introduction of relevant sources of energy should be promoted according to geographic preferences, on the national level, as well as with the help of the World Bank Group. This needs political stimulus on the part of its major donors.

Providing such high-level political stimulus to the development of renewables is the key to energy security and the sustainability of future economic development. Thus renewable energy should be visibly present on the G8 and even the G20 agenda. ◆

Flexibility enables stability

In West Texas, wind has often been the theme of country ballads. Increasingly, it is also a source of something more practical: electricity

Around the world, energy demand and fuel prices fluctuate unpredictably, and environmental legislation keeps tightening. One significant response to environmental concerns is the fact that more and more energy is being generated from the wind. In 2009, almost 10,000 MW of wind power generating capacity was commissioned in the United States. That's more than any other type of energy source, including coal, oil and gas.

Also, because of changes in legislation, system operators are increasingly responsible for maintaining the stability of their power generation, and this means they have to keep some of their plants on partial load, able to ramp up their output rapidly in response to sudden fluctuations in load or wind generation output.

The demand for wind power enabling solutions that help ensure a stable level of energy is, therefore, also increasing. After all, the need for power doesn't stop just because the wind stops blowing.

Of course, this also raises new technical challenges, as predicting the precise balance of power demanded and supplied at any given time is becoming more and more challenging. Part of the challenge is created by the unpredictable – and often fast shifting – variations in wind power.

Enabling the rising wind

In West Texas an innovative project by Wärtsilä that enables the potential of wind power is showing the way toward more stable and efficient power solutions that will help energy providers stay in control and ensure the supply of energy, now and in the future.

In January 2008 Wärtsilä was awarded a power plant contract by South Texas Electric Cooperative (STEC). Wärtsilä's winning proposal offered a flexible power plant that is able to provide 25% of full power in just two minutes, and achieve full output in less than ten minutes. These engines also offer the highest output levels available in the industry, low lifecycle costs, rapid response to varying grid conditions (including wind power generation), and consistent performance under varying ambient conditions.

According to STEC's General Manager Michael Packard, "Analysis of our different options showed Wärtsilä to be the clear winner in both environmental and economic terms, and in the ability to meet rapidly changing market conditions."

Commissioned in April 2010 in Pearsall, Texas, fifty miles southwest of San Antonio, the project's solution called for a flexible power plant with 24 Wärtsilä gas engines. These were chosen for their high efficiency and low emissions – including their capabilities in compensating rapid shifts in wind power generation. The use of multiple engines allows STEC to use only the number of engines required to meet the real-time demands of its energy cooperative's members while maintaining optimum efficiency.

The Pearsall plant is connected to the region's electrical grid, and is expected to run for about 4000 hours each year. "This flexible facility will efficiently provide the electricity needed for the region's rapid growth, as well as the grid stability required to cope with the increasing proportion of wind generated electricity," notes Frank Donnelly, President of Wärtsilä in North America.

According to Jussi Heikkinen, Director, Business Development, Wärtsilä Power Plants, Wärtsilä offers exactly the right set of power plant solutions to meet the key challenge. "To date Wärtsilä has more than 1 GW of power output installed or

on order in power plants that are dedicated to stabilizing the grid in the US."

Filling in the gaps – worldwide

Of course, as more and more power generated from the wind is being employed – not just in Texas, but around the world – new solutions are needed to make sure the power grid remains stable. Wärtsilä's flexible power plants fulfill exactly these criteria.

And while Wärtsilä carefully customizes every solution, they each offer the highest levels of efficiency available in the industry, consistent performance under varying ambient conditions, low lifecycle costs and rapid response to varying grid conditions. Depending on the specific load profile, ambient conditions and what fuel is available (gas, LFO, HFO, crude oil, liquid biofuel) Wärtsilä ensures the most productive and cost-effective solution.

There are currently more than 9700 engines installed in more than 4500 Wärtsilä power plants, producing 44 GW of dependable power around the clock in 166 countries around the world.

Honing the technology

According to a study by VTT Technical Research Centre of Finland, global capacity in wind-driven electricity generation is increasing rapidly. The reasons for this are several: CO_2 emission reduction targets, the need to reduce dependence on fossil fuels and a hedge against increasing fuel prices.

Wind turbine technology continues to evolve. Individual turbines are becoming larger, wind farms are getting bigger and the turbines are becoming more precisely controllable. In addition, better network connections will make the output of wind farms easier to manage effectively.

Power systems are adversely affected by the variability and unpredictability of wind farm output. In general terms, the variability of wind-generated power decreases as the number of turbines increases and wind farms become more widely distributed. Having wind farms over larger areas also reduces the number of hours when output is zero. When wind power is added to a power system, existing short-term reserves are used for balancing the system: reducing any net imbalance between load and generation output. At higher levels of wind power penetration the challenges require modifications to overall power system planning and operation.

Although wind power is primarily installed to decrease the need for future power generation using fossil fuels, it can also be used to replace existing power plant capacity. Flexibility in power systems can be increased by adding facilities that offer flexible generation reserves – and Wärtsilä power plants are well suited to this role.

Through fast-response solutions that smoothly and reliably fill the gaps between electricity demand and production, wind power can be made profitable, even in areas with less than perfect weather conditions or where a constant supply of electricity is crucial. For Wärtsilä, it is clear that new business opportunities are – quite literally – blowing in the wind.

Wärtsilä in brief

Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. By emphasising technological innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. In 2009, Wärtsilä's net sales totalled EUR 5.3 billion with more than 18,000 employees. The company has operations in 160 locations in 70 countries around the world. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.

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Cooling towers at Gundremmingen nuclear power station, Germany. Nuclear energy could help significantly reduce carbon emissions

By Trevor Findlay, The Norman Paterson School of International Affairs, Carleton University

The contributions and challenges of nuclear energy

Some organisations and governments are being persuaded of the benefits of nuclear energy. However, there remain political and technical barriers preventing effective use of this controversial power source

One of the arguments increasingly used to promote nuclear power is the need to tackle climate change. The British government, in laying out the case for 'new build' in the United Kingdom, has used this justification the most explicitly of any government: "Set against the challenges of climate change and security of supply, the evidence in support of new nuclear power stations is compelling." Some 'Greens', notably the founding member of Greenpeace Patrick Moore and British scientist James Lovelock, have been converted to a pro-nuclear stance on the grounds that climate change is so potentially catastrophic that all means to reduce greenhouse gases must be used. Pro-nuclear energy non-governmental organisations (NGOs) have emerged to campaign for increased use of nuclear energy, such as Environmentalists for Nuclear Energy and the US-based Clean and Safe Energy Coalition.

Nuclear power, like hydropower and other renewable energy sources, produces virtually no carbon dioxide directly. *Nuclear Energy Outlook* notes that fossil fuel sources used in uranium mining, construction and transport indirectly produce an "extremely small amount" of carbon dioxide. The generation of nuclear electricity does, however, emit carbon by using electricity from the grid for fuel fabrication, the operation of nuclear power plants themselves and in other aspects of the nuclear fuel cycle, especially enrichment and reprocessing. It is not, therefore, entirely carbon-free.

To date the international climate change regime has not favoured nuclear energy. Under the Kyoto Protocol states may use nuclear power to help meet their greenhouse emission targets, but may not build nuclear power plants in developing countries in order to obtain certified emissions credits under the Clean Development Mechanism. This was due to strong opposition to nuclear energy from influential state parties on the grounds of sustainability, safety, waste disposal and weapons proliferation.

Although the December 2009 Copenhagen climate conference failed to agree on a new regime, one will likely emerge that includes deeper mandated emission cuts, the involvement of a broader range of states in such cuts and, potentially, a global carbon cap-and-trade system (accompanied in some states by a carbon tax). The latter would be favourable to nuclear energy. Nuclear energy may even find greater official encouragement in a new climate change treaty, due to the growing urgency of tackling climate change. Changes in the attitude of some key

> "Set against the challenges of climate change and security of supply, the evidence in support of new nuclear power stations is compelling"

governments about nuclear power, such as Italy, Sweden and the UK, may help propel this.

The Intergovernmental Panel on Climate Change (IPCC) has meanwhile reached the startling conclusion that to stabilise global temperatures at 2°C above pre-industrial levels would require greenhouse emissions to be cut by up to 85 per cent below 2000 levels by 2050. Scenarios devised by international agencies for doing this propose a significant role for nuclear on the grounds that it is one of the few established energy technologies with a low carbon footprint.

A study in the scientific journal *Science* in 2004 demonstrated how current technologies, including nuclear energy, could help reduce carbon emissions by 7 billion

tonnes of carbon per year by 2050 through seven 'wedges' of 1 billion tonnes each. The nuclear wedge, 14.5 per cent of the total, would require adding 700 gigawatts of capacity to current capabilities, essentially doubling it, by building about 14 new plants per year. While this is a reasonable rate, the estimates did not consider that virtually all existing reactors will have to be retired by 2050, even if their operating lives are extended to 60 years. Thus 25 new reactors in total would have to be built each year through 2050 to account for retirements.

The International Energy Agency (IEA), in its 2008 *Energy Technology Perspectives*, suggested that there should be a "substantial shift" to nuclear to permit it to contribute 6 per cent of carbon dioxide savings, considerably lower than the 14.5 per cent wedge, based on the construction of between 24 and 43 1,000 megawatt nuclear power plants each year between now and 2050. The figures differ from the *Science* wedge analysis because the IEA envisages higher carbon levels by 2050 and more severe cuts in carbon. The IEA implied that not all countries would need to choose nuclear, noting that "flexibility exists for individual countries to choose" a mix of carbon capture and storage (CCS), renewables and nuclear technology. The IEA called for nothing less than an energy revolution, arguing that the market cannot stimulate industry to act swiftly "without clear signals or binding policies from governments".

IEA recommendations for achieving greenhouse gas targets by 2050 are relevant as a driver of interest in nuclear energy, but industry must gear up now to sustain the substantial, steady increase envisaged. It would still have to compete with alternative technologies for achieving carbon abatement. The low estimate by the Nuclear Energy Agency (NEA) projects that nuclear will displace only slightly more carbon per year than it does now. This assumes that CCS and renewable technologies are successful, "experience with new nuclear technology is disappointing" and that public opposition to nuclear power continues. The NEA's high scenario projects almost 5 gigatonnes of carbon displacement and assumes a positive experience with "a high degree of public acceptance of nuclear power". A 2003 study by the Massachusetts Institute of Technology (MIT) estimated that a three-fold expansion of nuclear generating capacity by 2050 would avoid about 25 per cent of the increment in carbon emissions otherwise expected in a business-as-usual scenario.

These hedged scenarios reveal that the barriers to nuclear contributing significantly to meeting targets for reducing greenhouse gases are both technological and political. Opinions differ as to how high these barriers are. Members of the 2007 Keystone Nuclear Power Joint Fact-Finding Dialogue, a broad range of stakeholders, reached no consensus on the likely rate of expansion of nuclear power over the next 50 years in filling a substantial portion of its assigned carbon wedge. The MIT study recommended changes in government policy and industrial practices needed in the near term, but in a 2009 review of its earlier report despaired at the lack of progress.

On the political side, there appears to be consensus that a business-as-usual approach to nuclear energy will not increase its contribution to tackling climate change. Nuclear's long lead times (reactors take up to ten years to plan and build) and large up-front costs mean that without a determined effort by governments by 2030 nuclear would have little impact in reducing greenhouse gas emissions. Even replacing the existing nuclear fleet to maintain the current contribution to avoiding greenhouse gases will require a major undertaking. Despite the rhetoric, there is scant evidence that governments are taking climate change seriously enough to effect the energy revolution that the IEA has called for, much less implementing policies that would promote nuclear energy as a growing part of the solution.

Even if carbon taxes or emissions trading schemes help level the economic playing field by penalising electricity producers that emit more carbon, these measures are likely to take years to establish and achieve results. They will also benefit, probably disproportionately, cheaper and more flexible low- or non-carbon emitting technologies such as renewables, solar and wind. And they make conservation and efficiency measures more attractive.

One argument for using nuclear to tackle climate change is that the problem is so potentially catastrophic that every means possible should be used, regardless of cost. However, resources for tackling climate change are not unlimited. Already governments and publics baulk at the estimated costs. Therefore, the question becomes what are the most economical means for reducing a given amount of carbon. One answer is to examine the financial cost of reducing coal-fired carbon emissions through various alternative means of generating electricity.

> "Large-scale expansion of nuclear energy is simply too slow and too inflexible compared to the alternatives"

Runaway global warning may become more apparent and politically salient through a catastrophic event such as a sudden halt to the North Atlantic sea current, or the disappearance of all summer ice from the North Pole. A growing number of climatologists have concluded that the IPCC underestimated both the scale and pace of global warming, notably changes in the Arctic ice sheet and sea levels. Some say the situation is so dire that the business of burning coal should be shut down by 2030, if not much sooner. In such circumstances, massive industrial mobilisation to build nuclear power plants rapidly may be politically and technologically desirable.

But nuclear power would still face numerous barriers in responding to such a catastrophe. Large-scale expansion of nuclear energy is simply too slow and too inflexible compared to the alternatives, if reductions in carbon emissions must be made by as early as 2015. As the *Keystone* report noted, just to build enough nuclear capacity to achieve the carbon reductions of a wedge would require an immediate return to rapid growth as in the 1980s and '90s sustained for 50 years.

There is also the vast amounts of water that nuclear reactors normally need for cooling purposes. If climate change reduces river flow or results in warmer water, new nuclear power plants will have to be located on sea coasts. Plant costs can reportedly change by $1 billion depending on whether a plant is cooled by saltwater or freshwater. Plants already using river water may be forced to close or require costly changes to avoid overheating water that is to be discharged back into increasingly warm rivers. France has already been forced to shut down certain reactors during heat waves for this reason. The Indian Point reactor in upstate New York is currently facing closure unless it undergoes expensive modifications to avoid its discharge killing thousands of fish in the Hudson River every year. ◆

> "Flexibility exists for individual countries to choose a mix of carbon capture and storage, renewables and nuclear technology"

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G8 Research Group

In the rapidly globalizing world of the 21st century, the Group of Eight major market democracies serves as an effective centre of global governance. G8 members – the United States, Japan, Germany, Britain, France, Italy, Canada and Russia, plus the European Union – contain many of the world's critical capabilities and are committed to democratic values. At its annual summit and through a growing web of G8-centred institutions at the ministerial, official and multi-stakeholder levels, the G8 does much to meet global challenges, especially in the fields of development and security.

The G8 Research Group is a global network of scholars, students and professionals in the academic, research, media, business, non-governmental, governmental and intergovernmental communities who follow the work of the G8 and related institutions, such as the G7. The group's mission is to serve as the world's leading independent source of information, analysis and research on the G8. Founded in 1987, it is managed from the Munk School of Global Affairs at Trinity College in the University of Toronto. Its Professional Advisory Council members, Special Advisors and participating researchers span the world. Through the G8 Research Group, Trinity's John W. Graham Library has become the global repository of G7/8 documents, transcripts, audiotapes, media coverage, interviews, studies, essays, memorabilia and artifacts.

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Books on the G8 and Related Issues from Ashgate Publishing

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Global economic and environmental challenges call for new solutions for mobility and the energy supply of the future. Low emissions and high efficiency – these are the greater criteria while developing alternatives for fossil fuels and today's engines and heating systems. Products and applications based on hydrogen and fuel cell technology offer huge potential for the challenges ahead.

Hydrogen can store large quantities of energy – which makes it the medium of choice for storing excess energy generated from renewable sources; energy that up to now needs to be used right away or else is lost due to the lack of suitable storage. Used as fuel, hydrogen's impact on CO_2 emissions reductions is dramatic, since hydrogen powered vehicles emit nothing but water.

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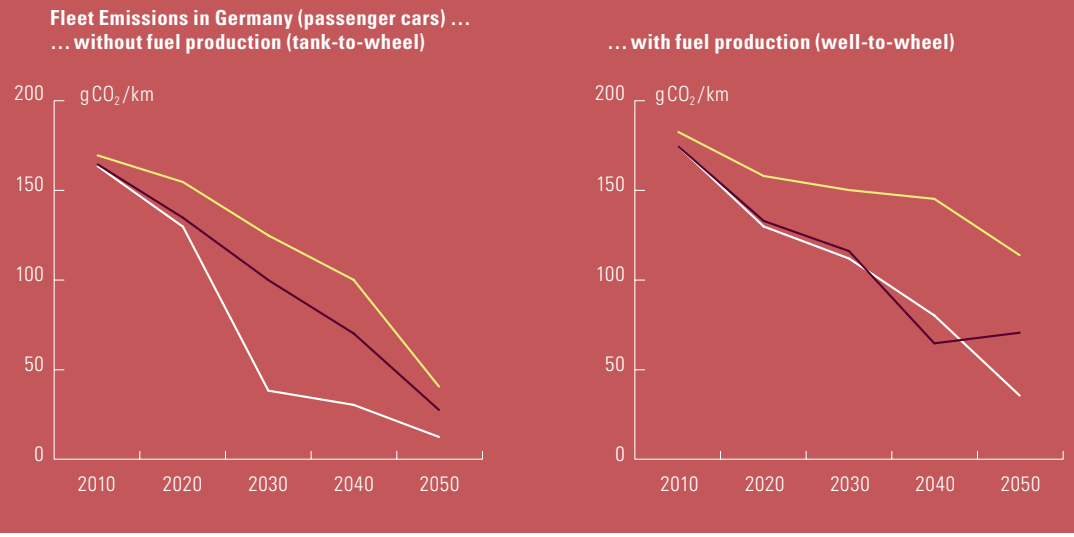
IMPACT OF HYDROGEN ON CO_2 FLEET EMISSIONS – THREE SCENARIOS, FROM 2010 TO 2050



- "Moderate development" (conservative continuation of trend)
- "Shortage of resources" (massive shortages of fossil resources)
- "Climate protection" (ambitious climate protection policy)

Source: GermanHy
http://www.germanhy.de

NOW
Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

Hydrogen and fuel cell technologies complemented by battery electric technology will over the coming years provide a wide range of products and applications that are not only clean and efficient, but will also provide opportunities for new industries, business areas and employment. Therefore, decision-making players from the worlds of politics, industry and science need to form resilient and focused long-term strategic alliances to accelerate market preparation as well as market introduction for these products.

In 2008 the German government, in close cooperation with industry and academia, set up the NOW GmbH National Organization Hydrogen and Fuel Cell Technology as a public-private-partnership. NOW's task is the implementation of the National Innovation Program Hydrogen and Fuel Cell Technology (NIP) and thereby demonstrating in comprehensive field tests with partners from industry and academia that these technologies are able to offer sustainable solutions in terms of efficient and clean products and applications.

Taking the complementary character of fuel cell and battery-electric technologies into account and the consequent need for their integrated introduction to the market, in 2009 NOW has also been put in charge of the implementation of the 'Model Regions Electric Mobility', a program of the German Federal Ministry for Transport. The program aims at establishing Germany as Europe's lead market for electric mobility.

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Energy security concerns: do they matter?

Adequate supplies of affordable energy are essential to any country's wellbeing, but how can a country that imports energy secure supply and delivery?

By Robert E. Ebel
Center for Strategic and International Studies

Energy-exporting and -importing countries today share a common bond. They are worried that volatile energy prices, prospective shortages of one fuel but oversupply of another, and regional political crises, singly or together, may have a negative impact on the political and economic stability of their country. Policies stress diversity among sources of supply or markets to be served, diversity among the kinds of fuels exported and consumed, and diversity among the means of delivery to the market place.

Moreover, all are aware of the close linkage between energy security and national security. They are prepared to do whatever it takes to ensure that both are always well served.

Years ago the eminent American diplomat George Kennan offered the least complicated definition of national security: "the continued ability of this country to pursue its internal life without serious interference." That very same definition could easily apply to energy security today, given the irreplaceable role that adequate supplies of affordable energy play in any country's wellbeing.

These are not new concerns, but it has only been recently that the fragility of the world energy market, as a reflection of the worldwide financial crisis, has been demonstrated. Russia, a major supplier of natural gas to Western Europe, has watched demand for its natural gas decline sharply in that market. Demand declines are then inevitably transferred to reduced production levels in Russia and, equally importantly, to reduced financial contributions to the national budget.

Not only has Russia had to contend with the loss of markets through reduced demand but other sources of supply – liquefied natural gas from other suppliers – saw an opportunity and entered the West European markets, further diminishing the Russian share. Moreover, shale gas and coalbed methane appear to be standing in the wings.

The current situation is a very sharp turnaround from

A Yemeni soldier stands guard at the newly built liquefied natural gas plant in Balhaf on the Gulf of Aden

Workers on a natural gas drilling rig near Towanda, Pennsylvania. While some in the US seek energy independence, many feel that diversity of supply and delivery is key to energy security

the winter of 2008-09 when Russia stopped delivery of natural gas to Ukraine for failure to pay for natural gas already consumed. Russia cut off all gas flows to Ukraine, but Ukraine is also a transit country for gas flows to Europe. That meant European consumers were caught short, in midwinter.

The message was very clear. Pipelines circumventing Ukraine, plus increased energy efficiency and biofuels, could offer the energy security these European importers needed.

The United States has long been an importer of crude oil and natural gas. Candidates for political office have recognised the tremendous outflow of US dollars into the pockets of the exporters. They have sounded the call for energy independence, playing to the interests of the general public. They say they must do away with their dependence on unreliable and politically confrontational suppliers who do not stand with them on the issues of the day. Once in office, however, the call is muffled as energy independence becomes a distant goal. But, if not energy independence, what?

The public seeks energy security, whether they understand that or not. And they look to diversity among suppliers and diversity as to how the imports of crude oil and natural gas are delivered to US shores. But how to achieve that diversity is the responsibility of the government and corporations, not the general public. The average consumer likely cares not where the gasoline pumped into his or her automobile comes from. That consumer is interested only in the price that has to be paid and whether there is a limit as how much can be bought.

Another contributor, beyond diversity, to energy security should be recognised. That is technology. Technological advances normally develop over time. That is particularly true for the oil and gas industries. To illustrate, the development and application of technology to allow the drilling and fracturing of shale beds to produce shale gas took years to come to today's status. The success achieved so far has allowed the media to use the term 'game changer', as shale gas contributed 26 per cent of total US gas production during 2009.

> "Candidates for political office have sounded the call for energy independence, playing to the interests of the general public"

What does the future hold? No more imports of natural gas, millions of automobiles fuelled by natural gas and replacement of coal with shale gas in the generation of electricity readily come to mind.

Energy independence? Not yet, but a step in the right direction, some say. The success of shale gas has caught on worldwide and has stimulated other countries to revisit their prospects for shale, as well as opportunities in coalbed methane and tight gas formations. Yet sceptics quickly point out the lost promise that nuclear electric power stations were once believed to hold.

Before the full promise of shale gas can be put to work, long-term environmental issues and concerns regarding public health will have to be resolved. Above all, the potential impact of hydraulic fracturing on underground water formations through the release of chemicals used in the fracturing process must be considered.

Another energy-importing country, of rapidly growing international significance, is China. China no longer is a stranger to the world community. What China does in terms of economic growth, and particularly in the demand for crude oil and natural gas to fuel that growth, carries worldwide implications.

Unfortunately, China is comparatively poor in domestic reserves of crude oil and natural gas. Because of that, it must look to imports to cover the growing gap between domestic production and demand. That growing dependence – 52 per cent dependence on foreign oil in 2009 – means that China must do as any importing country must: seek security through diversity. It works to secure that diversity through its 'go out' policy: that is, Chinese oil companies prowl the world seeking to acquire equity oil they believe to be secure.

That program has been successful, as fully one-quarter of Kazakhstan's oil production is now in Chinese hands.

Today, China is a key driver in world oil demand growth, with Chinese imports rising by an average of 510,000 barrels per day in 2009. But can China continue its past high growth rates? And when the slowdown does come, can the required accommodations successfully be made? ◆

Energy policy: paradigm shift needed

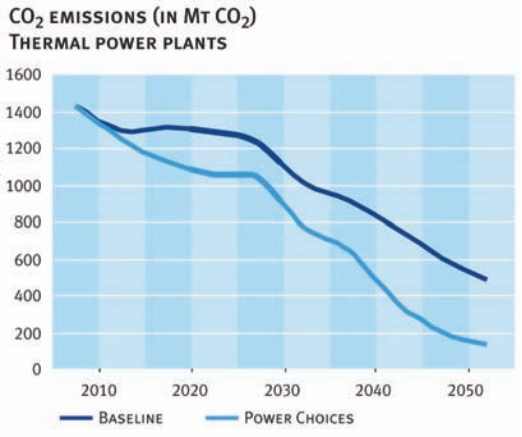
EURELECTRIC Power Choices study shows the path to a low-carbon Europe

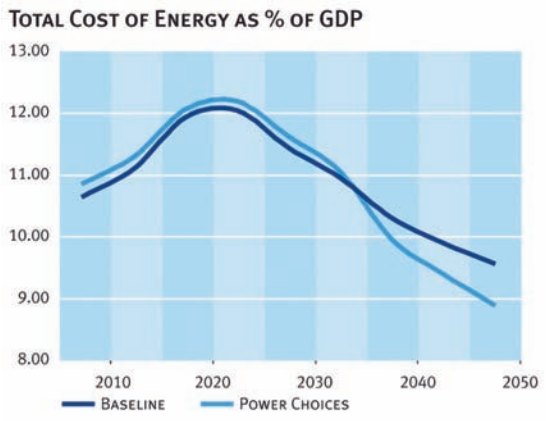
It is feasible to attain carbon-neutral electricity in Europe by 2050 through the market system, with a CO_2 cap-and-trade system driving technology deployment. However, if Europe is to move to a low-carbon economy at reasonable cost, it will require a paradigm shift in energy demand, away from direct use of fossil fuels to energy-efficient electric systems in key areas such as household heating & cooling and road transport.

Climate change has emerged as the most serious environmental challenge of our time. The way the world produces and uses energy will be a crucial factor in the drive to keep global warming to 2ºC above pre-industrial levels by drastically reducing emissions of greenhouse gases (GHGs).

The electricity industry recognises its responsibilities as a major emitter of GHGs and continues to play a pro-active role towards achieving an energy-efficient, carbon-neutral economy. In March, Chief Executives of power companies representing over 70% of EU electricity production signed a declaration committing to a carbon-neutral power sector by mid-century. The EURELECTRIC study Power Choices: Pathways to Carbon-Neutral European Electricity by 2050 demonstrates how this vision can be made reality.

The study shows that with the right policies and technologies – both on the supply and demand side – Europe can cut its own CO_2 emissions by 75%, spearheaded by a power sector which reduces its emissions by 90% from 2005 levels by 2050. This will also lead to an overall reduction in both primary and end-use of energy; energy import dependency; and overall energy cost in the economy.





Key recommendations to policymakers are:

- Support the carbon market and ensure all sectors internalise the cost of their GHG emissions
- Actively promote an international agreement on climate change
- Ensure that all low-carbon power technologies remain available for deployment
- Encourage public approval for building modern energy infrastructure
- Lead a widespread drive for energy efficiency, adopting standards and incentives to help consumers choose energy-efficient technologies in the home and in transport
- Promote the roll-out of electric road vehicles and the necessary infrastructure

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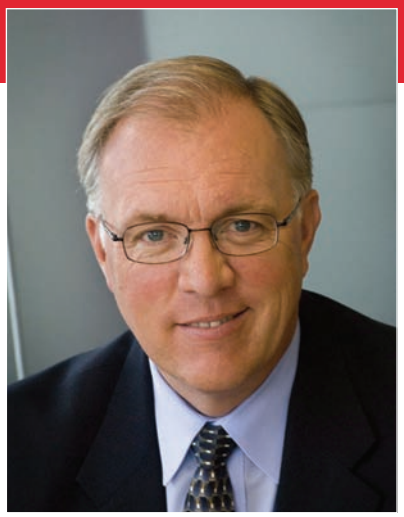
Industry welcomes constructive dialogue and collaborative solutions on oil sands development



By Dave Collyer, President, Canadian Association of Petroleum Producers

Much has been said and written recently about the oil sands, both across Canada and around the world. For some, oil sands are the economic savior of a recession-weary country. For others oil sands development symbolizes a world that has grown too dependent on fossil fuels. In reality, the oil sands are neither. The truth, as they say, rests somewhere in-between.

Canada's oil sands sector, the individual companies involved in oil sands development, and the Canadian Association of Petroleum Producers (CAPP) as the leading industry association, have spoken at length about the need to demonstrate our environmental and social performance and to communicate more effectively about our very important role in the economy, in creating jobs across Canada and in meeting the world's energy needs.

We fully understand that our reputation is determined by our performance and how we communicate, and that both must be delivered consistently and authentically over time. Where necessary, we will counter our detractors with objective, verifiable facts. At the same time, we recognize the need for more two-way dialogue – to share perspectives and to work toward solutions. On both sides of the dialogue there is an opportunity for less talking and more listening.

A constructive dialogue and collaboration on solutions is what is required, and what we believe most Canadians and international stakeholders expect. Experience shows that collaboration, not confrontation and rhetoric, is the most direct path to solutions. It's essential, however, that these conversations be based in reality rather than exaggerations and misrepresentations. Some of our critics make a point of telling only part of the story: descriptions of water use ignore the fact that current mining production only uses less than one per cent of the Athabasca River's mean annual flow, an amount far less than rivers in industrial areas elsewhere in the world. Characterizations of oil sands extraction as the most carbon-intensive oil production process on earth ignore that CO_2 emissions from Canada's oil sands account for just 1/1000th of total global energy emissions and that emissions from many other crude oil products sources are comparable to those from oil sands crude on a full life cycle basis.

As an industry, we understand that people are genuinely concerned about the environment and the social impact of a growing oil sands sector. Just as our critics should acknowledge the oil sands' vital role economically and in providing a secure and reliable energy supply, industry must respond to the public's concerns about the environmental and social impact of oil sands development.

For many in the oil and gas industry, this is not a new insight. Canada's oil and gas sector has been measuring and reporting on their stewardship efforts for many years. The examples of outstanding project results and the reporting of overall industry performance have contributed to ongoing improvement in industry performance. For example, greenhouse gas emissions per barrel of production from oil sands crude have dropped by more than one-third since 1990, and we continue every day to apply technology to improve oil sands emissions relative to those from conventional lighter crude oils.

However, we also understand the need for change. Perhaps now more than ever, we have a responsibility to demonstrate our performance, to communicate our actions, and to improve our reputation. Our new program, Responsible Canadian Energy™ establishes for CAPP members a forward-looking framework for continuous performance improvement, as well as enhanced reporting of our performance as an industry. This in turn provides a platform for sharing of ideas and stimulating dialogue within our industry and with our stakeholders, both within Canada and around the world.

Canada's oil and gas industry is proud of its achievements to date, but we also realize good is not always good enough. In a world that is always moving and changing, we can't stand still. We have to do better, and we will. We aim to learn from the lessons of our past, listen to key stakeholders and leverage new technologies to improve how we do business today and tomorrow.

It's everyone's responsibility to strive for solutions that advance our core objectives together, energy security, environmental performance and economic growth. And for us, that must be based in healthy, respectful conversations about performance as well as continuing development of solutions that enable us to deliver energy in a responsible way, everyday.

The Arctic energy treasury house

Climate change has revealed valuable resources in the Arctic that are now accessible to southern people. However, who owns these lands and their bounty?

By Rob Huebert, associate director, Centre for Military and Strategic Studies, University of Calgary

The Arctic is undergoing a fundamental transformation. Climate change is creating both the reality and the perception that the Arctic is opening up to the entire international community. The potential of a new treasury of resources in the region has captured the world's imagination and interest. Historically, extreme climate conditions limited the exploitation of Arctic resources to only the region's indigenous population. These hardy people not only survived but also flourished in the face of the extreme cold and ice conditions. Southerners who dared enter the region either dedicated all of their resources to simply surviving or they perished. Now, warming temperatures, melting ice and vast improvements in technology have made it possible for southerners to survive in the Arctic, and even to begin exploiting the region's resources.

The expectations for the region are huge. In 2008, the US Geological Survey estimated that the Arctic potentially holds up to 30 per cent of the world's undiscovered gas reserves and 13 per cent of the world's undiscovered oil reserves. On the basis of three new northern mines, Canada has moved from producing no diamonds to becoming the world's third-largest producer. Possibly the world's largest deposit of iron ore is now being prepared for development in Nunavut. These are only a few of the many cases of actual and potential resources.

But before the full potential of the North can be unlocked, numerous international challenges must be met. Who owns and who can exploit these new resources? The extreme environmental sensitivity of the region necessitates careful consideration of the environmental standards and rules that must be developed. Of particular concern is the issue of ownership of resources in the Arctic Ocean and who gets to develop and enforce the new rules.

The changing physical landscape of the Arctic has been accompanied by a changing set of international laws governing the control of all ocean space through the United Nations Convention on the Law of the Sea (UNCLOS). It provides the international rules on the use of ocean resources. However, several significant challenges arise when applying its articles to the Arctic.

First, the United States, one of the most important and powerful Arctic states, has neither signed or ratified the convention. For reasons that are confusing to the rest of the world, the United States is the only Arctic state that is not a party to the Convention. This influences how the remaining coastal Arctic states can make their claims over new zones of control. The convention allows states to claim control over the soil and subsoil of much of the Arctic Ocean. But to do so, the claimant state must determine if the region is part of its extended continental shelf. This requires difficult and challenging scientific efforts to map the seabed. The Arctic claimant states (also known as the

> The Arctic potentially holds up to 30 per cent of the world's undiscovered gas reserves and 13 per cent of the world's undiscovered oil reserves

Arctic Five) – Russia, Canada, Denmark (for Greenland), Norway and the United States (despite not being a party to UNCLOS) – have been engaged in this work for the past few years. Under the terms of UNCLOS they have a deadline by which they must complete this work. They must then submit their claims to a UN body that will determine if their scientific findings support their claim. Then they must resolve any differences among the various claims. One problem that arises is how a state that is not a party to the convention can submit its claims to this body.

To address this problem, the Arctic Five met in 2008 in Ilulissat, Greenland. They agreed that all of them, including the US, would follow the terms of the convention and, more importantly, would resolve any differences on a peaceful basis. Evidence of this process's success is the announcement on 26 April 2010 by the Russian and Norwegian governments that they had resolved a 40-year dispute over their respective maritime Arctic boundaries.

Nevertheless, the meeting of the Arctic Five and a subsequent meeting in Canada in 2010 have been met with criticism. Some other Arctic states and indigenous populations believed that these meetings were exclusionary. Those that were not invited to these meetings hold the position that even if they do not have an Arctic continental shelf, they will be affected by the economic development in the region. Thus the question has emerged of what is the best forum for developing international cooperation for the future exploitation of the region's resources that is inclusive rather than exclusive.

An aerial view of the Diavik diamond mine, south of the Arctic Circle in Canada's Northwest Territories. Once a hotbed of gold mining, Canada's far north is now unearthing riches from a different precious commodity – diamonds

The most suitable forum is the Arctic Council. Created in 1996 as a Canadian initiative, it was originally intended to create an international body in which all circumpolar issues could be raised and discussed. It was hoped that this would lead to cooperative action to resolve disputes and problems. Unfortunately some of the Arctic states were reluctant to give this new body a comprehensive mandate and capability. It was specifically forbidden to consider issues relating to security and has also tended to avoid politically sensitive issues. Nevertheless, it has proven to be very effective with respect to international environmental issues. Some of its most significant successes have been in the production of several groundbreaking reports on environmental issues facing the Arctic. These include the Arctic Climate Impact Assessment and the Arctic Shipping and Marine Assessment. These have been instrumental in creating a shared understanding of the environmental issues and challenges among the Arctic states and alerting the world to the problems the Arctic now faces. It has been an international pioneer in indigenous relations by including the region's indigenous population in most of its actions. And the Arctic Council is the only multilateral body that includes all of the Arctic states, the organisations representing the northern indigenous peoples and a growing number of non-Arctic states that are becoming interested in the region.

But the Arctic Council still has it weaknesses. It has not been particularly successful in developing cooperative measures to address the problems it has uncovered. It has constantly faced the problems created by very limited budgets. And, as illustrated by the holding of the Arctic Five meetings, it is not always seen as the body of first choice to resolve specific problems.

> "The Arctic Council was originally intended to create an international body in which all circumpolar issues could be discussed"

It is clear that it is time to strengthen the Arctic Council. It needs to have both the mandate and the powers that its original proponents had hoped it would be given. Its success in providing an understanding of the impact of climate change on the region, the future of maritime shipping and other such initiatives demonstrates what it can do. Now the council must be entrusted with all circumpolar issues. This requires expanded and improved support for the council. Most importantly, the Arctic states have to regard it as the principal body for addressing the developing circumpolar issues and problems.

As the ice melts, technology advances and the vast untapped resources of the Arctic are developed, there will be many problems and challenges. These can best be met by a shared commitment to cooperation and partnership. The Arctic Council has already demonstrated its success in regards to environmental issues. Now it is necessary to go to the next level. ◆

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