Deployment of Climate Change Mitigating Technologies in the Electricity Sector

The e_8 perspectives and recommendations

Climate change is one of the greatest economic, social, and environmental challenges of our time. Expert scientific evidence has confirmed that human activity is altering the global climate, revealing the gravity of the challenge and the urgency to act. The extent to which this global challenge is effectively addressed will depend on several key factors including the level of international cooperation, the rate of development and implementation of new technologies, future cost reductions, financing and technology transfer, in addition to other regional, country-specific and sectoral factors.

At the industry level, the electricity sector is deploying significant efforts to identify, develop and deploy technological solutions with the objective to contribute to achieving substantial reductions of global greenhouse gas emissions while ensuring security of supply and economic sustainability.

What is the e_8

The e_8 is a non-profit international organisation, composed of 10 leading electricity companies from the G8 countries, whose mission is to play an active role in global electricity issues within the international framework and to promote sustainable energy development through electricity sector projects and human capacity building activities in developing and emerging nations worldwide.

The e_8 members

American Electric Power
(United States)

Duke Energy
(United States)

Électricité de France
(France)

ENEL S.p.A
(Italy)

Hydro-Québec
(Canada)

JSC "RusHydro"
(Russia)

Kansai Electric Power Company, Inc.
(Japan)

Ontario Power Generation
(Canada)

RWE AG
(Germany)

Tokyo Electric POwer Company, Inc.
(Japan)

1. CLIMATE CHANGE MITIGATION TECHNOLOGY SCENARIO

1.1 The specificity of the electricity sector

On the front line of the global fight against climate change, the electricity sector enables economic development and growth through the provision of an essential service which can no longer be produced and consumed in the same way that it used to be.

With projections suggesting that sector emissions might double by 2030, the question of how to meet the increased demand for electricity at an affordable price while effectively reducing emissions becomes a crucial challenge. Technological potential and possible measures have been identified by the electricity utility industry to meet this challenge and effectively contribute to a low carbon society.

The challenge facing the electricity sector is tremendous but not out of reach. In fact, it holds significant opportunities given some distinct, electricity sector-specific characteristics:

- Electricity is an extremely flexible energy carrier: the spectrum of available generation technologies goes from CO_2–free technologies, like renewables and nuclear, to medium-CO_2 emitting technologies, such as Combined Cycle Gas Turbine (CCGT) and ultra supercritical coal plants (24 ultra-supercritical units are already operating worldwide in countries such as Denmark, Germany, Japan, the Netherlands, and USA).
- The range of available options becomes even wider if the demand side is taken into consideration: from housing-insulation to energy-efficient processes and appliances.
- At the end-use level, decarbonizing the electricity mix can lead to the substitution of fossil fuels by electricity and result in faster and greater penetration of low-carbon emitting technologies and equipment, such as electric vehicles, plug-in hybrids, heat pumps, etc., in other industry sectors.
- Nevertheless the above-mentioned technologies are not all at the same level of maturity:
  - Zero-emission or more efficient technologies exist today and are competitive. Thanks to past R&D investment, business has brought to the market such technologies, on the supply side: hydro, wind in best locations, nuclear, CCGT, super-critical coal-fired power plants, and on the demand side: building insulation, smart metering, efficient lighting, heat pumps, etc. These technologies are ready for market deployment over the next 20 years.
  - Some technologies such as carbon capture and storage (CCS), Gen. IV nuclear and photovoltaic still need additional R&D efforts to become competitive, and others such as Integrated Gasification Combined Cycle (IGCC) technology still require multiple utility-scale demonstrations prior to commercialisation. All these technologies should be available for market deployment in the coming decades.
- The sector is presented with an extraordinary window of opportunity given the current and projected investment needs either for replacement of existing aging plants (especially in developed countries) or for additional infrastructure development required to meet the growing demand for electricity (especially in developing countries). According to the International Energy Agency (IEA), figures are projected at a value of 11 trillion USD of required investment by 2030. This represents a required four-fold increase from the level of investment recorded in the second half of the 20th century. This provides a tremendous opportunity to invest in low-carbon technologies in power generation, delivery and use. More than half of these investments is needed for the improvement of transmission and distribution, which is key to enabling the successful integration of many clean technologies and maximising the impact of energy efficiency measures.

- There is an urgent need for action to drive investment toward existing zero or lower carbon technologies in order to avoid lock-in effects due to long-life investment (two to five decades for power plants), as reinforced by the Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report.

1.2 The e_8 position as a voice of the international electricity sector

The e_8 supports the recommendation set forth in the 2008 G8 Hokkaido Toyako Summit Leaders Declaration regarding the need for commitment to the meaningful mitigation actions by all major economies while reflecting the diversity of approaches, advanced technologies on a time scale that accommodates capital mobilization, technology R&D and sectoral approaches, presented as a useful means–among others–to reduce GHG emissions:

“Making progress towards the shared vision, and a long-term global goal will require mid-term goals and national plans to achieve them. These plans may reflect a diversity of mitigation and adaptation approaches… in order to ensure an effective and ambitious global post-2012 climate regime, all major economies will need to commit to meaningful mitigation actions…”

“Sectoral approaches can be useful tools to improve energy efficiency and reduce GHG emissions through dissemination of existing and new technologies in a manner compatible with economic growth.”

This document proposes an approach specific to the Electricity Sector (see item 2.3) which takes its special features into account in the difficult task of effectively reducing global CO_2 emissions.

2. TECHNOLOGY DEPLOYMENT POLICIES

If the technologies exist, the issue remains that they are not implemented quickly and widely enough. As a result, CO_2 emissions from the electricity sector have increased by almost 50% in the last 10 years (source: WEO 2006-80). Reconciling growth and climate change mitigation will need an unprecedented level of political commitment and solutions and will rely on a bundle of tools given that there is no “miracle” policy solution to address this complex issue. Solutions will require the use of an appropriate combination of mechanisms and instruments, including price instruments, which establish a value for carbon emissions or reductions, portfolio requirements, appropriate siting procedures and voluntary programs under “pledge & review”.

To ensure wide and effective technology implementation, we need:

- Government commitment to develop consistent and effective policy packages to deploy best available technologies, on both the supply and demand side (2.1).
- Enhanced international cooperation to promote technology diffusion in order to encourage developing countries to mitigate emissions without jeopardizing growth (2.2).
- A streamlined and enlarged Clean Development Mechanism (CDM), which includes such mitigating technologies as nuclear, large hydro and clean coal (2.2.2).
- An electricity sector approach that could help coordinate national energy policies towards worldwide emissions reduction. (2.3)

2.1 Deployment policies and technology maturity timeframes

2.1.1 Deploying mature technologies

At the generation level: we will need, at the same time, prices which include a value for CO_2 as well as licensing and siting procedures which allow to build infrastructure without excessive delays.

Nuclear energy is regarded as one of the key mature technologies to mitigate CO_2 emissions. With large-scale hydro, conventional nuclear power plants provide competitive, cost-efficient performance, which can further be enhanced through government support.

At the end-use level (i.e. energy efficiency): we will need, at the same time, standards, tax incentives and electricity prices which allow to avoid the "rebound effect[1]".

Heat pumps provide an example of the necessity to combine different tools. Efficient deployment of such a technology, as is the case in Japan, requires:

- Energy prices which provide incentives for energy efficiency, or tax credit for the consumer;
- CO_2 standards in the building sector, information campaigns to increase public awareness, structured and enhanced skills within the sector in charge of the installation of these equipments.

The effectiveness of policies will critically depend on:

- The quality of their design, as demonstrated by the current debates, in many countries, regarding the European Union Emission Trading Scheme (ETS), particularly on such issues as allowance allocation methods.
- The need to prioritise objectives and measures, as highlighted by European debates on the appropriate balance between CO_2 emissions reduction, energy efficiency and renewables objectives.
- The necessity to avoid exclusion of technologies [for instance nuclear where possible; hydropower through International Hydropower Association guidance (IHA)].
- Electricity prices which appropriately reflect investment costs and a carbon value.
- The willingness of end-users to pay for efficient, low-carbon products and services: mechanisms to foster wise end-users' choices should be pursued.

2.1.2 Bringing new technologies to the market

For mature technologies at the brink of competitiveness[2] (wind for example), there is a need for enabling regulations to allow their effective market deployment; for instance, subsidy schemes (feed-in tariffs, renewable portfolio standards,…) and procedures, and at the end-use level, measures including tax credits, standards and appropriate electricity prices.

In some countries, where this type of technologies may already exist or are progressively introduced, there is also a prior need for the establishment of appropriate institutional, regulatory frameworks and adapted energy policies that balance the need to accelerate the descent of the learning curve with cost control for customers.

For future technologies (CCS, photovoltaic, Gen. IV nuclear etc.): businesses' efforts in technology innovation and development need to be supported by enabling government policies and frameworks, such as:

1. *A rebound effect* refers to increased consumption that results from actions that increase efficiency and reduce consumer costs (Musters, 1995; Alexander, 1997; Herring, 1998).

2. Even as the level of competitiveness may vary from country to country.

- **Technology development strategies** that support fundamental research and innovation as well as emerging and near-commercial technology fields, in order to ensure a pipeline of new technologies;
- **Research programs** targeted at local barrier identification and the recognition and support of opportunities;
- In addition, policies can include **positive incentives for R&D,** with direct public funding focusing on technologies for which commercialisation prospects are too uncertain -or remote- from a business perspective.

2.2 Technology diffusion enhancement

Technology transfer (or diffusion) has been a key issue on the agenda of the UN Climate Change Conference in Bali and will be an essential part of any future international agreement on climate change. It is clear that the participation of developing countries in the shaping of global climate change policy, namely through the reduction of their emissions in relation to their "baseline", cannot be delayed. The issue of development is key, knowing that emerging countries such as China, India and Brazil and developing countries at large will account for more than two-thirds of the increase in global levels of CO_2 emissions by 2030.

Specific tools promoting development assistance and technology transfer have to be implemented, especially with the help of international investment and development banks. Human capacity building, access to energy and adaptation to climate change are key for developing countries.

2.2.1 Tailoring policies to the technology status in the host country

For technologies that are mature and competitive in developed countries, emerging economies, and developing countries (hydro, for instance), efforts need to be focused on sharing knowledge (on project management, operations feedback, regulatory frameworks, etc.) and best practices.

For technologies that are mature in developed countries but not yet to the same extent in emerging economies and developing ones (nuclear, for instance), the objective is to achieve significant cost reductions to reach competitiveness in the host country. For that, policies should be aimed at securing and encouraging foreign direct investment (FDI), joint-ventures and investments in CDM (Clean Development Mechanism) projects – which provide investors with emissions credits under the Kyoto Protocol- in partnership with local players.

For future technologies (clean coal with CCS, for instance), there is a need for collaborative research to enable ex-ante definition of intellectual property rights and ensure that developing countries will be able to have access to these technologies when they become available.

2.2.2 Facilitating technology trade

In order to facilitate technology transfer, it is of utmost importance to:

- Identify and remove non-technological barriers: barriers may take the form of legal requirements that prevent or limit foreign investment in developing countries or taxes on imports that impede transfer between rapidly industrializing countries and least developed ones.
- Promote changes in regulations in the host country (especially in emerging countries) in order to evolve toward more efficient electricity pricing.
- Promote South-South business by recognizing that emerging countries may be a source -as well as a recipient- of new technology for developing and least developed countries.

- Streamline and enlarge the CDM: in view of the end of the first commitment period under the Kyoto Protocol in 2012, the CDM should be improved, so that: 1) small project registration process streamlining, which is underway, is brought rapidly to a successful conclusion; 2) all technologies which can result in real and measurable emissions reductions are accommodated within the post-2012 agreement, specifically including large hydro, nuclear power and clean coal technologies such as carbon capture and storage; 3) enabling rules for the realization of programmatic CDM are fast-tracked to rapidly facilitate learning by doing, and to allow large-scale deployment of best available technologies while improving related standards, removing barriers for replication and diffusing good practices.

2.3 Toward a definition of an electricity sector sectoral approach

The electricity sector is much more fragmented than other sectors, has a wider spectrum of technologies and national energy policies are closely integrated into its decision-making processes. Consequently, an electricity sector sectoral approach should reflect these peculiarities and imply:

- **The development of a common understanding of the electricity sector's challenges and perspectives,** shared by all relevant stakeholders worldwide, including operators, public authorities, customers, national and international agencies, etc. Such vision should extend over the whole spectrum of technologies as well as their respective costs and maturity timeframes. This could be achieved for instance through capacity-building, exchange on best practices, etc.
- **At the national and regional levels, the establishment of public policies based on this common vision.** These policies should aim at enabling national authorities to improve each country's carbon intensity, through more efficient use of fossil fuels and, in the long-run, at decarbonising the electricity mix by identifying best available mitigating technologies on the supply side (nuclear, large hydro and other renewables, clean coal, more efficient thermal plants, T&D reinforcement, etc.) and on the demand side, and by similarly identifying the most efficient tools to deploy them. It is also important to note that the electricity sector plays an essential cross-sectoral role in realizing low-carbon economies through greater energy efficiency and substitution of conventional use of fossil fuels at the end-use level (e.g. electrification in production processes, modal shift to rail transport and electric vehicles/plug-in hybrids and heat pumps in buildings).
- **At the international level, the need for scaled-up technology transfer and enhanced technology cooperation,** for both mitigation and adaptation technologies. Scaling up technology transfer would require 1) adapted regulations (facilitated joint-ventures, favourable cross-border fiscal policies), 2) a sound investment environment and 3) efficient mechanisms, such as an enhanced CDM, which include key mitigating technologies like nuclear, large hydro, clean coal and energy efficiency programmes. Cooperative opportunities, including capacity-building, transfer of technological expertise and technical support initiatives, should be enhanced through appropriate incentives. Collaborative R&D for promising technologies such as CCS, Gen. IV nuclear and photovoltaic will also be required. Finally, any common international decision should be tailored to individual country needs, capacity, and should comply with countries' respective Sustainable Development Policies and Measures (SDPAMs). If properly implemented, these elements would facilitate the dissemination of best practices as well as favour an increasingly precise understanding of each country's actual mitigation potential.
- **An international sectoral approach cannot and should not be a substitute** to national energy policy nor for intergovernmental agreements. An electricity sector sectoral approach depends on the implementation of these agreements and policies and must work within their framework.

Annex 1 – Technology situations

Technology situations	Level of maturity and competitiveness	Main policy response	Technology example
1	Mature and competitive	Enabling deployment regulations	Housing insulation, Compact Fluorescent Light Bulbs (CFL), Large hydro, CCGT, 2nd&3rd Gen Nuclear
2	Mature and competitive if carbon is valued	Carbon valuation tools (Cap & Trade or Carbon tax systems, Mandatory performance standard systems)	Ultra-super-critical (USC) Pulverized Coal (PC) power generation Wind power in best locations Heat pumps
3	Close to maturity and near a competitive stage	Mass-deployment schemes (Feed-in tariffs, Tradable green certificates, etc.)	Wind power in average quality locations
4	Promising but far from being mature and competitive	Direct support of Research, Development and Demonstration (RD&D), and Public-private partnerships	IGCC CCS 4th Generation nuclear

Technology situation - 1

Some end-use or carbon-free generation technologies such as housing insulation, hydro or nuclear power generation (in certain countries) are mature and competitive. They simply, but urgently, require regulation that builds public acceptance and fosters successful implementation. Some may also require incremental financing to bridge the affordability gap. Such regulations should be technology and country-specific, and, could for instance:

- Provide for the assessment of hydro projects according to the IHA Sustainability Assessment Protocol;
- Ensure that clear and transparent licensing and safety procedures are in force for nuclear power.

Technology situation - 2

Some technologies, like ultra-super critical PC coal-fired generation[3], wind power -in optimal locations- and normal temperature heat pump-based heating-cooling, are mature and would be competitive if electricity prices included a carbon value through market mechanisms like cap & trade systems or carbon taxes.

3. Ultra-super-critical (USC) pulverized coal (PC) generation technology is in this category because demonstration large-scale plants exist, although the technology still needs further R&D (on materials for instance).

Technology situation - 3

Some technologies like wind power and heat pumps for heating-cooling are mature or quasi-mature, the main issue being to deploy them at large scale so as to quickly descend learning curves and obtain wide-scale deployment. They will need mass-deployment support through feed-in tariffs or financial incentives[4].

In addition, defining development zones for wind power will be important to minimize "NIMBYism[5]" and ensure that mass-deployment schemes result in the required investment in the most geographically suitable locations.

Technology situation - 4

Lastly, other technologies, like IGCC, CCS or Gen. IV nuclear, are promising but not yet mature. The key objective in such a technology situation is to accelerate research and development (R&D) and boost large-scale demonstrations (D) necessary to prove their commercial viability and make them eventually competitive in the market. This will require direct RD&D, public support and the successful organization and coordination of public-private partnerships with international participation.

4. Photovoltaic (PV) energy features a limit case for current technology generations: the cost of a PV-based MWh is today 10 to 15 times the market price. Considering the technology is mature enough to be pulled to the market through mass-deployment schemes (as several countries do) is questionable. More support of R&D might be appropriate.

5. "Not in My Back Yard" behaviour.

For more information:

e_8 General Secretariat

505 de Maisonneuve blvd W., Lobby
Montreal QC H3A 3C2
CANADA

T : +1-514-392-8876
F : +1-514-392-8900

December 2008