DEDICATED TO MAKING A DIFFERENCE

Powering a Sustainable Future

Policies and measures to make it happen

An interim report

World Business Council for
Sustainable Development

About the WBCSD

The World Business Council for Sustainable Development (WBCSD) brings together some 200 international companies in a shared commitment to sustainable development through economic growth, ecological balance and social progress. Our members are drawn from more than 30 countries and 20 major industrial sectors. We also benefit from a global network of about 60 national and regional business councils and partner organizations.

Our mission is to provide business leadership as a catalyst for change toward sustainable development, and to support the business license to operate, innovate and grow in a world increasingly shaped by sustainable development issues.

Our objectives include:

Business Leadership – to be a leading business advocate on sustainable development;

Policy Development – to help develop policies that create framework conditions for the business contribution to sustainable development;

The Business Case – to develop and promote the business case for sustainable development;

Best Practice – to demonstrate the business contribution to sustainable development and share best practices among members;

Global Outreach – to contribute to a sustainable future for developing nations and nations in transition.

www.wbcsd.org

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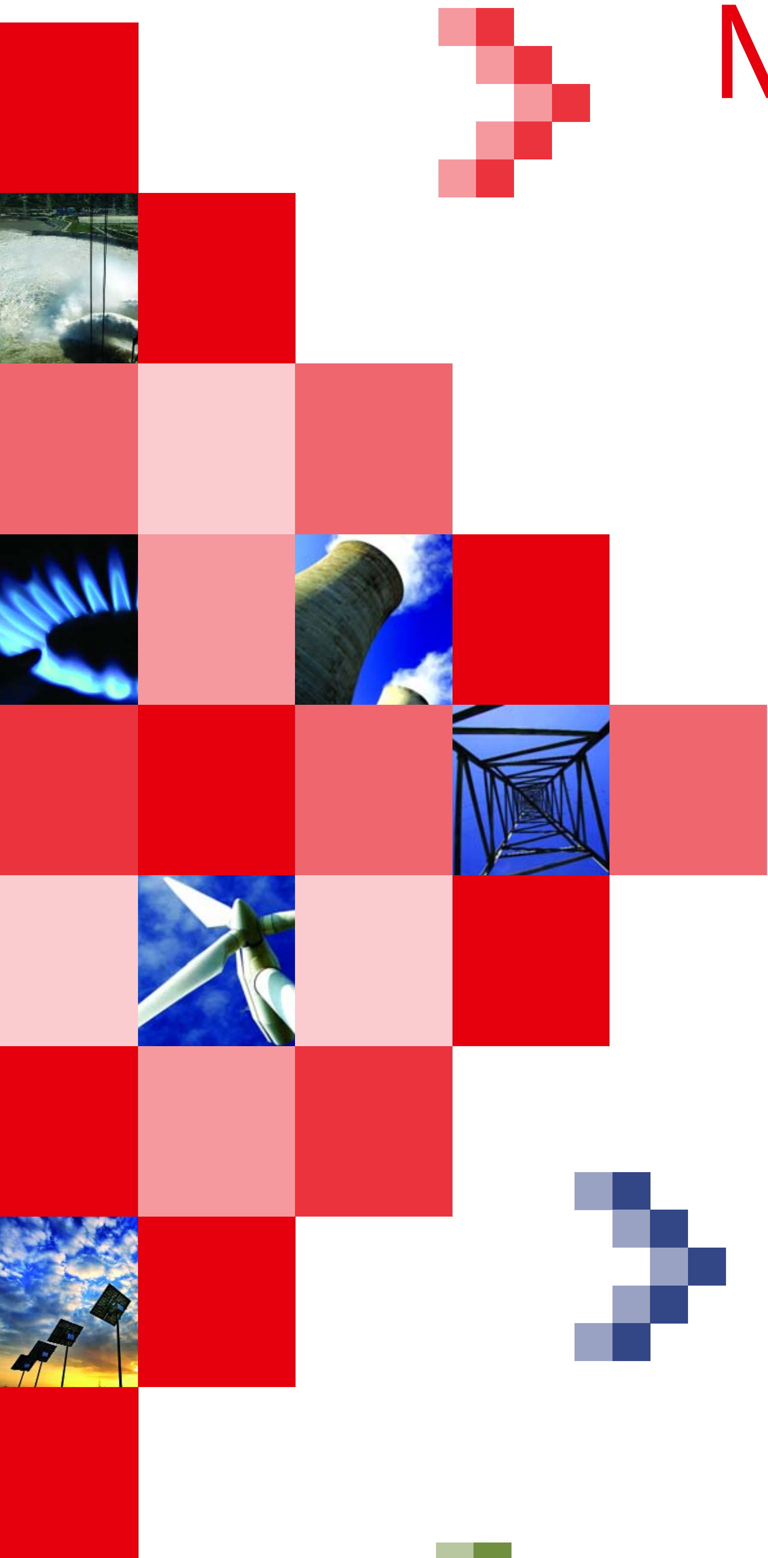
See the inside back cover for our comprehensive booklet on power generation technologies and demand-side management measures.

Message from



We come together as a group of ten global companies within the WBCSD Electricity Utilities Sector Project, working to promote the achievement of a sustainable electricity future. Together, we collectively represent over 405,000 MW of installed generating capacity and touch over 306 million customers every day.

The power sector is currently responsible for 41% of global energy-related CO_2 emissions and projections suggest that electricity demand will double by 2030. It is crucial to meet increased demand for electricity at an affordable price and ensure adequate return while contributing effectively to climate change mitigation. Electricity consumption must therefore be more efficient and supply less carbon intensive. We recognize that this is an enormous and urgent challenge but one that is not out of reach. We are prepared to take action and here, we call on governments to do the same.

Building on our past work, this publication focuses on how we can harness the full potential of low carbon options for both power generation and consumption. We have identified technologies that are mature for commercial implementation, as well as future solutions which currently face technological or commercial barriers to deployment. To both enhance the implementation of existing solutions and ensure the development of promising ones, we highlight the need for new policies, and propose detailed recommendations for individual solutions.

The following points summarize the key actions that we believe will enable our sector to enhance its contribution to addressing the global climate change challenge:

Fred Kindle
Chief Executive Officer
ABB Ltd.

Pierre Gadonneix
Chairman and Chief Executive Officer
EDF Group

Michael Morris
Chairman, President and
Chief Executive Officer
AEP

Andrew Brandler
Chief Executive Officer
CLP Holdings Ltd.

the CEOs

- Immediately establish energy policies that *incentivise investments* in currently available low or zero emission technologies at the end-use and generation levels;
- *Support innovation and R&D efforts* across a wide range of promising technologies to secure that a continuous pipeline of options are brought to the market in the medium and long term;
- *Customize policy interventions* and continually review their effectiveness to make sure they take account of national needs and objectives as well as technological maturity;
- Ensure the *complementary implementation of policy tools* such that they work together in achieving the overarching objectives of CO_2 mitigation, social development and energy security;
- Use an *effective blend of policy tools* that combine market and regulatory instruments and encourage voluntary action;
- *Promote realistic pricing* that reflects investment cost and CO_2 value while addressing social development issues through specific policy measures;
- Realize the *potential of emission reductions along the entire electricity supply chain*, from production to end-use by consumers;
- Fully recognize the *importance of transmission and distribution* and ensure the required investment;
- Establish *strong integrated infrastructure planning* and policy environments which promote coordinated disaster recovery plans and mechanisms, in order to meet existing climate adaptation challenges;
- *Increase developing countries' capacity to adopt climate change related technologies* through enhanced technology transfer supported by policies tailored to the host country needs;
- *Expand the use and effectiveness of the CDM or other future mechanisms* to facilitate the large scale deployment of key technologies.

We are confident that an enabling policy environment, which sets the right framework conditions, will allow us to establish a global, quantifiable, long-term GHG emissions pathway in order to make markets work and attract investments to the most effective projects. In line with these requests, we are committed to acting today to reduce our carbon footprint through accelerated investment in low carbon technology development and deployment; continued work to reduce the carbon intensity of our electricity generation and improve the efficiency of our operations; collaboration with government and other stakeholders to drive R&D; and engagement to improve the end-use energy efficiency of our customer base.

We cannot do this in isolation; we need to work together with all governments and other stakeholders to find the solutions. We realize that this change will take many years, but by leveraging effort, we are in no doubt that a low carbon and sustainable energy future can be achieved. Through this publication, we have outlined some possible options and trust that this will provide a basis for further discussion and engagement.

Jacob Maroga
Chief Executive
Eskom Holdings Ltd.

Shosuke Mori
President
Kansai Electric Power Company

Gérard Mestrallet
Chairman and Chief Executive Officer
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Jean-François Cirelli
Chairman and Chief Executive Officer
Gaz de France

Bård Mikkelsen
Chief Executive Officer
Statkraft

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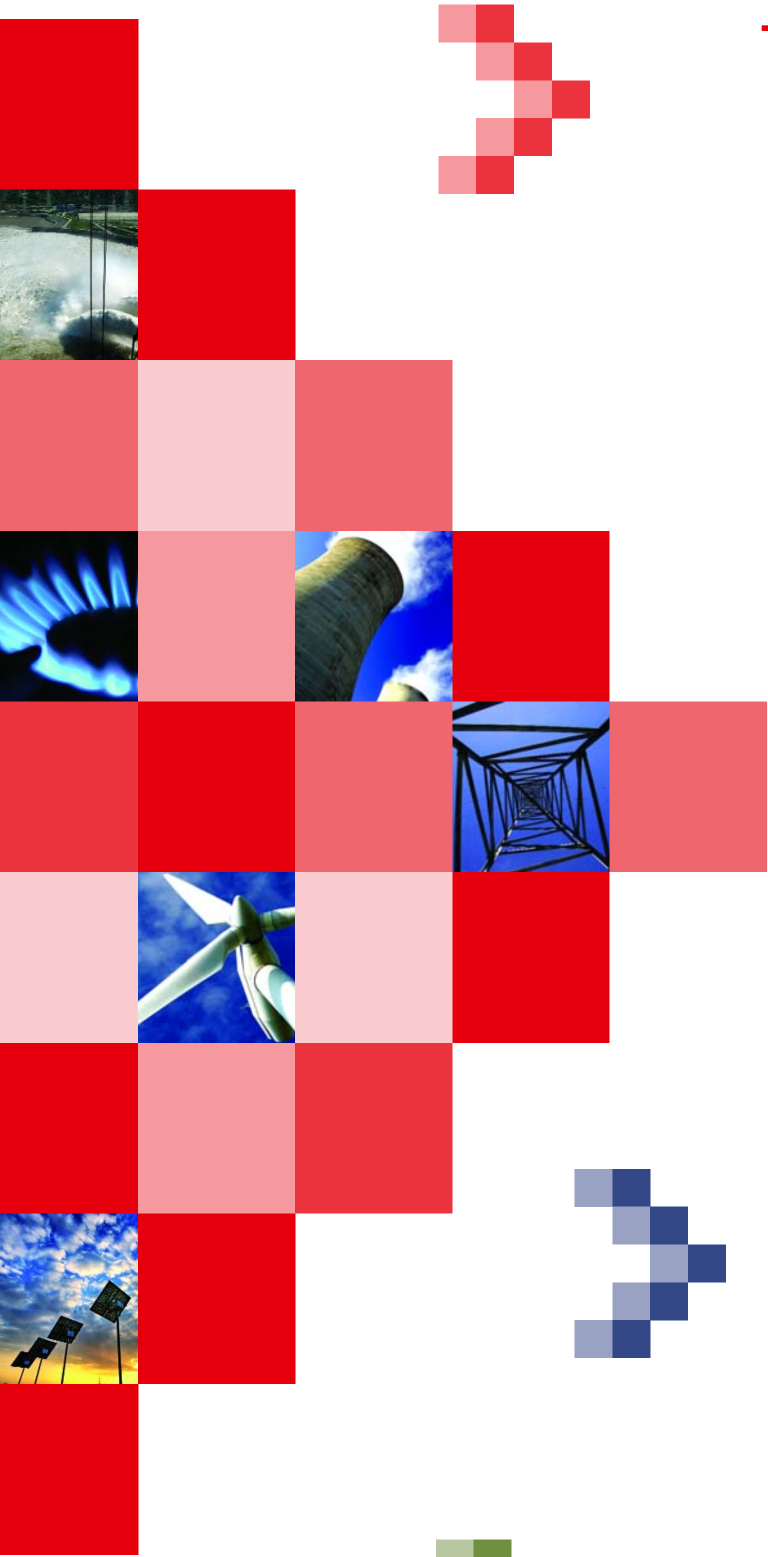
Tokyo Electric Power Company



The WBCSD Electricity

This report is issued by the ten member companies of the WBCSD Electricity Utilities Sector Project. This project was initiated within the WBCSD in January 2000, bringing member companies together to develop a deeper and more concrete understanding of the sustainability challenges facing the sector, examine potential business contributions, and explore policy needs.

Sustainability in the electricity utilities sector, a first report published in 2002, details sustainability principles and strategies for the sector. It provides concrete examples of industry activities through case studies, as well as a collection of best practices.

In an October 2006 Phase 2 report entitled *Powering a Sustainable Future: An Agenda for Concerted Action*, the companies identified six urgent needs requiring the efforts of all stakeholders:

1. Secure investment in infrastructure
2. Get more power to more people
3. Use the resource of end-use efficiency
4. Diversify and decarbonize the fuel mix
5. Accelerate research & development
6. Reinforce and smarten the grids

In support of this agenda, the project developed a series of “facts and trends” and “issue briefs” on the technical options available to the electricity utilities sector. The analysis shows that there is enough technological potential to meet the global energy and climate change challenges in the longer term, that all technologies have advantages and drawbacks and that a portfolio approach is needed. Conclusions underscore that policy is required for the technological potential to be fully realized, leading to the work presented within this report. We summarize our current findings in the pages that follow and within the *Powering Sustainable Solutions: Policies and measures* booklet included in the inside back cover of this document. These documents are presented as an interim report to inform a series of international stakeholder dialogues that will take place through 2008.

Utilities Sector Project

Member companies (Phase 3):

ABB
AEP AMERICAN ELECTRIC POWER
CLP 中電
EDF
Eskom
Gaz de France
THE KANSAI ELECTRIC POWER CO., INC.
Statkraft
SUEZ
TEPCO

Project profile:
represents total capacity of project members

Gross generating capacity (MW)	405,500
Number of customers (million)	306
Large hydro capacity (MW)	54,730
Other renewable capacity (MW)	7,240
Nuclear capacity (MW)	104,840
Natural gas capacity (MW)	93,800
Advanced coal capacity (MW)	23,500
Demand management (MW)	170
Transmission & distribution (km)	3,194,650
Transformers (MVA)	939,185
Gas/liquid capacity (MW)	930

Addressing the
global climate change challenge

The electricity utilities industry faces an enormous responsibility in the global fight against climate change. The sector facilitates economic development and growth through the provision of an essential service that can no longer be produced and consumed as in the last century. As the industry is currently responsible for 41% of global energy-related CO_2 emissions, and 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 contributing to climate change mitigation efforts becomes a crucial challenge.[1]

The positive news is that the electricity sector does have a huge opportunity to contribute to CO_2 emissions reduction.

First, many of the technological solutions exist today to address the challenge:

- As electricity is a flexible energy carrier, switching to lower emitting fuels can substantially reduce sector emissions;
- Carbon-free (hydro, nuclear and wind in some regions) and lower carbon (supercritical pulverized coal (SCPC) plants, combine cycle gas turbine (CCGT)) generation technologies as well as highly efficient end-use technologies (building insulation, lighting, heatpumps, and solar heating in some regions) are currently available to contribute to the reduction of carbon emissions;
- Other promising technologies, like carbon capture & storage (CCS), generation IV nuclear or photovoltaic, have the potential to contribute to the substantial decarbonization of the sector at acceptable cost by 2050.

Second, the sector is presented with an extraordinary window of opportunity given that the current investment needs in terms of capital replacement and additional infrastructure development are projected at US$ 11 trillion in required investments by 2030. This represents a four-fold increase over the investment wave in the second half of the 20th century. These funds will primarily be necessary to meet demand growth requirements in developing countries, and to replace ageing plants in developed countries, providing an opportunity to invest in low-carbon technologies for power generation, delivery, and use.

Acting within this window of investment opportunity is a challenging task. The existing solutions need to be deployed at the scale and speed required to curb the emissions trend and move the electricity sector towards a low-carbon future, in developing as well as industrialized countries. Furthermore, research and development (R&D) of promising technological solutions must be enhanced if we intend to meet the clear need for massive investments from now to 2050 sustainably.

How is the electricity utilities sector contributing to the solution?

The electricity utilities industry is participating actively in climate change mitigation efforts within the framework defined by governments:

- It helps bring to market more efficient and cleaner technologies through a continuous innovation process, as guided by its market understanding and public research, development and deployment (RD&D) incentives;
- It plans to continue investing in climate change related technologies, taking into account the influence of existing policies and regulations on the relative costs of available technologies and local circumstances;
- It is pursuing substantial work on how to adapt its generation and transmission to climate change and prepare for potential impacts on business operations.

How to achieve more?

This important contribution of business could and should be substantially greater. The electricity sector would invest more systematically in climate change-related, best-available technologies, if a more effective policies and measures framework were in place for the sector. This would enable further action in those countries that signed the United Nations Framework Convention on Climate Change (UNFCCC) more than a decade ago.

The two-fold purpose of a policies and measures framework for the sector should be:

- First, to drive investments towards available efficient power delivery and end-use equipment and carbon-free/low-carbon power generation technologies through the two first decades following the renegotiation of an international framework (2013-2025/2030);
- Second, to ensure that the promising technologies researched and developed today are brought to market in the following decades (2025/2030-2050), with a long-term objective of substantial decarbonization of the sector (e.g., halving sectoral GHG emissions worldwide by 2050).

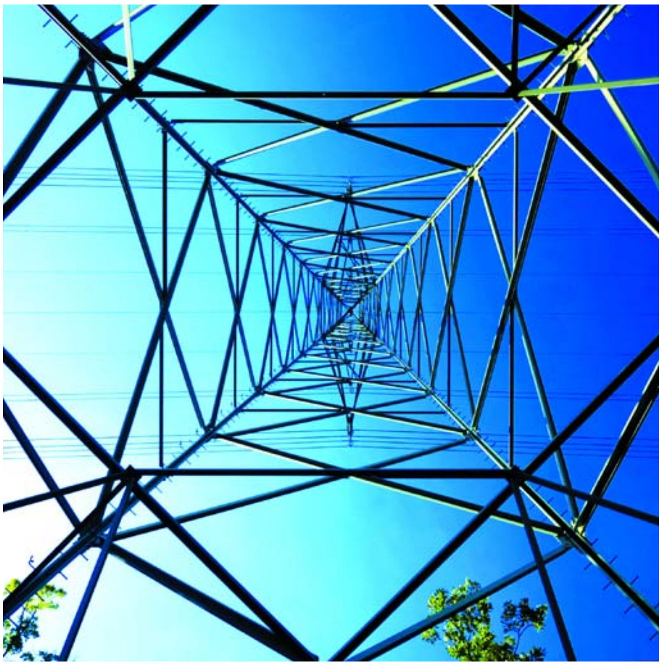
Those policies and measures for the electricity sector may be part of a basket of “sustainable development policies and measures” aiming to achieve development with reduced emissions, without sacrificing economic growth or well-being. As such they are basic elements for the post-Kyoto international climate framework, regardless of how this framework defines common but differentiated responsibilities for countries.

The purpose of this report is to describe the key features of this sectoral policies and measures framework. We have identified nine "wedges" on which to focus policy building efforts. Our analysis illustrates the types of policies and measures that are being used around the world today, or could be used to enable these nine identified wedges to meet their potential. The following pages describes what we have identified as the key features of a policies and measures framework for the sector and our wedge analysis is included within the *Powering Sustainable Solutions: Policies and measures* booklet included in the inside back cover of this document.

We do not advocate any one approach in particular. We recognize that all of the approaches have potential merits, and that their effectiveness depends to a large extent on the jurisdictional context. We believe that a portfolio of policies and measures is needed, and recognize that ideal combinations will vary from place to place depending on national or regional circumstances.

Powering Sustainable Solutions: Policies and measures

- End-use energy efficiency
- Hydropower
- Non-hydro renewables
- Nuclear power
- Natural gas
- Generation efficiency
- Advanced coal technologies
- Carbon capture and storage
- Transmission and distribution



Shaping a policies and measures

framework for the electricity sector

The following statements are built on the premise that for the deployment of appropriate technologies to occur at the required scale, collaboration between the power sector, government and societal actors is key, and must be underpinned by sound public policy.

Powering a Sustainable Future: An Agenda for Concerted Action previously examined the broad scope of sustainability opportunities and challenges facing the electricity sector and the enormous benefits electrification provides to developing countries for social and economic development. Without undermining the importance of all sustainable development issues facing the sector, this report focuses on climate change mitigation policies and measures, which provides an opportunity to focus on these urgent policy needs.

A two-fold objective

To stabilize and then reduce GHG emissions from the electricity sector with the long-term objective of substantial decarbonization, we need:

1. On the demand (or end-use) side:
- Dramatic energy savings through energy conservation as well as efficiency improvements that provide comparable or better energy services with less consumption;
- Acceleration of end-use electrification by displacing some stationary uses of fossil fuels.

2. On the supply side:
- Transformation of electricity infrastructure toward low-carbon electricity generation;
- Smart and robust grid to deliver this power efficiently, and to serve an increasingly complex network with many distributed sources of power.

Such efficiency and decarbonization objectives imply a dramatic departure from current "business as usual" electricity generation and emissions trends. The International Energy Agency (IEA) Baseline scenario projects that electricity output will triple between 2003 and 2050 and that emissions will increase from about 10 to 26 Gt CO_2. Their alternative, "Tech Plus" scenario suggests a potential decrease of sector emissions in 2050 to 5 Gt CO_2 with only a doubling of electricity output.[2] This estimates that the sector has the capacity to achieve an approximate 21 Gt CO_2 reduction in emissions as compared to the "business as usual" projections by 2050. Our "wedge" documents have based their policy analysis on this mitigation potential scenario.

This two-fold objective, while seemingly clear, is complex in its realization. Achieving them will require a combination of policy instruments designed and implemented with consideration of technology characteristics, national circumstances and, eventually, the coordination of nationally developed policies at the international level.

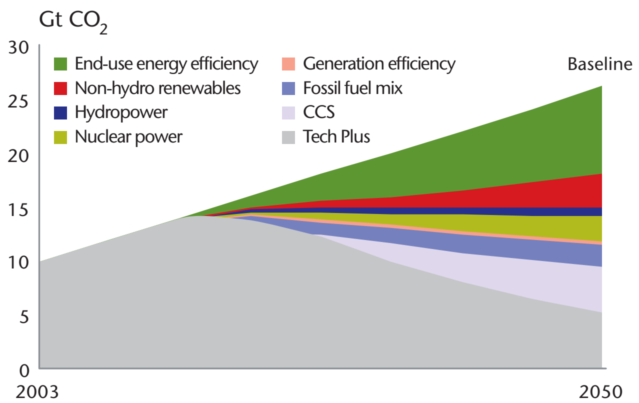


Figure 1: CO_2 reduction potential within the power generation sector by contributing factor (adapted from IEA, 2006).

Policies catered to

technological maturity

A variety of technological solutions are available for the electricity utilities sector today, each with different carbon mitigation potentials, and each at different stages of development and deployment. This calls for different types of policy intervention, as indicated in the table below and described in the next four paragraphs.

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 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 International Hydropower Assocation (IHA) Sustainability Assessment Protocol (see box);
- Ensure that clear and transparent licensing and safety procedures are in place for nuclear power.

Technology situation 2

Some technologies like ultra supercritical pulverized coal (USCPC)[3] power generation and wind power in optimal locations are mature and would be competitive were the value of CO_2 emissions internalized into electricity prices. This could be done through mandatory performance standards, carbon taxes or cap & trade systems.

Technology situation 3

Some technologies, like wind power in average quality locations or heat pumps for cooling & heating, are mature or quasi-mature and not far from competitiveness. The main issue relates to ensuring their large-scale deployment to enable them to descend learning curves quickly and obtain wide-scale uptake. They will need mass-deployment support through, for example, feed-in tariffs or financial incentives.[4]

In addition, defining development zones for wind power will be important to minimize the “not in my backyard” syndrome (NIMBYism) and ensure that mass-deployment schemes result in the required investment in the most geographically suitable locations.

Technology situation 4

Other technologies like CCS or generation IV nuclear are promising but not yet mature. The basic need for these technologies is to accelerate research and development and boost large-scale demonstrations necessary to prove their commercial viability and eventually make them competitive in the market. This will require direct public RD&D support, and moreover the successful organization and coordination of public-private partnerships with international participation.

Clearly, a given technology is often not in a single maturity/competitiveness class in every country and for every application. Its position along the development and

Table 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 lamps (CFL) • Large hydro • CCGT • Generation II & III nuclear
2	Mature and competitive if carbon is valued	• Carbon valuation tools (cap & trade or carbon tax systems, mandatory performance standard systems)	• USCPC power generation • Wind power in best locations
3	Close to maturity and near a competitive stage	• Mass-deployment schemes (feed-in tariffs, tradable green certificates...)	• Wind power in average quality locations • Heat pumps
4	Promising but far from being mature and competitive	• Organize and support direct RD&D • Public-private partnerships	• CCS • generation IV nuclear

deployment path depends on the country of deployment and the way in which the equipment incorporating the technology is designed and used. While heat pumps are generally considered to be near a competitive stage in many locations, they are already competitive in Japan. Solar water heating equipment in China is designed for a simple application, and is thus competitive. The more complex design and application in many developed countries limits the competitiveness of this technology.

Policies must also take into account the fact that technology systems may require the deployment of individual technologies which are at difference stages of maturity. Such is the case for CCS: while CO_2 transport technologies are mature, carbon capture technologies at the power generation level are at various stages of demonstration or technically unproven for certain types of coal. Geological carbon storage is still in a very early testing phase. An important element of the policy response is to accelerate the development of the technological elements of the system that are lagging.

IHA Sustainability Assessment Protocol

The International Hydropower Association (IHA) published Sustainability Guidelines in 2003 to promote greater consideration of environmental, social, and economic sustainability in the assessment of new energy supply options, new hydro projects and the management and operation of existing hydropower facilities. Convinced that the hydropower sector should be able in the future to prove that its performance meets high sustainability standards, the IHA went further in 2006, in partnership with other international organizations, to develop a simple tool for objective assessment of each proposed hydro project or existing scheme, the Sustainability Assessment Protocol (SAP).

The idea is to have independent and documented auditing look at whether a project is needed, whether it is rightly located, whether it is acceptable from a social and environmental point of view, and whether its proposed financing, planning and management are adequate to meet sustainability criteria.

Assessments rely on objective evidence to support a sustainability score against each of twenty sustainability aspects:

1. Political risk and regulatory approval;
2. Economic viability;
3. Additional benefits;
4. Planned operational efficiency and reliability;
5. Project management plan;
6. Site selection and design optimization;
7. Community and stakeholder consultation and support;
8. Social impact assessment and management plan;
9. Predicted extent and severity of economic and social impacts on directly affected stakeholders;
10. Enhancement of public health and minimization of public health risks;
11. Safety;
12. Cultural heritage;
13. Environmental impact assessment and management plan;
14. Threshold and cumulative environmental or social impacts;
15. Construction and associated infrastructure impacts;
16. Land management and rehabilitation;
17. Aquatic biodiversity;
18. Environmental flows and reservoir management;
19. Reservoir and downstream sedimentation and erosion risks;
20. Water quality.

The IHA is studying the possibility of accrediting independent auditing companies for performing such an assessment in order to use a common and valuable tool worldwide.

Building consistent and

effective policy packages

To ensure meaningful and effective implementation of technologies, consistent and effective policy packages will have to be developed, using an appropriate combination of mechanisms and instruments.

Different types of mechanisms are available to build public policies:

- Market-based mechanisms (such as tradable allowances, credits and taxes), which establish a value for carbon emissions or reductions, are important to promote existing solutions that are competitive or nearly so but not being deployed rapidly enough.
- "Command and control" regulations (such as performance standards, portfolio requirements, siting procedures or voluntary programs under "pledge & review") are are indispensable tools for implementing policies aimed at reducing emissions.

The effectiveness of a mechanism depends critically on the quality of its design, as highlighted in the box on cap & trade on page 12.

Public policies will also have to use a combination of the different types of instruments, with consistent integration and coordination.

For instance:

- Tax credit systems and mandatory performance standards and labeling schemes in the case of, for example, energy-efficient solutions like CFLs or housing insulation whose diffusion require substantial front-end consumer investment and have high transaction costs.
- Cap & trade systems associated with regulations that facilitate market access and foster successful deployment for mature power generation technologies. Such supportive regulations are, for example, those that provide more predictable and reasonable timelines for siting and licensing of base load (coal-fired, gas-fired, nuclear) power plants, or define development maps for wind power.

Policy instruments must be combined with regard for complexity, cost and global effectiveness:

- The combination of tax credits with advanced but robust technology standards is for instance successful in boosting the deployment of high-efficiency products like heating and cooling heat pumps systems. Adding a white certificate system to this framework (where a mandatory energy savings objective borne by energy suppliers is attainable through certified actions that bring tradable certificates to the market) may increase flexibility for the participants, but also lead to increased complexity and higher transaction costs for both participants and regulators (see box on page 13 for more details about white certificates).
- A support scheme for mass-deployment for mature or quasi-mature renewable energy is appropriate. This scheme should minimize the total need for financial support, and minimize the negative environmental consequences. It should also secure the right investment incentives at the lowest possible cost, be robust against changing framework conditions, and create an attractive and stable framework for investors and suppliers. Applying this principle is all the more important as deployment targets become increasingly ambitious.

The EU has for instance adopted a binding 2020 target of 20% renewable energy sources, which could mean as much as a 34% share for renewables in the electricity mix. The current support system, which consists of non-harmonized national schemes, most of them based on feed-in tariffs, some on tradable renewable certificates (see box below), is not considered adequate to meet the target at an acceptable total cost. An EU-wide system, which selects a specific instrument (whether it be feed-in tariffs or renewable certificate instruments) for all countries, appears a more a cost-effective option as it would allow the optimization of EU resource potential across borders.

ROC Policy

A Renewables Obligation Certificate (ROC) is a green certificate issued to an accredited generator for eligible renewable electricity generated within the United Kingdom and supplied to customers within the UK by a licensed electricity supplier. The ROC is the main support scheme for renewable electricity projects in the UK. It places an obligation on UK electricity suppliers to source an increasing proportion of their electricity from renewable sources.

Making cap & trade work

A cap & trade (C&T) system (i.e., setting a GHG emissions absolute target and allowing subsequent trading of emissions permits between the players that have binding emissions targets), is one possible mechanism with which to attribute a market value to emission reductions, otherwise unaccounted for in traditional markets. C&T systems have had some success, for example, the North American acid rain program. Other price mechanisms such as taxes, for instance, can set a regulated price for emissions. Mandatory performance standards are further (non-price) means of carbon emissions valuation.

If a C&T system is used, conditions must be met for it to play its expected role, which is among others, to provide incentives for investments in cleaner technologies:

- The rules of the C&T system must provide players with long-term visibility over framework conditions on a time horizon in line with their investment choice. This requires that market rules be defined over at least 15-20 years and that market stability be, to the greatest extent possible, maintained so as to provide certainty to investments in low-carbon technologies;
- The specific details of the market rules should be defined in such a way that they effectively encourage investment in lower carbon and carbon-free technologies. Economic theory, and the example of the US SO_2 market, show that the following rules can lead to such an efficient market:
  - Allowance of permit banking within the operating period;
  - Free allocation of permits to existing plants through "grandfathering" once for all, with a decrease over time according to emissions reduction objectives;
  - Obligation for all new projects to buy their emissions permits;
  - No withdrawal of emission permits when plants are decommissioned.
- Capping emissions and leaving the determination of the carbon price to the free market may appear risky as future abatement costs are fairly uncertain in the short and mid term periods. Several actors therefore request the introduction of a "safety valve" to protect industry against excessive emission price spikes.

In parallel, all direct uses of fossil fuels, including energy services provided at customer sites (such as space or water heating) must bear the cost of the emissions for which they are responsible (possibly through some carbon tax or an "upstream" cap & trade system). Otherwise, the significant CO_2 reduction potential deriving from the substitution of direct fossil-fuel burning by low-carbon electricity will be hindered.

Realizing the potential of

emissions reduction on the demand side

Efficiency improvements and direct emissions reduction through the use of low-carbon end-use systems and appliances represent the greatest global potential for cost-effective emissions reductions, but face a number of specific behavioral and economic barriers:

- The number of individual decision-makers (i.e., customers) is extremely large and consumer preferences are such that the present value of consumption is estimated at a higher value than potential long-term savings (i.e., customers would rather pay less today for an appliance despite the fact that a slightly more expensive alternative is more economical in the long-run due to lower operational costs).
- Those actors making investment decisions are not necessarily those that will reap the benefits, or alternatively those who will bear the cost (i.e., in the case of rental housing, the landlord is responsible for any energy efficiency investments, while it may be the tenant that benefits from the savings; or in the case of leased office space, the tenant may alter behavior, but it is the building owner or operator who benefits).
- Finally, the potential “rebound effect” of energy efficiency improvements is such that some consumers may tend to increase consumption due to the lower cost of electricity, thus undermining any efficiency gains.

Establishing performance standards for end-use energy consumption is an important and effective step, but alone may not achieve sufficient reductions. A specific collection of complementary policy measures is typically necessary:

- Repeated information campaigns to make customers fully aware of cost-economic investments;
- Regulations and incentives to ensure the alignment of multiple players in investment decisions (i.e., landlord and tenant interests in the case of housing);
- Financial mechanisms to address consumer reluctance to make high front-end investment (in exchange for a sequence of future savings over a long period of time);
- The maintenance of tax credits for buyers for some period of time when the technologies embedded in equipment are considered mature and cost-effective;
- Electricity prices reflecting their full cost, including greenhouse gas reduction costs, in order to limit the “rebound effect”;
- Policies allowing electricity utilities to recover investments made in energy efficiency measures, for instance through tariff structures.

“White certificates” in the UK and France

A “white certificate” system is a C&T system: there is a mandatory energy savings objective borne by energy suppliers and attainable through certified actions (which may include, for example insulation improvements or double glazing windows) that introduce tradable certificates to the market. To hold the required volume of certificates, companies can act alone or in partnership to support customer investment in efficiency projects, or buy certificates from registered vendors. Savings are thus expected to be attained at the lowest possible cost.

Such a system was introduced first in the UK, followed by France and Italy. It has given a positive impulse to the energy efficiency improvement process in countries where it was introduced and it promotes consumer awareness.

It adds substantial complexity (there are usually some 50 kinds of measures, generating high transaction costs).

The originally implemented version of the mechanism has been modified in the UK to also ensure effectiveness in reducing GHG emissions.

Fully recognizing the importance of

transmission and distribution

Low investment in transmission and distribution (T&D) in the last two decades and changes in power flows due to market liberalization have resulted in ageing and overloaded networks and increased risk of power failures in industrialized countries. In addition, the need for more integrated and expanded alternating current (AC) and direct current (DC) infrastructure is enormous in many developing countries. Furthermore, network strengthening and development is increasingly complex as a result of the need to connect renewable intermittent power generation plants, decentralized generation, and a number of very large, new base-load plants. The building of T&D lines and interconnections can be problematic in terms of public acceptance and finding suitable routes generally raises fierce opposition.

Policy support to carbon-free and lower-carbon power generation schemes can only be effective if power T&D grids are strengthened and developed to deliver clean energy. As power is mainly delivered through regulated, natural T&D monopolies, this is almost a pure policy and regulatory issue.

Policy-makers should be aware that grid investments are not likely to be a major cause of electricity price increase as high-voltage transmission generally accounts for 7 to 10% of total electricity supply cost. On the other hand, to secure the necessary investment in smartening and reinforcing the grid, regulation of transmission must allow network operators sufficient rate of return on the required investments.

Policies aiming at boosting the development of low-carbon generation schemes must be matched with network development plans that include the reinforcements required to accommodate desired new generation. They must also consider the allocation of new plant connection costs between the generator and the network operator.

Transmission regulation in federal states should be such that authorization for building transmission lines rests with federal regulatory bodies. In regions (such as Western Europe), where interconnections between countries are needed, concerned states should work in cooperation to ensure their development.

Bringing in a

pipeline of breakthrough technologies

Developing breakthrough electrical technologies is integral to achieving global energy objectives. The electricity sector needs technologies to improve energy efficiency and reduce the carbon intensity of the energy mix. Technologies are also required to provide universal access to electricity and a reliable infrastructure to underpin development (although the implementation of existing technologies will also play a significant role). A key condition to ensure the development of a pipeline of technologies, will be the successful leveraging of resources and partnerships.

Business efforts in technology innovation and development need to be supported by national enabling policies and frameworks:

- National technology development strategies that cover fundamental research and innovation as well as emerging and near commercial areas in order to ensure a pipeline of new technologies;
- National research programs targeted at local barrier identification and the recognition and support of opportunities;
- Policies can include positive incentives for R&D, with direct public funding focused on technologies for which commercialization prospects are too uncertain or remote from a business perspective.

For technologies of global importance and high RD&D cost, national programs should be coordinated at the international level and multinational programs should be strengthened and further developed. Such technologies include CCS, solar photovoltaic, generation IV nuclear or fusion.

It is critical that, as a whole, technology development programs cover a wide range of technology options. Given the plethora of national and local conditions, resources and policies, these technologies must be developed in parallel rather than sequentially, in order to bring them to market in time to stabilize emissions.

For instance, setting up a mechanism for the development of 20 CCS pilot plants (with some funding to cover the incremental cost) in key countries around the world would speed up learning and more importantly, the acceptability of the CCS technologies at the local level.

There is a great need for public funding for additional large-scale demonstration projects around the world. The FutureGen global initiative for clean coal, in which public and private sector participants are jointly funding and guiding the research, is one example (in that it is open to foreign partners). These projects should be closely linked to capacity-building initiatives, particularly in developing countries, and allow for wide diffusion of intellectual property.

The FutureGen Project

FutureGen is a public-private partnership between the US Department of Energy (DOE) and the FutureGen Industrial Alliance Inc., a non-profit consortium of 12 leading international energy companies, to build a first-of-its-kind 275 megawatt coal-fueled, near-zero emissions power plant (capable of powering about 150,000 average US homes), at an estimated net project cost of US$ 1.5 billion.

The plant will use cutting-edge technologies (such as IGCC) to generate electricity while capturing and permanently storing CO_2 deep beneath the earth. It will also produce hydrogen and by-products for possible use by other industries.

The integrated use of these technologies is what makes FutureGen unique: while researchers and industry have made great progress in advancing technologies for coal gasification, electricity generation, emissions control, CO_2 capture and storage, and hydrogen production, these technologies have yet to be combined and tested at a single commercial-scale demonstration plant. This is an essential step for technical and commercial viability.

The Alliance comprises seven coal producers and five electricity utilities who are responsible for designing, constructing, and operating the facility. The DOE is responsible for independent oversight and coordinating the participation of international governments. Alliance member companies are dedicating nearly US$400 million toward the project's cost and bringing valuable technical expertise and power plant engineering and construction experience to this effort.

During the first four years of operation, DOE regulations require that a significant amount of the information about plant operations be made public. Most of the intellectual property employed in FutureGen is expected to be owned by the suppliers of the novel equipment (e.g., gasifiers) that are incorporated into the plant.

Increasing developing countries'

capacity to address climate change

A key global policy objective is to encourage developing countries to maintain/improve the efficiency of their existing plants, to invest in best available technologies and to contribute to developing future technologies.

To effectively enable these objectives to be achieved, the following points must be considered:

- Policies and instruments to support technology transfer need to be tailored to the maturity of technologies.
- For technologies that are mature and competitive both in developed and developing countries, effort needs to be focused on sharing knowledge related to project management, operations feedback, regulatory frameworks and best practices.
- For technologies that are mature in developed countries but not yet in developing ones, policies should be aimed at securing and encouraging foreign direct investment (FDI), joint-ventures or investments in CDM projects (that provide developed countries with emissions credits under the Kyoto Protocol), in partnership with local players.
- For future technologies, collaborative research is required to enable *ex ante* definition of intellectual property rights and ensure that developing countries will be able to access future technologies when available.
- Barriers that may prevent technology transfer or deployment must be removed. These 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 countries. In some circumstances, changes in regulations in a recipient country can accelerate technology transfer. Electricity market restructuring in China, for example, has occurred rapidly and corrected the regulatory flaw of not using merit order dispatch that previously prevented the country from optimizing its power generation.
- It should be recognized that developing countries may also be a source of new technology development, as well as recipients.

As many companies have a global reach through markets or supply chains, business has a key role to play in the diffusion of developed technologies worldwide through FDI as well as through the supply chain. This may be possible, provided that the barriers noted above are overcome and the issue of intellectual property is dealt with. The concept of "patient capital" also needs to be considered in order to leverage resources and reduce risk. This would consist of leveraging private equity with other forms of support, such as from the World Bank and other development banks, official development assistance (ODA) and the CDM.

While the CDM is an important mechanism, it is not achieving the large-scale clean energy technology development and emission reductions originally envisaged. Barriers include the low level of capacity to identify and implement projects, high transaction costs (which are prohibitive for many small projects), "excessive" additionality requirements, a project-based approval process that is self-limiting, and the *de facto* exclusion of certain technologies.

At the conclusion of the first commitment period of the Kyoto Protocol in 2012, the CDM should be expanded as follows:

- Streamlining the approval process of small projects, which is currently underway, should be brought rapidly to a successful conclusion.
- All technologies that can result in large scale reductions need to be accommodated within the CDM and future mechanisms of the post-2012 agreement. Specifically, nuclear power and clean coal technologies with carbon capture and storage should be included.
- Enabling rules for the realization of large or programmatic CDM need to be fast tracked to rapidly facilitate learning by doing, and allow large scale deployment of technologies (e.g., an energy efficiency program applying to a city or a city district in a developing country).

The Generation IV International Forum (GIF)

The Generation IV International Forum was established in January 2000 to coordinate international research & development on innovative nuclear energy systems to benefit from comparative advantages that include reduced capital cost, enhanced nuclear safety, minimal generation of nuclear waste and further reduction of the risk of weapon materials proliferation.

It is now a thirteen-member R&D consortium that includes Argentina, Brazil, Canada, China, Euratom, France, Japan, Republic of Korea, Russia, Republic of South Africa, Switzerland, United Kingdom, United States.

After the evaluation of some 100 system concepts through international collaboration, six systems have been selected for further study and cooperative development: gas-cooled fast reactor, very-high-temperature reactor, supercritical-water-cooled-reactor, sodium-cooled fast reactor, lead-cooled fast reactor, molten salt reactor. The technology roadmap published in December 2002 describes the R&D pathways for establishing their technical and commercial viability, demonstration and, potentially, commercialization.

Working extensively on

adaptation

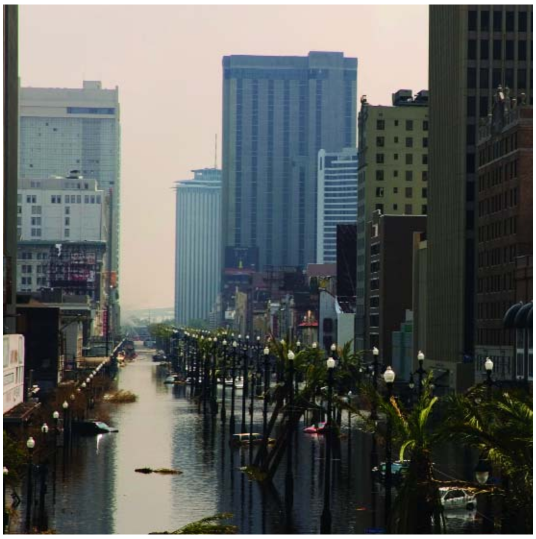
While this report focuses mainly on the new policies necessary to limit the extent of climate change, adaptation to the impacts of unavoidable climate change is a critical issue to consider within the international climate change debate.

Adaptation is not a new issue for electricity utilities. It is embedded in their sustainable development and risk management strategies. Hydropower management is a good example of a field in which utilities have begun work on adaptation to climate change.

The electricity utilities sector has started addressing issues related to adaption by developing a clear understanding of:

- How the science of climate change is advancing and what the physical impacts on facilities and operations will be;
- How risks can be identified, quantified and managed in a proactive manner, including through the development of early warning systems;
- How changes in global climate will affect the sector's stakeholders, (i.e., employees and contract staff, customers and users, lenders and investors, suppliers and service providers);
- How utilities should work with governments and other parts of civil society and business on infrastructure development and disaster management;
- How new climate policies will affect the electricity utility business, and what new policies will be needed to facilitate adaptation of the economy and society;
- What technologies and R&D need to be deployed and developed to limit damage and to increase the sector's ability to adapt.

Electricity utilities are particularly vulnerable to the negative impacts of climate change given that operations are generally geographically widespread and particularly sensitive to meteorological situations (i.e., temperature and rainfall). Strong integrated infrastructure planning and policy environments which promote coordinated disaster recovery plans and mechanisms are necessary. Policies that promote research and innovation into new technologies and predictive capabilities are also key. Collaboration amongst all relevant stakeholders will be critical in improving resilience and response times. Governments need to take the lead in addressing the many social and planning issues and utilities need to work closely with governments (and in some cases more than one government) to understand these issues and plan effectives responses.



Concluding remarks

Through this report, we have tried to outline the policies and measures that, in our view, are required for the full decarbonization potential of the electricity sector to be realized. In the short term, these policies and measures should aim to foster investments in clean technologies at the lowest possible incremental cost. In the longer term, we expect them to help support the development of a pipeline of breakthrough technologies through which we can change our lifestyles and collectively invent a new sustainable energy future. As such, these policies and measures need to be developed in coordination with, and integrated within other public policies, such as those dealing with water resource management, urban planning, and economic development. Public education, awareness raising and the development of new competencies will also be required.

This assumes strong and long-lasting cooperation between all stakeholders, which is a challenge that is not to be underestimated. Only under these conditions will the current sense of urgency related to the climate change challenge be translated into action at the appropriate scale.

This report is presented as an interim piece, proposed as part of an ongoing dialogue, through which we will continue to engage with stakeholders in refining our analysis and policy recommendations.

Glossary

alternating current (AC): An electrical current whose magnitude and direction vary cyclically, as opposed to direct current (DC), whose direction remains constant.

carbon capture and storage (CCS): A long-term alternative to emitting carbon dioxide to the atmosphere is capturing it at its source of emission and storing it. Geological carbon storage involves the injection of CO_2 into subsurface geological formations.

carbon credit/offset: Represents a certificate for avoidance of carbon emissions. It can be used to meet a carbon target.

certified emission reduction (CER): A type of carbon credit/offset that is issued through the Clean Development Mechanism.

clean development mechanism (CDM): An international mechanism put in place by the Kyoto Protocol to facilitate greenhouse gas emissions reductions in developing countries.

combined cycle gas turbine (CCGT): The current state-of-the-art technology for power generation utilizing natural gas, combining steam and gas turbines.

combined heat and power (CHP): A process or technology that uses waste heat from power generation, and significantly raises the efficiency of energy exploitation.

direct current (DC): The constant flow of electrons from low to high potential. In direct current, the electric charges flow in the same direction, distinguishing it from alternating current (AC).

feed-in tariffs: Tariffs that private generators can charge for electricity that they feed into the power grid. Feed-in tariffs are higher than the power price if they are designed as subsidies, e.g., to encourage the installation of renewable energy capacity.

foreign direct investment (FDI): An investment made with the objective of obtaining a lasting interest in an enterprise operating outside of the economy of the investor.

generation II light water reactors: The majority of nuclear reactors that exist today. They include pressurized water reactors and boiling water reactors.

generation III light water reactors: Designed to improve safety and improve economic performance. A small number have been built or are under construction in East Asia, Europe, India and China.

generation IV fast breeder reactors: In the R&D stage. Six different technologies are currently being explored.

greenhouse gases (GHG): Gases in the Earth's atmosphere that absorb and re-emit infrared radiation thus allowing the atmosphere to retain heat. These gases occur through both natural and human-influenced processes. The major GHG is water vapor. Other primary GHGs include carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).

heat pump (HP): An electrical device that takes heat from one location and transfers it to another. A typical refrigerator is a type of heat pump since it removes heat from an interior space and then rejects that heat outside. Heat pumps can work in either direction (i.e., they can take heat out of an interior space for cooling, or put heat into an interior space for heating purposes).

integrated gasification combined cycle (IGCC): This technology involves the gasification of coal to increase the efficiency of coal-fired power plants and provide a basis for pre-combustion carbon capture and storage (CCS).

International Energy Agency (IEA): An intergovernmental body committed to advancing security of energy supply, economic growth and environmental sustainability through energy policy co-operation.

Intergovernmental Panel on Climate Change (IPCC): Established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess scientific, technical and socio-economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation.

kW, MW, GW: kilowatt, megawatt (1,000 kW), gigawatt (1,000 MW). A measure of electrical capacity (e.g., of a power plant).

kWh, MWh, GWh: kilowatt hours, megawatt hours (1,000 KWhs), gigawatt hours (1,000 MWhs). A measure of electrical output or use (energy).

merit dispatch order: The dispatch of generation means based on incremental cost minimization

not in my backyard (NIMBY): Commonly cited term that refers to the resistance of local communities to infrastructure developments.

nuclear fusion: In this reaction, two light atomic nuclei fuse together to form a heavier nucleus and release energy. Nuclear fusion technology for power generation is currently being researched and developed in international experiments.

pulverized coal (PC): This technology, put into widespread use worldwide in the 1960s, involves "pulverizing" coal into very small fragments and then mixing these with air. This mixture is then injected into a boiler where it behaves very much like a gas and burns in a controlled manner.

solar photovoltaic power: Power generated through the conversion of the sun's electromagnetic waves by solar cells.

supercritical pulverized coal (SCPC): A type of advanced coal generation that is considered to be mature and competitive

ultra supercritical pulverized coal (UCSPC): A type of advanced coal generation that is globally considered to be in the deployment phase, while plants are currently in operation in Japan, Denmark and Germany.

United Nations Framework Convention on Climate Change (Conference of the Parties) (UNFCCC (COP)): An international treaty to begin to consider what can be done to reduce global warming and to cope with whatever temperature increases are inevitable. The Conference of the Parties refers to the meeting of those countries that signed the UNFCCC.

white certificates: A market-based mechanism for the promotion of energy efficiency. White certificates allow industry to meet energy efficiency targets through direct investment in efficiency projects or by buying certificates from other organizations that have implemented a project.

Notes and references

1 International Energy Agency (IEA). *World Energy Outlook 2006.* 2006. (According the "Baseline"– i.e., business as usual – Scenario).

2 International Energy Agency (IEA). *Energy Technology Perspectives 2006: Scenarios and Strategies to 2050.* 2006. All scenarios built in this study as an alternative to the "Baseline Scenario" assume an accelerated development and deployment of low-carbon and carbon-free technological solutions through dedicated public policies. The Tech Plus scenario is currently the most optimistic in terms of both technological innovation and diffusion. It leads to a 16% global reduction below current levels in 2050. Within the power generation sector, it projects a 50% reduction below the 2050 Baseline scenario.

3 The ultra-super-critical pulverized coal (USCPC) generation technology is in this category because demonstration large-scale plants exist, but the technology still needs some R&D on materials.

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

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Technology “issue briefs” and further information

In the second phase of the Electricity Utilities Sector Project, an in depth analysis of the factual context for seven power generation technologies was undertaken on:

- Coal
- Gas
- Carbon capture and storage
- Nuclear
- Hydro
- Non-hydro renewables
- Hydrogen

The project also produced “issue briefs” on the topics of access to electricity, transmission and distribution and energy efficiency. This analysis provides additional supportive technical detail to the content within this publication.

These are available for download at www.wbcsd.org/web/electricity.htm.

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