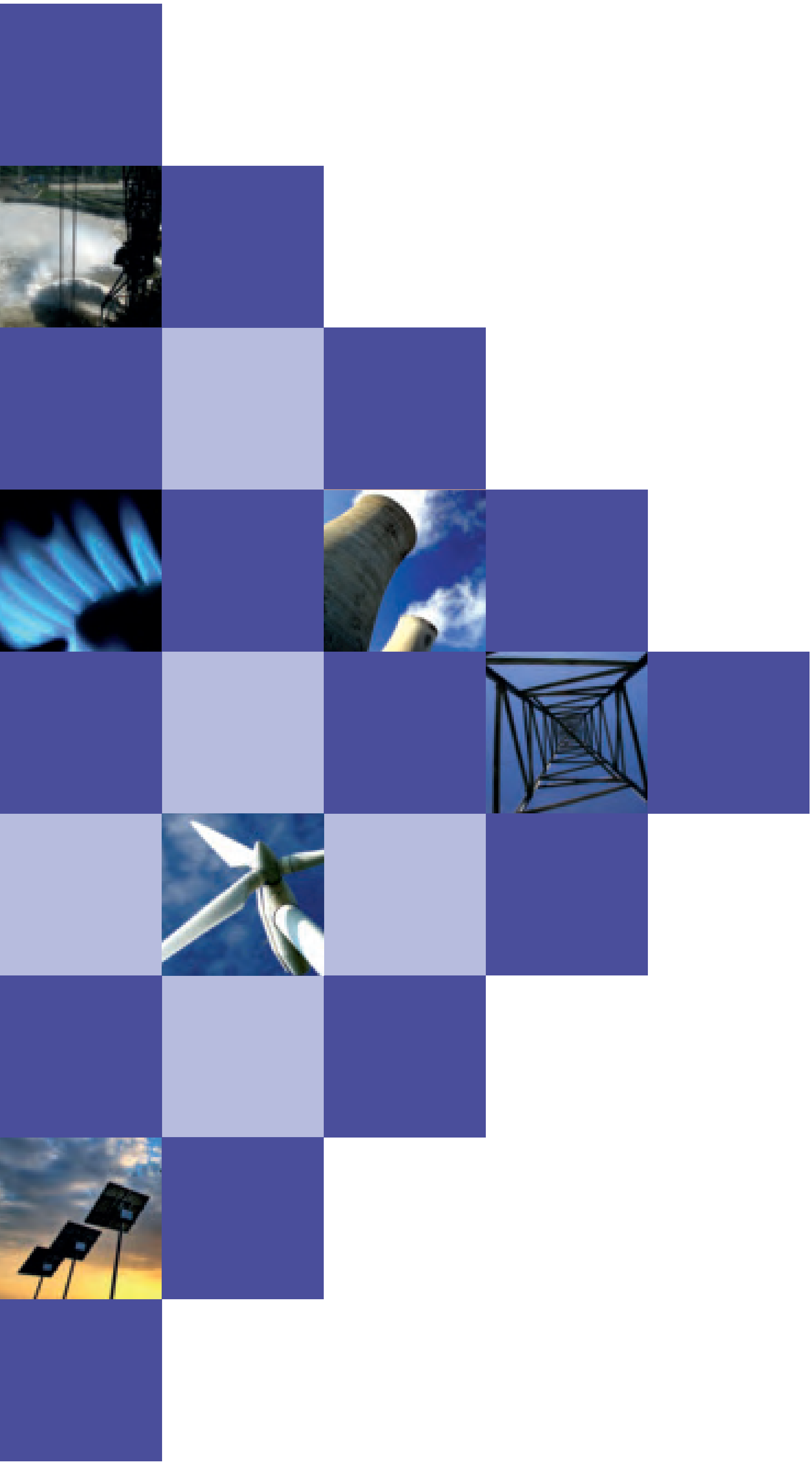
DEDICATED TO MAKING A DIFFERENCE

Power to Change

A business contribution to a low-carbon electricity future

World Business Council for
Sustainable Development



Contents

Powering a low-carbon economy

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

Message from the CEOs

In the coming decades, the world will need double today's generation capacity. We in the power sector have a strong opportunity to take a lead in combating climate change. But we cannot do this alone. We need to work with governments and other stakeholders to find solutions. We realize some of these changes will take many years, but there is no time to lose and it is only through combined efforts that we will succeed in creating a low-carbon, sustainable energy future.

The power sector bears a front-line responsibility in the urgent global struggle against climate change. It is willing to take resolute action to address a three-fold challenge:

- Sustain economic growth through competitive and available electricity generation
- Reduce CO_2 emissions and mitigate the impact on the environment
- Ensure access to affordable energy for low-income customers to guarantee social cohesion.

This challenge is huge, but not out of reach. Representing some 10% of the world's global installed generating capacity and serving over 304 million customers every day, we within the WBCSD Electricity Utilities Sector Project are eager to face up to our responsibility. We believe in a sustainable electricity future that will be achieved through progressive decarbonization of the electricity mix, more efficient use of electricity by end-users and through enhanced substitution of electricity for fossil fuels.

The necessary technologies, on the demand and on the supply sides, have been developed by business, and are already available. Some are commercially mature and can be deployed much more widely today; others – while having promise – are not yet ready for the market and need reinforced and accelerated focus on research and development. In both cases we are prepared to do our part and take action.

But business cannot act alone. Success also depends on urgent action by governments. Current market and regulatory conditions alone will not drive the global development and deployment of low-carbon technology to the extent necessary to address the challenges of climate change. The recent crisis in the global financial markets must not be allowed to stifle or delay critical infrastructure investments at a time when these are so badly needed.

There is no "silver bullet" – neither on the technology nor on the policy side – and we recognize that countries will continue to use their indigenous resources, including fossil fuels, out of concern for energy security. In order to encourage investment in the right technologies at the right time and the right place, policies and mechanisms will need to be tailored to match both national contexts and to capitalize on the maturity of each technology.

Joe Hogan
Chief Executive Officer
ABB Ltd.

Michael Morris
Chairman, President
and Chief Executive Officer
AEP

Andrew Brandler
Chief Executive Officer
CLP Holdings Ltd.

Pierre Gadonneix
Chairman and
Chief Executive Officer
EDF Group

Jacob Maroga
Chief Executive
Eskom Holdings Ltd.

At the national level, public policies should promote:

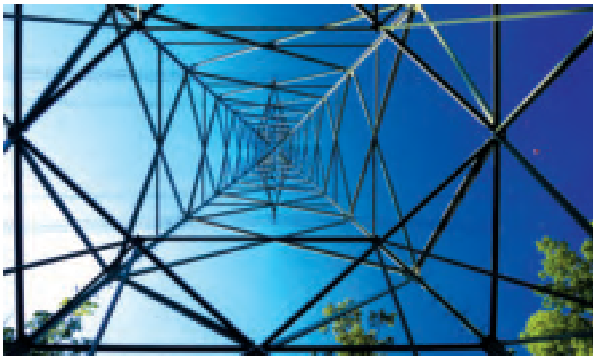
- A realistic pricing of electricity to reflect both investment cost and a value for carbon emissions with targeted support for low-income customers;
- Standards and norms for energy efficiency improvement, and efficient siting and licensing procedures to enable rapid and effective investments in new generating capacity;
- Immediate establishment of energy policies that incentivize investments in commercially available low- or zero-emissions technologies at the end-use and generation levels;
- Investment in transmission and distribution;
- Support for innovation and R&D across a wide range of promising technologies.

At the international level, we call for:

- The timely establishment of a long-term, stable international framework on both emissions reduction and the promotion of low-carbon technologies and energy efficiency measures that are relevant to each country's shared and differentiated responsibilities and capabilities. Such agreement should involve all major economies;
- Flexibility mechanisms, whether new, existing or improved, open to all key mitigation technologies, for the purpose of replicating the deployment of low-carbon facilities and energy efficiency programs;
- Pooled efforts in R&D for emerging clean energy technologies (such as joint R&D and demonstration programs);
- International adaptation mechanisms to support the acquisition of information technology and finance and facilitate the development of adaptation capacity, resilience and risk management strategies.

These recommendations are the key building blocks for any attempt to define a sectoral approach for the electricity sector, which would require – under the leadership of national governments – a thorough and detailed understanding of the technologies and the sector's challenges and specificities.

The power sector is ready and willing to pioneer and deploy new and existing technologies to drive down its carbon emissions. At the same time we look to governments and other stakeholders to create a policy environment that encourages and supports this massive future investment in new infrastructure.



Gérard Mestrallet
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President
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The WBCSD Electricity Utilities Sector Project

This report is issued by the nine 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.

Building on these findings, in 2007, the project focused more specifically on climate change and the role of the power sector. An interim report entitled *Powering a Sustainable Future: Policies and measures to make it happen* and a technology solution booklet *Powering Sustainable Solutions: Policies and measures* were published in December 2007.
The report concluded that while technologies have the potential to play a large role in addressing climate change, existing and new solutions will not be deployed sufficiently without the right policy and market frameworks.

Through 2008, the project conducted an extensive stakeholder consultation process to inform the completion of this final report. In addition to soliciting written stakeholder feedback, four international roundtables were convened by the project, bringing together business, government and civil society representatives to share perspectives on the essential mitigation and adaptation measures within the sector:

Bali, Indonesia, December 2007
During the United Nations climate change conference Powering a Sustainable Future: Policies and measures to make it happen interim report launch

Beijing, China, April 2008
International roundtable on low-carbon electricity technology solutions

Johannesburg, South Africa, June 2008
Understanding risks and vulnerabilities faced by the companies with respect to climate change: A discussion of possible actions to reducevulnerability and increase adaptive capacity

Tokyo, Japan, July 2008
The role of the electricity utilities sector in addressing climate change and achieving a low-carbon society.

These dialogues highlighted a number of key points for consideration in the completion of the report and future project work. While this is not a complete list, we highlight a number of issues and questions raised during the discussions:

- Policy proposals that address climate change within the power sector cannot be dealt with in isolation – many other dimensions such as development, energy and national security impact policies and decisions made at the national and international levels. A balance must be found.
- Electrification is a key element that will bring society towards a low-carbon future.
- The positive contribution that this will bring should be highlighted and further explored.

- Improvement of energy efficiency on the demand side is essential – but the current incentives are too low, which must change.

- Energy savings should be promoted by the government through education to change attitudes and develop a culture of energy conservation.

- A greater focus on the challenge of network approval and construction is necessary.

- Technology innovation and deployment is crucial, and policies should be designed to enhance the pace of change.

- We face a high risk of being locked into low-efficiency power, transport and construction sectors: all parties need to *collectively* focus on preventing this from happening.

- Resource prices are a major issue – some benchmark commodity prices may change future technology choices. These prices also change from country to country in terms of resource availability and cost of resources. Tracking these issues moving forward may have a major impact on the shape of policies to come.

- While the power sector operates primarily at the national level, there is a need for a stronger emphasis on policy proposals directly linked to the international negotiation process – *What can be done at the international level to support the decarbonization of the sector?*

- With respect to international sectoral approaches, there is currently no specific definition to which everyone agrees. Work should be done to further explore this issue, acknowledging that the details of the concept will take time to define within the negotiations.

Project profile

represents total capacity of project members as of July 2008

Gross generating capacity	**381,640 MW**
Number of customers	**304 millions**
Large hydro capacity	**49,553 MW**
Other renewable capacity	**9,807 MW**
Nuclear capacity	**97,491 MW**
Natural gas capacity	**66,301 MW**
Advanced coal capacity	**6,380 MW**
Conventinal coal capacity	**89,603 MW**
Demand management	**650.4 MW**
Transmission & distribution	**3,036,162 km**
Transformers	**1,245,535 MVA**
Gas / liquid capacity	**25,933 MW**

- In dealing with adaptation, better coordination and communication between the scientific community, meteorologists, disaster recovery units and business would go a long way to improve risk assessment and response to climate change impacts.

The discussions from these dialogues provided critical feedback and were highly valuable for the finalization of this report. A focus on key regional priorities and policies provided a greater understanding of the challenges, necessary actions and policy measures that will enable business, government and civil society to collectively address climate change. While the answers are by no means clear, we hope that this document will contribute to an ongoing dialogue in finding solutions.

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 reductions.

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, combined cycle gas turbine (CCGT) generation technologies, as well as highly efficient end-use technologies (building insulation, lighting, heat pumps, 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$ 11.6 trillion in required investments by 2030. This represents a four-fold increase over the investment wave in the second half of the 20th century. More than half of these funds will be necessary to develop transmission and distribution networks, and the rest to meet demand growth requirements in developing countries, and replace ageing plants in developed countries. This provides 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.

"The view point of abundance always prevailed, because you can plan within it. It is more difficult to plan within constraint."

Johannesburg international roundtable, 2008

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.

> *"Governments should adopt climate policies and measures that the economy can withstand not only in times of prosperity but even in times of recession."*
>
> *Tokyo international roundtable, 2008*

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.

"We are in an energy crisis, and not enough is being done about it."

Johannesburg international roundtable, 2008

The purpose of this report is to describe the key features of this sectoral policies and measures framework at national and international levels. A detailed technology-by-technology analysis is included within the *Powering a low-carbon economy* booklet in the inside back cover of this document.

We have identified nine technology areas on which to focus policy building efforts, as well as crosscutting issues that will influence investment flows and the types of technologies that are implemented. Our analysis illustrates the types of policies and measures that are being used around the world today, or could be used to enable a range of technology options to meet their potential. To illustrate our analysis, we refer to the *International Energy Agency Energy Technology Perspectives 2008* ACT Map and BLUE Map scenarios for the power generation sector.

The 2008 ACT Map scenario illustrates the necessary actions to bring global emissions in 2050 back to 2005 levels. This would require urgent deployment of key technologies and major commitments by public authorities as well as industry. The BLUE Map scenario is the more aggressive of the two, and illustrates the *radical* actions, technology breakthroughs and investments necessary to achieve a 50% reduction in CO_2 emissions by 2050 (450 ppm stabilization case). Achieving this would require "urgent implementation of unprecedented and far-reaching new policies in the energy sector."[2]

It is therefore critically important that all low-carbon technologies be deployed rapidly. If this is not the case, atmospheric concentrations of greenhouse gas emissions will not stabilize as scheduled, and accessibility to electricity will not be realized.

The summary table of key elements provides an overview of:

- The key enabling technologies and demand-side measures
- The challenges that prevent these technologies from meeting their potential
- The role of electric utilities in scaling-up technology development and deployment
- The potential roles of governments and agencies through national policy development, the building of an effective international policy framework, and various support requirements such as financial support and R&D efforts.

We recognize that all of the approaches have potential merits, and that their effectiveness depends to a large extent on the jurisdictional context. We do not advocate any one approach in particular. 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. All actors across the supply chain havea major role to play, from technology developers through to electricity providers and end-consumers.

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

Electricity sector stabilization wedge
Energy & carbon dioxide savings potential in 2050
IEA Act Map
IEA Blue Map
Innovation & commercialization
R&D
Demonstration
Deployment
Cost competitive
End-use energy efficiency
(% gigawatt-hour / year savings, relative to baseline)
– 21 %
– 15 %
Heat pumps (including water heater)
Smart meters
Solid state lighting
Electric & plug-in vehicles
2000
2015
2030
Power generation
(Total CO_2 savings, gigatonnes / year)
14.1
18.3
Generation efficiency
(including combined heat and power)
0.8
0.4
Trigeneration
2000
2015
2030
Solar
1.3
2.5
Concetrated solar
Photovoltaic
2000
2015
2030
Wind
1.3
2.1
Onshore wind
Offshore wind
2000
2015
2030
Biomass & geothermal
0.3
2.1
Biomass gasification
Geothermal hot rock
2000
2015
2030
Hydropower
0.3
0.4
Hydropower
2000
2015
2030
Nuclear power
2
2.8
Generation III
Generation IV
2000
2015
2030
Advanced coal
(ultrasupercritical & integrated gasification combined cycle)
1.4
1.4
Ultra-supercritical (700°C)
Integrated gasification combined cycle
Underground coal gasification
2000
2015
2030
Fossil fuel generation with carbon capture
2.9
4.7
Pre-combustion
Post-combustion
Oxyfuel combustion
2000
2015
2030
Natural gas
3.8
1.8
G-series gas turbines
H-series gas turbines
2000
2015
2030
Transmission & Distribution (T&D)
T&D investment and upgrades are necessary for the optimal operation of generation facilities and stable network
Ultra-HVAC (> 1,000 kV)
Ultra-HVAC (> 800 kV)
2000
2015
2030

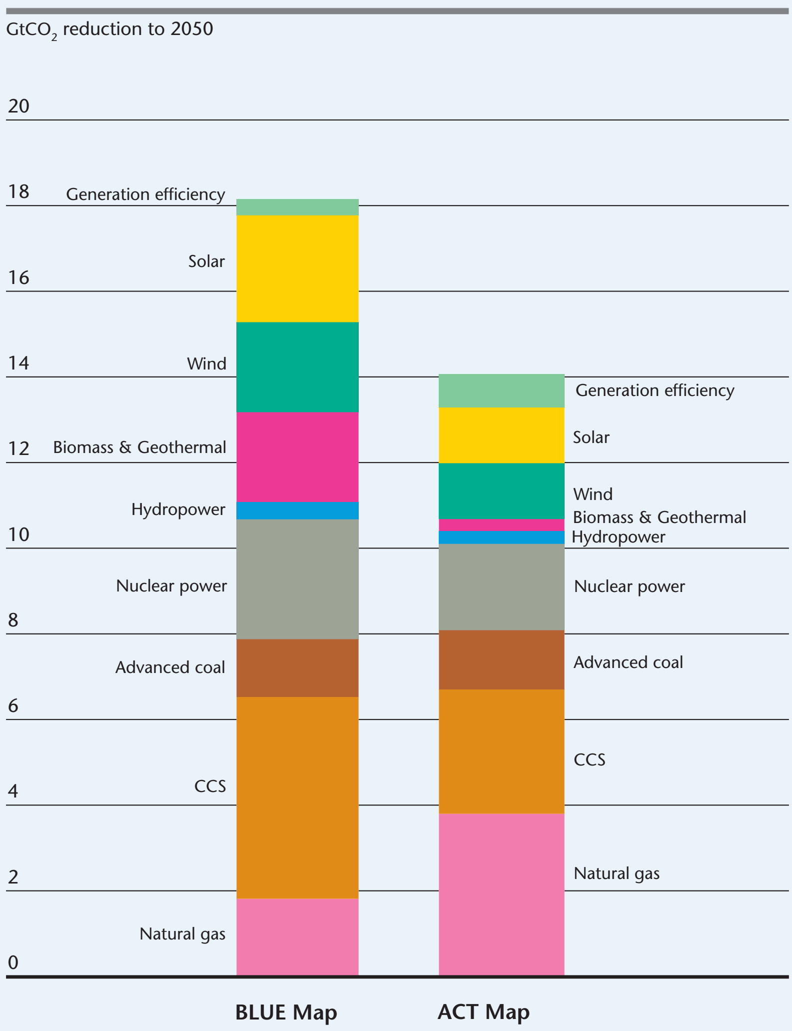
Challenges	Role of electric utilities
• A complex web of wide ranging options • Low awareness, low priority and low cost of energy • Business model misaligning the life-cycle costs and benefits	• Collaborate across sectors for energy savings • Promote deployment of electric technologies with lower value chain/life cycle CO_2 emissions • Promote consumer awareness
• Achieving these reductions will require radical actions, technology breakthroughs and large-scale investments, in addition to the "urgent implementation of unprecedented and far-reaching new policies in the energy sector" • Achieving the pace of change necessary given the current capital stock will be an immense challenge	• Engage stakeholders in energy policy dialogue on balancing carbon reductions with other key sustainability and energy security measures • Develop technology roadmaps • Invest in/operate large-scale, low-carbon, capital-intensive, long-lived power plants and transmission and distribution networks (T&D) • Ensure the provision of electricity
• Inadequate operational and maintenance practices and lack of knowledge • Low cost of some fuels • Lack of relevant knowledge for identification and implementation of combined heat and power (CHP) schemes	• Maintain and improve efficiency of operating plants • Invest in higher efficiency options for new plants
• High cost of generated power • Not in my backyard (NIMBY) attitude towards new sites • Variability and predictability of power generation and its impact on the grid	• Collaborate on R&D of new technologies • Test and demonstrate new technologies • Invest in multi-MW systems
• High cost of generated power • Not in my backyard (NIMBY) attitude towards new sites • Variability and predictability of power generation and its impact on the grid	• Integrate large scale variable output wind farms • Provide back up power and stability for the grid under the guaranteed scheme for incremental cost recovery
• High cost relative to conventional energy	• Cooperate on assessments of resource strength and reliability
• In developing countries (which have substantial resource potential), high capital cost for large projects, and limited financing resources • Shared concerns about social and environmental impacts	• Extend the power grid to remote facilities • Implement and share best practices for sustainability
• Safety • Public acceptance and NIMBY syndrome • Uncertainty in licensing and procedures leading to excessive construction cost and delay	• Operate safely and transparently • Invest in capital-intensive new plant projects for the long term
• Need for R&D and technology status improvement • Higher capital cost for advanced coal technologies • Lack of knowledge and technology in some regions	• Invest /operate large scale (> 200 MW) new plants and demonstrations
• High incremental cost for power generation • Undemonstrated use with different plants and fuels; undemonstrated technical storage feasibility, local potential and permanence in all regions • Lack of legal framework including liabilities for long-term CO_2 storage • Public acceptability and uncertainty related to safety	• Cross boarder cooperation on R&D • Demonstrate carbon capture from new or existing power plants at large scale (e.g., 1 million tonnes CO_2 per year) with public financial support
• Rising cost of natural gas • Tight gas supply market • NIMBY attitude towards new liquefied natural gas (LNG) infrastructure	• Invest/operate CCGT where gas is available and affordable
• Lack of incentive for investment • Unclear division of responsibility for the integration of renewables & distributed resources • NIMBY syndrome towards new T&D infrastructure	• Collaborate on R&D for smart grids • Invest in grid expansion and reinforcement

A contribution to discussions on sectoral approches

Domestic policies & measures to promote development (•) and deployment (•)		*International policies and measures to support cooperation and transfer of low-carbon technology in the electricity sector*
	• Promote understanding and realization of the true cost of energy • Adopt performance standards and labeling (e.g., for buildings and appliances) • Set national targets with financial incentives • Provide funding and support for energy R&D across sectors • Educate the public and provide training to the workforce	• Set up programmatic international flexibility mechanisms for programs of many small energy saving applications, allowing technology (e.g., efficiency lighting) and behavior (e.g., controls) based approaches • Provide an international platform for cooperation on energy-saving technology and policies • Invest in international public-private partnerships for technology transfer • Promote protection of intellectual property rights
• Include all sectors of the economy in emissions management • Establish long-term regulatory clarity, stability and certainty with regard to emissions • Provide guidance on the role of different resources in the future national energy mix • Recognize that the carbon price alone will not bring the necessary new technologies to the market	• Adopt policies and measures consistent with the differences in cost and maturity of low-carbon energy technologies • Create technology roadmaps and set development targets	• Recognize that energy resources and energy uses vary widely from country to country • Recognize that electricity markets vary widely from country to country, including both regulated monopolies and fully contestable markets, and many variations and combinations of these • Recognize that the electricity sector has many participants, both public and private, most of which are serving primarily local needs
• Set guidelines and clear incentives for higher efficiency • Provide public and private funding for R&D on breakthrough technologies	• Develop and promote programs for energy audits and optimization of operation & maintenance	• Provide platforms for transfer of knowledge and best practice • Develop efficiency and operational guidelines for new plants • Introduce programmatic international flexibility mechanisms for improvement of generation efficiency
• Invest in R&D for emerging technologies through public and private funding • Assess resource availability, reliability and costs • Invest in R&D for utility-scale electric energy storage	• Set achievable national targets • Provide for grid access and offtake provisions	• Set up programmatic international flexibility mechanisms for distributed solar • Provide a platform for international R&D exchange on breakthrough technologies
	• Set achievable national targets • Assess resource availability, reliability and costs • Provide for grid access and offtake provisions • Invest in R&D for utility-scale electricity storage	• Phase in domestic content requirements for new projects
• Invest in R&D for emerging technologies through public and private funding • Assess resource availability, reliability and costs • Invest in R&D for utility-scale electric energy storage	• Assess resource availability, reliability and costs • Provide for grid access and offtake provisions	• Provide public and private funding for demonstrations of new technologies in different countries
	• Develop a reliable institutional framework in the energy and water sector • Engage stakeholders on sustainability considerations • Streamline permitting process • Extend the grid to remote facilities • Support climate modeling and forecasting to help optimize development and operation	• Enhance opportunities for sustainable large hydropower within international flexibility mechanisms • Promote uptake of International Hydropower Association Assessment Guidelines
• Provide public funding for international collaborative R&D on Generation IV technologies	• Establish an independent safety authority and promote safety culture and stakeholder consultation • Clarify and streamline licensing and permitting procedures • Make relevant legal decisions with respect to long-term management of waste	• Collaborate on R&D for Generation IV nuclear power technologies • Recognize within the international flexibility mechanisms • Integrate technology transfer in nuclear power development agreements • Foster international cooperation and standards on safety, waste management and non-proliferation
• Provide funding for large scale (>250 MW) demonstrations of new combinations of plant and fuel • Sponsor basic R&D for high temperature resistant materials • Establish a stable investment environment that respects intellectual property rights		• Maintain eligibility of advanced coal within international flexibility mechanisms • Promote protection of intellectual property rights • Provide an international platform for sharing experience with new plant technologies in combination with different types of fuels
• Provide direct financial support for large scale (>1mt CO_2/year) demonstration projects • Map out carbon storage potential and preferred sites	• Establish legal framework to enable CCS • Take up liability for long-term storage of CO_2	• Develop models for regulating carbon storage in different countries • Provide public and private funding for early demonstrations of large-scale (>1mt CO_2 per year) power plants with CCS in different countries • Develop an international platform for national policy development on CCS • Recognize CCS through international flexibility mechanisms
	• Provide a clear regulatory framework for liquefied natural gas (LNG) and identify suitable locations for receiving terminals • Promote long-term predictability and stability in prices and delivery of natural gas • Provide guidance on the best opportunities for combined heat and power (CHP)	
• Provide funding for R&D on high-power electronics and superconductors • Provide funding for R&D on smart grids with variable and distributed resources	• Adopt clear policy with adequate return on investment in regulated T&D infrastructure, and incentives for superior reliability and efficiency • Establish clear roles & responsibilities for integration of renewables & distributed resources, and provision on backup power	

FIGURE 1

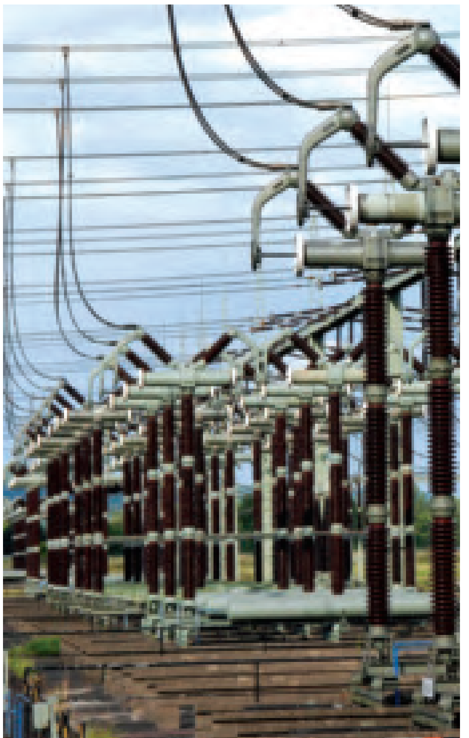
CO_2 reduction within the power generation sector by contributing factor based on ACT Map and BLUE Map scenarios



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 and adaptation 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 grids 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 almost triple between 2005 and 2050 and that emissions from the sector will increase from about 10 to 26 Gt CO_2. Their alternative ACT Map scenario suggests a decrease of about 14 Gt CO_2 below "business as usual" (baseline) by 2050, but in order to confine global warming to between 2-2.4°C by 2050, the BLUE Map scenario projects a necessary 18 Gt CO_2 reduction by 2050 within the sector.

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.

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. Appropriate policies should be established now for all stages of all technology to provide a long continuum of support for and certainty to technology vendors, the electricity sector and policy-makers that the technology will be deployed on time and be affordable. This calls for different types of policy intervention, as indicated in table 1 and described below.

Technology situation 1

Some end-use or carbon-free generation technologies, such as housing insulation, hydro or nuclear power generation are mature and competitive. They urgently require regulation that builds public acceptance and fosters successful implementation at a larger scale in different countries. 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 Association (IHA) Sustainability Assessment Protocol
- Ensure that clear and transparent licensing and safety procedures are in place for nuclear power
- Provide favorable investment frameworks through rigorous energy and resource planning such as governmental options assessment at the regional and national levels.

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 onshore wind power in average quality locations or heat pumps for cooling and 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, market-based support schemes or other 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, generation IV nuclear or ocean energies are promising but not yet mature. The basic need for these technologies is to accelerate research and development and boost the 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 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. At the same time, effective policies for technology development in one region can have positive impacts on technology deployment to other regions.

Policies must also take into account the fact that technology systems may require the deployment of individual technologies that 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 are technically unproven for certain types of coal. Geological carbon storage is still in an 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.

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	• 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

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 emission allowances, green certificates, 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 indispensable tools for implementing policies aimed at reducing emissions or increasing energy efficiency.

The effectiveness of a mechanism depends critically on the quality of its design, as highlighted in the box on cap & trade on page 19. 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 requires substantial front-end consumer investment and has 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. Building on these schemes, one way of efficiently achieving global emissions reductions can be through trading of emission allowances or carbon credits under a global cap, which would potentially substantially decrease the cost of emissions reductions making electricity more affordable and accessible. Details of this mechanism are elaborated within the WBCSD's *Establishing a Global Carbon Market publication*.

"At a time when inflation is a main concern in the emerging and developed world, realistic pricing may remain a utopia for a long time to come."

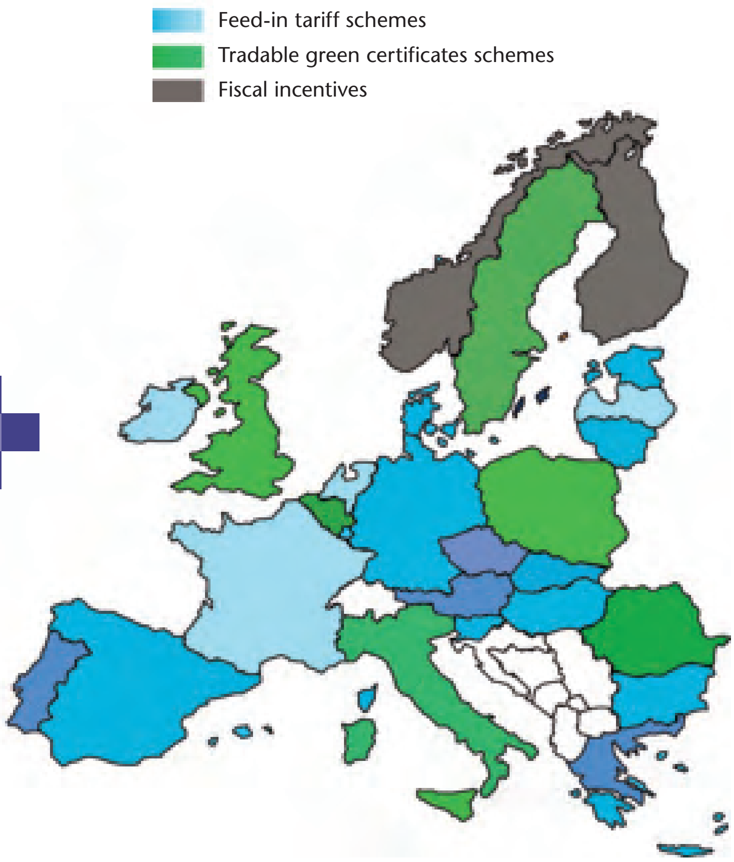
Stakeholder commentary

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 pump 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 21 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.

Europe 2008



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 (see box on page 19), some on tradable renewable certificates (see box in *Powering a low-carbon economy* booklet) 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 cost-effective option as it would allow the optimization of EU resource potential across borders.

Feed-in tariffs

Feed-in electricity tariffs were introduced in Germany as an effective practice in encouraging the use of new renewable energy technologies to generate electricity. Under the German feed-in tariff regime, grid operators are required by law to purchase electricity from all qualified renewable energy suppliers at fixed rates, while retail companies shift the additional purchase cost to the selling price. Each approved technology is eligible for a different feed-in rate depending on the maturity of the technology. The feed-in tariffs are lowered every year for each technology to encourage more efficient energy production. The feed-in tariff system will play a role in meeting Germany's renewable energy target of 12.5 % of electricity consumption in 2010 and 20 % in 2020.

Concern has recently been voiced regarding the introduction of feed-in tariffs for technologies that are too far away from commercial maturity and still require significant R&D support. The German legislature has decided to lower the feed-in tariffs for solar power as of 1 January 2009. In view of significant costs, Spain imposed an annual cap of 400 MW on newly installed solar power. In Italy, costs resulting from a projected 1,500 MW of installed solar power are estimated to reach more than € 1 billion per year.

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 to attribute a market value to emission reductions that are otherwise unaccounted for in traditional markets. C&T systems, for example, the North American acid rain program, have had some success. 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 a long period of time, 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.

" 'Moderate in material consumption and rich in spiritual pursuit' should prevail over competing for luxury. Energy saving should take root in the heart, and create a culture of energy saving."

Beijing international roundtable, 2008

" We should recognize that if we have to halve global emissions by 2050, we have no options other than further electrification."
Tokyo international roundtable, 2008

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)
- Enabling policy environments, which for example, integrate efficiency standards into building requirements
- 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.

Performance standard

An energy efficiency performance standard: a flexible market-based approach to deploy energy efficiency as an energy resource to help meet customer needs through energy-efficiency programs requires utilities to achieve electricity or natural gas savings equal to a set percentage of their baseline sales or load through energy-efficiency programs.

Japan's top runner program
The Top Runner Program was introduced in 1998 in order to curb increasing energy consumption in the commercial and transportation sectors by improving energy efficiency in appliances and vehicles. The program uses a maximum standard value system under which targets are set based on the value of the most energy-efficient products on the market at the time of value setting. The system therefore gives manufacturers incentive to develop more energy-efficient equipment.

Since 1997, the energy efficiency of air-conditioners has improved by 70% and the fuel efficiency of passenger vehicles has already achieved 22% improvement, although the target for 2010 is set at 23%.

The success of the program has been underpinned by the important information dissemination and labeling processes that enable consumers to make an informed choice.

"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 for ensuring 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 that 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.

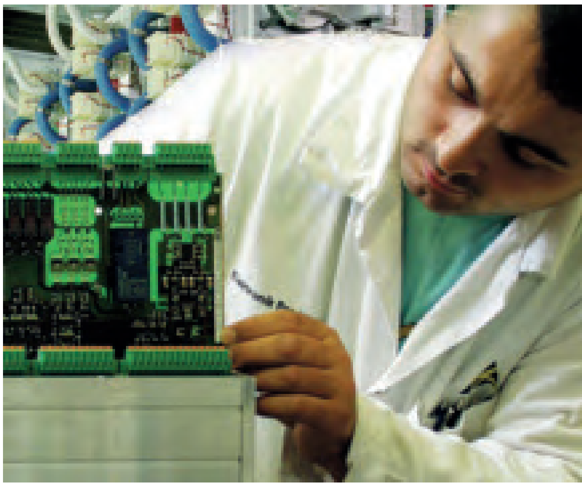
It is critical that, as a whole, technology development programs cover a wide range of technology options. Given the plethora of national and local conditions, resources and policies, these technologies must be developed in parallel rather than sequentially in order to bring them to market in time to 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 CCS technologies at the local level. Because the use of coal and natural gas are expected to increase into the future, it is critical that CCS be commercialized to be retrofitted to existing fleets, and built as part of future plants where appropriate storage potential is expected. These direct CO_2 emissions reductions are essential to stabilize atmospheric concentrations of CO_2.

" There is no incentive for the 'transferor' of technology."

Beijing international roundtable, 2008

There is a great need for public funding for additional large-scale demonstration projects around the world. The cancellation of the FutureGen global initiative for clean coal, in which public and private sector participants were jointly funding and guiding the research, is one example of the challenge in seeing such collaborations to a successful conclusion. These projects should be closely linked to capacity-building initiatives, particularly in developing countries, and allow for wide diffusion of intellectual property.



Enabling developed and devel and deployment

There are many existing lower carbon technologies. However a significant change in the way in which the world develops and deploys new and existing technologies will have to be realized in order to accelerate the *pace* of change of the electricity sector towards a lower carbon future. Fulfilling the objectives of the "road map" adopted last year in Bali will require national and global policies aimed at rapidly scaling up technology transfer. This will require changes in international and national policies and collaboration in R&D but also in financial policies and approaches needed to attract the capital required to develop and deploy new low-carbon emitting electric generating and delivery technologies.

According to the International Energy Agency, over 10 trillion dollars in the coming decades will be required to satisfy new power demand with advanced low CO_2 emitting generation and delivery technologies and end-use efficiency. Public sector funding will only be able to underwrite some of this new technology deployment. Business follows new growth opportunities, often bringing new technologies. As many companies have a global reach through markets or supply chains, business has a key role to play in the diffusion and deployment of technologies. But given the scale of the problem and the pace of change required, it is not something that can be done in isolation. It will require broad based collaboration and partnerships across a wide variety of sectors and stakeholders.

As described above, the level and type of policy required to promote technology development and deployment will vary depending on the level of commercialization of technologies and the same is true for the type of investment required. For example, commercially available technologies are, in most cases, inherently less risky than technologies that have not been commercially proven. For these types

G8 Support for CCS

The G8 plus China, India and South Korea re-affirmed their commitment to 20 large scale CCS projects by 2020 at a meeting in Japan in June 2008. Yet at least four major clean fossil fuel power projects with CCS have been cancelled or funding put at risk in 2007 and 2008 due to a combination of significantly higher than expected costs, challenges of enhanced oil recovery, and lack of government funding. Without a significant increase in public funds for CCS power projects, CCS will not be commercialized in time to fill its potential for emissions reductions by 2050.

2007 also saw the cancellation of several large IGCC coal power plants, in part due to rising construction costs and to uncertainties over future emissions regulations.

Reference plant approval

The competitiveness of nuclear power depends on a smooth regulatory process and adoption of a standardized design. In France, a standardized plant design was licensed by the national safety authority and then deployed in series, taking advantage of significant economies of scale. In the US, however, many nuclear projects in the 1970s had large budget overruns because of evolving regulatory requirements leading to frequent revisions of non-standardized designs. In the current US regime, more extensive previews and licensing for a design with minimal local adaptations are being adopted to avoid repeating the experience.

Nuclear plants have higher capital costs and lower fuel costs than coal plants. The capital cost and the length of time required for permitting a nuclear facility both contribute to investment risk of nuclear power. Favorable government policies can be helpful in overcoming these barriers. The trend today in the US is to certify specific reactor designs that could then be used by any utility, subject to the specifics of the selected site. The US is also introducing an Early Site Permit process so as to address public issues earlier in the process. Even so, the permitting process for nuclear is likely to be longer than for conventional plants.

of technologies, the additional cash flow generated from mechanisms such as the Clean Development Mechanism (CDM) or other future mechanisms may be sufficient in order to make the business case and the policies required to support them may be national standards or incentive based mechanisms such as tax breaks.

Technologies that are near commercial may require more complex financing mechanisms with some up-front capital support being required in addition to a stream of CDM-related credits. For many developing countries for which affordability is a key consideration, covering the incremental costs of new technology deployment will be critical. Thus projects need to be assessed in their entirety and, where equity investments are required, processes for identifying and linking investors need to be identified.

Those technologies in the development phase and which have significantly more risk associated with them may require public-private partnerships or multinational funds to finance a suite of pilot projects or accelerate R&D on a global scale. This would be the case for technologies with a high potential impact for reducing global emissions that could be deployed on a global scale and where the pace of development is too slow to meet the large scale reductions required. This will mean that countries will need policies that are attractive for investment in R&D and the deployment of power generation and transmission on a commercial basis. They may also potentially need to make financial commitments to global research funds.

In order to ensure that the full life cycle of technology development and deployment happens on a global scale, practical business-oriented options to financing the deployment of technologies will be needed. For example, the G8 has created a multi-billion dollar Clean Technology Fund and intends to use other instruments such as the Global Environment Facility (GEF) and public-private partnerships to help finance development and deployment. It is critical that these funds be well managed to help ensure that they are effectively used to accelerate new technology deployment and dissemination according to market principles.

In addition to pooled funds, the following financing strategies are critical:

- Securing and encouraging foreign direct investment (including innovative regulation)
- Accessing the capital markets
- Establishing joint ventures
- Investing in Clean Development Mechanism projects that provide carbon emission reduction credits
- Eliminating financial barriers e.g., limits on foreign investment, import taxes
- Providing financial resources for R&D, cost reduction incentives
- Creating tariffs that recover costs and a reasonable rate of return for potential investors in the market
- Using power purchase agreements to encourage and guarantee investment.

Where appropriate, organizations that already have international outreach programs such as the World Bank and United Nations Environment Programme Sustainable Energy Finance Initiative (UNEP SEFI) would also be included. The G8 governments, the World Bank and UNEP SEFI could help provide access and facilitate working relationships between the private sector, G8 nations and developing countries.

One of the key market-based mechanisms is grounded in the Kyoto Protocol's Clean Development Mechanism (CDM), which should be revised and enhanced in order to further meet the needs of developing countries' access to clean technologies, and achieve the large-scale clean energy technology development and emissions reductions originally envisaged. The implementation of projects in developing countries has enabled operators in developed countries to draw Certified Emissions Reductions (CER) worth 202 million tons of CO_2eq.[5] Yet this figure represents a mere 4% of total EU emissions.

"CDM is indispensable for the encouragement of wind power in China. It provides more than 10% of the total income for wind power companies. Without this, wind is not commercially viable."

Beijing international roundtable, 2008

Barriers include the low level of capacity to identify, implement and facilitate the approval process for projects, high transaction costs (which are prohibitive for many small projects) stringent 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 or any future mechanism developed as follows:

- A longer term price signal needs to be clear
- There should be no exclusions of low-carbon technologies from the CDM or future mechanisms
- Methodologies for programmatic and small scale CDM need to be established in order to streamline the large scale roll out of key technologies and provide sustainable development benefits
- A variety of mechanisms for dealing with risk and uncertainty need to be established and implemented in order to facilitate large volumes of additional projects, including proposals on how to ensure environmental integrity while at the same time encouraging new projects
- The capacity for processing projects at the Executive Board level needs to be increased and costs decreased
- Emerging emission trading schemes need to be linked with the CDM or future mechanisms in order to provide a large and more stable market while leveraging cost benefits.

The technology development and deployment question is central to success in the global drive to reduce greenhouse gas emissions. There are many issues that need to be clarified, including, in some cases, intellectual property rights. The critical policy issues are however those that provide enabling frameworks for investment as well as identify the various funding and financing requirements. These vary not only regionally but are dependent on the developmental status of the technology and on the mechanisms in place to allow access to these sources of funding.

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 to the negative impacts of climate change requires a holistic long-term perspective that considers risks, opportunities and limitations. The international process is looking to provide support for governments to take action, including legislation, regulations and incentives to mandate or facilitate changes in socio-economic systems aimed at reducing vulnerability to climate change and increasing resilience. This essentially means incorporating adaptation plans into national developmental plans. Adaptation therefore requires a basket of options from information to technology to finances and an enabling policy environment that facilitates the development of adaptive capacity, resilience and risk management. The international process is important to guide national processes that in turn will guide local responses and business input is essential at every level: the role of business – and the opportunity presented – is enormous. In addition, for adaptation to be meaningful at a business planning level, its principles and requirements need to be deeply embedded in the decision-making process and this in itself requires businesses to adapt from business as usual.

" Science still needs work – but communication can be vastly improved with what is already out there and how business and government can use it."

Johannesburg international roundtable, 2008

For electricity utilities this is particularly important given the large footprint most utilities have across their areas of operations. Climate change impacts on infrastructure and resource availability may significantly affect the ability of utilities to provide electricity. It is for this reason that adaptation is not a new issue for electricity utilities. It is implicit in their sustainable development and risk management strategies and for many utilities is becoming more and more mainstream. Many utilities are in the process of developing adaptation strategies that are linked to national adaptation plans or strategies.

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
- The possibility of downscaling global climate models to determine local impacts in areas of operation
- 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 new policies utilities will require in order to adapt operations; for example, the impact of droughts on hydro power as well as cooling technologies for power generation from non-hydro plants

- What technologies and R&D need to be deployed and developed to limit damage and to increase the sector's ability to adapt
- What technological advances in the mitigation space can be applied to adaptation needs as well; for example, smart grids that improve the efficiency of the grid but also allow flexibility to manage the load should circumstances require.

For the utility sector, it is clear that strategies and plans to address adaptation based on the negative impacts of climate change are necessary no matter how the international negotiations unfold – as these impacts are already being felt and have already affected operations in certain instances. For example, the growing severity of floods and droughts highlights the need for a comprehensive approach that includes structural measures such as reservoirs and dikes and also non-structural measures such as land-use regulation and guidance. It is for this reason that governments must be urged to make tangible progress in the area of adaptation. The utility sector can make valuable contributions through:

- Profiling existing activities
- Ensuring that a realistic and holistic policy is developed that maximizes opportunities and minimizes risk across a broad spectrum of activities
- Guiding governments in integrating adaptation issues into long-term infrastructure development
- Leveraging resources and building local capacity where plants and operations are located
- Minimizing risk by the development and implementation of robust early warning systems to protect assets and other capital
- Sharing experience in terms of resilience and adaptive capacity that other businesses can start incorporating in decision-making processes
- Supporting strong integrated infrastructure planning and policy environments that promote coordinated disaster recoveryplans and mechanisms.

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 effective responses.

Contributing to the dialogue on sectoral approaches within the electricity sector

The Bali action plan underlines the possibility for business to formulate concrete proposals for an effective contribution to climate change mitigation and adaptation. In this regard, negotiators made an explicit reference to cooperative sectoral approaches as one of the ways forward. The proposals for policies and measures put forward within this report, with due consideration of each individual country's specificities as well as the electricity sector's particularities, can contribute to defining a potential sectoral approach for the power sector.

With 41 % of energy-related carbon emissions, it is no surprise that the electricity industry has drawn much interest for sectoral scrutiny. But as described within this report, the range of technology options, their development status, the quality and availability of energy resources, the costs of deployment, and the market structure significantly impact decisions made at the national level. No one sectoral measure can deploy all technologies that are urgently needed, nor is there any single suite of measures that could achieve least cost decarbonization in all nations.

It is for this reason that setting out a common understanding of the electricity sector's challenges and opportunities, understood by all relevant stakeholders worldwide, including operators, public authorities, customers, national and international agencies, is an essential first step in leading the sector towards decarbonization through the development of effective policies and measures. This understanding should extend over the whole spectrum of technologies as well as their respective costs and maturity timeframes. We believe our report provides a useful contribution in this regard.

A sectoral approach for the electricity sector should therefore be developed according to the inherent specificities of the electricity industry:

- It is highly fragmented on a global scale, with its 10 biggest corporations together making up no more than around 10 % of global electricity output. The majority of the world's electricity companies, with a few exceptions, are primarily active in their home markets.
- Policies in the electricity sector are still overwhelmingly devised and implemented at the national level. National energy policy can also be closely integrated into the decision-making of electricity companies, especially as a secure, reliable supply of electricity underpins economic growth, particularly in developing countries.
- The spectrum of technologies used for electricity generation is extremely wide and so is their range of direct carbon emissions: from 0 for hydro or nuclear to 1,000g/KWh for subcritical coal-fired generation. In addition, the potential use of technologies is largely dependent on local sources of primary energy.
- In contrast to other industrial sectors, the challenge for the electricity sector should not be to establish benchmarks by technology (mandatory performance standards), due to the huge spectrum of technical, geographical, environmental and market parameters involved in the construction and operation of plants. The real challenge is to achieve, over time, the decarbonization of the electricity mix, which low- and zero-carbon technologies will allow. This has an impact not only on the electricity sector's own contribution to climate change mitigation, but also on other industries' potential to mitigate, through substitution of electricity for fossil fuels in their own production processes.

Considering the priority of decarbonizing the electricity mix as much as the sector's specificities, a sectoral approach in electricity could consist of:

At the national or regional level, public policies that enable authorities to identify the most appropriate zero or low-emission technologies in accordance with local or regional contexts. These policies should also support the identification of the most appropriate tools to deploy these technologies and other policy mechanisms such as for the promotion of energy efficiency, from demand-side management to electrification and substitution. An intensive dialogue on best practices between business and governments can ease a swift implementation of these tools. In this regard again, our report suggests a wide range of useful policy instruments.

At the international level, technology cooperation and scaled-up technology transfer. This will require, as addressed in page 24 of our report:

- Adapted regulation (i.e., facilitated joint-ventures, favorable cross-border fiscal policies)
- New price instruments, such as enhanced CDMs that include all low-carbon technologies
- Collaborative research and joint R&D for promising technologies such as generation IV nuclear, photovoltaics or CCS. Options, timelines and measures will of course have to be taken into account by individual countries according to their own energy choices and sustainable development policies and measures.

An international sectoral approach cannot and should not be a substitute for national energy policy, nor for intergovernmental agreements and would have to be developed under the leadership of national governments. This will guarantee that each decision is tailored to each individual country's needs and possibilities and complies with its current sustainable development policies and measures. Such a sectoral approach would enable, on a bottom-up basis, the assessment and coordination of energy policies among countries involved in order for them to move together towards the objective of lower greenhouse gas emissions. They would thus act as a preliminary basis for further in-depth discussions on global burden-sharing, in effective compliance with the principle of "common but differentiated responsibility" set out by the UNFCCC.

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 2008 : Scenarios and Strategies to 2050*, 2007. All scenarios built in this study as an alternative to the "baseline scenario" assume accelerated development and deployment of low-carbon and carbon-free technological solutions through dedicated public policies. The BLUE Map scenario is the most aggressive in terms of both technological innovation and diffusion, enabling the stabilization of global temperature rise to between 2-2.4°C.

[3] The ultra-supercritical 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 for R&D might appear preferable instead.

[5] United Nations Framework Convention on Climate Change, "CDM Statistics", http ://cdm.unfccc.int/Statistics/Issuance/CERsRequestedIssuedBarChart.html (accessed 24 October 2008)

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 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 cooperation.

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 development.

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.

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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;

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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.

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Acknowledgements

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Joe Hogan (ABB)
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Jacob Maroga (ESKOM)

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Adam Roscoe (ABB), Dennis Welch, Paul Loeffelman, Kristy Monk, Marty Mcbroom, Bruce Braine, Scott Weaver (AEP), Gail Kendall, Simeon Cheng (CLP), Jean Paul Bouttes, François Dassa, David Bornstain (EDF), Wendy Poulton, Mandy Rambharos (ESKOM), Christine Faure-Fedigan, Philippe Opdenacker (GDF SUEZ), Masashi Nishikawa (Kansai), Live Dokka, Mette Vagnes Eriksen, Oluf Ulseth (Statkraft), Yoshiharu Tachibana, Ikuo Nishimura, Hiroyuki Takahashi, Masahiro Sugimura (TEPCO)

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This publication was developed by the Electricity Utilities Sector Project working group, who wish to thank Antonia Gawel and Christian Kornevall of the WBCSD Secretariat for their contribution.

Disclaimer

This report is a result of collaborative work among executives from ten member companies of the WBCSD Electricity Utilities Sector Project. This work was convened and supported by the WBCSD Secretariat. All member companies of the project have thoroughly reviewed drafts of the report. However, this does not mean that every member company necessarily agrees with every statement in the report.

Photo credits: CLP, Flickr (Koert Michiels, Phertronnic, Twentyeight), iStockphotos
ISBN: 978-3-940388-33-9

Printer: Atar Roto Presse SA, Switzerland
Printed on paper containing 50% recycled content and 50% from mainly certified forests (FSC and PEFC) 100% chlorine free. ISO 14001 certified mill.

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