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19thCAETS Convocation

Preliminary Summary and Conclusions
June 30, 2011

CAETS

International Council of
Academies of Engineering and
Technological Sciences

DEPLOYMENT OF LOW-EMISSIONS TECHNOLOGIES FOR ELECTRIC POWER GENERATION IN RESPONSE TO CLIMATE CHANGE

Working Group Report Executive Summary and Recommendations 1 September 2010

PROJECT BACKGROUND

The International Council of Academies of Engineering and Technological Sciences (CAETS) at its Council Meeting in Calgary, Canada, in July 2009 endorsed a project entitled *Evaluation of Strategies to Deploy Low Emissions Technologies for Electric Power Generation in Response to Climate Change*.

A CAETS Working Group was established comprising representatives of CAETS member academies¹. At a meeting in Tokyo from 2 to 3 March 2010, members of the Working Group:

- Presented reports of the status of energy and electricity generation and related developments in their countries;
- Formed the view that there is limited extant evidence to enable a systematic evaluation of technologies for electric power generation in response to climate change, other than levelised cost of electricity and real option values; and
- Identified key issues for the deployment of low emissions technologies.

Following that meeting, members of the Working Group prepared a report entitled: *Deployment of Low Emissions Technologies for Electric Power Generation in Response to Climate Change*². The report represents a joint effort to document the key technological issues being faced in the deployment of low-emission technologies for supplying electrical energy to meet the world's needs. The following Executive Summary, Collaboration and Issues and Recommendations are taken from the CAETS Working Group report.

¹The representatives on the CAETS Working Group are listed below:

- Australia - Australian Academy of Technological Sciences and Engineering
Dr Vaughan Beck (Chair) and Dr John Burgess
- Canada - Canadian Academy of Engineering
Professor Robert Evans
- Germany - acatech
Professor Dr Frank Behrendt
- India - Indian National Academy of Engineering
Professor Hanasoge S. Mukunda

- Japan - Engineering Academy of Japan
Dr Kozo Iizuka
- Korea - National Academy of Engineering of Korea
Professor Myungsook Oh
- South Africa - South African Academy of Engineering
Mr Willem du Preez
- UK - The Royal Academy of Engineering
Professor John Loughhead

² See: www.caets.org

CAETS is the International Council of Academies of Engineering and Technological Sciences, Inc. It consists of those national academies of engineering and technological sciences that have satisfied an agreed set of criteria for membership. It was established in 1978 and was incorporated as a charitable non-profit corporation in the District of Columbia (US) in 2000. Its Articles of Incorporation, Bylaws and Operating Procedures set down its objectives and governance arrangements. These documents and its membership and achievements are posted on the CAETS website, www.caets.org.

EXECUTIVE SUMMARY

There are massive technological and financial challenges involved in reducing greenhouse gas emissions from electricity generation while, at the same time, ensuring that sufficient electric power is available to meet the growing needs of the world. There are significant incentives and opportunities for CAETS to undertake collaborative work to facilitate the timely and cost-effective deployment of low-carbon generation technologies.

The primary challenge for the future of energy in a world combating climate change is that the global economy is predicted to grow four-fold by 2050, with commensurate benefits in improved standards of living, but the offsetting challenge that increased energy supply needed to support that growth must come from low-carbon-emission sources. Implementing low-carbon technologies on these scales will be costly, with high uncertainty and technical risk. Users will be paying a substantially higher price for the same service. The engineering challenge is also huge, to the extent that governments must provide strong leadership in technology development and deployment.

Financial modelling is a useful tool for evaluating critical energy generation and distribution infrastructure. A brief description is given of models that can be used to assess individual technologies and to aggregate a mix of technologies in response to demand scenarios. Because of the many potential low-carbon technologies and the variety of circumstances where they might be deployed, there is need for expert comment and evaluation of their technical and financial viability in order to inform public debate and government policy. This is a role that the engineering Academies around the world can undertake.

Electricity is increasingly being seen as the energy carrier of choice for transportation and there will be a movement towards an 'Electricity Economy'. The preferred means of road transport will most likely be the plug-in hybrid vehicle and electrical generation capacity will need to expand still further to meet this new market. To enable the increased use of low-emission technologies and to cater for the load-levelling potential of off-peak battery charging, the architecture of many existing grids will have to change, in particular with the introduction of smart grids.

With regard to the role of government, the relatively short timeframe, high risks and large costs involved in deploying new technologies mean that governments may need to take a leading role (for example, via policy development, regulation and funding support). At the basic R&D end of the development spectrum, there need to be further technical breakthroughs and cost reductions before renewable energy can supply a significant fraction of future energy needs. These will only be possible with continued long-term support by government. At the other end of the spectrum, innovative new technologies will need government support to continue to the demonstration and

deployment stages, even though the decision to take a technology to that commercial stage is best made by the private sector. The global nature of energy and climate issues calls for more international cooperation, supported by governments, especially in the area of rapid deployment of low-carbon technology. Such international cooperation allows sharing of knowledge of the basic science and technology. Governments can also share the burden of investing in expensive demonstration projects.

More efficient combustion technologies, carbon capture and storage, nuclear power and renewables will all have a place in future low-carbon electricity generation. There are also many opportunities for improved efficiency in the end-use of energy, both by industrial and domestic energy users. Global deployment of existing best practice in energy efficiency would deliver enormous reductions in carbon emissions without large development expenditure or risk.

The less-developed economies will show the fastest growth rates in energy requirements. Each country will probably develop its own portfolio of electricity-generating technologies drawn from a wider global set. They will be forced to rely for some time on fossil fuels but will improve energy-conversion efficiencies through new technologies. Many now rely heavily on biofuels and more efficient production of such fuels will need to occur. Smaller, distributed generation based on renewables will continue to be a feature of electrical energy supply in developing countries. Nuclear power will make an increasing contribution to the energy mix. Small reactors without on-site refuelling may be especially appropriate for the needs of developing economies.

Renewable energy sources will make an increasing contribution to global electricity supply. However, the potential of renewable energy, over at least the medium term, is inevitably limited by its variability and large land requirements. Dependence on topography and natural endowments means that the contribution of renewables to national energy requirements will vary from country to country. The overall global picture shows a continued reliance on fossil fuels, with some nuclear generation, over at least the medium term up to 2030.

The distributed and intermittent nature of many kinds of renewable energy generation introduces new demands on the design of the whole energy supply system (including transmission and distribution). Measurement and control – using information and communications technologies – will be carried out within so-called smart grids, with demand management an essential component. Such systems will rely heavily on the availability and implementation of appropriate standards for physical interfaces, communication protocols and common data formats. Because of the associated information flows, the introduction of these new technologies into the power supply system will raise a suite of new social issues and concerns to do with privacy and individual freedom.

COLLABORATION

One of the main conclusions of the CAETS Working Group is that CAETS has a major role to play in acting as a hub for international collaboration of engineers, technologists and scientists in the crucial matter of providing the world with secure, low-emission electricity at the lowest possible cost.

That collaboration should include efforts:

- to convey to governments and the public the serious dimension of the technical challenges ahead;
- to develop better ways for selecting the best generating technologies;
- to encourage further development in key technologies;
- to disseminate authoritative information about the benefits as well as the costs of competing electricity generating technologies; and
- to influence governments to provide the level of financial support to ensure technological success.

The CAETS Working Group report contains a number of issues and recommendations for future CAETS actions. These all involve collaboration between member Academies as well as with other bodies. There should be collaboration on communicating the huge challenge posed by the future need for secure low-carbon electricity, on encouraging government investment, on developing better financial evaluation models for different technologies, on publicly disseminating technically sound information on energy technology issues and on setting priorities for further technology development.

ISSUES AND RECOMMENDATIONS

1. **ISSUE:** The generation of electrical energy must expand to meet the growing demands of the world for more energy, especially in the form of electricity. A global revolution is needed in ways that energy is supplied and used. In the face of that growth, greenhouse gas emissions from electricity generation must nevertheless be reduced. Governments and the public need to understand and acknowledge the massive technological, engineering and financial challenges involved. **RECOMMENDATION:** *The members of CAETS should collaborate in the vital task of communicating these challenges globally.*
2. **ISSUE:** While solutions to the problems of providing more electricity with lower emissions must reside in new technologies, the technological and financial risks involved are great. Accordingly, governments must provide strong leadership (for example via policy development and funding) to support further technology development and deployment. **RECOMMENDATION:** *CAETS should actively encourage and persuade governments to provide the required leadership, as well as communicate to both governments and the public the significant technical risks still to be overcome with technologies such as carbon capture and storage and geothermal energy.*
3. **ISSUE:** There is limited sound, objective evidence to support systematic evaluation and selection of competing technologies for electric power generation in response to climate change. **RECOMMENDATION:** *As part of the strategy to advance knowledge in this field, CAETS should lead an international cooperative effort to assess and improve quantitative methodologies for determining financial and technical risks associated with deploying new electricity generating technologies.*
4. **ISSUE:** There is a need for more informed public debate to enable formation of enhanced public policy. **RECOMMENDATION:** *Using its favourable position for enabling international collaboration, CAETS should lead and support the development and dissemination of authoritative information about electricity generating technologies in both its member countries and more broadly, in order to encourage informed public debate and public policy.*
5. **ISSUE:** While every means of reducing carbon emissions should be pursued, there are several priority areas for further technology development. **RECOMMENDATION:** *CAETS should encourage focus on: Improved efficiency of energy end use and means of promoting efficient usage globally;*
 - a. *Basic research leading to technical breakthroughs and cost reductions in renewable energy;*
 - b. *Advanced nuclear reactors, as well as small nuclear reactors suited to distributed generation;*
 - c. *Research, development and commercialisation of carbon capture and storage technologies; and*
 - d. *New technology for electricity distribution networks, especially to optimise systems to handle fluctuating renewable sources and loads from charging electric vehicles.*
6. **ISSUE:** In view of the need for expanded use of nuclear energy for reducing emissions and meeting growing power needs, a global effort is required to ensure public understanding and resolution of major issues of concern in regard to safety and security of nuclear power generation. **RECOMMENDATION:** *CAETS should participate in this effort as well as cooperate in an exchange of experience in matters of safety and public attitudes in each country.*

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