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IEA role in international cooperation on clean energy

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We built our civilisation by harnessing energy, which is at the core of economic growth and prosperity. But in 2012, in a weak world economy, oil prices soared and carbon dioxide emissions from energy reached record highs. The ways we supply and use energy threaten our security, health, economic prosperity and environment. They are clearly unsustainable. Under current policies, both energy demand and emissions are likely to double by 2050. Despite considerable progress in development and deployment of clean energy technology, investments in fossil-fuel technologies continue to outpace investments in best available clean energy technologies. Continued heavy reliance on a narrow set of technologies and fossil fuels is a significant threat to energy security, stable economic growth and global welfare, as well as to the environment.

The IEA demonstrated in its *Energy Technology Perspectives 2012* publication that the strategic application of clean energy technologies could deliver benefits of enhanced energy security and sustainable economic development, while also reducing the impact on the environment. In fact, a development path that would cut energy-related emissions of CO2 in half by 2050 is not only technically possible, but would also bring global economic benefits. However, in the Tracking Clean Energy Progress 2013 report, The IEA's most recent comprehensive tracking of progress in clean energy technology, stark messages emerge: progress is not fast enough; glaring market failures are preventing adoption of clean energy solutions; considerable energy efficiency potential remains untapped; policies must better address the energy system as a whole; and energy-related research, development and demonstration all need to accelerate. But Alongside these grim conclusions there is positive news. In 2012, hybrid-electric vehicle sales passed the 1 million mark. Solar photovoltaic systems were being installed at a record pace. The costs of most clean energy technologies fell more rapidly than anticipated.

Energy efficiency, many types of renewable energy, carbon capture and storage, nuclear power and new transport technologies will all require widespread deployment if we are to achieve a more secure and sustainable future. However, development and deployment will not occur spontaneously. Every major country and sector of the economy must be involved and take strong and determined action, both unilaterally and in co-operation with other countries. The task is urgent if we are to make sure that investment decisions taken now do not saddle us with sub-optimal technologies in the long run.

The IEA has for decades had an important role to play in providing analysis of sustainable energy technology policies and in fostering international co-operation, including through its yearly *Energy Technology Perspectives (ETP)* publication, *Technology Roadmaps* and topical technology publications, as well as through activities of the IEA Energy Technology Network and the International Low-Carbon Energy Technology Platform, among others.

IEA international collaboration mechanisms

IEA Energy Technology Network

Scaling up existing low carbon technologies and developing and implementing innovative solutions can only be achieved through co-operation between multiple stakeholders. The IEA energy technology network provides the focus for such co-operation on energy technology and R&D supported by the IEA Secretariat. Under the guidance of the Committee on Energy Research and Technology (CERT), four Working Parties and 42 Implementing Agreements not only bring together more than 6 000 RD&D specialists and have completed more than 1 000 research projects, but also allow closer engagement with major IEA member and partner countries and the private sector. In addition to the synergies created to develop, demonstrate and deploy the most promising technology options, these collaborative efforts also help gather information on the potential impacts that the technology innovation process may have on energy policy goals, as well as on some cross-cutting policy issues that may be introduced by emerging technologies.

The IEA Implementing Agreements ("IAs") provide a mechanism for collaboration, research and analysis on energy technology. There are currently 41 IAs working in the areas of efficient end-use, fossil fuels, fusion and renewables.

Since the IA mechanism was created by the IEA Governing Board in 1975, participants have examined more than 1 400 topics in the energy field through applied research, testing, expert networks, databases, workshops and scientist exchanges. Key outcomes include crafting policy recommendations; setting international standards; developing recycling models; carrying out life-cycle assessments; analysing case studies; preparing best practice guidebooks and manuals; gathering important data; and building pilot or demonstration projects. During 2011-2012 alone, nearly 200 topics were examined, with the final results of 86 collaborative studies published and the initiation of a further 21 on a wide range of energy research topics, from the Life-Cycle Analysis of Transportation Fuels Pathways, to Barriers to the Implementation of Carbon, Capture and Storage, to Economical Superconductors and Equipment for the Power Sector, and many more.

Increasingly, the IA mechanism is being recognised as an effective means of international collaboration on energy technology and science, including beyond IEA Member countries. Organisations worldwide representing 51 countries, 58 non-governmental entities, and 4 international organisations currently participate in an IA. Currently, Partner countries represent 12% of all participations in IAs. The IEA continues to expand its efforts to grow the IA network, notably by presenting information about the value and work of the IAs at events in Partner countries (in 2012 - the Caspian Region, Russia and Asia in Beijing). The past year saw 14 new participations in IAs, five of which were from Partner countries and one of which was from an international organisation (International Thermonuclear Experimental Reactor).

International Low-Carbon Energy Technology Platform

Created in 2010 by the G8 and IEA Ministers, the Technology Platform is a tool for IEA engagement on low-carbon technologies, with IEA Members and with emerging and developing economies (Partner countries). The Platform serves as a means to disseminate IEA analyses and policy recommendations on low-carbon technologies and to enhance IEA brand in this field, as well as to share international best policy practice, for the deployment of low-carbon technologies globally and by helping countries implement such recommendations. In addition to 16 international, regional and national level workshops on low-carbon energy technologies, the Platform initiated the 'How2Guides' project to provide guidance on the development of national energy technology roadmaps.

High level international activity

The IEA continues to serve as a partner to efforts under the Clean Energy Ministerial (CEM) process. In addition to its contribution of its annual "Tracking Clean Energy Progress" report, the IEA continues its involvement in six technology-specific initiatives under the CEM. The IEA has an active (such as a high level of collaboration) or Secretariat role in: the Electric Vehicles Initiative (EVI), the International Smart Grid Action Network (ISGAN) (established as an IEA Implementing Agreement under the IEA Energy Technology Network), and the Carbon Capture Use and Storage Action Group (CCUS). In addition, the IEA acted as a participant alongside a number of other members in three other initiatives: the Clean Energy Solutions Centre, the Sustainable Development of Hydropower Initiatives, and the Multilateral Solar and Wind Working Group.

IEA Sustainable Energy Policy Analysis and Advice

Energy Efficiency Policy Analysis and Implementation

Energy efficiency offers a powerful and cost-effective tool for achieving a sustainable energy future. Energy efficiency provides a myriad of benefits, from health benefits to fiscal savings on fuel to reductions in GHG emissions. For example, Energy Technology Perspectives 2012 confirmed that energy efficiency offers the biggest scope for cutting emissions. Improvements in energy efficiency reduce the need for investment in energy infrastructure, cut fuel costs, increase competitiveness and improve consumer welfare. Environmental benefits are achieved from the reduction of greenhouse gases emissions and local air pollution. Energy security is increased with reduced reliance on imported fossil fuels and an improved balance of trade. In OECD countries, energy efficiency is an important tool to a wiser use of our energy resources and an important part of reinvigorating growth. Energy efficiency provides for a sounder growth path in emerging economies, and supports expanded access in poorer developing countries. The IEA will prioritise its work on promoting sound energy efficiency polices and their implementation, working with governments, development agencies and other energy efficiency organisations and bodies, such as the International Partnership for Energy Efficiency Co-operation (IPEEC).

The IEA's 25 Energy Efficiency Policy Recommendations (25 EEPR) are a useful framework for developing a suite of cost-effective polices that, when implemented fully, will drive substantial improvements in energy services and reduced demand for energy IEA member countries. They provide a useful basis to engage with Partner countries to develop a distinct suite of energy efficiency policies that are crafted to suit their needs and circumstances. A multilateral engagement

in developing this framework provides an effective vehicle to enrich the development of this suite of policies by providing for cross-country sharing of views and experience, including across Partner countries.

Energy, Climate and Environment Policy Analysis

The IEA also has an established track record on climate policy analysis, whether in the area of market mechanisms, or in informing the UNFCCC negotiations via the OECD/IEA Climate Change Expert Group. The IEA has extended its reach in this area to key partner countries such as China (notably on emissions trading and the electricity sector). As IEA countries seek to further engage partner countries on low-carbon energy choices, the IEA will continue to be an honest broker of best practice in the area of climate and energy policy integration.

Energy Technology Policy Analysis and Advice

Governments and other stakeholders have an urgent need for comprehensive and impartial advice to guide the development and deployment of the most appropriate energy technologies that will contribute to meeting overall energy policy objectives. IEA activities on technology policy focus on studies and assessments that advance the development and use of clean, clever and competitive energy technologies to enhance energy security, reduce environmental consequences from energy production and use and ensure economic development. These studies are conducted across a broad range of energy technologies including electricity generation, transmission and distribution and efficient and low-carbon endues technologies in buildings, industry and transport sectors. Cross-cutting issues relating to the integration of these various technologies into an intelligent and sustainable energy system also are a major focus of this work, which is undertaken to analyse and estimate the costs and benefits of developing and deploying cleaner and more efficient energy technology under various policy and market conditions. Indicators are used to track progress and identify opportunities for further action. Scenario analyses look at the most appropriate combinations of technologies to meet future energy policy goals. Roadmaps are used to identify barriers and measures to address them.

Work is undertaken to identify best practice in the design and monitoring of RD&D policies. The outputs help foster greater co-operation and communication on energy technology policy issues with national governments in IEA Member countries and key partner countries, other international organisations and the private sector.

Energy Technology Perspectives Programme

The focus of the ETP Programme is to provide advice to policy and decision makers on the potential of technology to contribute to policy and business objectives. The work focuses on the status and outlook for current and future energy technologies, what actions can accelerate progress, while considering regulatory and macro-economic drivers that influence technology pathways. The analysis is done bottom up, starting at sub sector level, and contains rich technology detail. The objective of the project is to identify technology development and deployment opportunities that can provide an energy system that enables secure and stable economic growth while minimising environmental impacts. Assessing options for cutting energy-related CO2 emissions in line with the targets set under the UNFCCC framework of limiting long-term global temperature increase to 2°C remains a central objective for the work.

Technology Roadmaps

In 2008, the G8 and other IEA member countries asked the IEA to develop an energy technology roadmap programme to accelerate the development and deployment of the major technologies needed to reach our ambitious goal of limiting global temperature increases to 2°C. The technology roadmaps are based on the Energy Technology Perspectives low carbon scenario and set out the policies and other actions that will be necessary to meet the scenario objectives. Technology roadmaps as developed by the IEA are aimed at addressing 3 main questions:

- Where are we today?
- How do we move forward?
- What are the near term actions to get us there?

The technology roadmap programme's approach involves engaging experts from industry, government, academia and research to work together with the IEA in developing an implementable strategy to accelerate the development and deployment of a given technology or realizing the energy and emissions reduction potential of a given industry sector. The roadmaps identify barriers in technology development, policy, finance, regulation and public acceptance and actions and milestones to guide implementation of the roadmap.

The IEA technology roadmap programme has published 21 global and 2 national roadmaps since 2009, and is now working on developing roadmaps for Building Envelope technologies, Energy Storage and Hydrogen, with a technology roadmap on Ocean Energy under consideration. The programme has also released a roadmap update of its Carbon Capture and Storage Technology Roadmap in July 2013, and is planning to release roadmap updates for its technology roadmaps for Wind in 2013 and for Solar and Nuclear in 2014.

Examples of Energy Technology Collaboration

Realising the importance of ALL energy sources: Fossil Fuels Technologies

Past and present, fossil fuels have played a major role globally in the provision of energy. Today, more than 80% of total primary energy demand satisfied by fossil fuels, with oil, gas and coal all used extensively across the power, industry, building and transport sectors. Over two-thirds of the world's electricity is currently generated from fossil fuels. However, as fossil fuels are also the primary source of anthropogenic greenhouse gas (GHG) emissions, this level of unabated use is clearly unsustainable. For both these reasons – its major role in the provision of energy and its contribution to the level of GHG emissions – fossil fuels continue to be addressed at all levels within the IEA.

Fossil fuels have historically and will continue to be the subject of important content in the IEA's annual two flagship publications, the World Energy Outlook (with its main focus on markets) and Energy Technology Perspectives (that focuses more on technology). Each of them provides policy advice to governments and decision makers across the energy sector. Additionally, there are many other publications each year that address fossil fuels, with the Medium Term Market Outlooks that are published annually on oil, gas and coal being key examples. Another major example is Resources to Reserves 2013, published earlier this year: with adequate resources of fossil fuels to meet the increasing energy demand for decades to come, Resources to Reserves 2013 investigates the

technology, prices and policies that can ensure resources are developed into proven reserves in financially viable and environmentally sustainable ways.

The IEA also supports a broad community of researchers in the area of fossil fuels, mainly through its Committee on Energy Research and Technology (CERT), and its subsidiary Working Party on Fossil Fuels. Under its mandate, the WPFF provides advice on the role of fossil fuel technologies to make a contribution to the reality of a sustainable and secure energy future to the IEA. Together with the six multilateral technology initiatives (or Implementing Agreements) that report to it, the Working Party has an integral role in supporting the IEA in meeting its energy policy goals. Implementing Agreements that report to the WPFF address both upstream and downstream fossil fuel technologies, covering topics such as high-efficiency, low-emissions coal; fluidised bed conversion technologies; carbon capture and storage; gas and oil technologies; and enhanced oil recovery.

Apart from its publications and its energy technology network, there are a number of other vehicles within the IEA that address fossil fuels. For example:

a) On 10 December 2012, an Experts Meeting on 'Cleaner and more efficient coal technologies in Russia and in the World' was held at Moscow's World Trade Centre. With attendance from around 50 international and national experts, the meeting was jointly organised by the IEA and InterRao under the auspices of the International Low-Carbon Energy Technology Platform (ILCETP).
b) A group of high level executives from coal-related industrial enterprises, established by the IEA to provide advice to the IEA on a wide range of issues relating to coal, meet during each year to actively progress its work programme throughout the year. The Coal Industry Advisory Board (CIAB) provides advice to the IEA through its joint IEA-CIAB meetings, as well as through workshop proceedings, publications and papers in which the CIAB plays a major part.

Finally, the IEA is very active in sharing messages from its analysis via international conferences, seminars and workshops. The IEA is held in high regard globally for the objectivity of its analysis, the quality of its publications and the value of its policy advice. As a result, representatives of the IEA are actively sought to share their views at international events. For example, representatives of the IEA will be sharing their views on fossil fuels technology at:

a) "Improving Efficiency of Coal-fired Power Plants", China Electricity Council's 42nd Annual Meeting for 300MW Power Plants, Dalian, China, 14 August 2013;
b) "Prospects for power generation from coal to 2050", Clean Coal Day in Japan 2013 International Symposium, Tokyo, Japan, 4-5 September 2013;
c) IEA Session on "New Technologies in the Energy Industry – from Vision to Reality", Kazenergy Eurasian Forum, Astana, Kazakhstan, 8-9 October 2013.

Enabling the future of the Energy System: Smart Grids

Global discussion and debate on smart grids has dramatically evolved over the last several years. By leveraging its convening authority, analytical capability and Technology Network, the IEA has played a major role in influencing this debate.

In 2009 the IEA developed definitional and scoping work on Smart Grids and published it as part of the Energy Technology Perspectives 2010. In support of this effort, broad advice was sought from the Technology Network, especially from two particular implementing agreements: Demand Side Management (DSM) and Electricity Networks Analysis, Research and Development (ENARD). This set the stage to proceed with a global Smart Grid Technology Roadmap.

Published in April 2011, the roadmap articulated the challenges of the smart grid discussion and pathways to using this technology to both directly contribute and enable other technologies to contribute to global climate goals. As a broad based systems technology that can provide many different services across the entire electricity system (as opposed to a generation technology or end-use technology that serves a single purpose in one part of the electricity system), Smart Grids required targeted consideration and analysis. A strong emphasis on the framework for debate and support of Smart Grids was a key outcome of the roadmap, to provide policy makers with the tools to make appropriate decisions in this highly complex technology arena.

As this work was proceeding, the during 2010 and 2011, the IEA membership, in partnership with members of the Clean Energy Ministerial, decided to form an implementing agreement focused on smart grids as part of the IEA Technology Network. Using the IEA's framework for global collaboration was a practical and efficient framework to fuel ongoing debate, analysis and support of global research, development and demonstration of Smart Grids. The International Smart Grid Action Network (ISGAN) was officially launched in April 2011 with over 20 member countries and is continuing to grow today.

More recently, the IEA continues to further contribute analytical content to the Smart Grid area. In Energy Technology Perspectives 2012, new analytical work on electricity networks and the role of Smart Grids was published, demonstrating costs and benefits in long term system planning and operation. The Tracking Clean energy Progress 2013 featured Smart Grids for the first time, indicating data challenges – both due to the fact that it is new technology area and as a broad based systems technology. Plans are currently in place to publish an update of the global Smart Grids Technology Roadmap and a How-to-Guide for developing such a roadmap at a national or regional level.

Conclusions: The Importance of Collaborative Innovation Mechanisms

Innovation is a key driver in the transition to a low-carbon economy. Technological change and development will significantly enhance the portfolio of options available and, over time, will bring down the cost of achieving global climate change goals. Governments have an important role in this context. They can help by creating an attractive environment for research, development and demonstration (RD&D) and safeguarding the drivers of innovation. Well-designed targeted technology policies on both the supply and demand sides are a fundamental ingredient in a strategy to accelerate innovation. While the specific combination of policy measures will depend on country circumstances, in all cases it will be important to set the appropriate framework to allow breakthroughs to happen.

For these reasons, the IEA carries out focussed analysis on best practice in R&D, facilitates cross-fertilisation between basic science research areas and energy research, and supports international

collaboration to share costs and increase results. The IEA Energy Technology Network is an ever-expanding, co-operative group of more than 6000 experts that support and encourage global technology collaboration, working in more than 40 independent, multilateral technology initiatives – the Implementing Agreements (IAs). The IAs encourage technology-related activities that support energy security, economic growth, environmental protection and engagement worldwide. Through a flexible and effective framework, the IA mechanism enables IEA member and non-member countries, businesses, industries, international organisations and non-government organisations to share research and best practice on existing and breakthrough technologies, to fill existing research gaps, to build pilot plants and to carry out deployment or demonstration programmes. To date, more than 1200 projects have been completed.