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# RESEARCH AND INNOVATION IN THE ENERGY SECTOR

During the coming decades, there are likely to be major changes in energy systems throughout the world as efforts are made to meet the growing demand for affordable energy and reconcile demand with the need to effectively address climate change. How will it be possible to supply a rapidly growing world population with energy in ways that are economically, environmentally and socially acceptable? Fostering research in the energy sector will undoubtedly be an important step on the way forward with the results of this research used to support innovation. In view of the global nature of the challenges at hand, international organisations including the OECD, the International Energy Agency (IEA) and the OECD's Nuclear Energy Agency (NEA) will play increasingly important roles.

## Including energy as a high-profile issue in the OECD Innovation Strategy

The OECD Innovation Strategy was launched by Ministers at the May 2007 OECD Ministerial Council Meeting to underpin a more comprehensive, coherent and timely understanding of the dynamics of innovation in today's economies, and how to promote, measure and assess such innovation. The importance ascribed to innovation has increased as economies become more dependent upon advanced use of knowledge. Innovation processes are changing as a result of many factors including, for example: the expanded flows of information, technology, capital, goods, services and people around the world; the internationalisation of research and development; the growing contribution to innovation of non-technological contributions; and the emergence of increasingly open innovation models.

Ensuring clean, cost-effective, efficient and reliable supplies of energy will be one of the most pressing challenges faced by societies throughout the world for decades to come. There are likely to be many consequent innovations in the generation, storage, transmission and use of energy. Some are likely to be specific: for example, better photovoltaic cells or mechanisms for carbon capture. Others may be systemic: new patterns of organisation of urban communities and the development and supply of key goods and services, which radically change the energy footprint of societies. Research is required both to understand and develop new technological options and to understand how these options combine to support innovation within and around the energy sector.

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In BIAC's view, the OECD, in close cooperation with its sister organisations, has an important role to play in proposing coherent and integrated policy packages to support innovation, focusing both on cross-cutting and specific policy areas, as well as energy-efficient use.

We therefore encourage the Organisations to consider innovation in the energy sector as a key priority area within the OECD Innovation Strategy, and to devote efforts to understanding how new and emerging energy technologies can effectively be brought into widespread use and how patterns of innovation can most effectively support the broader objectives of sufficient, clean, efficient and reliable energy supplies for present and future generations. Research in the energy sector, in our view, presents an ideal case study to exemplify recent and ongoing changes in global innovation and the cross-disciplinary strategy that the OECD intends to develop.

## The importance of energy efficient technologies

Research in the energy sector and the spread of environmentally friendly technology will undoubtedly be fundamental in making it possible to meet the world's growing energy needs in an economically, socially and environmentally responsible way. BIAC supports the need for innovation as one of the primary tools for developing balanced, sustainable energy policy. Both public and private sector research and development as well as new public-private and international cooperation will be of utmost importance.

According to the 2008 OECD Environment Outlook, world greenhouse gas (GHG) emissions are projected to grow by 37% by 2030 and by 52% to 2050 compared to 2005 levels, if no new policy action is introduced. The overarching nature of the global warming challenge bears significant consequences on nearly every sector of modern economies and poses challenges to all countries, developed and developing alike.

All sectors are likely to face growing pressures to reduce carbon footprints and achieve efficiency improvements in the production and use of energy. Solutions, therefore, require collective action, and depend upon an effective balance of responsibilities between the public and private sectors.

## Framework conditions for innovation within the energy system

Open markets, operating within a clear, stable and well-designed legal, fiscal and regulatory framework are the foundation for a well-functioning market that operates without distortions. Research into the technological bases of energy should not be considered in isolation from the integrated policies that reconcile economic, climate and security policy objectives. The knowledge provided by research is of limited value unless there are effective development pathways available to understand the utility of this knowledge and to drive down cost curves. Government-supported R&D programmes should therefore cover the broad range of possible energy technologies and sources, be based on sound science and tangible costs/risks and benefits over the total energy chain, and they should be properly integrated into the patterns of responsibility for energy supply and demand adopted in the host country.

Consequently, this research needs to be carried out using both public and private resources. In particular, governments need to provide support for the long-term risk aspects of research and development and provide the institutional support for basic research that ensures the community can draw upon the skills and resources of its universities and public research organisations when the need arises. At the same time, public policies should be designed to take into account the potential and complexities of environmentally beneficial innovations, as well as the incentive structure that encourages firms to innovate. The provision of an enabling framework for the private sector that facilitates the necessary financial flows and that encourages firms to address climate change is essential. BIAC considers the following issues as particularly important:

- Greater emphasis on international collaboration to foster R&D, which minimises unwarranted duplication and maximising opportunities for international cooperation in basic research by achieving critical mass across disciplinary boundaries;
- Cooperation between governments and the private sector for research on the range of energy technologies that are likely to lead to improvements;
- An overall policy framework, including a high quality IPR regime, that provides adequate incentives to create and adopt new technologies in all areas and that encourages the private sector to invest and engage in technology cooperation;
- Human resources for the energy sector, including relevant specialist subjects in university and adequate engineering capacity that is necessary to ensure ongoing maintenance and delivery of new generation and network infrastructure;
- A forward-looking and solution-oriented approach that looks beyond the energy sector and considers improvements that can be achieved through progress in other sectors, i.e. in key technologies such as information and communication technologies, micro- and nanotechnology, or biotechnology and understands the systemic dependence of different patterns of social development on energy supply and use;
- Trade and investment liberalisation to facilitate the diffusion of technology;
- Incentives to the banking sector in order to address the risks involved in R&D investments in the energy sector.

BIAC believes that the work of the IEA and OECD can play an important role in advising countries as to how to set a framework promoting research in the energy sector, benefit from the new dimensions of the innovation process and foster international cooperation.

## Addressing the range of energy options

It is important to ensure equitable treatment of different low-carbon technologies. The overall objective should be to step up development in a range of areas, develop existing technologies further while at the same time exploring new options. There is significant potential for reducing emissions by using and improving upon existing technologies that are

not yet realised at their full capacity. At the same time, the development of new approaches will also be essential, and this will require a policy framework that provides adequate incentives to create and stimulate adoption of the new underpinning technologies. As new innovations for different energy types are deployed into the market, there will often be a need for regulatory reform to facilitate and encourage this process.

Research and approaches within other disciplines can also bring about significant advances for energy technologies. Such disciplines include, to name but a few examples: materials research and the development of new materials for energy production; catalysis research and the development of processes that increase efficiency and the conservation of resources; and also biotechnology research, where synergies between gene technology, microbiology, process technology, chemistry and bioinformatics can optimise production processes and resource use.

Policy frameworks and R&D should consider the full range of efficiency improving technologies, including those that enable safe and more productive use of fossil fuels, nuclear energy, renewable energies, as well as technologies for carbon capture and storage. Public perception issues need to be addressed, in particular for those technologies that hold the potential to lead to major emissions reductions in an economically viable way, while not creating additional safety and security concerns. Some of these options, in particular where the OECD, IEA or NEA could have a key role, are briefly addressed hereafter.

### *Clean Fossil Fuels*

The vast majority of the world's primary energy demand is currently being met by fossil fuels. Demand by 2030 is expected to increase by 60%, with fossil fuels continuing to meet more than 80% of demand. This underlines the importance of understanding how to use fossil fuels cleanly and the scope for carbon abatement. A range of CO2 emissions reduction technologies exist, including: higher efficiency conversion processes, fuel switching to lower carbon alternatives (including co-firing), coal gasification, as well as carbon capture and storage (CCS), which should be recognised as a clean fossil fuel technology. CCS has an important role to play in reducing industrial CO2 emissions, especially those from large point sources. In addition to additional research, CCS requires the development of an appropriate regulatory framework as well as resolution of issues regarding liability for storage. A number of commercial challenges exist, including, but not limited to, the high cost of implementation and capital-intensive technology required. We encourage the IEA to continue its work on informing global cleaner fossil fuel activities, with particular emphasis on improving fossil plant efficiency and facilitating the expansion of CCS.

### *Fuel cells*

Fuel cells are an important part of the solution to today's energy challenges because they offer the potential of an efficient and flexible use of energy. The technology has the potential to provide clean, scalable and reliable energy. The many application areas for fuel cells fall into three main markets: stationary, transport and portable. In addition, a wide spectrum of fuels is in use including natural gas, biogas, hydrogen or methanol in a range of performance classes. In order to reduce the cost and increase the service of fuel cell systems and their

components, additional research is required. The costs and benefits of the different energy types required to produce the fuels should also be considered in this research.

### *Renewable energy*

Renewable energy technologies include solar power, wind power, hydroelectricity/micro hydro, biomass and biofuels (including waste), each of which have different roles to play in finding a sustainable energy policy for the future. Since the possibilities to use renewable energies are largely different, the need for research also differs greatly between the individual renewable energies. While renewable energy options are playing an increasingly important role in many countries' energy systems, their success is in some cases built on far-reaching support programmes. A central task of energy research should therefore be to achieve progress in cutting costs, with a view to ensuring economic viability over the medium to longer term.

### *Biofuels*

A renewable energy option that is currently heavily debated is biofuels. The OECD has carried out excellent analysis on the effects of biofuels, both positive and negative, and their interaction with other key policy objectives. Efforts to stimulate the research and development of second generation technologies could bring long-term improvements, although this will largely hinge upon national regulatory frameworks. In our view, the OECD and the IEA can continue to offer in-depth expertise towards this objective. BIAC's views on biofuels policy research are summarised in a forthcoming separate paper which will be submitted to the OECD, entitled "Considerations for Research on Biofuels".

### *Nuclear energy*

The use of nuclear energy is being re-evaluated in some national policy frameworks around the globe as progress in reactor technology has led to advances in safety, security and productivity. Nuclear energy can make a major contribution to sustainable energy production, but its public acceptance will largely depend on the degree to which society is convinced that nuclear energy can be produced and administered safely and that its waste can be safely stored. In order to build public trust, safety and security management have to not only protect against the consequences of human errors and model design defects, but also provide counter-measures against terrorist or criminal attacks, aircraft crashes, sabotage, and corruption. One of the most obvious advantages of nuclear energy is that it produces only a minimal amount of greenhouse gases while contributing large volumes of electricity. Additional research and development, coordinated at the international level, is needed to further explore the potential of nuclear energy and achieve further efficiency improvements. It is also important to explore safe ways of dealing with radioactive waste to reduce the long-term risk potential. The OECD Nuclear Energy Agency can play an important role in shedding further light on the potential of nuclear energy and the challenges to be addressed.

### *Distribution and End-use of energy*

High priority should be attached to the more efficient and sustainable distribution and use of energy, requiring research and innovation in a range of areas: grid construction, preferred

energy vectors, industrial process and production technology, requiring sector-specific research initiatives and solutions; technology options for the production of fuels and increased energy efficiency in the transport sector; as well as new building technology to improve the energy performance and increase the energy efficiency of buildings. Adequate research initiatives to increase energy efficiency in the range of end-uses of energy need to be given the utmost importance. We encourage the IEA to continue its successful work on energy efficiency addressing the range of energy uses. [1]

### *Systemic Innovation affecting energy demand*

The demand for energy depends to a large degree on the patterns of organisation that society adopts. These patterns change as a result of broad factors including trade patterns, division of labour, and provision of food and other resources. Looking beyond the scope of energy technologies, the OECD also addresses various fields which can contribute towards making the energy system more sustainable, including: information and communication technology (ICT); biotechnology; micro- and nanotechnology; and its general understanding of the economics of trade, competition and pricing. We encourage the OECD to give due attention to the link between innovation in these sectors and the contribution they can make to a more sustainable energy supply. Addressing global challenges, including climate change, should be given high priority in the Organisation's work on these technology options.

The above-mentioned list is not exhaustive, but focuses on specific areas where the OECD, IEA and NEA could add specific value. Other areas could be added, such as more efficient, cleaner combustion engine control systems that could improve the fuel economy of future vehicles; lighter, smaller and more durable high performance batteries for advanced transportation; hydrogen production and storage, to name just a few.

## Deployment of technology through open markets

In addition to research in the energy sector, due attention needs to be given to encouraging the global spread of innovative technologies, especially as non-OECD economies are becoming larger emitters. Technology cooperation and capacity building require trust, long-term commitment and clearly demonstrated mutual benefits for all partners to support this more integrated approach. Whether as a commercial transaction or as part of an overseas development assistance package, successful technology cooperation should be beneficial both for the host nation, by offering economic growth, better training of workforces and improved environmental management, and for the investor, in that it can be an attractive investment opportunity. The main vehicle for the transfer of technology will be the private sector, through its day-to-day business activities of technology development, foreign direct investment and technology sales and dissemination. OECD countries should continue to work with non-member countries to establish appropriate incentives to foster trade and

[1] BIAC issued a paper on energy efficiency in 2007.

investment liberalisation to encourage the spread of technologies through open markets and partnerships.

## Conclusion

As global energy demand rises, countries are realising that there is a growing need for policies aimed at diversifying energy supplies and changing the patterns of distribution and use of energy in order to ensure energy security, sustain economic development and reduce GHG emissions. In addition, consumer behaviour and changes in current practices, technological innovations and research in energy will be of crucial importance in achieving these goals. Energy research must create the basis for a sustainable, efficient energy supply in the world, which meets the social and economic needs of a growing population in the long term and in a secure and environment-friendly manner. In view of the enormous challenges we are facing today, no responsible option can be disregarded. Significant cuts in carbon emissions will be needed in the global response to climate change. What business users and producers require is a clear, stable, and sustainable policy framework which enables them to invest in energy research, seek broad cooperation and take advantage of the new dimensions of global innovation.

BIAC encourages the OECD, in close cooperation with its sister organisations, to consider energy research as a high profile issue in the context of the OECD Innovation Strategy, with a view to ensure that the issue can be addressed in a comprehensive and multi-disciplinary way. The Organisations have, in our view, a key role to play towards improving the conditions for innovation in the energy sector, thus helping to address the global challenge of ensuring reliable energy supply.