Summary Document
International Energy Agency (IEA) Expert Group on Science for Energy Meeting
Science for Energy: Improving Linkages to Accelerate Energy Technology Breakthroughs
4-5 May, 2009
IEA Secretariat, Paris, France

Background

The International Energy Agency's (IEA) Expert Group on Science for Energy (EGSE) is a recently-created advisory body mandated by the IEA's Committee on Energy Research and Technology (CERT) to bridge the gap between the basic science and applied energy research communities through information exchange and outreach to accelerate future technology breakthroughs. The EGSE expands on the efforts of its predecessor, the Ad-Hoc Group on Science and Energy Technologies (AHGSET). For more information about the EGSE, visit http://www.iea.org/about/egse.asp. With the above aim in mind, the IEA hosted a meeting on 4-5 May that included science and energy experts from around the world. Participants discussed the need for increased international collaboration and information exchange in the areas of basic science and applied energy research, along with what is needed for energy technology breakthroughs and whether mapping science for energy efforts is useful. This Summary Document attempts to capture the main points of discussion, with a particular emphasis on the brainstorming discussion session that was held at the end of the workshop. Comments on this document are welcome; please contact Tom Kerr at tom.kerr@iea.org to provide feedback.

Attendees

The EGSE Workshop had 40 attendees representing 17 different countries. Participants worked in the fields of basic science research, energy research, industry, academia, and government. The attendee list included EGSE members and general workshop participants.

Scene-Setting Panels

The IEA's Executive Director, Mr. Nobuo Tanaka, opened the workshop by outlining global energy and environmental challenges with an urgent call to action. Citing the *World Energy Outlook 2008* reference scenario, Mr. Tanaka called attention to the projected increase in CO_2 emissions between now and 2030 from non-OECD countries. Mr. Tanaka stressed that both OECD and non-OECD countries must work towards reducing CO_2 emissions through energy efficiency and clean energy technologies. To achieve energy technology goals for the future, he discussed the importance of long-term national policies and global agreement on climate change policies, coupled with R&D and market deployment of low-carbon technologies to bring costs down. The IEA is developing global technology roadmaps to support and ensure earlier commercialisation of these low-carbon technologies. In particular for the focus of this workshop, Mr. Tanaka highlighted the critical role that breakthroughs in energy technologies would play in allowing the world to achieve its ambitious emission reduction goals in the longer-term, i.e., from 2030-50. He asked for the EGSE's help in better defining the necessary breakthroughs.

Mr. Tanaka was followed on the opening panel by Mr. Douglas Ray of the U.S. Department of Energy's (USDOE) Pacific Northwest National Laboratory. Mr. Ray highlighted, from a scientist's perspective, the scientific challenges facing applied energy research and deployment of technologies.

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Mr. Ray emphasized the importance of moving away from carbon-based energy sources, which requires a better understanding of technology options such as biological systems, sequestration and fusion energy; however, he felt there should not be a discipline-specific list as all the options are cross-cutting and interdisciplinary partnerships are essential to achieve real breakthroughs. Mr. Ray concluded by saying that success requires that we focus on outcomes rather than picking technologies.

Mr. Robin Batterham of Rio Tinto, formerly the government of Australia's Chief Scientist, presented on the corporate and academy approach to science for energy activities, including areas for international collaboration. He highlighted a key challenge for new technologies: overcoming the increased risks and costs that are faced by new technologies when they attempt to scale up deployment. He stressed the need for increased focus on R&D to aid the scale-up and implementation of energy technologies. Mr. Batterham went on to describe some potential key areas for international collaboration to improve energy efficiency. He concluded with an outline of some of the benefits of collaboration and also suggested that significantly more time should be spent helping the public understand the work of science and energy research to garner support.

This opening panel was followed by a second scene-setting panel, which provided country and regional perspectives and current activities in the science for energy field. Mr. Jacques Bonnin of the European Commission (EC) discussed European Union (EU) technology challenges for the next 10 years, which will help meet the EU 2020 and 2050 greenhouse gas reduction targets. Mr. Bonnin presented the ''community'' as a vehicle to achieve the needed scientific breakthroughs in energy technology. He also highlighted some specific activities that can foster the application of basic research to energy, such as joint energy calls for proposals, the need to optimise use and development of research infrastructures, the importance of frontier research, and coordination of national policies. He concluded by summarising the EU's INNER programme, which has similar goals and activities to the EGSE.

Mr. Werner Weiss of the AEE - Institute for Sustainable Technologies followed with a technology-focused presentation on the strategic research agenda for solar thermal energy. Mr. Weiss highlighted that heating and cooling account for 49% of the EU's total energy demand and that reducing this must be a key area of focus for research. He went on to list the achievements and market development of solar thermal while stressing its long-term potential. Specifically, the long-term potential (2050) of solar thermal is to cover about 50% of the EU heat demand. However, he also stressed that to reach that potential, more research is needed to further develop solar capture and storage technologies.

The next speaker was Mr. Kazuhiko Ogimoto of the Collaborative Research Center for Energy Engineering at The University of Tokyo. Mr. Ogimoto provided an overview of Japan's approach in basic science for energy. Mr. Ogimoto presented on Japan's energy programs, including the Cool Earth – Innovative Energy Technology Program, which focuses on realizing a substantial reduction in global emissions through innovative, long-term energy technology RD&D. He also described the 21 key innovative technologies that make up this program. Similar to IEA, the program is developing technology roadmaps which Mr. Ogimoto believes should be shared to accelerate international cooperation for RD&D. He also felt that international cooperation should be strengthened with an expansion of RD&D investment by developed countries, and provided some suggestions for EGSE activities.

Mr. Jerry Simmons of the USDOE's Sandia National Laboratories closed the panel with a discussion on the U.S. government's increased efforts to systematically link basic science with applied energy research and deployment of technologies. Mr. Simmons highlighted USDOE's priorities, specifically the priority to invest in science to achieve transformational discoveries. He stressed the need to

focus on transformational science, develop science and energy talent, and collaborate universally. Mr. Simmons also presented two new U.S. energy initiatives, the Energy Frontier Research Center (EFRC) and the Advanced Research Projects Agency – Energy (ARPA-E), which will both work to fund scientific breakthroughs needed to create advanced energy technologies. Specifically, EFRC will pursue collaborative fundamental research while ARPA-E will fund immature but potential transformational energy research.

Brainstorming Session

The IEA's Head of the Energy Technology Policy Division Dr. Peter Taylor kicked off the brainstorming session with a brief overview of the IEA *Energy Technology Perspectives 2010* publication (ETP2010), currently in preparation, with a focus on the technology roadmaps. After presenting on the structure of the publication and the elements and current status of the roadmaps, Mr. Taylor highlighted how the EGSE could provide input to the ETP2010, such as joining with the Expert Group on R&D Priority Setting to map global R&D efforts and identify cross-cutting basic science needs for the roadmaps. Mr. Tom Kerr from the IEA followed with a brief presentation on EGSE and explained the goals for the brainstorming session were to discuss (1) necessary breakthroughs in science for energy, (2) mapping science for energy efforts, and (3) expanding international collaboration. This input will be used to shape the future of EGSE and its priorities and activities.

The workshop participants were split into three breakout groups, with each group assigned one of the aforementioned discussion topics. After a full discussion of their assigned topic, the groups reunited to further examine each topic together. The following are the main points of discussion during the workshop's brainstorming session.

Topic #1: Breakthroughs in Science for Energy: What is Needed?

- **Major technology opportunities include:**
  - Improving technology efficiency and reducing the costs.
  - Improving systems for energy storage (transportation) and for the recovering/converting of waste heat.
  - Centralising energy generation while decentralising its use.
  - The group agreed to the adoption of the basic energy research list in Table 1 (AHGSET Oak Ridge Workshop) of the workshop background paper with certain modifications and the addition of electrochemical research (under ''Use-inspired'' Energy Research Opportunities) and thermal energy (under Energy Technology Challenges).
- **Major opportunities in transitioning (''bridging'') ideas from science communities to energy applications:**
  - Motivate basic researchers to be cognizant of ''real world'' parameters facing successful implementation of energy applications so they are able to pick the appropriate material, approach, and/or goal. Furthermore, inform basic researchers on the pressing needs of industry. Foster use-inspired R&D understating in the energy sector and motivate industry not to be risk-averse.
  - Bring together science disciplines that are often compartmentalized and path-dependant, lacking access to interdisciplinary activities and research.
  - Solve any intellectual property (IP) issues such as a lack of understanding on the part of basic scientists of when the patent route really makes sense.
  - Create more funding mechanisms for research in the "valley of death."
  - Create opportunities for physical co-location (or centres) where basic scientists and applied scientists can rub shoulders on a daily basis.
  - Include social science and research social acceptance of innovative technologies.

- Evaluate how to ''bridge'' proposals more adequately and introduce peer review groups.

- **Promising priority solutions:**
  - Create (virtual) centres for use-inspired research through calls for funding proposals that include activities to address basic research challenges as well as areas that are ripe for feasibility of scale-up or device fabrication issues. Centres need to be created by scientist and engineers from the bottom up.
  - Educating and attracting talent for science and engineering is important.
  - Explore the "open source" sharing model to aid in the IP dilemma.

Topic #2: Mapping Science for Energy Efforts

- **Features of successful mapping efforts include:**
  - Training and inclusivity: more training for scientists, involving students, and involving application-oriented scientists.
  - Expanded co-operation between scientists and industry in funding of research.
  - Flexible and accommodating framework (e.g., the IEA Implementing Agreements).
  - Longer-term continuous contracts and a science mission (e.g., USDOE's efforts).
- **Good examples of current activities or best practices:**
  - Programs such as the INNER Ideas Factory, Portuguese MIT program, and Norwegian Center for Research-Based Innovation.
- **Is mapping a useful exercise?**
  - Participants were sceptical about mapping as it may lead to a focus on the ''here and now'' and not on what needs to be done.
  - Mapping needs to be defined and may not be the right word. Consider using the word inventory.
  - Mapping needs to be cross-disciplinary, including benchmarks and comparisons; it should also include some sort of "best practices" for others to model after.
  - Mapping should be a framework to create new ideas, including creative events and exchanges.

Topic #3: Expanding International Collaboration and Linkages between Science and Energy

- **How can we efficiently ''mine'' scientific discoveries for energy?**
  - There is a need to locate the scientists who are making relevant discoveries. This could be done by ''headhunters'' who periodically review what is being published and suggest possible contributions or contributors to the energy sector.
  - There is a need for some generalists to identify advances in science and facilitate early-stage conversations and mobility between science and energy groups. EGSE could play a role here. When exchanging information and experience it is important to adapt scientific communication into the language of the target audience.
  - Expose people to new challenges/environments such as "pressure cooker" workshops on specific science/energy challenges. If IEA wants to see maximum impact it should concentrate on facilitating a few such workshops with institutions to foster cross-cutting work (e.g., UCLA, Imperial College, MIT, CSIRO).
  - Funding people-to-people interactions is key.
  - Need to take a longer-term look at universities, and make innovation a part of training of the scientific community.
  - Need to reach out to education and science ministries and have a meeting of country science advisories to discuss activity already happening at the national level.

- **Barriers to mining:**
  - Intellectual property is perceived as valuable. As the currency in academic life is international publicly-reviewed publications, sharing of pre-publication work is actively discouraged.
  - More than 80% of all publications come from 20% of the researchers. How do you motivate the productive researchers to change their focus so they're coming up with research useful to energy?
  - There is a need for facilitation and communication to aid the energy sector in recognizing inputs from basic science research. EGSE should play a role here.
  - There is a need for funding for science research. There are a lot of funds for incremental research available but not for fundamental breakthroughs. Also, there needs to be funding and mechanisms available for early IP protection.
- **Measures and incentives to address these challenges? What can IEA do?**
  - List leading countries in terms of types of research in IEA country In-Depth Reviews.
  - Produce a publication outlining current best practices at the national level.
  - Mapping types/characteristics of funding available for research can help improve awareness of differences and identify funding for international collaboration.
  - The EGSE/IEA could run various workshops such as:
    - A global "idea forum" through the internet
    - More frequent regional workshops, which ensure developing countries are involved and travel costs are kept down
    - A multi-scale modeling workshop
  - IEA can implement annual energy "Innovation Awards" and hold competitions to incentivize scientists to look for scientific breakthroughs. One idea is to frame a science question to students and then convince venture capitalists to fund the research.