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Future Fuel Technology for APEC Regions

Foresight Brief No. 105

Authors: Nares Damrongchai nares@tmc.nstda.or.th
Mayuree Vathanakuljarus mayuree@tmc.nstda.or.th

Sponsors: Asia-Pacific Economic Cooperation (APEC) and many other co-organizers

Type: Regional Foresight Project

Organizer: The Government of Canada**,** Bureau of Energy and Industrial Science and Technology Research Institute (ITRI), Chinese Taipei**,** National Metal and Materials Technology Center (MTEC), Thailand**,** APEC Center for Technology Foresight (APEC CTF), Technology Management Center, National Science and Technology Development Agency, Ministry of Science and Technology, Thailand

Duration: 2004-2005 **Budget:** US $ 500,000 **Time Horizon:** 2030 **Date of Brief:** June 2007

Purpose

The main aspiration was to gain strategic intelligence on future fuel technologies going beyond the current status and trends of present day energy technology and to draw roadmaps of selected future fuel technologies leading to robust plans for the future of technologies in the APEC region up to 2030. Moreover, the co-organizers of the project also anticipated continuous activities referred to as "post foresight" within APEC economies and among fuel technologies experts both during and after the project.

Asia-Pacific to Become Largest Consumer of Energy

The share of world energy use by the Asia-Pacific region is increasing, and projection from current trends indicates that by 2010 the area will be the world's largest consumer of energy. While much of this can be supplied from indigenous resources, an increasing proportion will need to be imported, particularly oil from the Middle East. The instability of this region poses threats to future supply. The vulnerability of a number of APEC economies is clear, and several economies are already completely dependent on imported oil while others will move to a dependent position by 2020.

Against this background, the project was initiated on recommendation of the 'APEC Center for Technology Foresight'`s International Advisory Board and of MTEC, a national R&D centre of Thailand. Encouragement and collaboration came from APEC Industrial Science and Technology Working Group, the Government of Canada, and in the course of the project additional participants from the Bureau of Energy and ITRI, Chinese Taipei, became active players. At the early stage, the APEC Energy Working Group (EWG) was also approached by APEC CTF to seek further research collaboration as the energy topic involved both working groups. The APEC Science Ministers' official meetings at Christchurch, New Zealand and Port Douglas, Australia in 2004 infused the activities with heightened enthusiasm; EWG group members agreed to participate in the study where experts shared technical information and have taken active roles in the project's workshops. This proved to be a unique cooperative exercise between the Industrial Science and Technology Working Group (ISTWG) and EWG to provide strategic intelligence on future fuel technologies for the APEC region.

Finding Pathways to Future Fuel Technologies in the APEC Region

This project aims to assess potential use of fuel technologies for the future in the APEC region through co-creation of technology roadmaps, involving stakeholders from business, academia and government across the APEC community. The

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roadmaps would include pathways for future fuel technologies to reach achievable technology targets and commercial success. It was hoped that by shaping thinking and fostering interaction, the process will eventually help institutions in planning for the future.

Workshops from Vancouver to Taipei

A pair of foresight methods were used; scenario writing and technology roadmapping (TRM). The scenario workshop was arranged in December 2004, in Krabi, Thailand. The main purpose was to create scenarios of futures of emerging energy and to use the results of the scenarios to influence and design technology roadmaps. Then technology roadmapping was employed to enable the identification of critical steps in the development of fuel technologies. There were two consecutive TRM workshops: the first workshop was hosted by Industry Canada in April 2005, in Vancouver, Canada; and the second one was organized by the Bureau of Energy and Industrial Technology Research Institute, Chinese Taipei in August 2005, in Ping-Tung, Chinese Taipei.

The project selected and grouped future fuel technologies into three different areas, i.e. hydrogen/fuel cells, conventional/unconventional hydrocarbons, and biofuels. Participants of the TRM workshops were divided accordingly into three groups for brainstorming on the selected fuel technologies roadmaps.

At the end of the project, a symposium was organized and hosted by MTEC and CTF in Chiangmai, Thailand. The objective was to wrap up what had been discussed and to summarize final key findings of the project in the light of future fuel technologies. The symposium also provided opportunities for audiences and all stakeholders to participate by commenting on the issues and creating further networks for post-foresight activities.

Stakeholder involvement from 17 countries

A total of 309 participants from seventeen APEC Economies participated in the project. Both experts of technologies and non-experts participated in the scenario workshop. About sixty experts and specialists were involved in each of the scenario TRM workshops. Seeking involvement of experts was normally handled by the network of APEC Industrial Science and Technology Working Group (ISTWG) and the Energy Working Group (EWG). Another important channel was APEC CTF's website where all information, announcements, and the latest news were regularly posted, updated and circulated among all participants during the project.

Identifying the Uncertainties

During scenario creation, key drivers of development for future fuel technologies were identified using STEEP classification – social, technological, economic, environmental and political. The results are summarized in table 1:

Social: • Environmental and health concerns • Urbanization and rural income disparity • Knowledge-based society with increased awareness
Economic: • Rising cost of fossil fuels, particularly oil • Need to increase employment
Political: • Energy security • Interdependence of energy supplies across regions • Enforcement of an agreed protocol on emissions
Technological: • Integrated approach combining various technologies • Low carbon economy with large reduction of carbon dioxide emissions
Environmental: • Global climate change concerns • Local pollution of air and water

Table 1: Key drivers for future fuel technologies

Then major uncertainties affecting development of future fuel technologies were identified and used in the breakout group discussion to create scenarios of the energy situation for APEC in 2030. These include:

- Impacts of dramatic climate change e.g. collapse of Antarctic ice sheet, changes in ocean currents, shift of demand patterns for energy over wide regions.
- Dwindling supply of oil and gas leads to bitter conflicts between major powers for control of current sources.
- Regional groupings emerge for energy cooperation to secure supplies and develop common technologies, e.g., biofuels.
- Accidents occur in development of new nuclear or hydrogen power plants.
- Public becomes intolerant of R&D on new fuels because of failure to deliver benefits.
- Technological breakthrough occurs, e.g. cheap solar, stable fusion, low temperature fuel cells.
- Leadership in alternative energy technologies by China and India alters energy choices of other counties.
- Terrorism leads to destruction of major power supply and distribution systems.

- Governments in developing countries give priority to rural energy systems.

Designing Broad Approaches for Energy Futures

The roadmaps then clarified the possible development pathways of each fuel area, mentioned in the *Methodology/Approach* section, and merged issues related to the interaction of these into an integrated energy pattern. The roadmaps and energy supply are vital for maximum use of investment in fuel extraction, production and distribution infrastructure to meet the needs for overall energy security, wealth of public health, and sustainable development. Distinction of fuels for two different types of applications were considered for future developments. First, transport applications, such as vehicles, require on-board supplies of readily stored, high energy density fuels, preferably liquids and gases. Second, stationary applications, primarily for electricity production and heat for commercial, industrial and residential applications, can be satisfied by a variety of input energy sources including solids, liquids and gases. This development of stationary application provides opportunities for a broader approach to energy futures (Figure 1).

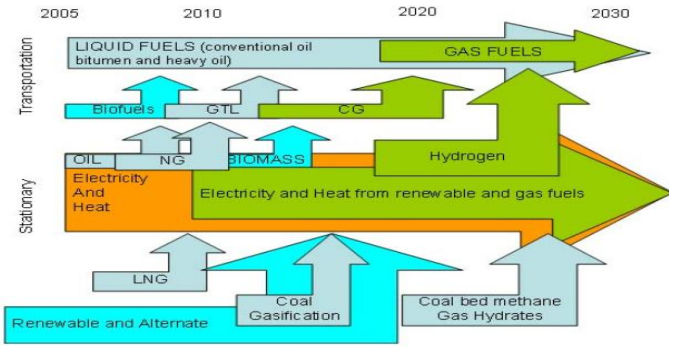

Figure 1: Possible integration of future fuel technologies

Three Major Drivers

The study emphasised three key drivers as underlined by the diagram above, i.e. 1) need for diversity of energy sources for security of supply; 2) creation of a low carbon economy to reduce greenhouse gas emissions to mitigate climate change and its impacts; and 3) improvement of urban air quality for public health.

Security of Supply

The first concerned long term risks of heightened political instability in many areas rich in liquid and gaseous fuels and the vulnerability to natural disasters of others. Within the time frame of this project, oil will remain a significant fuel particularly for transport and a move to alternate fuels is imperative for those economies that depend on imported oil.

Reduction of Emissions

The second is vital given the increasing evidence of major changes in the Earth's climate such as the rapid melting of glaciers and the increased frequency of severe storms. The move to a low carbon economy can be achieved with both fuels for stationary applications and for transport. Hydrocarbon gas fuels have lower carbon content than liquid or solid hydrocarbons and their increased use, together with CO_2 sequestration, will lead to a reduction in carbon dioxide emissions in the stationary sector. For transport the use of biofuels either as blends or neat is a move to a low carbon economy provided that engine technology is adapted for such fuels.

Improvement of Air Quality

Third, air pollution in Asian megacities stems from badly maintained vehicles and domestic use of solid fuels. Strict legislation on emissions and its enforcement, together with potential improvements on engine efficiency in new vehicles can probably solve this problem. However, growing societal pressure for change supported by political will and significant investment could lead in the long-term to a transition to a hydrogen economy through hybrid petrol-electric vehicles to fuel cell vehicles using hydrogen from a variety of sources. Vehicle manufacturers are already well advanced in the development and production of hydrogen.

Further Exchange and Technology Research Needed

Despite discussions and recommendations from the quarters of APEC economic experts, there is no one solution to the future fuel needs of the APEC region. To ensure energy security, an integrated approach is needed in which various energy technologies can make significant contributions. The roadmapping exercises of this project have developed technology roadmaps for three fuel areas and how they can be used in an integrated approach.

The emphasis on research and development of energy technologies will vary from one economy to another, depending on their resources and R&D capabilities. There is a clear need for cooperation and exchanges of research information and personnel in materials and energy R&D within APEC.

Policymakers need to be conscious of community attitudes to new energy technologies and ensure adequate steps are taken by their governments to communicate with the general public on issues of health and safety, and environmental impacts associated with such technologies, e.g. biofuels, hydrogen and nuclear power.

Even though the study has focused on three fuel areas, it is clear that development and application of other energy technologies, e.g. photovoltaic arrays, wind turbines and advanced nuclear power systems are important components of an integrated energy approach.

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