

**Synthesis of the Survey of APEC Member Economies'
Renewable-Energy-Based Priority Needs and Issues
Relating to Sustainable Development**



ASIA-PACIFIC ECONOMIC COOPERATION

**Expert Group on New and Renewable
Energy Technologies**

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Executive Summary

The “Survey of APEC Member Economies’ Renewable-Energy-Based Priority Needs and Issues Relating to Sustainable Development” was sent out by the United States in November 2000 as the first major activity of the APEC 21st Century Renewable Energy Development Initiative. The Survey invited the energy officials of the APEC member economies to share information on current renewable applications relating to sustainable development and growth, and to identify barriers, issues and priorities involving these applications. Fifteen of the twenty-one economies responded to the Survey, including Australia, Brunei Darussalam, Canada, People Republic of China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Mexico, New Zealand, the Philippines, Singapore, Thailand and the United States. This report is the synthesis of the responses to the Survey. The results are summarized as follows:

- Transportation and air pollution reduction is the most common sustainable development priority and goal among the APEC member economies. Six member economies selected this goal, of which three economies (Hong Kong, Japan and Singapore) placed it as their first priority. Rural development and electrification was mentioned by four member economies (Brunei, China, Mexico and Thailand) as their top priority. The other areas that most member economies identified in their top three sustainable development priorities and goals were poverty alleviation and education.
- The other sustainable development priorities and goals mentioned included to have a market-based energy system which is cognizant of the environmental impact of energy-related practices (Australia), to encourage, promote and support energy efficiency, energy conservation and the use of renewable energy (New Zealand) and to reduce the reliance on foreign oil imports and non-renewable fuels (the U.S.)
- The development and use of bioenergy are in different stages among the member economies. In general, the developed economies used more advanced technology applications such as biomass gasification, landfill gas and biofuels for transportation while in developing economies, these technologies are either not being adopted, still in a demonstration stage, or used only in small-scale operations. The most common biomass-related technology currently being used in the Region is cogeneration and the least common biomass-related technology being used is biomass gasification. The other biomass-related technology applications mentioned in the Survey are municipal solid waste combustion technology and biogas technology applied to organic waste and wastewater.
- Wind-related technology applications are, for the most part, in a demonstration stage in the developing economies. The wind energy technologies utilized by developed economies are more advanced and larger in scale. For example, developed economies focus on grid-connected wind farms and large turbine

manufacturing. On the other hand, the developing economies employ wind technologies in small off-grid connected applications. The task specific applications such as water pumping for irrigation employed in the developing economies are at a small scale or implemented as demonstration projects.

- Off-grid PV is more widely used than grid connected PV in both developed and developing economies because of its cost effectiveness. While PV is much more expensive than conventional power available on the grid, off-grid PV is more price competitive against grid extension or conventional stand-alone power systems. Off-grid PV is mainly for telecommunication. The common use of solar thermal power is for water heating. Solar thermal is not commonly used for electric power generation in the Region.
- Besides biomass, wind and solar technologies, diesel/solar/wind hybrid systems are the most identified technology (by 11 member economies) as being used in their economies to address development needs, followed by small hydro (mini- and micro-hydro) systems. The utilization of electric vehicles for transportation is still at a small scale and fuel cell technology is mainly still under R&D. The other renewable energy technologies mentioned by the member economies include tidal power and earth energy systems being used in Canada, wave power in Australia, methane recovering from coal mines in Japan, dendrothermal power in the Philippines and Australia, and geothermal in Australia, Indonesia, Japan and the U.S.
- Regarding future plans to apply the renewable energy technologies to the sustainable development goals and priorities, some economies have emphasized development of particular renewable energy resources. Malaysia has focused on biomass for power generation. Thailand sees potential in biomass, biogas and PV technologies (especially PV roof top grid connected). Brunei mentioned its hydro potential. Japan identified four areas of emphasis—PV power generation, wind power generation, waste power generation and fuel cells. China emphasized PV, solar water heater, wind power (both grid-connected and small off-grid), geothermal (for space heating and power generation), biogas (from agricultural and industrial wastes), and straw gasification for heating/power generation.
- Some economies have future plans to use renewable energy to meet their other goals in addition to sustainable development goals. An example is Canada and the Philippines who have policies of using renewable energy for climate change mitigation.
- Selected elements in the member economies' future plans to apply renewable energy technologies to sustainable development goals and priorities include encouraging the private sector to develop renewable energy technologies (Indonesia), establishing a performance certification center for renewable energy technology (Korea), teaching the new generations to conserve energy and use

renewable energy more efficiently, productive and environmental friendly (Mexico), emphasizing transport policies that contribute to energy efficiency and the reduction of CO₂ from vehicles (Singapore) and continuing improvements in energy efficiency and a progressive transitions to renewable energy (New Zealand).

- The availability of technology is not the most significant technical barrier associated with the use of renewable energy technologies in APEC. More advance technologies such as fuel cells, biofuels or hybrid electric systems may not be available in all economies. However, simple and/or commercialized technologies are available in most economies or can be imported. Lack of physical infrastructure to deliver renewable energy technologies to the point of end use was mentioned by only three economies (China, Indonesia and Mexico). It seems clear that the most common technical barrier associated with the use of renewable energy is *lack of in-country personnel to operate and maintain the technologies in the economies*. This barrier was mentioned by seven economies.
- The key competition to the use of new and renewable technologies for addressing sustainable development needs is fossil fuels. Their cost-effectiveness as compared to fossil fuels was a function of various factors that were identified by each member economy. These included availability of fossil fuels, established infrastructure for fossil fuel utilization, established fossil fuel technologies, low electricity prices, and government subsidy policies in favor of fossil fuels.
- Standards and certification programs do not widely exist in APEC. Only Canada and the U.S. claim that standards and certification programs exist or are underway in their economies for all renewable energy technologies. On the other hand, Brunei, Korea, Hong Kong, Malaysia and the Philippines said that there are no national standards and certification programs for the design and installation of renewable energy systems in their economies. In the economies where standards and certification programs for renewable energy technologies exist, it will be mainly for solar systems especially solar water heating systems.
- The legislative, policy and business-related barriers to the use of renewable energy technologies are both *lack of policies that support the use of renewable energy and the existence of policies that are counterproductive to the promotion of renewable energy utilization*. Uncertainties associated with the development of renewable energy for power generation, such as the lack of long-term contracts to buy electricity generated from renewable energy, were also mentioned as a barrier by Korea and Mexico.
- The main financial barrier to the use of renewable energy technologies is *their high up-front costs* (identified by 7 economies including Australia, Brunei, Japan, Korea, New Zealand, Thailand and the U.S.). Because of the high investment costs, and, as identified by Japan, the unfavorable views of loan officers on

profitability and reliability of renewable energy businesses, receiving a loan from a commercial bank for a renewable energy project is difficult. The lack of financial support from the government and/or good financial mechanisms in the economy are essential to promoting renewable energy deployment and were mentioned by 5 member economies including China, Indonesia, Malaysia, Mexico, and the Philippines.

- The member economies use various financing arrangements to promote renewable technology deployments in their economies. The financing arrangements adopted most include tax incentives (such as tax write-offs, tax reductions and tax exemptions on machinery and equipment), loan and financial supports (such as in R&D or on pilot projects). The other financing arrangements include government subsidies and micro-enterprise credits. Korea has an arrangement that mandates the purchase of renewable-based electricity. Some states in the U.S. require that electricity suppliers provide a minimum percentage of their supply from renewables. In addition, in some states in the U.S., a standard fee is collected from all electricity consumers and the money is used to fund renewable investment. The green pricing option, where consumers can voluntarily increase their payment to buy power from renewable sources, has also been adopted in Australia, New Zealand and the U.S. Brunei, Hong Kong and Mexico stated that there are no financial arrangements in their economies to support renewable technology deployment.
- China, Indonesia, Mexico, the Philippines and Malaysia mentioned that they have received some type of donor grants or bi-lateral aid in support of developing renewable energy programs in their economies. However, not all donor-funded renewable energy projects have resulted in sustainable business practices at the completion of the projects. Only China stated that in Inner Mongolia and Guangdong, some Danish donor-funded wind projects have resulted in satisfactory results in sustainable development. Some economies including Australia, Brunei, Canada, Hong Kong, Japan, Korea, and the U.S. replied that there are no donor grant or bi-lateral aid programs in their economies.
- Private institutions do not seem to play a major role in supporting renewable energy development in an economy. Most economies mentioned government agencies as the main institution that supports renewable energy deployment, followed by government laboratories, public research centers/agencies, and local universities. Indonesia and New Zealand were the only two economies who stated that the private sector supported renewable energy deployment in their economies. Thailand, Malaysia and Mexico mentioned public utilities as the other institution involving in renewable energy deployment.
- Most economies also have NGOs working with renewable energy technologies. The economies that do not have NGOs working in this area include Brunei, Hong Kong, Korea and Thailand.

- The economies support enterprises and business development for new and renewable energy technologies in several ways. These include, for example, providing government funds, grants, and loans to support new businesses (e.g., Australia and Japan), providing financial assistance from commercial banks (e.g., Malaysia), forming an agency to work closely with industry in developing and implementing marketing strategies (e.g., Canada and New Zealand) and institutionalising renewable energy into the national government (e.g., the Philippines). In the U.S, although some special subsidy programs exist, renewable energy systems are generally financed through commercial lending programs. No special support has been given to business development of renewable energy technologies in Hong Kong, Korea, Mexico and Thailand.
- Most economies did not give a direct answer to the question on the availability of renewable energy enterprise/business development-related programs or activities for specific sustainable development. Instead, they simply listed the renewable energy projects implemented in their economies without mentioning any specific sustainable-development areas. It also seems that those mentioned projects/activities are not particularly enterprise/business development-related. Australia provided a rather clear answer that the renewable-energy enterprise/business development-related programs in its economy are typically not directed to a specific area, but designed to enhance the capacity of the renewable energy industry as a whole. Indonesia mentioned the installation of micro-hydro in rural areas for supplying electricity for the purpose of income generation. Mexico is working on the massive use of solar water heating systems, which will enhance the development of Mexican renewable energy technology enterprises, and a project to identify viable renewable energy productive projects in rural communities located away from the electric grid. The Philippines mentioned several projects that, although not stated, seem to support rural electrification goals. The U.S mentioned the programs to encourage the use of renewables on Native American lands, particularly for off-grid electricity supply. On the other hand, Brunei, Hong Kong, Japan and Korea replied that there are no renewable-energy enterprise or business development-related programs or activities for specific sustainable-development areas in their economies.
- Six member economies (including Korea, Indonesia, Malaysia, the Philippines, Thailand and the U.S.) mentioned issues related to *financing* as a barrier to providing adequate delivery mechanisms for renewables use in their economies. The other barriers include lack of supporting policies from the government (mentioned by China, Indonesia, Malaysia and Thailand), high cost of renewable energy technologies (mentioned by Australia, Brunei, Japan and Malaysia), lack of information/knowledge about technologies (mentioned by Australia, Indonesia and Malaysia), lack of human capacity (i.e., lack of local expertise, manufacturers and maintenance mentioned by Malaysia), and lack of physical infrastructure (identified by Indonesia and Malaysia). Canada and the U.S. mentioned the

existence of unfavorable government policies that create a non-level playing field for renewable energy system.

- *Knowledge of financing and fee collection requirements* was identified most (by four economies including China, Korea, Indonesia and Thailand) as a key information barrier that prevents delivery mechanisms from being put in place. Knowledge of the in-country capacity to service and maintain renewable technologies was identified by China, Indonesia and Korea as a key information barrier. Knowledge of the technology and its characteristics, lack of capacity of in-country institutions to provide technology and information assistance and lack of knowledge of technology sources were mentioned by China and Indonesia. Australia also mentioned the problem related with knowledge of technology sources associated with maintenance of renewable energy systems and lack of rapid access in remote sites. China, Indonesia and Korea stated that knowledge of renewable sources is one of their key information barriers while Mexico mentioned that for its economy, it is not as much about the knowledge of resource sites as the knowledge of total potential of the resources. The other barriers include lack of information, awareness and/or understanding of renewable energy systems and renewable industry (pointed out in different extents by several economies including Australia, Japan, Malaysia, Mexico, New Zealand, the Philippines and the U.S, and lack of training for maintenance and operation of renewable energy system (identified by Mexico).
- The main national energy-planning model used in the Region is MARKAL. LEAP is used in some economies including Indonesia, the Philippines and the U.S. The village level models—HOMER and ViPOR—are used in China, the Philippines and the U.S. Canada uses RETScreen, a standardised and integrated renewable energy project analysis software that can be used world-wide to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of renewable energy technologies.
- Brunei, Korea and Mexico stated that there were no organizations working on renewable-energy delivery mechanisms in their economies. Other member economies listed the types of institutions that are working on renewable-energy delivery mechanisms in their economies. In most economies, the governments seem to play a larger role in working on renewable-energy delivery mechanisms in their economies than the private sector. The private sector plays an important role in this area in economies like Australia and the U.S where the renewable energy industry is more established. Australia, Canada, China, Indonesia, Japan, the Philippines and Thailand identified the work of the NGOs, and the Philippines and Thailand identified the work of international organizations and/or foreign institutes, on renewable energy delivery mechanisms in their economies.
- China, Indonesia and the Philippines commented that the existing donor programs/projects have supported the creation of markets and assisted with

private sector participation in the renewable energy sector. Indonesia also mentioned that some activities in these programs/projects increase local incomes.

- China, Korea, Malaysia, Mexico, the Philippines and Thailand stated that there is a need for institutional capacity building for renewable-energy programs in their economies. On the other hand, Australia, Canada and the U.S replied that they already have such programs in place, and institutional capacity building is not a constraint to the renewable energy industry in their economies.
- China, Korea, Mexico, the Philippines and Thailand replied that the development of renewable-energy industry organizations is needed. In contrarily, Australia, Canada, Japan, and the U.S replied that there is no need to develop renewable energy industry organizations in their economies because they already exist. On the other hand, Brunei and Hong Kong responded that there is no need to develop renewable energy industry organizations in their economies because the renewable energy industry is not important for their economies.
- The current collaboration among the member economies is mainly in the form of aid and assistance from the developed economies to developing economies. Examples are projects funded by Canada, Japan, New Zealand and the U.S. Australia has worked with other economies to promote greenhouse gas mitigation. Korea mentioned collaboration with China in organizing seminars on new and renewable energy.
- The majority of the member economies agreed in the benefits of sharing experiences from other economies. Australia, Canada, Japan and the U.S were most mentioned as having technologies or experiences relevant to meeting sustainable-energy priorities in other member economies.
- Regarding a preference in the type of collaboration, collaborative R&D is the most preferred among the member economies. Five economies (including Australia, Canada, Hong Kong, Mexico, and the U.S.) identified this as being beneficial in addressing needs, issues and barriers to the use of renewable energy technologies. Hong Kong and Thailand preferred collaboration on the presentation of case study experiences. Australia and Thailand mentioned the benefit of collaboration with planning tools, and Hong Kong and China identified the importance of collaboration on joint project development. Besides the collaboration on joint project development, which is its first choice, China also mentioned its preference for training programs and business development forums. Malaysia and the Philippines stated the importance of all six suggested collaborations, and Korea identified the important on all but creation of “smart subsidy” donor programs that result in sustainable renewable-energy business practices, but did not state a preference on any particular type of the collaboration. The other collaborations mentioned in the Survey are related to information exchange and were suggested by Australia and Brunei.

Introduction

The APEC 21st Century Renewable Energy Development Initiative (the "Initiative") was adopted by APEC Energy Ministers at their 4th Ministerial Meeting in San Diego, California, USA in May 2000. The purpose of the Initiative is to develop a series of "collaborative" within the framework of the APEC Expert Group on New and Renewable Energy Technologies to advance the use of renewable energy for growth and sustainable development in the APEC region. A "collaborative" is designed to address the energy needs and issues of individual APEC member economies through multi-economy cooperation that leads to action and results.

Two benchmark activities were conducted in the first year of the Initiative. The first activity was conducting the "Survey of APEC Member Economies' Renewable-Energy-Based Priority Needs and Issues Relating to Sustainable Development." The second activity was convening the "APEC Private Sector Renewable Energy Forum" in Portland, Oregon, USA on March 26-27, 2001.

This report is the synthesis of the responses of the APEC member economies to the "Survey of APEC Member Economies' Renewable-Energy-Based Priority Needs and Issues Relating to Sustainable Development." The Survey was sent out by the United States to all APEC member economies in November 2000 to invite the energy officials of APEC member economies to share information on current renewable applications relating to sustainable development and growth, and to identify barriers, issues and priorities involving these applications. The purpose of the Survey was to provide information to help in the design and implementation of collaborations that effectively respond to the APEC member economies' priorities.

The Survey was divided into four main parts. Part A included questions regarding the APEC economies' sustainable development priorities and goals that were renewable energy based, and renewable energy applications that addressed these priorities and goals. Part B examined major issues, needs and barriers related to the renewable energy applications—including application-driven issues, programmatic issues and issues related to renewable energy delivery mechanism. Part C surveyed background information on collaborative activities that can be undertaken by APEC to address these issues and needs. Finally, Part D examined suggestions from the member economies on collaborative activities. Fifteen of the twenty-one economies responded to the Survey, including Australia, Brunei Darussalam, Canada, People Republic of China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Mexico, New Zealand, the Philippines, Singapore, Thailand and the United States. The detailed response to the Survey from each economy can be viewed at <http://www.apecnetwork.org>.

The purpose of this report is to synthesize the responses of the member economies to the Survey so the information can be more effectively shared. The ultimate objective is to promote opportunities for renewable energy investment and project collaborations among the APEC member economies.

It should be noted that this report is based entirely upon the responses to the Survey of the member economies. As such it should be recognized that, as in any survey, the information presented is based on the knowledge of the responders and thus may not capture all the activities in the economies.

Part A: Sustainable Development Priorities and Goals, And Renewable Energy Applications to Address Them

A1. Sustainable development priorities and goals of the APEC member economies

The member economies were asked to reveal their sustainable development priorities and goals in the areas of (a) rural development and electrification; (b) poverty alleviation (both in rural and in urban areas); (c) health improvement; (d) education; (e) population resettlement/transmigration; (f) transportation and air pollution reduction; and (g) other areas. The results from the survey showed that of all these mentioned areas, transportation and air pollution reduction (f) is the most common sustainable development priority and goal. Six member economies selected this goal, of which three economies (Hong Kong, Japan and Singapore) placed it as their first priority. Rural development and electrification was mentioned by four member economies (Brunei, China, Mexico and Thailand) as their top priority. The other areas that most member economies identified in their top three sustainable development priorities and goals are poverty alleviation and education. Table 1 lists the sustainable development priorities and goals identified by the APEC member economies.

Australia stated that its sustainable development priorities and goals in the energy area are based on a market-based approach. The economy relies on competitively priced energy while being cognizant of the environmental impact of energy-related practices. Its energy policies are designed to be consistent with, and support of, the economic, social and environmental requirements of a sustainable energy future. Australia focuses on the development of an open and competitive national energy market including the provision of reliable energy services to its people, improving energy efficiency, reducing the local and global environmental impacts of energy production, supply and use, and realizing the sector's export potential (commodities, technology and services) as new capacities are developed.

Table 1: Sustainable Development Priorities and Goal of APEC

Australia	<ul style="list-style-type: none"> • Market-based energy market that is cognizant of the environmental impact of energy-related practices
Brunei	<ul style="list-style-type: none"> • Electrification
Canada	<ul style="list-style-type: none"> • Education • Poverty alleviation • Healthcare improvement • Urban air pollution
China	<ul style="list-style-type: none"> • Poverty alleviation • Rural development and electrification • Education • Transportation and air pollution reduction • Population resettlement/transmigration • Health improvement
Hong Kong	<ul style="list-style-type: none"> • Transportation and air pollution reduction
Indonesia	<ul style="list-style-type: none"> • All (no priority)
Japan	<ul style="list-style-type: none"> • Transportation and air pollution reduction
Korea	<ul style="list-style-type: none"> • Health improvement • Transportation and air pollution reduction
Malaysia	<ul style="list-style-type: none"> • All (no priority)
Mexico	<ul style="list-style-type: none"> • Rural development and electrification • Poverty alleviation • Education
New Zealand	<ul style="list-style-type: none"> • Encouraging, promoting and supporting energy efficiency, energy conservation and the use of renewable energy
Philippines	<ul style="list-style-type: none"> • All (no priority)
Singapore	<ul style="list-style-type: none"> • Transportation and air pollution reduction
Thailand	<ul style="list-style-type: none"> • Electrification
USA	<ul style="list-style-type: none"> • Reduction in the reliance on foreign oil imports and non-renewable fuels

As for the specific priorities and goals mentioned in the Survey such as rural development and electrification, Australia mentioned that it has a well-developed electricity infrastructure of grid interconnections, which provides low cost, reliable and accessible energy services for nearly all Australians. Only 1.5% of Australian electricity is independent from the national grid. The remote regions of Australia are used for agriculture, mining and tourism, and are home to many of its indigenous people. Renewable energy is an increasingly used option in those areas. For education, the Australian Government released its “Environmental Education for a Sustainable Future - National Action Plan in July 2000”. The Plan is intended to provide leadership to the sectors involved in environmental education activities and to promote better coordination of these activities. The Australian Greenhouse Office is also carrying out renewable industry vocational training with Technical And Further Education colleges, in

conjunction with the Sustainable Energy Industries Association. The aim is to train industry representatives about all aspects of sustainable energy, including information management. In addition, a computer-based tool has been developed to assist firms assess the technical and economic potential of cogeneration as an energy supply. The National Utilities and Electrotechnology Industry Training Advisory Board is also developing core competencies for alternative energy supply training to complement the work on conventional energy supply training already undertaken. As for the goal to reduce air pollution, the National Environment Protection Measure set ambient air quality standards—the Australia's first national air quality standards—in June 1998.

In Brunei, about 99% of the population is electrified. The remaining unelectrified areas are the remote, not easily accessible areas where people use portable generator for their electricity requirement. Brunei's sustainable development priority and goal is to provide continuous supply of electricity to all population economically and safely. Thailand also put the first priority on electrification for the reason that electrification is "a common factor" of any development.

Canada stated the priorities in the areas of education, poverty alleviation, healthcare improvement and urban air pollution. The government is committed to strengthening its relationship with Aboriginal people including working to ensure that basic needs are met for jobs, health, education, housing and infrastructure. The plans for healthcare improvement include reforming and supporting innovation in primary care, adopting modern health information technologies, purchasing needed diagnostic and medical equipment, championing community-based health promotion and disease prevention measure, encouraging physical fitness and participation in sport, combating substance abuse, reducing tobacco consumption, promoting mental health, and enhancing the research into disease prevention and treatment, the determinants of health and health system effectiveness. The government of Canada is also in the process of establishing the Sustainable Development Technology Foundation, which will support technologies to reduce greenhouse gases and air emissions.

Indonesia stated the importance of rural development and electrification programs due to the fact that more than 60% of its population lives in rural areas, and only 52% of total households are electrified. In supporting rural economic development goals, the policies are aimed at using local energy for productive use, increasing the efficiency of production processes, utilizing appropriate technology for income generating and increasing rural economic welfare. The poverty alleviation programs are aimed at the development of micro-enterprise by using micro-credit, increasing social activities, developing infrastructure, supporting education, and supplying energy needs. Indonesia realizes the important of using local renewable energy to improve the quality of life of rural people such as the use of renewable energy for power generation in remote villages, rural health care facilities, and rural schools. The government also promotes resettlement and transmigration programs by preparing facilities and infrastructure such as streets, agriculture fields, electricity, and water supply especially in Java Island, which is the smallest but crowded and the highest economic activity in the economy. For its transportation and air pollution reduction goal, the Indonesian government has

implemented the program to promote energy conservation and clean energy utilization for transportation such as the use of natural gas and ethanol.

Rural development in Malaysia emphasizes uplifting the living standard of the rural sector through improving productivity and incomes of rural households. Programs to strengthen the economic base of the rural areas focus on infrastructure development and promotion of organized farming activities to increase value-added and improve economy of scale. In addition, efforts are being made to diversify the economic base of rural areas and to increase rural off-farm incomes through the implementation of the one-village one-product approach and an establishment of rural industries as well as agro-tourism and eco-tourism ventures. Besides the proven technologies of grid extensions, mini-hydro stations and diesel engines, an emphasis is given to the utilization of alternative technologies, such as photovoltaic, micro-hydro and hybrid system for rural electrification. Poverty alleviation programs emphasize income-generating projects such as cash crop cultivation, livestock rearing, aquaculture, petty trading and cottage industries. For the urban poor, priority will be given to income-generating projects as well as the provision of adequate basic amenities such as low cost housing. For health improvement, greater emphasis is given to preventive health, expansion of health services in the rural areas, and corporatization and privatization of hospitals and medical services. Education and training programs are directed at expanding capacity, improving quality and increasing accessibility at all levels. Efforts to address air pollution from transportation have also been intensified. New regulations include regulations to control emissions from motorcycles and regulations requiring public vehicles to use clean natural gas as fuel.

The Philippines provided its sustainable development priorities and goals in great detail. In summary, its rural development goal is to diversify the rural economy through the development of alternative employment opportunities in farm and non-farm activities to sustain an increase in incomes and standard of living of rural people. The electrification priority and goal is to attain a competitive, affordable, and reasonably priced energy supply through a socially and environmentally compatible energy infrastructure. Its poverty alleviation goal is to improve quality of life of all Filipinos and increase employment and income opportunities. Its health improvement goal is to transform the health care delivery system into one that is more dynamic, efficient and responsive to devolution. For education, priority is on basic learning needs especially for under-served or marginalized groups. Population resettlement/transmigration is to promote community-based, center-based and gender-sensitive social welfare interventions for the poor, vulnerable, and disadvantaged people. For air pollution reduction, the priority is to use cost-effective technologies to produce clean and environmentally acceptable fuels.

Japan, Singapore and Hong Kong put transportation and air pollution reduction as the key sustainable development priorities. Japan is concerned about the growth of CO₂ emissions from vehicles since its transportation sector accounts for 20% of total CO₂ emissions in metropolitan areas, and the rate is expected to rise continually. For the purpose of reducing CO₂, Japan has established a plan regarding the amount of new and renewable energy to be utilized by the year 2010. In order to achieve the target,

introduction and promotion of technology development of cost-effective, highly efficient usage of energy from hydroelectric, geothermal, photovoltaic, wind and waste are being conducted.

On the other hand, the U.S.'s energy policies have focused on reducing the reliance on foreign oil imports and non-renewable fuels through federally supported advanced research in renewable energy technologies, and support through various federally mandated incentive programs such as production tax credits to promote the use of renewable energy. Finally, New Zealand identified its goal as to encourage, promote and support energy efficiency, energy conservation and the use of renewable energy in the economy.

A2. Biomass-related technology applications

The survey asked what biomass-related technology applications that are currently being applied in the member economies: (a) use of agricultural or animal waste for gasification for cooking and heating; (b) use of agricultural waste or products for co-generation of electricity or to produce heat; (c) landfill gas utilization; (d) biofuels for transportation; and (e) other.

The development and use of bioenergy are in different stages among the member economies. A traditional biomass application is for direct burning. The economies in the cold climate like Canada, the U.S. and New Zealand use wood for residential space heating normally as a supplementary heating sources or a back-up system for occasional or emergency use. In rural areas in developing economies like Indonesia, Thailand, Mexico and the Philippines, there are still a large number of households using biomass for cooking by traditional stoves. The main biomass fuels for cooking are charcoals and fuel wood. The Philippines also uses animal manure for cooking in upland farms. Besides the direct burning of biomass for cooking and space heating, the combustion of waste materials such as those from forest products and pulp and paper industries is conducted in some economies to generate electricity, steam, and heat for their own use.

An economy like Australia has a substantial biomass resource, i.e., forestry and agricultural residues, municipal and animal wastes, agro forestry and energy crops, that could provide the feedstock for substantial biomass energy. Australia also has substantial experience in landfill gas, sewerage biogas and bagasse power plants. A variety of biomass utilization technologies are also applied throughout the U.S., including direct combustion (7500 MW installed capacity) and co-firing (using wood, agricultural, and municipal solid wastes). A number of biomass co-firing plants have been installed in the U.S. either as commercial operations or as demonstration facilities. In these plants, biomass is added as a partial substitute fuel in high-efficiency coal boilers. Tests are also underway to develop small modular biopower systems to be used for export for rural electrification in developing countries. In the near term, biomass wastes for oxygenates are in development in the U.S. Over the longer term, energy crops will be used for bulk fuel. Research is also underway to convert unused farmland into commercial energy crop production such as switch grass and trees.

In contrast, no major biomass related technology applications are being applied in Hong Kong besides a very limited small-scaled trial project of landfill gas to generate electricity for on-site domestic consumption and bio-diesel for transportation. The biomass-related technology applications in Korea focus on landfill gas utilization and gasification for cooking and heating.

In general, the developed economies used more advanced technology applications such as biomass gasification, landfill gas and biofuels for transportation while in developing economies, these technologies are either not being adopted, still in a demonstration stage, or at a small-scaled operation.

A2.1. Biomass for gasification

Of all the biomass-related technology, biomass gasification is least popular. Canada, China, Indonesia, Japan, Korea and the U.S. have experience in biomass gasification technology at different stages. Canada combusts crop residues in bail burners on farms in large cereal and canary seed straw surplus regions such as southern Manitoba. At present about 6,000 poultry and hog farmers in Canada use some sort of space heating from biomass with total seasonal heating loads of 1,700 GJ for poultry operations and 684 GJ for hog operations.

In the U.S. a biomass gasifier, which converts biomass into gas for electric power generation, has been successfully tested in the state of Vermont. This technology makes a fuel gas from organic materials such as wood waste, waste rice hulls, grass, and dedicated energy crops, by heating the waste under carefully controlled temperature, pressure, and atmospheric conditions. Biomass gasification combined cycle technologies using energy crops are also in development.

Gasification technology in Indonesia is still in a demonstration stage. Gasification has been installed in some locations in Indonesia using rice husks, and wood and is mainly for supplying electricity in the areas that far from electricity grid. Japan uses feces of animal such as cattles and pigs in a biogasification process in the stockbreeding industry. Korea uses both agricultural and animal waste in its gasification process.

Gasification is under R&D in Australia and the Philippines. The Philippines tested biomass gasification as an option for drying farm products with emphasis on rice paddies. Biomass gasification technology for internal gas and diesel combustion engines for irrigation water pumping was introduced in the 1970's by the national government in an attempt to mitigate the energy crisis in the economy. There was no on-going R&D in this area in the Philippines at present.

A2.2 Biomass for co-generation

Co-generation is the most commonly used biomass-related technology in APEC. Australia has combined capacity of about 300 MW of electricity generated from wastes

from sugar mills. The Rocky Point Green Energy Corporation in Australia is developing a 30 MW biomass cogeneration plant using wood waste. This plant is expected to reduce CO₂ emissions by over 220,000 tonnes per year. Also, a biomass cogeneration plant with capacity of 30 MW is being designed and installed at the Rocky Point Sugar Mill to provide electricity to the Queensland grid. An advanced swirl burn combustion system (SBCS) has been designed to improve the capacity and efficiency of existing boilers fired by bagasses. This technology has shown to be financially attractive for retrofit existing boilers in sugar mills to expand their processing capacity. It is also estimated that up to 10,000 GWh per year of electricity could be generated from sawmill wastes, rejected logs and other residues. However, dispersed locations lead to high collection costs.

Canada does not use agricultural products, but forest biomass residues, for heat, electricity and co-generation. The pulp and paper industry has about 1,000 MW of electricity generating capacity that is fueled partly from the combustion of their residues, in combination with other fuels such as fuel oil and natural gas. There are also some Independent Power Producers that generate electricity from the combustion of wood wastes from sawmills.

In Indonesia, cogeneration from agricultural wastes has been commercialized and installed in many industries including sugar, palm oil and wood industries. Malaysia uses fibers and shells from palm tree as fuels for cogeneration in more than 300 palm oil mills. Mexico uses cane wastes from the sugar industry in their cogeneration systems. New Zealand uses wood processing residues for process heat such as that required for kiln drying timbers and only a small proportion of the wood wastes from wood processing is used directly for cogeneration.

It is not clear if the Philippines has utilized a cogeneration system. The Philippines mentioned the utilization of a bagasse-fired power plant at Hacienda Luisita (Tarlac) to augment power requirement of the sugar mill, and pilot projects of ricehull fired power plants for in-plant use of rice mills in Central Philippines and Southern Philippines. However, there was no detail concerning if these power plants employed cogeneration. These power plants are not in operation at present. There was also an attempt to operate a rice-hull fired power plants in Luzon with no success.

The use of agricultural waste for cogeneration has taken place in Thailand and will become more attractive following a project "Promotion of Small Power Producers (SPPs) Using Renewable Energy." Thailand's National Energy Policy Office (NEPO) has launched this project in order to encourage SPPs to participate in the power industry. A financial subsidy from the Energy Conservation (ECON) Fund is provided to SPPs for the amount of power generated from renewable energy (generally biomass). Interested SPPs must propose their power prices for the portion that is in excess of the purchasing prices under the existing SPP Program. The SPP with the lowest offer, which is not over the specified rate, will receive a financial subsidy from the ENCON Fund. A pilot period has been initially set for 57 years, targeting 300 MW of electricity to be connected to the grid. An allocation of about US\$ 48 million is provided for this project. To support this project, the Global Environment Facility (GEF) and the United Nations Development

Programme (UNDP) provided grants to NEPO to establish a biomass center in Thailand. This center will be a one stop clearing house for a party interested in biomass for power generation by providing technical advisory services, such as feasibility studies and technical trouble shooting to developers, providing information on financing sources, arranging project financing package to potential investors, and facilitating biomass power pilot plants to increase confidence of financing institutions in biomass technologies.

A2.3. Landfill gas utilization

Landfill gas technology is widely used in Australia, Canada and the U.S. Australia's landfill gas projects have most developed in the past five years. There is potential for expansion to reach approximately 300 MW installed capacity. The gas from landfills is used to produce grid-sold power, biogas to factories located adjacent to the landfill, and fuel for cogeneration plants and domestic heating. Australia also has a project to use biocell at adjacent landfill facilities to enhance production of biogas from waste. The landfill and biocell will utilize technology that accelerates the degradation process, and increases the production of landfill gas and biogas.

In Canada, about 1.2 megatonnes of methane is generated from landfills in about 10,000 active and closed landfill sites. In some of these sites, the captured gas is simply flared as a way to minimize adverse impacts of landfill gas such as nuisance odors and explosion risks, but other sites utilize the gas for energy purposes. These sites capture 0.2 megatonnes of methane per year representing a primary energy production valued at 9.6 petajoules. About 70% of the methane captured for energy purposes is used to generate electricity for sale to electric utilities estimated at about 650 GWh per year (assuming 90% capacity utilization of total generating capacity of 82.5 MW). The rest of the methane is piped out of the landfill sites and sold to nearby clients for the generation of thermal energy, for space heating of buildings, and for process heat in gypsum manufacturing plants, cement plants and recycling plants. At one site, landfill gas feeds a boiler to generate heat for a greenhouse during winter and cool summer evenings while the CO₂ generated in the boiler is used to enhance plant growth.

Landfill gas is utilized in small quantities at a few sites in New Zealand for electricity production. Mexico uses gas from a landfill to generate power for an illumination of a public park. Evaluations of several viable landfill sites for electricity generation have been undertaken in Mexico.

Hong Kong and Thailand have experienced landfill gas technology as demonstration projects. In Thailand, the Energy Conservation Fund has provided financial support to Kasetsart University to undertake a trial project at a landfill site on its campus at Kampaengsaen district, Nakhon Pathom province. The total amount of solid waste at the site is 8 million tons, which can produce 130,000 cubic meters of biogas per day with a heating value equivalent to 65,000 litres of diesel. The gas obtained can be used as fuel for two 435-kW generators. It is estimated that this power plant can serve 30-40% of normal power demand of the Kampaengsaen campus. After the project life period of 15 years, the estimated amount of power generated will be about 85.5 million kWh and the

amount of methane release can be reduced by approximately 399 million m³. In addition, the project can reduce the horizontal dispersion of gas and sludge flow from the landfill.

China, Indonesia, Malaysia and the Philippines do not use the landfill gas technology at present.

A2.4. Biofuels for transportation

Biofuel technology is still not currently cost effective. This technology is thus still either in a research and development stage or being used in a small scale with some subsidies or tax incentives from the governments. Manildra Energy Australia Pty Ltd. of Australia is researching technologies assisting the development of a commercial scale advanced technology fuel ethanol plant using wheat starch as a feedstock. The ethanol is sold as a 10% blend with petro through selected service stations. The CSR Distillers in Australia produces ethanol by fermenting molasses, the sugarcane milling byproduct, using Biostil semi-continuous fermentation technology. The plant capacity is 55 million litres of 95% strength ethanol per year. About half of the output is exported in bulk. The remainder is sold to domestic market with some of the ethanol upgraded to 100% strength. The University of Melbourne has developed a fluidized bed fast pyrolysis process that can convert black liquor, a waste product generated by paper and pulp making industry, into bio-oil. The bio-oil can be processed into transport fuel substitutes such as biodiesel.

Canada produces ethanol, mainly from corn and wheat, about 215 million litres annually, for which about 76% is used to blend into gasoline. The process for producing ethanol from starch-based feedstock is mature in Canada from a technology point of view. However, the cost of production is not competitive with gasoline but is subsidized in form of tax incentives by the federal and provincial governments. Research is currently underway to develop technologies for the production of ethanol from lignocellulosic biomass such as wood or agricultural waste, which is plentiful and low cost, to make cost of ethanol production competitive with gasoline.

Indonesia, Malaysia and the Philippines reported a research and demonstration stage of biofuel technology in their economies but the technology is not being used at present. Malaysia researched and tested the use of palm oil diesel as a diesel fuel substitute on a large number of vehicles including taxis, trucks, buses and passenger cars. The Philippines experimented gasifier technology for mobile power applications in light vehicles and fishing boats, and the use of coconut oil diesel and alcohol-gasoline blends for transportation. Indonesia is currently working on a detail study regarding the economic aspects of biofuel technology.

Gasohol is available at some petrol stations in Thailand. Its price is, however, subsidized by the Thai government. The use of coconut oil and palm oil in diesel engines are also reported in Thailand. Limited small scaled projects of bio-diesel for transportation have also been carried out in Hong Kong.

Extensive research on bioethanol and other alternative fuels is underway in the U.S.

A2.5. Other biomass-related technology applications

The other biomass-related technology applications mentioned in the Survey are municipal solid waste combustion technology and biogas technology applied to organic waste and wastewater.

Municipal solid waste (MSW) combustion technology

Four member economies—Australia, Canada, Singapore and the U.S.—mentioned the MSW combustion technology in their economies. Brighstar Environmental Ltd of Australia recently received \$2 Million Commonwealth grant for the design, construction, and installation of a solid waste energy and recycling facility at a municipal waste facility located in New South Wales. The facility will recover reusable and recyclable resources before the conversion of the organic components into gas and then electricity. Ten municipal waste incinerators with energy recovery were identified in Canada. These plants combusted 1.2 million tonnes of municipal solid waste with a primary energy content of 12.5 petajoules to produce either steam or electricity or both steam and electricity in cogeneration process, for sale to nearby industrial facilities. The energy produced by these plants, after transformation losses, is estimated at 6.3 petajoules. Some of these existing incinerators also showcase the most advance emission control technology. For example, the Burnaby incinerator in British Columbia and the Sydney incinerator in Nova Scotia have air emissions below the usual required performance. In Singapore, solid wastes are incinerated and the heat is used to generate electricity.

Biogas technology

The majority of major and midsize municipalities in Canada have sewage treatment plants with anaerobic digestion as part of the treatment process. In most cases, these plants use part of the methane production to heat their digester. In at least two plants, the methane is used in a cogeneration mode. The Ottawa regional plant generates 2.4 MW while the Bonnybrooke plant in Calgary generates 7.2 MW. All wastewater in Singapore is collected for treatment at six sewage treatment works and the biogas produced during the anaerobic treatment process is used to generate electricity to meet in-house energy requirements at the treatment works.

A large number of wastewater treatment plants in Australia recover biogas and use it for heating digesters and energy generation. Others plants flare the methane, which is beneficial in greenhouse terms but wastes a potential energy resource. Brisbane City Council operates 10 wastewater treatment plants. Six of these plants use anaerobic digestion and four of them have closed digesters with some degree of gas collection. Apart from one plant at Luggage Point, the other plants use the biogas to generate heat for the digestion process with the excess being flared. Luggage Point has used the biogas to generate electricity since around 1980. The waste heat from the engines is recovered from the cooling water and used to heat the digestion process. Around 70% of the electricity requirements of the plant are provided from energy recovery from biogas.

Export of power to the grid is a low priority due to the low buy-back rates that are currently offered.

Thailand does not use the anaerobic digestion process at general wastewater treatment facilities. However, the technology is being designed for wastewater treatment of small to medium-sized slaughterhouses. In addition, the King Mongkut's University of Technology Thonburi (KMUTT) has developed an anaerobic fixed film technique to produce biogas from factory wastewater. Also, Thammasat University has developed a simulation model for anaerobic biochemical reactor to produce biogas from wastewater of palm oil extraction plants, using a 100m³ gasifier.

Biogas from organic wastes was mentioned by Australia, Thailand, Indonesia and the Philippines. EarthPower Technologies Pty Ltd in Australia is constructing an anaerobic digestion facility, which converts up to 82,000 tonnes/year of food wastes from industrial and commercial sectors into biogas to be sold to neighbouring industry to replace the use of natural gas. In addition, EarthPower's process also captures the nutrient value of food wastes by producing high quality solid and liquid fertilizers and reusable, clean water.

Thailand has applied biogas technology to animal manure. Livestock raising has been rapidly expanding in Thailand causing the problems with increasing manure, residues and wastewater. The Thai government's ENCON Fund thus has been used to promote the establishment of biogas systems in livestock farms. This has not only alleviated the farm owners' energy cost for wastewater treatment but also produced biogas that can be used as a substitute energy source for LPG, petroleum and electricity.

Biogas technology using animal wastes has also been continuously promoted by the Philippines' Department of Energy. Many livestock farms in the Philippines produce biogas from animal manure for power generation for inplant use. Biogas from manure has been installed in some locations in Indonesia to reduce environment impacts. Biogas in Indonesia is mainly for cooking and also still in the stage of demonstration project. One of the barriers for biogas promotion in Indonesia is the social aspect that most people feel disgust in using the energy from manure biogas.

The summary of biomass-related technology applications currently being used in the APEC region is shown in Table 2.

Table 2: Biomass-Related Technology Applications in APEC

	Gasification	Cogeneration	Landfill Gas	Biofuels for Transport	Others
Australia	R&D	Yes	Yes	Yes	MSW, Biogas
Brunei ^{1/}	NC	NC	NC	NC	NC
Canada	Yes	Yes	Yes	Yes	MSW, Biogas
China	Yes	Yes	No	No	Biogas
Hong Kong	No	No	Yes—D	Yes—D	No
Indonesia	Yes—D	Yes	No	R&D	Biogas
Japan	Yes	Yes	NC	NA	NA
Korea	Yes	No	Yes	No	No
Malaysia	No	Yes	No	R&D	No
Mexico	NA	Yes	Yes--S	NA	No
New Zealand	NA	Yes	Yes--S	NA	No
Philippines	R&D	NC	No	R&D	Biogas
Singapore	NA	NA	NA	NA	MSW, Biogas
Thailand	No	Yes	Yes—D	Yes—S	Biogas
USA	Yes	Yes	Yes	Yes	MSW

Notes: NA refers to “Not answered”;

NC refers to “the answer is not clear”;

D refers to “Demonstration/pilot project”, being implemented for trail;

S refers to “Small-scaled project”, being used but not widespread;

R&D refers to the project under research and development, not being implemented at present,

^{1/} Brunei only mentioned that “no biomass-related technology is currently being applied for electricity generation.”

A3. Wind-related technology applications

The Survey asked the member economies to identify the wind energy related technology applications currently being applied in their economies such as (a) grid-connected wind farms to strengthen the national grid; (b) offgrid (rural and remote) electricity supply; (c) wind energy for water pumping to support agricultural practices; and (d) other.

From the responses to the Survey, wind-related technology applications are, for the most part, in a demonstration stage in the developing economies. The wind energy technologies utilized by developed economies are more advanced and larger in scale. For example, developed economies focus on grid-connected wind farms and large turbine manufacturing. On the other hand, the developing economies employ wind technologies in small offgrid connected applications. The task specific applications such as water pumping for irrigation employed in the developing economies are at a small scale or implemented as demonstration projects.

A3.1. Grid-connected wind farm

Australia, Canada, China, Japan, Mexico, New Zealand, the US., and—to a lesser extent—Thailand, have experience with grid-connected wind technology. Australia's biggest current wind farm is the 8 x 600 kW project at Crookwell in New South Wales. The other major wind farm in Australia is the Ten Mile Lagoon Wind Farm in Western Australia which generates electricity from 9 x 225 kW wind turbines. An additional 10 MW of wind turbines is being planned for Blayney in New South Wales, which will double Australia's installed capacity of wind generation to 20 MW. The Hydro Electric Corporation has large plans for wind generation in western Tasmania. A number of companies are interested in establishing wind farms along the coast of western Victoria and south east South Australia, which have some of the best wind resources in mainland Australia.

Canada's first sizable wind farm was the Cowley Ridge wind farm in Alberta. It was built in the early 1990s with a capacity of about 20 MW. The output is sold under long term contract to TransAlta Utility. There are several other wind energy facilities across Canada, mostly single-turbine facilities, aggregating to an additional 5 MW in capacity. The other large wind farm started in 1998 is Le Nordais wind farm in Quebec with a 100 MW capacity. The electricity from Le Nordais is sold to Hydro Quebec under a long-term contract paying a reported 5.8 cents per kWh. With the completion of Le Nordais, electricity production from wind in Canada will amount to over 300 GWh, or 1.2 petajoules, per year. With the exception of the Cowley Ridge and Le Nordais wind farms, the introduction of wind energy in Canada remains limited. This is due in large part to Canada's abundant, low-cost, competing sources of electricity supply.

Japan has used grid-connected wind power generation systems since 1992. In 1998, electricity purchase agreements by domestic power companies under long-term contracts were developed, enhancing the full-scale introduction of wind power generation systems. Total capacity of wind power generation systems in Japan was 83 MW in 1999 with a target of 300 MW by 2010.

Mexico has operated several grid-connected wind farms. One of the most efficient wind farms is La Venta grid-connected wind power station in Oaxaca. The project consists of seven Vestas Danish wind turbines with 1.5 MW capacities. Other projects include the development of small powered wind turbines installed in 1991 in Toluca, an installation of a 1.5 kW wind turbine during 1987-1995 in Hidalgo, and a 250 kW wind turbine demonstrate project in Baja California Sur.

China reported 34.4 MW installed capacity of the grid-connected wind in its economy.

To date, two grid-connected wind farms (of 32 MW, and 3.5 MW) have been developed in New Zealand. These are significant achievements given that the wind farm projects must compete directly with large gas fired combined cycle power plants within the fully deregulated New Zealand electricity market.

An interest in grid-connected wind is growing rapidly in the U.S. due to rising fuel prices and energy shortages, environmental concerns, and state-supported financial incentives. By the end of 1999, 2,500 MW of total installed wind energy capacity existed in the U.S., of which 803 MW was in the 12-state "Great Plains" region. In 1999 alone, 732 MW of new capacity was installed, with 614 MW in the Great Plains region. About 50200 MW of new capacity was installed in the U.S. in 2000. Four wind farms of 200 MW or more were installed in Texas, California, and the Pacific Northwest in 2001. Electricity from some of the U.S. projects has been contracted at less than 3 cents/kWh, which establishes wind energy as a power source more affordable than natural gas.

A grid-connected wind farm in Thailand to strengthen national grid is unlikely due to a limitation of wind resources. The only known grid-connected wind turbine generator in Thailand is a 150 kW induction generator demonstrated by the Electricity Generation Authority of Thailand at Phuket Island, southern Thailand. At present, the Provincial Electricity Authority (PEA) has installed four wind measurement devices along the eastern and western coasts of Thailand to evaluate the wind energy potential for determination of the economic viability of a grid-connected wind farm. If the potential of wind energy in the targeted areas is high, PEA will carry out a follow-up project on the installation of a grid-connected wind farm with a minimum generating capacity of 1,000 kW. In addition, the Department of Energy Development and Promotion (DEDP) has recently finished a wind energy resource map study that depicts estimated distribution of wind resources in Thailand, including average wind speed, wind power density on annual and monthly basis, inter annual/seasonal and diurnal wind variations.

A3.2. Off-grid electricity supply

The off-grid wind technology for electricity supply has been used in the U.S., Australia, Canada, New Zealand, China and Mexico. Off-grid use of wind in the U.S. is limited primarily to providing electricity for vacation homes or remote installations located far from the grid. In 1999, there were about 9,800 small (<50 kW) systems installed in the U.S. Canada has used small, residential-sized wind turbines for powering cottages and remote housing. There are also many small wind turbines used in Remote Area Power Supply (RAPS) systems in New Zealand to provide electricity to single residences in rural areas. These RAPS systems are typically developed at sites that are beyond about 2 km from the existing local electricity network. China reported the use of 170 thousand sets of small off-grid wind turbines at present.

The off-grid wind technology is utilized in Hong Kong, Indonesia, Malaysia and the Philippines in small-scale or demonstration projects. Hong Kong has small off-grid wind turbines installed in remote outlying islands to provide national electrical power to serve data recording equipment for weather monitoring purposes. Indonesia has small scale wind energy systems installed in rural and remote areas for fulfilling the basic electricity needs. Malaysia has installed the first and only wind energy conversion system in Pulau Layang-Layang, a remote island in Sabah. The system has been installed and constructed by TNB Research, featuring a wind turbine generator hybrid system with 150 kW.

Finally, the Philippines has utilized demonstration units of wind turbine generators for electricity generation, but these are still in the pilot stage.

A3.3 Wind energy for water pumping to support agricultural practices

Australia is a longtime user of small wind pumps for agricultural purposes. The total numbers of small pumping windmills in Australia are estimated to be more than 15,000. This area, however, appears to be losing market share to solar pumping systems. The use of wind for water pumping is also no longer a major industry in the rural U.S.

There are several thousand water-pumping wind turbines in Canada, primarily in the Prairies. The common application is to pump underground water to the surface and stored in a basin, for example, to provide drinking water to cattle. Wind powered water pumping is also used in Indonesia, Mexico, New Zealand and the Philippines to provide water for livestock.

Wind energy for water pumping installed in some locations in eastern part of Indonesia for irrigation. China uses wind energy for water pumping at a small scale. Hundreds of local-made wind turbines for water pumping have also been reported in various parts of Thailand. However, their effectiveness has yet to be analyzed because in most parts of the country, wind resources are not good.

A3.4. Other wind-related technology applications

The other wind related technology includes the use of wind turbines to aerate ponds and lakes in Canada and the use of old fashioned (canvas or wood blades) wind turbines to pump seawater to make salt in Thailand. Philippines mentioned the use of wind for water pumping for domestic and potable water application in a number of households in Central Luzon with scattered occasional units around the country including a few educational institutions. Mexico also mentioned the use of water pumping for human consumption at the agricultural zone El Vizcaíno. The energy at El Vizcaíno comes from the wind power station of Guerrero Negro with a power of 600 kW. It is composed of only one wind turbine with a diameter of 14 meters assembled on a tower of 50 meters high. Guerrero Negro has lower wind resource intensity than the other location. However, electricity costs by diesel generation are high, thus wind has excellent opportunities. In addition, as the zone is considered a Biosphere Reserve, wind generation is an appropriate complement for diesel generation because it doesn't produce hazardous emissions to the atmosphere. The use of wind-related technology applications in APEC is summarized in Table 3.

Table 3: Wind-Related Technology Applications in APEC

	Grid-Connected Wind farm	Off-Grid Electricity Supply	Wind Energy for Water Pumping for Agriculture	Others
Australia	Yes	Yes	Yes	NA
Brunei ^{1/}	NC	NC	NC	NA
Canada	Yes	Yes	Yes	Aerate ponds & lakes
China	Yes	Yes	Yes—S	NA
Hong Kong	No	Yes—S	No	NA
Indonesia	No	Yes--D	Yes--D	NA
Japan	Yes	NA	NA	NA
Korea ^{2/}	NC	NA	NA	NA
Malaysia	No	Yes—D	No	NA
Mexico	Yes	Yes	Yes	Drinking water for households
New Zealand	Yes	Yes	Yes	NA
Philippines	No	Yes—D	Yes	Drinking water for households & institutions
Singapore	NA	NA	NA	NA
Thailand	Yes—D	No	Yes—S	Pumping seawater for salt making
USA	Yes	Yes	Yes	NA

Notes: NA refers to “Not answered”;

NC refers to “the answer is not clear”;

D refers to “Demonstration/pilot project”, being implemented for trail;

S refers to “Small-scaled project”, being used but not widespread;

^{1/} Brunei only mentioned that there is no wind energy related technology being applied for electricity generation.

^{2/} Korea only mentioned that it “has made efforts to promote grid-connected wind farms.”

A4. Solar-related technology applications

The member economies were asked to reveal the solar technology applications currently being applied in their economies such as (a) grid-connected photovoltaic (PV) arrays to strengthen the national grid; (b) offgrid (rural and remote) PV applications to meet local electrification needs such as home lighting, commercial and agricultural applications, education, rural health clinics; (c) concentrating solar power technologies for generating electricity or solar heating for domestic or industrial hot water supply; (d) passive design architecture to take advantage of natural solar heating and ventilation, and daylighting; and (e) other.

Based on the responses to the Survey, off-grid PV is more widely used than grid connected PV in both developed and developing economies because of its cost effectiveness. While PV is much more expensive than conventional power available on the grid, off-grid PV is more price competitive against grid extension or conventional stand-alone power systems. Off-grid PV is mainly for telecommunication. The common use of solar thermal power is for water heating. Solar thermal is not commonly used for electric power generation in APEC.

A4.1. Grid-connected photovoltaic

Grid-connect PV is not widely used in APEC because of its cost ineffectiveness as compared to conventional power system. The utilization of this technology is in small scale operations or demonstration projects. Japan seems to utilize this technology more than other economies. Production of PV cells in Japan was 80 MW in FY 1999. The cumulative capacity of grid-connected PV installed in Japan by the end of 1999 reached approximately 205 MW with the target of 5,000 MW in 2010.

Grid-connected solar farms have been constructed in Western Australia, New South Wales and South Australia. Several demonstration sites have also been established by Australian electricity utilities. There are also many demonstration projects for grid connected solar PV applications in the U.S. supported by federally financed programs such as the Utility Photovoltaic Group and the Million Solar Roofs Program. A number of state programs, such as New York's State Energy Research And Development Administration and California's Sacramento Municipal Utility District, also support grid connected solar roof programs.

Canada has less than 40 gridconnected PV systems installed with total capacity of only 267 kW. Since the cost of PV power is still 5 to 10 times higher than conventional power available on the grid, PV is unattractive for gridconnected applications at present. Many of the grid-connected systems in Canada were installed as technology demonstration projects such as the 85 kW system installed on the Hugh McMillan Rehabilitation Centre in Toronto and the 20 kW system installed on the CANMET Energy Diversification Research Laboratory of Natural Resources Canada in Quebec.

Two grid-connected solar PV demonstration projects (5 kW and 3 kW) are under operation in Malaysia at University Kebangsaan Malaysia and University Tenaga Nasional campuses.

Thailand has a demonstration project on PV rooftop grid connected systems. A potential of using grid-connected PV to strengthen the grid network is high because of plentiful solar energy (yearly average of 15-20 MJ/m²/day) in most parts of the economy and the availability of the both national grid (69500 KV extended to all provinces) and distribution grid (11-33 KV serving 99% of sub district areas). The only barrier for this option is the high investment cost. A feasibility study, however, has shown advantages

of PV over other alternatives in some areas in Thailand (such as in the remote areas in Mae Hong Son Province, northern Thailand).

A4.2. Off-grid PV applications

Telecommunication is the common offgrid PV application in the member economies. In Australia, telecommunication remains a major market for solar technology. The other applications include railway signaling systems, navigational aids, cathodic protection, water pumping, street lighting and remote refueling (aviation) installations. These applications continue to account for well over half of domestic sales. Australia also uses high efficient solar powered water pumping systems, which are based on standard photovoltaic modules and standard pumps but incorporate innovative approaches in power electronics and new motor designs.

The bulk of the installed capacity in Canada is for offgrid applications where PV is proven to be price competitive against grid extension or conventional standalone power systems. Typical applications include electric power for telecommunication systems, water pumping and purification, remote monitoring and control, remote residential properties, various coast-guard lighting and beacon systems, and numerous consumer applications including handheld calculators. The largest individual PV system user in Canada is the Canadian Coast Guard who is using PV in an estimated 7,000 navigational buoys, beacons and lighthouses.

Brunei uses stand-alone PV systems in remote areas for telecommunication, marine navigation, and some off shore oil platforms. China uses solarPV home systems for lighting, commercial and agricultural applications, education and rural health clinics with total capacity of about 13 MW. Indonesia has around 5 MW offgrid PV systems for home lightings, education, rural health clinics, communication, and commercial and agricultural applications. To date Malaysia has installed more than 2 MW of solar PV systems under rural electrification scheme, telecommunications, and the oil and gas offshore industries.

There is no grid-connected PV, but off-grid PV systems have been installed in Mexico. In the early 1980s several lighting systems were installed at children shelters of the Instituto Nacional Indigenista (INI). This program benefited about 153 communities. Also, in 1982 the Instituto Mexicano del Seguro Social (IMSS) acquired about 400 of these systems for its rural clinics. Later, in 1989 the Federal Government established a rural electrification plan and installed more than 40,000 small PV systems. Offgrid PV systems have also been used for communications, water pumping for livestock and communities, fisheries, icemaking, electric fences and fish tank oxigenation.

The Philippines has installed a number of offgrid PV systems for home lightings, commercial, education, rural health applications, and PV pumping of household and community water supply. The Rural Electric Cooperatives used the PV-solar heating system concept for rural electrification with limited success because of institutional and technical problems, among others. PV applications for refrigerators and freezers for

vaccines and pharmaceutical applications were implemented by the Department of Health.

There are currently no large grid-connected PV systems in New Zealand, only a few residential grid connected systems and demonstration projects. The use of PV in New Zealand is mainly for Remote Area Power Supply (RAPS) systems. The common applications are for remote telecommunication and maritime signal lighting, rather than residential power due to the relative high costs of PV compared to wholesale electricity or other RAPS systems such as wind or micro hydro.

Many off-grid applications of PV have been used in the U.S., including the use of PV for powering transmission towers, highway signs and railroad signals.

A4.3. Concentrating solar-power technologies for power generation or solar heating for domestic or industrial hot water supply

Solar thermal for power generation is not commonly used. Australia, Japan and the U.S. reported the use of this technology at R&D or demonstration stages. Australia constructed 5 MW solar thermal power plant at Stanwell Power Station in Queensland. The plant uses the new compact Linear Fresnel Reflector (CLFR) technology. This new type of solar array can be used to produce steam for generators that use conventional steam turbines. The project uses a large array of solar reflectors, driven by an electrical tracking system, to collect the energy from the sun. The CLFR technology allows the existing coal fired power station to provide commercially viable green energy to the electricity grid. In addition, Anutech Pty Ltd, Transfield Pty Ltd and CS Energy Ltd of Australia received Federal funding for the installation of 17 "Big Dish" solar thermal collectors at Mica Creek Power Station. The project aims to demonstrate the technical viability of a 2 MW equivalent solar thermal array for power generation through integration with the existing 33 MW fossil fuelled power plant. This project will generate further expertise in component design, construction and plant operation that will establish this solar thermal technology as a promising new element of Australia's renewable energy industry.

The concentrating solar power industry in the U.S. has had success at the SEGs trough plants in southern California with total 350 MW of installed capacity. However, this industry is still primarily in the R&D stage, and federal research support to this technology has decreased over the past several years. A small private sector industry is emerging with interests within the U.S. Primary technologies under consideration include troughs, power towers and dish sterling systems.

Solar thermal capacity in Japan reached 913 Mkl in 1998 with a target of 4,500 Mkl for 2010.

The more common used of the concentrating solar power is solar heating. Solar water heating has been established in Australia since the 1950s and now is a well known, fully commercial industry. The four main manufacturers (Solahart, Edwards, Beasley and

Rheem) produce about 30,000 units per year, of which roughly 40% are exported with a value of around \$21 million annually. The volume of exports makes Australia one of the worlds leading exporters of solar water heaters.

In Canada, the most cost-effective solar energy technologies are those used for low-temperature heating applications such as domestic water heating, pool heating and commercial/industrial ventilation air preheating. An estimated 12,000 residential solar hot-water systems and 300 commercial/industrial solar hotwater systems are currently in use in Canada. Energy production from these systems is estimated at 0.1 petajoules per year. Following the collapse of oil and gas prices in the mid1980s and the termination of off-oil government programs, sales of new systems have slowed down considerably. Approximately 200 new systems are installed annually, representing sales of less than \$1 million. About half of the residential systems are used for seasonal pool heating which allows Canadians to use their pools later in the season without incurring any extra fuel costs. The other half contributes to heating water for domestic uses, using year-round systems that include solar panels, antifreeze solutions and heat exchangers. In this latter application, the solar system typically provides half of the hot water for a household, reducing the demand for fuel or electricity for the conventional hot water system.

The solar water heating systems, concentrated and directs, are growing at a very fast pace in China. There are now more than 1000 large- and small-scale solar water heater manufacturing companies in China with total applications reaching 20 million²m Solar heating has also been commercialized in Indonesia. There are one manufacture and many dealers of solar water heaters in Indonesia. Hong Kong uses solar heating for swimming pools and slaughterhouses. Brunei has solar heating for domestic hot water in a small number of houses.

Mexico has used solar water heating systems in the residential sector for 40 years. At present, Conae is working on the massive use of SWHS, which promotes a program of Mexico City's Government, and in the development of standards to regulate equipment. As a result, Conae generated a document called "Protocol to Assign Financing to Solar Water Heating Systems Projects".

Concentrating solar power is not considered effective in Thailand because the solar insulation usually consists of 50% diffused radiation (which can not be concentrated). However, some low to medium temperature systems may be utilized through the use of evacuated heat pipes and flat plate collectors with selective surface coating.

A4.4. Passive design architecture to take advantage of natural solar heating and ventilation, and daylighting

Australia has embarked on a number of measures—both voluntary and mandatory—to improve energy efficiency in residential and commercial buildings. The National House Energy Rating Scheme, for example, operates in most States and Territories to assess energy efficiency in the residential sector. There is also an Energy Management Taskforce consultative process to identify new measures to improve energy efficiency in

commercial buildings that have the potential to capture the support of key stakeholders. Energy efficiency information services are being provided under the National Greenhouse Strategy.

Passive design architecture to take advantage of natural solar heating and ventilation, and daylighting is also conducted in cold areas in north China, in Indonesia (especially in commercial building and household in relation with energy conservation program), in Mexico and New Zealand, and very few in Thailand.

A4.5. Other solar-related technology applications

Other solar technology applications mentioned by the member economies include the use of solar thermal technology in Indonesia for drying agricultural crops such as paddy, chilly, tea and coffee. Canada uses solar-assisted air conditioning, detoxification of wastewater, direct fuels/materials production, and ventilation application. The most common solar air heater in Canada is the Canadian designed Solarwall™, a solar pre-heated air ventilation system which uses metal solar collectors that transfer heat to ventilation make-up air as it flows through the perforations in the collectors.

Table 4 summarizes the use of solar-related technology applications in APEC.

A5. Other renewable energy technology applications

The Survey asked the member economies to describe other renewable energy technology applications being used to address development needs, such as (a) diesel/solar/wind/hybrid systems for rural electrification; (b) electric vehicles for transportation; (c) microhydro resources for rural electrification; (d) fuel cells; and (e) others. Among these mentioned technologies, diesel/solar/wind hybrid system is most identified as being used in APEC, followed by small hydro (mini and micro-hydro) systems. Besides electric vehicles and fuel cells, the other renewable energy technologies mentioned by the member economies include tidal power and earth energy systems being used in Canada, wave power in Australia, methane recovering from coal mining in Japan, dendrothermal power in the Philippines and Australia, and geothermal in Australia, Indonesia, Japan and the U.S.

Table 4: Solar-Related Technology Applications in APEC

	Grid-connect PV	Off-grid PV	Solar thermal (1) or Solar Heating (2)	Passive Design Architecture	Others
Australia	Yes—S	Yes	Yes (1)—D Yes (2)	Yes	NA
Brunei	No	Yes	Yes (2)—S	No	No
Canada	Yes—S	Yes	NC (1) Yes (2)	NA	Solar-assisted air conditioning etc.
China	NC	Yes	Yes (2)	Yes	No
Hong Kong	No	No	Yes (2)	NC	No
Indonesia	No	Yes	Yes (2)	Yes	Solar thermal for drying agricultural crops
Japan	Yes	NA	Yes (1)—D	NA	NA
Korea	Yes—S	No	Yes (2)	No	No
Malaysia	Yes—D	Yes	NA	NA	NA
Mexico	No	Yes	Yes (2)	Yes	NA
New Zealand	Yes—S	Yes	Yes (2)	Yes	NA
Philippines	No	Yes	NA	NA	NA
Singapore	NA	NA	Yes (2)	NA	NA
Thailand	Yes—D	Yes—S	Yes—S (2)	Yes—S	NA
USA	Yes—D	Yes	Yes (1)—R&D Yes (2)	Yes	NA

Notes: NA refers to “Not answered”;

NC refers to “the answer is not clear”;

D refers to “Demonstration/pilot project”, being implemented for trial;

S refers to “Small-scaled project”, being used but not widespread;

R&D refers to the project under research and development, not being implemented at present.

A5.1. Diesel/solar/wind hybrid systems for rural electrification

Diesel/solar/wind hybrid systems have been installed in most economies, especially in remote areas where the systems are proved to be cost-effective as compared to other options. Australia has increasingly utilized renewable energy in the Renewable Remote Area Power Supply (RAPS) systems for off-grid electricity supply for small holiday homes and shacks, boats and recreational vehicles, small rural farms (single homes), large station homesteads (with multiple residences), remote aboriginal communities, small mining operations and various telecommunications applications. Most of the

RAPS systems use PV, but a few use wind energy or hybrid systems. Other common system components are diesel or petrol back up generators, deep cycle batteries, inverters and control systems. It is estimated that more than 10,000 RAPS systems have been installed in Australia with the largest number in southeast Australia. In 1997, Western Power installed a variable speed wind turbine and communications, control and SCADA equipment on the Denham diesel power grid. This turbine generates on average more than 20% of the Denham's electricity requirements and thus reduces the town's reliance on imported diesel by 175,000 litres per year. At certain times the wind turbines, with the support of flywheels, provide 100% of Denham's electricity supply. Operation of the turbine cuts CO₂ emissions by more than 500 tonnes per year.

A diesel/solar hybrid system is being used in the remote national park Belalong in the Temburong District in Brunei. Diesel/solar/wind hybrid systems are being used in remote regions of Canada particularly in the North, some remote areas and islands in China, very remote locations of the U.S. (such as Alaska), also in New Zealand, and Indonesia. PV/wind/diesel hybrid systems have been demonstrated at some national parks and wild life sanctuaries in Thailand. Future prospect of the hybrid systems is promising in Thailand, particularly for communities on small islands.

A solar/diesel hybrid system was implemented at the Nature Education and Research Center, Endau Rompin National Park, in Malaysia in 1998 under the funding of Electrical Supply Industry Trust Account (ESITA) and Danish Cooperation for Environment and Development (DANCED). A total of 112 solar modules have been installed with total array power of 10 kW. The diesel generator has the capacity of 6 kW.

Mexico has installed a few hybrid systems. The hybrid project XCalak was installed in 1992 in Othón Blanco village, Quintana Roo, composing of 60 kW wind generators, 11.2 kW PV systems and a 125 kVA diesel generator. The X-Calak project supplies electricity to the whole village. Smaller hybrid projects were installed, such as El Junco project in the city of Zacatecas composing of 1.6 kW PV panels and 10 kW wind turbines. In addition, the hybrid project San Antonio Agua Bendita was installed in the State of Mexico in 1993 containing 12.4 kW PV panels, 20 kW wind system, and a 40 kW diesel generator.

The Philippines has installed LPG/solar hybrid standalone systems using Rural Energy Services Companies (RESCO) format of funding. The project is implemented by Shell in Madalag, Alaminos and Aklan in central Philippines.

The development of diesel/solar/wind hybrid systems is underway in Korea.

A5.2. Electric vehicles for transportation

Australia mentioned the hybrid electric vehicle technology in its economy. The new vehicle—*aXcess 2*—is a low emissions vehicle that produces 10% of the emissions of an average family car, while reducing fuel costs by half and weighing much less than normally hybrid electric vehicles.

Electric and hybrid vehicles are already in practical use in Japan. There are more than 3,000 small private and public electric vehicles for commercial transportation in Mexico City. In the U.S., some states (such as California) have strong air pollution control standards that mandate the future use of electric vehicles. Singapore uses tax rebates as an incentive to encourage motorists to buy electric and hybrid cars instead of conventional gasoline-powered cars.

Battery-powered automobiles are not at present a viable choice for consumers in Canada and the Philippines. Canada uses battery-powered vehicles such as forklift trucks and ice rink cleaning machines only indoor where air quality is important. Similarly, the Philippines uses vehicles powered by storage batteries as golf carts in almost all golf parks and as forklifts in industrial warehouses where ventilation is restricted. At present, Canada is working on the Electric Vehicle Project-Montreal 2000 to evaluate 30-40 electric vehicles of different models and makes to determine the viability of using battery-powered cars and light trucks.

Electric vehicles for transportation are still under R&D stage in China, Indonesia, Malaysia and Thailand.

A5.3. Small hydro resources for rural electrification

There are micro-hydro and mini-hydro generating systems in several locations in Australia despite the fact that the opportunity to utilize them is limited. Australia mentioned several small hydro projects in its economy. Examples include the Pemberton Project (110 kW), the Mannus Creek Project (500 kW), the Copperlode Falls Dam (780 kW), the Yarrangobilly Caves (50 kW), the Murray 1 Standby (900 kW), and the Macquarie Generation Project in New South Wales (800 kW).

Small-hydro and low-head hydro are proven technologies and have been applied in numerous sites across Canada. Canada is continuing research on novel concepts such as very low head turbines, low cost automation, assistance and fish passage, and site assessment methods. Both expertise and equipment are exported to other economies as well.

Micro-hydro is very popular in south China. In Yunnan province, power from mini and micro-hydro occupies 50% of the total power supply in rain fall season.

Indonesia has high potential of microhydro resources and the technology has been semi commercial. At present around 54 MW of micro-hydro systems have been installed in Indonesia to supply electricity in rural areas.

Malaysia has identified the use of small hydro to meet a goal of rural electrification. The category of hydro varies from small to medium size weirs and dams allow water to be regulated on a diurnal to weekly basis. The power capacity is between 100 kW to 500 kW.

Mexico has more than 100 years of experience in minihydraulic energy, mostly in rural zones and for textile industries. The minihydraulic production in Mexico is mostly private, which is a favorable factor to the development of new enterprises willing to generate energy for self-consumption.

There could be about twenty or more micro-hydro schemes in the Philippines and the number is increasing. If the resource is available, microhydro is emerging as the best option among all renewable energy electrification technologies for electrification of remote communities where grid electricity is not expected in the next 510 years.

A number of minihydro resources have been developed in remote areas of Thailand. However, the effectiveness of using the resources has yet to be evaluated since most of them are developed under a rather tight budget situation, followed by insufficient O&M programs.

In the U.S., microhydro resources are used only in remote mountain locations to provide power for vacation homes.

A5.4. Fuel cells

Fuel cell technology is mainly still in the R&D stage. More advance R&D and demonstrations have been carried in Australia, Canada, Japan and the U.S. The Commonwealth Scientific and Industrial Research Organization (CSIRO) and Ceramic Fuel Cells Limited (CFCL) of Australia have successfully demonstrated a 5 kW solid oxide fuel cell stack. A 200 kW system started an operation in mid 2001. CFCL also established an electrolyte-supported cell fabrication plant in Noble Park, Victoria. This facility employs over 100 people and is now producing about 1,000 fuel cells per week. Canada has run the world's first hydrogen fuel cell bus since 1993. Using PEM fuel cell technology and compressed hydrogen fuel, Ballard Power Systems of North Vancouver is leading the way in fuel cell powered buses. BC Transit began operating three Ballard buses in revenue service in 1999. PEM has become the fuel cell of choice for light transport applications such as automobiles. Recent advances have achieved the power density necessary for commercial use in an automobile. Driving range is in the order of 400 to 500 kilometers—comparable to today's internal combustion engines and far ahead of battery powered systems. At the point where an automobile operates at its average power (15% load), a fuel cell system is roughly twice as efficient as a spark ignition engine. Ballard is also developing a prototype 250 kW fuel cells for stationary applications. A 250 kW solid oxide fuel cell is being constructed in Toronto, Canada. It is a joint project of Kinetrics, SeimensWestinghouse, the US Department of Energy and Natural Resources Canada. Global Thermoelectric is developing a 1 kW solid oxide fuel.

The use of fuel cells for stationary power supply in the U.S. is growing through industry initiatives, and federal and private sector R&D for fuel cell usage for transportation is also growing in the U.S. In addition, Japanese automobile manufacturers are developing various kinds of fuel cell power generation systems jointly with overseas companies.

R&D on fuel cell technology has also been conducting in China, Indonesia, Korea, Malaysia, Mexico and Thailand. Mexico mentioned a fuel cell pilot project funded by the Global Environment Facility to implement 20 fuel cell transportation units for passengers in Mexico City. Thailand is also studying the potential to establish a fuel cell technology center in the economy.

A5.5. Geothermal power

Geothermal energy technology for power generation has been utilized in large scale in the U.S, Japan and Indonesia. There are several large geothermal facilities in the U.S., totaling 2,700 MW installed capacity. There is also an additional 4,000 MW capacity of geothermal heat pumps. The total capacity of geothermal facilities in Japan is 530 MW at present with the target of 1,000 MW in 2010. Indonesia has installed about 525 MW of geothermal capacity for power generation. Indonesia has also begun a pilot phase of using geothermal technology for drying systems.

Australia has limited experience in the use of geothermal energy. Large hot dry rock resources have been identified in the Cooper Basin, the Eromanga Basin and the Upper Hunter Valley. The significance of these resources, in energy terms, cannot be determined until technologies to extract the energy have been developed. In general, the remoteness of the best resources from major centers of energy demand tends to make costs high, and hence diminish the size of the economically feasible resource. However, the Hunter Valley site could, if commercial, offer significant opportunities given its location to major demand centers. There is some minor use of geothermal hot water/steam for heating in Portland, Victoria. In addition, the University of New South Wales is using Hot Dry Rock (HDR) technology to develop Australia's first granite reservoir in the Woronora No.1 well south of Sydney. This well was originally drilled as an oil/gas exploration well and bottoms into granite representative of Australia's extensive HDR resources. The project aims to develop assessment methodology and criteria for characterizing HDR resources and determining the most appropriate reservoir development approach.

A5.6. Wave power

The wave power technology is utilized to extract energy from the ocean waves and convert it to electricity. This technology was identified in use by Australia. The system is located on the breakwater at Port Kembla to demonstrate that wave energy can be a commercially viable renewable energy source. With a peak capacity of 500 kW, the system at Port Kembla is expected to save 1,000 tonnes of greenhouse gas emissions annually. The project will mark the first step in commercializing an innovative renewable energy technology designed and developed in Australia.

A5.7. Tidal power

Canada is among a few countries in the world that operates tidal power plants. The Annapolis Tidal Generation Station in Nova Scotia is the second largest tidal power plant in the world with a nameplate capacity of 20 MW, after the La Rance River in France, which is the 240 MW plant. The bay area between Nova Scotia and New Brunswick is one of the few places in the world where tides rise in the order of 10 meters. Under certain circumstances, tides can reach as high as 16 meters. The Annapolis plant was built as a low-head demonstration project and started its operations in 1984. The annual output has been in the range of 30 GWh per year. Currently, extraction of energy from the tides is considered to be practical only where large tides and geography provide favorable sites for tidal plant construction. In Canada, potential exists in several locations for which the three different sites in the Bay of Fundy are considered the best economical potentials with total capacity of 8,500 MW and an annual production of 22,000 GWh.

A5.8. Earth energy systems

Rough estimates of primary energy production for earth energy systems (EES) in Canada are in the range of 1.5 PJ. No precise estimates of the total potential of EES. However, it is believed to be significant. The only major constraint is the availability of land besides a building to lay the underground loop. There are approximately 30,000 residential EES in Canada. Currently residential sales are estimated around 1,000 systems a year, with about 40% of the sales in Ontario. A typical residential system has one heat pump unit with a capacity of 10 kW or 3 tons of refrigeration. Sales of EES are increasingly in the commercial and institutional markets, including schools and shopping centers. A survey of suppliers indicated that three-quarters of non-residential sales were for new buildings and the rest were used as replacements for existing HVAC systems. However, total EES installations represent less than 1% of the space/water heating and cooling market in Canada.

A5.9. Dendrothermal power

Dendrothermal power, or wood or tree farms, to supply power plants was mentioned by Australia and the Philippines. The Western Power Corporation in Australia has constructed an integrated wood processing demonstration plant at Narrogin to produce electricity to the main grid in the south west of Western Australia. Harvesting locally grown mallee, the 1 MW capacity plant, will generate electricity while producing eucalyptus oil and converting wood to activated carbon. The Philippines has installed dendrothermal power plants in Bolinao, Pangasinan and Zambales. However, the projects were not successful due to various technical, financial, social, political and biological barriers (that emerged during the process of developing the fuel wood plantations).

A5.10. Methane from coal mines

Japan mentioned the production of methane from coal mining, where it is collected and utilized as town gas. R&D is being conducted on how to exploit it as liquid propellant (e.g., dimethyl ether).

The list of the other renewable energy technologies applications in APEC is shown in Table 5.

Table 5: Other Renewable Energy Technology Applications in APEC

	Hybrid systems	Electric vehicles	Small hydro	Fuel cells	Others
Australia	Yes	Yes	Yes	Yes—D	Geothermal Wave power Dendrothermal
Brunei	Yes	NA	NA	NA	NA
Canada	Yes	Yes—S	Yes	Yes—D	Tidal power EES
China	Yes	Yes—R&D	Yes	Yes—R&D	NA
Hong Kong	NA	NA	NA	NA	NA
Indonesia	Yes	Yes—R&D	Yes	Yes—R&D	Geothermal
Japan	NA	Yes	NA	Yes—R&D	Geothermal Methane from coal mine
Korea	Yes—R&D	NA	NA	Yes—R&D	NA
Malaysia	Yes	Yes—R&D	Yes	Yes—R&D	NA
Mexico	Yes	Yes	Yes	Yes—R&D	NA
New Zealand	Yes	NA	Yes	NA	NA
Philippines	Yes	Yes—S	Yes	No	Dendrothermal
Singapore	NA	Yes	NA	NA	NA
Thailand	Yes—D	Yes—R&D	Yes	Yes—R&D	NA
USA	Yes	Yes—S	Yes	Yes—R&D	Geothermal

Notes: NA refers to “Not answered”;

D refers to “Demonstration/pilot project”, being implemented for trail;

S refers to “Small-scaled project”, being used but not widespread;

R&D refers to the project under research and development, not being implemented at present.

A6. Future plans to apply renewable energy technologies to the sustainable development goals and priorities

Australia believes in market mechanisms and competition for the use of renewable energy technology in its economy.

The future plans in Canada are related to the issue of climate change since Canada has committed to reduce its greenhouse gases by 6% under the Kyoto Protocol. The

government of Canada has introduced a number of new initiatives to take action on climate change, many of which are related to renewable energy—including alternative and future transportation fuels, fuel cells, electric vehicles, renewable energy in buildings and community systems, green power, solar energy, earth energy system, and energy from wastes. The Philippines also mentioned the future plans of utilizing renewable energy resources as part of climate change mitigation activities, in addition to the goal of using them for rural development and electrification. The renewable energy technologies mentioned in the Philippines' future plans include biomass, biofuels, wind, solar, hydro and hybrid electric systems.

To support its sustainable development goals and priorities, the government of Indonesia supports the development of renewable energy technologies particularly the utilization of renewable energy for productive uses in rural areas, so that it can contribute significantly to improving poverty alleviation, and increasing the living standard as well as economic welfare in rural areas. Among others, the future plans include continuation of R&D and pilot projects for the technologies that have not yet been commercialized, encouraging the private sector to develop renewable energy technologies, building local capacity, developing financial schemes and information dissemination.

Korea identified its future plans in general such as promotion of renewable energy technology demonstration program, establishment of a performance certification center for renewable energy technology and enhancement of renewable energy technology related information distribution.

Mexico emphasized its future plans for sustainable development on poverty alleviation and rural electrification as well as a priority to teach the new generations to conserve energy and use renewable energy more efficiently, productive, and environmental friendly. There is a plan to develop wind resources in Oaxaca with job creation through an installation of new enterprises being an additional goal of the project. For rural electrification, there is an initiative to develop mini and micro hydroelectric projects in Chiapas. There is also a project to install a hybrid electrical plant of 300 MW integrating a solar field of parabolic concentrators to a conventional combined cycle in Baja California.

As Singapore's sustainable development priority and goal was transportation and air pollution reduction, it has emphasized transport policies that contribute to energy efficiency and the reduction of CO₂ from vehicles. These policies include an integrated land use and transportation plan to minimize the need to travel, promoting a viable and efficient public transport system, managing the growth and use of private vehicles, controlling vehicular emissions, controlling automotive fuel quality, and mandatory periodic inspections and enforcement actions against smoky vehicles.

New Zealand revealed its future plan, as stated in the Government's Energy Policy Statement, including "continual improvement in our energy efficiency and a progressive transition to renewables."

Some economies have emphasized their future plans on particular renewable energy resources based on development potentials in their economies. Malaysia has focused on biomass for power generation due to its high potential and interest shown by private sectors. Malaysia is enriched with significant amounts of biomass resources. Potential biomass-based power generation is estimated at 665 MW capacities while current installed capacity is only about 138 MW, mostly from oil palm waste. Thailand sees potential in biomass/biogas and PV technologies (especially grid-connected roof top PV) due to the availability of energy resources in the economy and the fast declining in the investment cost of technology. Brunei mentioned hydro potential in the Temburong district.

Japan identified four areas of emphasis—PV power generation, wind power generation, waste power generation and fuel cells. For PV power generation, a goal is to broaden its uses. To this end, R&D on substrates and modules are being conducted to lower the cost of manufacturing and establish mass production technology. In addition, field-testing in factories and demonstration tests on PV power generation systems are being carried out. As for wind power generation, the development of advanced wind turbine systems for remote islands is being undertaken. Various data will be collected and analyzed in order to examine the stabilization of gridconnections through long-term operation and trial basis installation of the systems. Regarding waste power generation, development and field-testing of highly efficient waste power generation systems are being conducted. Finally, basic and practical use technologies for molten carbonate, solid oxide, and polymer electrolyte fuel cells are being developed.

China's State Economic and Trade Commission issued a "Renewable Energy Industries Development Plan 2000 - 2015", which states the targets of expanding the use of each renewable energy type to the year 2015. The renewable energy technologies mentioned in the Plan include the following (with its targeted capacity in 2015 noted in parenthesis): PV (320 MW); solar water heater (232 million m²); grid-connected wind power (7,000 MW); small off-grid wind power (105 MW); geothermal for space heating (30 million m²); geothermal for power generation (110 MW); biogas from industrial wastes (40 hundred million m³); biogas from agricultural wastes (4.5 hundred million m³); and straw gasification for heating/power generation (20.3 hundred million m³).

Hong Kong and the U.S. did not mention any specific plans. However, the U.S. mentioned that the use of renewable energy would grow significantly in the U.S. due to public support for renewables and the long-term goal of reducing dependence on foreign oil imports. However, federal support for R&D in renewable technologies is likely to remain flat or even decrease.

Part B: Identification of Major Issues, Needs and Barriers Related to the Renewable Energy Technology Applications

B1. Application-driven needs and issues

B1.1. Technical barriers associated with use of renewable energy technology applications

The Survey asked the member economies to identify the significant technical barriers associated with the use of renewable energy in their economies such as (a) the availability of technology in the economy or access to technology through import mechanisms; (b) capacity of in-country personnel and institutions to operate and maintain these technologies; and (c) the existence of physical infrastructure to deliver these technologies to the point of end use.

The availability of technology is not the most significant technical barriers associated with the use of renewable energy technologies in the Region. Although more advanced technologies such as fuel cells, biofuels or hybrid electric systems may not be available in all economies, simple and/or commercialized technologies are available in most economies or can be imported. Lack of physical infrastructure to deliver renewable energy technologies to the point of end use was mentioned as a technical barrier by only three economies (China, Indonesia and Mexico). It seems clear that the most common technical barrier associated with the use of renewable energy is *lack of in-country personnel to operate and maintain the technologies in the economies*. This barrier was mentioned by seven economies including Korea, China, Malaysia, Philippines, Thailand, Indonesia and, to a lesser extent, Australia. Table 6 summarizes the technical barriers associated with the use of renewable energy technologies as reported in the Survey by the member economies.

Table 6: Technical Barriers Associated with Use of Renewable Energy Technology Applications

Australia	<ul style="list-style-type: none"> • Technology capability and leadership are mostly within research institutions. • Shortage of trades people • Training facilities for trades people undertaking specialized courses in renewable energy are limited in number and scope. • Training for larger hybrid remote systems and maintenance operators are needed.
Brunei	<ul style="list-style-type: none"> • Not answered
Canada	<ul style="list-style-type: none"> • None

Table 6: Technical Barriers (Continued)

China	<ul style="list-style-type: none"> • Technical barriers are ranked in order of importance as: existence of physical infrastructure, capacity of in-country personnel and institutions to operate and maintain these technologies, and availability of technology within the economy.
Hong Kong	<ul style="list-style-type: none"> • Lack of space to install renewable energy equipment.
Indonesia	<ul style="list-style-type: none"> • Solar cells, fuel cells and wind turbine technologies are not available in the economy and need to be imported. • The capability of local people to maintain and operate renewable energy technologies is very limited. • The infrastructure in rural and remote areas such as road and transportation facilities is limited so it is difficult to deliver equipment to the end use.
Japan	<ul style="list-style-type: none"> • None
Korea	<ul style="list-style-type: none"> • Technologies are not available in the economy. • Lack of capacity of in-country personnel and institutions to operate and maintain renewable energy technologies.
Malaysia	<ul style="list-style-type: none"> • Lack of capacity to operate and maintain technologies. • Lack of economies of scale of renewable energy capacity, which makes it difficult to finance the high capital cost.
Mexico	<ul style="list-style-type: none"> • Lack of adequate infrastructure for production, transportation and distribution of hydrogen for fuel cells. • A method for economically producing hydrogen is needed. • Electric vehicle technology is unaffordable. • Implementation of a pilot project for electric vehicles is needed.
New Zealand	<ul style="list-style-type: none"> • None
Philippines	<ul style="list-style-type: none"> • Biomass and biofuels technologies and training are not available. • Large wind schemes and training are not available. • Limited capacities of solar systems hamper household applications, and productive end uses. • High-end appropriate innovations of hydro technology are not easily available and access to innovation from other economies is limited. • Technology adaptation R&D in hydro technology is needed. • Hybrid system technology and technical capability are limited. • Manpower development programs are needed for technicians, engineers, scientists, and professionals.
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Local people may not be able to manage sophisticated technologies such as hybrid systems and the RESCO services would be beneficial.
USA	<ul style="list-style-type: none"> • No significant technical barriers. However, further research is required to improve technology efficiency and reliability and to reduce costs.

B1.2. Key competition to the use of new and renewable technologies for addressing sustainable development needs

The key competition to the use of new and renewable technologies for addressing sustainable development needs is *fossil fuels*. Their cost-effectiveness as compared to fossil fuels was a function of various factors that were identified by each member economy. These included availability of fossil fuels, established infrastructure for fossil fuel utilization, established fossil fuel technologies, low electricity prices, and government subsidy policies in favor of fossil fuels.

For Australia, in grid-connected areas, competition with renewable energy depends on the spot price in the market. Base load electricity generation generally comes from coal. The low wholesale price of electricity causes most new renewable electricity sources to be uncompetitive without support. Similarly, a low wholesale electricity price in New Zealand's deregulated electricity market makes installation of renewable energy projects less financial viable.

The U.S and Hong Kong identified that the main competition to the use of renewable energy in their economies is low-cost fossil fuel generation. In U.S. it is particularly the use of natural gas-fired generation and large coal-fired power plants using low-cost domestic coal resources. Low-cost large-scale hydro and nuclear generation is also a competition to renewables in some parts of the U.S. Korea pointed out that nuclear power is one of the major competitors with new and renewable energy technologies in its economy.

Canada mentioned the conventional energy sources (such as oil and gas), grid-based electricity and energy efficiency are the key competitors with renewable energy technologies. Conventional energy in Canada is readily available, relatively cheap, has high energy density and an established infrastructure (financing, courses of study, codes and standards, etc). Until externalities (such as pollution of air and water) are taken into account, significant further penetration of renewables would be difficult. The evolution of relative costs of electricity will greatly influence the future penetration of wind in Canada.

Malaysia raised the point that the major power plants in its economy are mostly fossil fuel based with technology also well established. It is thus difficult for them to be competed with renewable energy where its use is very much dependent on site and availability of resources, and some of the technologies are still under development stage and not standardized.

Subsidy policies of the government (either to fossil fuels, grid-connected generation or grid extension) were also identified as a key competitor to the development of renewable energy technologies in many economies including Mexico, Indonesia and Thailand. Diesel oil is subsidized by the Indonesian government, which makes diesel generation the main competitor of renewable energy. In Thailand, power generation for the existing

distribution grid—which has already been extended to almost 99% of villages in the country under the government's rural electrification program—is heavily subsidized by the government and thus obstructs the development of new renewable energy projects.

Japan reported that a competitive means for promoting new and renewable energy in its economy is technology development to reduce the cost of energy generation, maintaining high quality and a secure supply.

B1.3. Standards and certification programs that exist or are needed for design and installation of renewable energy systems

Standards and certification programs do not widely exist in APEC. Only Canada and the U.S. claim that standards and certification programs exist or are underway in their economies for all renewable energy technologies. On the other hand, Brunei, Korea, Hong Kong, Malaysia and the Philippines said that there are no national standards and certification programs for the design and installation of renewable energy systems in their economies. In the economies where standards and certification programs for renewable energy technologies exist, it will be mainly for solar systems, especially solar water heating systems. Table 7 summarizes the existing standards and certification programs related to renewable energy technologies in each economy.

Table 7: Standards and Certification Programs for Design and Installation of Renewable Energy Systems

Australia	<ul style="list-style-type: none"> • Materials for solar collectors for swimming pool heating- Flexible or plasticised polyvinyl chloride. • Test methods for solar collectors - Thermal performance of glazed liquid heating collectors including pressure drop. • Solar water heaters - Design and construction. • Solar photovoltaic modules - Performance requirements. • Solar heating systems for swimming pools. • Wind turbine generator systems- Safety of small wind turbines. • Photovoltaic system performance monitoring- Guidelines for measurement, data exchange and analysis. • Stand-alone power systems - Safety requirements. • Stand-alone power systems - Installation and maintenance. • Home wood heater s.
Brunei	<ul style="list-style-type: none"> • None
Canada	<ul style="list-style-type: none"> • Standards and certification exist or are being developed for all renewable energy technologies.
China	<ul style="list-style-type: none"> • Solar home system- solar model, controller, inverter and DC lights • A national standard for solar water heater system and testing center are under preparation.

Table 7: Standards and Certification Programs (Continued)

Hong Kong	<ul style="list-style-type: none"> • None for stand-alone renewable energy systems. • The approval from electricity utility companies is required for grid connected renewable energy systems.
Indonesia	<ul style="list-style-type: none"> • Some standards—(no details).
Japan	<ul style="list-style-type: none"> • There are guidelines on technical requirements for grid connected PV and wind power.
Korea	<ul style="list-style-type: none"> • None
Malaysia	<ul style="list-style-type: none"> • None
Mexico	<ul style="list-style-type: none"> • Solar water heating systems.
New Zealand	<ul style="list-style-type: none"> • Not answered
Philippines	<ul style="list-style-type: none"> • None
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Hot water solar collectors. • Guidelines for PV modules are being established.
USA	<ul style="list-style-type: none"> • Standards and certification programs are underway for most renewable energy technologies, particularly solar PV and hybrid distributed generation technologies. • Hardware certification programs for solar thermal systems. • Hardware certification programs for PV components. • Hardware certification programs for wind systems. • Establishing certification programs for PV installation and maintenance practitioners. • Establishing certification programs for solar thermal installation and maintenance practitioners.

Regarding the future needs, Australia mentioned the necessity to ensure there are standards for all technology areas, to identify gaps and priorities for updating relevant standards and to provide independent testing against standards, as well as a need to have independent testing facilities to verify compliance with Australian Standards for renewable energy technology such as photovoltaic panels.

B1.4. Other important renewable energy technology applications-related needs and issues

Nine economies shared other important renewable energy technology related needs and issues in their economies. China mentioned the importance of training and information dissemination. Japan mentioned issues related to its development of geothermal and hydropower. The present cost of geothermal power generation is twice as much as that of conventional power generation. Moreover, most geothermal energy resources in Japan are located in national parks and are unsuitable for exploitation. Accordingly, new technological developments are necessary. As for hydropower generation, the current total capacity is 82,000 MW with a target of 105,000 MW by 2010. There are no new locations for large-scale facilities that could be effective and profitable. In addition,

large-scale facilities have negative impacts on the environment. Therefore, technological developments for cost reduction, and an increase of total capacity through smaller hydropower generation facilities are essential for Japan.

Malaysia stated that power reliability and quality are critical to implementing renewable energy technologies. Therefore, hybrid systems using energy storage are needed in the economy in order to achieve the level of power reliability and quality of conventional power plants.

The issue raised by Mexico is a need for education. That is, to instruct people about renewable energy technologies, their applications and their benefits, and to change the perception that renewables are only a futuristic application. Mexico also mentioned the need to change its legal framework so renewable energy could increase its share in the energy sector, and the need for financial incentives that would allow diversification of its energy resources.

Canada stated that renewable energy could benefit from a more open North American electricity market, where Independent Power Producers would gain access to the wholesale market and retail access would open up opportunities for differentiating electricity products based on their source and environmental impact. Furthermore, the imperative of national greenhouse gas emission reduction targets could provide conditions for accelerating the use of renewable energy sources as a way to meet new energy demand or replace existing energy production.

The Philippines commented that opportunities for telecommunications and "green" products marketing in remote communities are uncertain in its economy.

Singapore replied that they do not have hydro, geothermal or other renewable energy resources, thus the key challenge in its economy is the development of the technological capability to harvest solar energy in a cost-effective manner and with a minimum space utilization. At present, solar heating is the only commercially viable application of solar energy in Singapore. Research and development in solar technologies is still limited in the economy.

Thailand stated that study in the field of energy storage is needed since at present most batteries used in PV applications in Thailand are automobile types, which are not really suitable for PV applications.

For the U.S, secure federal funding to support high-risk research to improve technology efficiencies, reduce manufacturing costs, and assist the private sector in overcoming hurdles in project development are important needs in order to promote further growth of the renewable energy industry.

B2. Programmatic issues

B2.1. Legislative, policy, and business-related barriers to the use of renewable energy technologies

The legislative, policy and business-related barriers to the use of renewable energy technologies are both *lack of policies that support the use of renewable energy and the existence of policies that are counterproductive to the promotion of renewable energy utilization*. Uncertainties associated with the development of renewable energy for power generation, such as the lack of long-term contracts to buy electricity generated from renewable energy, were also mentioned as a barrier by Korea and Mexico. The list of legislative, policy and business-related barriers to the use of renewable energy in the member economies is shown in Table 8.

Table 8: Legislative, Policy and Business-Related Barriers to the Use of Renewable Energy

Australia	<ul style="list-style-type: none"> Rural electrification is a State Government responsibility and thus differences have arisen between jurisdictions. For example, method of connecting renewable energy facilities to the grid is not standardized throughout the economy.
Brunei	<ul style="list-style-type: none"> No legislation or concessions for renewable energy products.
Canada	<ul style="list-style-type: none"> Not answered
China	<ul style="list-style-type: none"> It is difficult for an independent power producer to access transmission lines. There are no green pricing mechanisms for consumers to choose. There are no renewable energy portfolios.
Hong Kong	<ul style="list-style-type: none"> No legislation and policy relating to the use of renewable energy.
Indonesia	<ul style="list-style-type: none"> Lack of supporting policy.
Japan	<ul style="list-style-type: none"> No voluntary green pricing mechanism. Unfavorable locations of renewable energy resources.
Korea	<ul style="list-style-type: none"> Uncertainties in regard to the use of renewable energy for power generation.
Malaysia	<ul style="list-style-type: none"> No definite policy or legislation for renewable energy. Preference over grid-connected electricity.
Mexico	<ul style="list-style-type: none"> Lack of an adequate regulatory framework to bring certainty in the development of electrical generating projects with renewable energy. There are no long-term contracts to buy electricity from renewable energy. Lack of a national program for promoting the use of renewable energy projects.
New Zealand	<ul style="list-style-type: none"> Not answered

Table 8: Legislative, Policy and Business-Related Barriers (Continued)

Philippines	<ul style="list-style-type: none"> • The use of PV solar home systems and freestanding renewable energy systems are excluded from incentives under the Board of Investments. • The production-sharing scheme acts as a barrier to the development of biomass-based cogeneration facilities. • Policy statements in the Philippine Energy Plan are not aligned with new priorities, and restrict the implementation of renewable energy programs. • Technology-driven projects have been implemented by or for government agencies, and there is little stimulation of private sector activity. • Lack of comprehensive development plans for the renewable energy sector. • Deficiency in project development capability among both government and private sector proponents. • Dilution of efforts. • Limited success stories. • Limited access to valid information or misinformation.
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Electricity prices are subsidized thus making it difficult for renewable energy to compete with the utility grid services.
USA	<ul style="list-style-type: none"> • Did not mention any barriers.

B2.2. Financial barriers to the use of renewable energy technologies

The main financial barrier to the use of renewable energy technologies is *their high up-front costs* (identified by 7 economies including Australia, Brunei, Japan, Korea, New Zealand, Thailand and the U.S.). Because of the high investment costs, and, as identified by Japan, the unfavorable views of loan officers on profitability and reliability of renewable energy businesses, receiving a loan from a commercial bank for a renewable energy project is difficult. The lack of financial supports from the government and/or good financial mechanisms in the economy are essential to promoting renewable energy deployment and were mentioned by 5 member economies including China, Indonesia, Malaysia, Mexico, and the Philippines. Table 9 summarizes the issues related to financial barriers to the use of renewable energy technologies in each economy.

Table 9: Financial Barriers to the Use of Renewable Energy Technologies

Australia	<ul style="list-style-type: none"> • High up-front capital cost of renewable energy.
Brunei	<ul style="list-style-type: none"> • Renewable energy technologies are more expensive compared to the grid supplied power.
Canada	<ul style="list-style-type: none"> • Not answered
China	<ul style="list-style-type: none"> • There are no specific green funds to support renewable energy which would cover the large initial cost for commercial development.
Hong Kong	<ul style="list-style-type: none"> • A study is being undertaken to identify financial barriers.
Indonesia	<ul style="list-style-type: none"> • Low price of fossil fuel due to government's subsidy. • Lack of financial institutions supporting this business. • The government budget is very limited in supporting renewable energy activities.
Japan	<ul style="list-style-type: none"> • The costs of renewable energy facilities and power generation from renewable energy are much higher than those of traditional fuels. • Renewable energy power generation projects, including wind power, are less likely to receive subsidies and loans than their counterparts because of the unfavorable views on their business profitability and reliability.
Korea	<ul style="list-style-type: none"> • High initial cost of renewable energy project • Lack of subsidies.
Malaysia	<ul style="list-style-type: none"> • Lack of financial support. • Lack of interest from lending institutions. • Inability of financing institutions to evaluate risks associated with renewable energy project.
Mexico	<ul style="list-style-type: none"> • No financial mechanisms for the development of projects. • No financial mechanisms for the acquirement of the systems. • No financial incentives.
New Zealand	<ul style="list-style-type: none"> • The expected costs of electricity from a renewable energy project is typically higher than the average price of electricity on the wholesale market. Thus renewables are only currently financially viable investments in niche situations.
Philippines	<ul style="list-style-type: none"> • The special privilege tax of 2% of gross receipts provided under the Mini-Hydro Law is a disincentive to project developers. • Lack of untapped partnerships for financing renewable energy projects. • Lack of untapped mechanisms for seed fund management, guarantee fund management, rediscounting window, project packaging and management, and grassroots organization and networking.
Singapore	<ul style="list-style-type: none"> • Not answered

Table 9: Financial Barriers (Continued)

Thailand	<ul style="list-style-type: none"> • High investment cost of renewable energy technologies makes it difficult to convince any commercial financing institute to support the loans.
USA	<ul style="list-style-type: none"> • High initial cost of renewable energy technologies. • There is a need to better educate banking and financial institutions on the technical advances of renewable energy technologies. • There is a need for an improved financial “infrastructure” for renewables.

B2.3. Financing arrangements that support renewable technology deployments

The member economies use various financing arrangements to promote renewable technology deployments in their economies. The financing arrangements adopted most include tax incentives (such as tax writeoffs, tax reductions and tax exemptions on machinery and equipment), loan and financial supports (such as in R&D or on pilot projects). The other financing arrangements include government subsidies and micro enterprise credits. Korea has an arrangement that mandates the purchase of renewable-based electricity. Some states in the U.S. require that electricity suppliers provide a minimum percentage of their supply from renewables. In addition, in some states in the U.S., a standard fee is collected from all electricity consumers and the money is used to fund renewable investment. The green pricing option, where consumers can voluntarily increase their payment to buy power from renewable sources, has also been adopted in Australia, New Zealand and the U.S. Brunei, Hong Kong and Mexico stated that there are no financial arrangements in their economies to support renewable technology deployment. Table 10 summarizes financing arrangements that support renewable energy deployments in the APEC member economies.

Table 10: Financing Arrangement Supporting Renewable Energy Deployments

Australia	<ul style="list-style-type: none"> • Green Power Scheme. • Assist early stage venture capital financing of renewable energy technologies. • Financial support of R&D.
Brunei	<ul style="list-style-type: none"> • None
Canada	<ul style="list-style-type: none"> • An accelerated write-off for certain capital assets used to produce renewable energy, including wind turbines and solar electric panels. • There exists a flow-through share financing provision of the business income tax to include early intangible expenditures of certain conservation and renewable energy projects
China	<ul style="list-style-type: none"> • Loans (especially for industrial retrofits). • Subsidy for R&D and pilot projects in renewable energy.

Table 10: Financing Arrangement (Continued)

Hong Kong	<ul style="list-style-type: none"> • None
Indonesia	<ul style="list-style-type: none"> • Government fund. • Soft loans. • Micro-enterprise credits.
Japan	<ul style="list-style-type: none"> • Subsidies (especially for photovoltaic power generation, solar heat utilization, wind power generation, phosphoric acid fuel cells, and waste power generation). • Low-interest loans from government-affiliated banks. • Tax exemption, special depreciation and tax reduction on fixed assets
Korea	<ul style="list-style-type: none"> • 10 % tax credit for renewable energy-based facilities • 5.5 % interest rate loan with 3-year grace periods, and 5-year repayment period. • Financial support of renewable energy pilot projects. • Mandatory purchase of renewable-based electricity.
Malaysia	<ul style="list-style-type: none"> • Income tax exemption on biomass development of 70% on statutory income for 5 years or Investment Tax Allowance of 60% of capital expenditure incurred within a period of 5 years. These are to be utilized against 70% of the statutory income. • Import duty and sales tax exemption on machinery and equipment for biomass projects. • Grants to eligible projects and activities that promote R&D on new and renewable energy.
Mexico	<ul style="list-style-type: none"> • None
New Zealand	<ul style="list-style-type: none"> • Green pricing scheme for wind power.
Philippines	<ul style="list-style-type: none"> • Village power fund.
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Subsidies to end-users. • Financial support for pilot and demonstration projects.
USA	<ul style="list-style-type: none"> • Renewable portfolio standards which require electricity suppliers to provide a minimum percentage of their supply from renewables • System benefits charge (a standard fee is collected from all customers and is then used to fund renewables investments). • Green power options, which allow customers to buy power from renewable sources. • Rebates. • Net metering. • Disclosure and certification. • Tax incentives such as production tax credits. • Loan programs. • Government purchase programs.

B2.4. Use of donor grant funding or bi-lateral aid support in developing renewable energy programs

China, Indonesia, Mexico, the Philippines and Malaysia mentioned that they have received some type of donor grants and bi-lateral aid in support of developing renewable energy programs in their economies. China has received several bilateral/soft loans since 1990's especially in the wind power sector to build wind farms. Some bilateral projects offering subsidies to end-users (especially for solar PV) are also under preparation. Indonesia has received soft loans for revolving funds, supporting R&D in renewable energy, as well as supporting renewable energy manufacturers. Indonesia also received funds from the World Bank for solar home system projects. Mexico is carrying out several activities with financial support from international organizations. For instance, the Fideicomiso de Riesgo Compartido (Share Risk Trust - FIRCO), entity dependent of the Secretaría de Agricultura Ganadería y Desarrollo Rural (Ministry of Agriculture, Livestock and Rural Development - SAGAR), has developed a large number of projects in the field of renewable energy with the support of Sandia National Laboratories, through the Mexico Renewable Energy Program, sponsored by the United States Department of Energy and the United States Agency for International Development. This program is an annex of the Bi-National Agreement between Mexico and the United States. The Philippines has used donor grant funding or bilateral aid support for activities such as capacity building programs to remove barriers to renewable energy in the country, institutional strengthening, and renewable market assessment.

Malaysia identified several external funding arrangements related to the promotion of renewable energy deployment, including:

- Danish Cooperation for Environment and Development (DANCED), which is currently carrying out a study to support the cooperation between Denmark and Malaysia on issues related to energy policy, energy utilization and efficiency, and renewable energy.
- Global Environment Facility (GEF) is making funds available under the United Nations Development Program (UNDP). UNDP is interested in promoting the use of biomass energy for power generation. Priority is given to projects that will result in the reduction of greenhouse gas emissions and ozone layer depletion. Also GEF has recently approved US\$ 8 million representing the incremental cost for a renewable energy project—biomass-based power generation and cogeneration in the Malaysian palm oil industry.
- ASEAN-EC COGEN Programme, which is undertaken jointly between ASEAN and the European Union to develop clean and efficient energy conversion projects. Eight Full Scale Demonstration Plants have been implemented under this program using various types of biomass in Malaysia.
- Obuchi Fund or Y Scheme Yen Credit, which was introduced by the Japanese Government in 1998. This Fund is used for environmental projects such as power generation from biomass. The total amount allocated for the scheme is US\$ 2030 million. Terms and conditions are very favorable, with interest at 1.8% per annum and total repayment of 40 years, with a 10 years grace period and 30 years repayment.

- TNB had received financial assistance from Japan's Official Development Assistance (ODA) for Tuanku Ja'afar Power Rehabilitation Project 2 (Port Dickson), Kenyir Hydroelectric Power Plant Project 2 and a sewage treatment plant project. The terms of loans are concessional with interest rates ranging from 0.75% to 1% with a repayment period of 30 years after a grace period of 10 years.

Not all donor-funded renewable energy projects have resulted in sustainable business practices at the completion of the projects. Only China stated that in Inner Mongolia and Guangdong, some Danish donor-funded wind projects have led to satisfactory sustainable development results.

Some economies including Australia, Brunei, Canada, Hong Kong, Japan, Korea, and the U.S replied that there are no donor grant or bi-lateral aid programs in their economies. Australia stated that it is actually a major aid donor, especially in the Asia Pacific region. Australia has committed A\$237 million towards projects that help abate greenhouse gas emissions and/or facilitate adaptation to climate change. Many of these are renewable energy programs.

New Zealand, Singapore, and Thailand did not answer this question.

B2.5. Public or private institutions supporting renewable-energy developments

Private institutions do not seem to play a major role in supporting renewable energy development in an economy. Most economies mentioned government agencies as the main institution that supports renewable energy deployment, followed by government laboratories, public research centers/agencies, and local universities. Indonesia and New Zealand were the only two economies who stated that the private sectors supported renewable energy deployment in their economies. Thailand, Malaysia and Mexico mentioned public utilities as the other institution involving in renewable energy deployment. The list of the institutions available to support renewable energy deployments is shown in Table 11.

Table 11: Public and Private Institutions Supporting Renewable Energy Deployments

Australia	<p><u>Federal Government Agencies</u></p> <ul style="list-style-type: none"> • Department of Industry, Science and Resources • Australian Greenhouse Office <p><u>State Government Agencies</u></p> <ul style="list-style-type: none"> • New South Wales Energy Department • Victoria Energy Department • Queensland Energy Department <p><u>Public Research Agencies</u></p> <ul style="list-style-type: none"> • Commonwealth Scientific and Industrial Research Organization <p><u>Commonwealth assisted Cooperative Research Centres</u></p> <ul style="list-style-type: none"> • Australian Cooperative Research Centre for Renewable Energy <p>Others—see http://renewable.greenhouse.gov.au/reid/</p>
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Table 11: Public and Private Institutions (Continued)

Brunei	<ul style="list-style-type: none"> • The answer is not clear.
Canada	<ul style="list-style-type: none"> • Government of Canada energy research laboratories • Universities
China	<ul style="list-style-type: none"> • State Economic and Trade Commission • State Development and Planning Commission • Ministry of Science and Technology • Many research laboratories
Hong Kong	<ul style="list-style-type: none"> • Innovation and Technology Commission • Research Grants Council • Local universities
Indonesia	<ul style="list-style-type: none"> • Research laboratories • Government • Universities • Private companies
Japan	<p><u>Government Agencies</u></p> <ul style="list-style-type: none"> • Ministry of Economy, Trade and Industry • Ministry of Land, Infrastructure and Transport • Ministry of Public Management, Home Affairs, Posts and Telecommunications <p><u>Organizations established under special laws</u></p> <ul style="list-style-type: none"> • New Energy and Industrial Development Organization <p><u>Organizations established by governmental permission</u></p> <ul style="list-style-type: none"> • New Energy Foundation • Solar System Development Organization <p><u>Local municipalities</u></p>
Korea	<p><u>Government Agencies</u></p> <ul style="list-style-type: none"> • Ministry of Commerce, Industry, and Energy • Korea Energy Management Corporation <p><u>Research Laboratory</u></p> <ul style="list-style-type: none"> • Korea Institute of Energy Research
Malaysia	<ul style="list-style-type: none"> • Standards and Industrial Research Institute of Malaysia • Forest Research Institute Malaysia • TNB Research Sdn. Bhd. • Institute of Higher Learning

Table 11: Public and Private Institutions (Continued)

Mexico	<ul style="list-style-type: none"> • CFE - Federal Commission of Electricity • IIE - Electrical Research Institute • CIE-UNAM - Research Center in Energy • PUE-UNAM - Energy University Program • SEMARNAT - Ministry of Environment and Natural Resources • University of Sonora • UAM - Metropolitan Autonomous University • II-UNAM - Institute of Engineering • SENER - Ministry of Energy • CONAE – National Commission for Energy Conservation
New Zealand	<ul style="list-style-type: none"> • Energy Efficiency and Conservation Authority • Ministry for the Environment • Foundation for Research Science and Technology • Universities • Various consultants, developers and renewable energy equipment suppliers in the private sector
Philippines	<p><u>Government Agencies</u></p> <ul style="list-style-type: none"> • Department of Energy (DOE) <p><u>Laboratories</u></p> <ul style="list-style-type: none"> • DOE-EUMB Fuels and Appliance Testing Laboratory • UP Solar Laboratory • National Hydraulics Laboratory • USC Water Resources Center <p><u>DOE Affiliated Non-Conventional Energy Centers</u></p> <ul style="list-style-type: none"> • Private and State Universities and Colleges
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<p><u>Government Agencies</u></p> <ul style="list-style-type: none"> • National Energy Policy Office • Department of Energy Development and Promotion <p><u>Electric Utilities</u></p> <ul style="list-style-type: none"> • Electricity Generating Authority of Thailand • Provincial Electricity Authority
USA	<p><u>Federal Laboratories</u></p> <ul style="list-style-type: none"> • National Renewable Energy Laboratory • Sandia National Laboratory • Oak Ridge National Laboratory • Lawrence Berkeley National Laboratory • Argonne National Laboratory <p><u>State Governments</u></p> <ul style="list-style-type: none"> • Notably California, New York, North Carolina and Florida

B2.6. Non-Government Organizations (NGOs) working with renewable-energy technologies

Table 12 provides the list of NGOs working with renewable energy technologies in the member economies. Most economies have NGOs working with renewable energy technologies. The economies that do not have NGOs working in this area include Brunei, Hong Kong, Korea and Thailand.

Table 12: NGOs Working With Renewable Energy Technologies

Australia	<ul style="list-style-type: none"> • International Centre for the Application of Solar Energy (CASE)
Brunei	<ul style="list-style-type: none"> • None
Canada	<ul style="list-style-type: none"> • None from the intention of the Survey. The NGOs in Canada are industry associations.
China	<ul style="list-style-type: none"> • Chinese Renewable Energy Industries Association
Hong Kong	<ul style="list-style-type: none"> • None. However, Friends of the Earth has recently been commissioned by an electricity utility company to conduct an exploratory project on wind power.
Indonesia	<ul style="list-style-type: none"> • IBEKA (microhydro) • YBUL (wind energy, biomass, solar energy) • Pelangi (study on renewable energy)
Japan	<ul style="list-style-type: none"> • Several NGOs—(No details)
Korea	<ul style="list-style-type: none"> • None
Malaysia	<ul style="list-style-type: none"> • Malaysia Energy Center (MEC) • Center for Environment, Technology and Development Malaysia (CETDEM) • Malaysia Nature Society (MNS) • Cetree (Center for Training on Renewable Energy and Energy Efficiency)
Mexico	<ul style="list-style-type: none"> • Asociación Nacional de Energía Solar (ANES- National Solar Energy Society)
New Zealand	<ul style="list-style-type: none"> • New Zealand Wind Energy Association • New Zealand Photovoltaic Association • Bioenergy Network

Table 12: NGOs Working With Renewable Energy Technologies (Continued)

Philippines	<ul style="list-style-type: none"> • Institute of Climate, Energy and Environment • Sibol ng Agham at Teknolohiya • Philippine Rural Reconstruction Movement • Preferred Energy, Inc. • Alternative Energy Development Philippines, Inc. • Center for Renewable Resources and Energy Efficiency • Center for Engineering, Research, Training, and Consultancy • Don Bosco Technical College • Energy Development and Utilization Foundation, Inc. • MADECOR Environmental Management Systems, Inc. • Philippine Association of Small Hydropower Development, Inc. • Renewable Energy Association of the Philippines • Total Solutions Technology, Inc. • UP-Solar Laboratory; Yamog Renewable Energy Development Group, Inc. • Village Engineering Specialist • Technology Development Extension Group, Inc. • Countryside Technology Consortium, Inc. • Village Technolink Foundation, Inc. • Daimi Foundation
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • None
USA	<ul style="list-style-type: none"> • American Solar Energy Society • Alliance to Save Energy • Sustainable Energy Coalition

B2.7. Other program, policy, and financial needs and issues related to renewable-energy technology deployments for sustainable development

China replied that incentive policies at the national level are needed in order to promote the use of renewable energy. In addition, renewable energy legislation, standards and testing (for quality assurance), market development, and aftersale services need to be strengthened. Financial support is necessary to ensure sustainable development of the industry. In addition, information dissemination, training and policy research will help support the deployment of renewable energy.

Indonesia mentioned the importance of having tax incentives, oil subsidy reductions and a renewable energy for rural electrification program.

In Japan, measures are in place so that electricity generated from renewable energy, such as wind and photovoltaic power, is purchased at a special price. A nationwide scheme of allocating donations raised by consumers through power companies to promote renewable energy resources such as wind and photovoltaic power has commenced.

The Malaysian government has announced the launch of a major renewable energy program that is aimed at grid-connected small renewable energy cogeneration plants to achieve a 5% share of Malaysian total electricity supply. A policy statement pertaining to the inclusion of renewable energy as an additional fuel in the expanded Five Fuel policy is being considered for incorporation in the Eighth Malaysia Plan (2000-2001).

The Government of New Zealand released an Energy Policy Statement with significant ramifications for the electricity sector. The outcome includes Environmental Sustainability, which calls for a continuity of energy efficiency improvements and a progressive transition to renewable energy. Also, the Energy Efficiency and Conservation Authority (EECA) is developing a National Energy Efficiency and Conservation Strategy to identify measures that are aimed at achieving the outcomes and goals sought in the Governments' Energy Policy Statement.

The Philippines pointed to the establishment of centers, programs and mechanism that support renewable energy technology deployment, including:

- A renewable energy technology research, development and extension center to generate and develop appropriate renewable energy technologies to support the growing local needs. This will result in lowering renewable energy costs to affordable levels which will help expand the use of renewable energy technologies especially in remote communities,
- An institutional and sustained capacity building program benefiting communities in relation to renewable energy technology with elements of enabling and people empowerment,
- An institutional strengthening program for policy makers and other key stakeholders except beneficiary communities,
- A market support center,
- An information dissemination program,
- A public awareness campaign program,
- A market strategy development program,
- An appropriate delivery mechanism,
- An innovative financing scheme, and
- The development of standards, testing and verification.

Finally, the U.S. stated that although it has a well-established renewable energy infrastructure that includes substantial installed capacity, suppliers, maintenance, financing, consumer acceptance, and future market potential, there is still a need to improve the policy and regulatory environment to greatly expand domestic markets. In addition, the existing grid infrastructure needs to be strengthened and modernized to incorporate needed new distributed generation capacity, including renewables.

B3. Issues related to renewable energy delivery mechanisms

B3.1. Support of enterprise/business development for new and renewable energy technologies

Australia listed 13 programs that are available to support enterprises and business development in the areas of new and renewable energy technologies in its economy. These programs range from supporting R&D (i.e., the R&D Start Program and the R&D Tax Concession); supporting the commercialization of innovative technology (i.e., the Commercialising Emerging Technologies (COMET), the Renewable Energy Commercialization Program (RECP), the Innovation Investment Fund (IIF), and the Renewable Energy Equity Fund (REEF)); supporting researchers to undertake international collaborative research with commercial potential (i.e., the Technology Diffusion Program); providing cash rebates to households (i.e., PV Rebate Program); providing a rebate to participating States and Territories for the installation of renewable remote area power supplies (i.e., Renewable Remote Power Generation Program (RRPGP)); subsidizing cost of installing renewable RAPS systems (i.e., State Government subsidy programs); and providing grants (i.e., Diesel and Alternative Fuels Grants Scheme (DAFGS) and Renewable Energy Showcase). Australia also developed a Renewable Energy Internet Site (<http://renewable.greenhouse.gov.au>) to provide an on-line database covering all organisations in the Australian renewable energy industry, to assist customers to find suppliers, and to facilitate networking within the industry.

Canada and New Zealand support renewable energy business development in their economies by forming an agency to work closely with the industry. Canada introduced the Renewable Energy Deployment Initiative Program (REDI) to stimulate market demand for commercially reliable, cost-effective renewable energy systems for space and water heating and cooling. The objectives are to develop and implement marketing strategies, provide an incentive to encourage businesses to gain experience with renewable energy systems and support further development of the industry infrastructure. New Zealand formed a government agency called Industry New Zealand with a mandate that includes working closely with industry, central and local government, and relevant community groups to develop and implement industry strategies at sectoral and regional levels and working closely with the government to contribute to the development of strategies, and the details of programmes, that implement the Government's policies for industry and regional development. Industry New Zealand is currently assessing how to best assist a number of new developments, including potential increased use of biomass within the forestry sector.

Japan offers various supports and incentives to individuals who implement photovoltaic power generation systems and various subsidies are granted for conducting model projects to introduce new energy systems to the economy. Other support from the government includes the development of infrastructure for introducing photovoltaic power generation systems for residential use, a project for supporting new energy enterprises, a project for promoting the local introduction of new energies, and a project for establishing local new energy visions.

Malaysia identified three programs that support business development. The Joint Venture Scheme was established between various interested parties such as Tenaga Nasional Berhad (TNB), Federal Land Development Authority (FELDA) and end users to operate an independent biomass power producer. The Banking Financial Scheme provides financial assistance from commercial banks. Finally, the Commercialization Research Development Fund (CRDF) was established by the Government and managed by the Malaysian Technology Development Corporation to commercialize the activities and products, including renewable energy, for high technology companies under the Promotion of Investment Act 1986.

The Philippines' government has engaged in several activities aiming at the development of entrepreneurs. Such interventions have resulted in an emergence of numerous NGOs and private business groups in the renewable energy sector. Those activities include institutionalizing renewables into the national government through the Department of Energy (DOE) by creating the Non-Conventional Energy Division of the Energy Utilization Management Bureau, establishing the network of Affiliated Non-Conventional Energy Centers (ANECs), developing and implementing collaborative renewable energy projects between the government, civil society, private sector and beneficiary communities for capacity building, and developing and implementing foreign funded projects for infusion of knowledge into the economy.

In the U.S, small-scale applications, such as solar home systems, are usually supplied through private vendors, and are financed through banks and/or special subsidy programs. Large-scale projects, such as grid-connected wind farms, are typically financed through venture capital (equity funding) and bank loans (debt funding), the sale of bonds, or initial public offerings supported by a power purchase agreement.

No special support has been given to business development of renewable energy technologies in Hong Kong, as renewable energy equipment is primarily imported from overseas, nor in Korea. At the moment the government of Mexico has not developed any support for enterprise/business development related to renewable energy. However, there are a few renewable energy related enterprises that may be considered successful even though they do not receive any specific support. Most renewable energy-related enterprises in Thailand also operate without any direct support from the government. A number of them are the contractors/subcontractors to government agencies (i.e., Department of Energy Development and Promotion and Public Work Department) to carry out construction, maintenance and services. There are a few companies which fabricate PV modules under joint ventures with foreign companies.

B3.2. Renewable-energy enterprise/business development-related programs or activities for specific sustainable-development areas

Most economies did not give direct answers to this question. They simply listed the renewable energy projects implemented in their economies without mentioning any

specific sustainable-development areas. It also seems that those mentioned projects/activities are not particularly enterprise/business development-related.

Australia provided a rather clear answer that renewable energy enterprise/business development-related programs in its economy are typically not directed to a specific area. Instead, programs are designed to enhance the capacity of the renewable energy industry as a whole, thus addressing general issues of health, poverty alleviation etc., in a broad brush approach, facilitated by greater market penetration and technology access.

Indonesia said that there are many programs, especially those managed by NGOs, that support sustainable development, such as the installation of microhydro in rural areas for supplying electricity for the purpose of income generation.

Mexico is working on the massive use of solar water heating systems, which will enhance the development of Mexican renewable energy technology enterprises. In addition, with the support from the World Bank, Mexico is working to identify viable renewable energy productive projects in rural communities located away from the electric grid. The development of these projects will open an important gate for the deployment and operation of renewable energy enterprises.

The Philippines listed the programs of the Department of Energy, stating that they mainly are aimed at increasing the role of the private sector in renewable energy development. The Philippines did not state any specific sustainable development areas or if they are enterprise/business development related. However, it seems clear that most of the projects mentioned are for rural electrifications. Examples of the renewable energy projects in the Philippines are as follows:

- USAID /NREL Philippine Renewable Energy Project
- UNDP-GEF PDF-B Project "Capacity Building to Remove Barriers to Renewable Energy in the Philippines
- WB Japan PHRD Grant on the Preparation of Rural Electrification Project
- ADB ADTA Institutional Strengthening of the Energy Sector on Rural Electrification
- ADB PPTA on Rural Electrification Project
- UNDP/MSP: Palawan Alternative Rural Energy and Livelihood Support Project
- Shell Renewables' Off-grid Electrification Project in Aklan Province
- AusAid/DILG Municipal Solar Infrastructure Project
- DAR/Spanish Aid Solar Power Technology Support Project
- PNOC/Dutch Miliev Environmental Improvement for Economic Sustainability
- AusAid/DOE/DOST Batanes Wind Hybrid System
- French Protocol PV Rural Electrification Service Project
- WB/AIJ Renewable Energy Applications in the Island Grids
- JICA Rural Electrification thru Hybrid Systems
- UNDP/FINESSE
- UNDP/DO/PGP Rural Electrification using Hybrid Systems in Remote Villages
- Belgian Government Pangasinan Solar Electrification Project

- DBP/DOE Energization of Rural Palawan thru NRE

Malaysia listed several renewable energy projects, but did not identify them as relating to any specific sustainable development areas. Those include the projects under the Malaysia Electricity Supply Industry Trust Account, which cover the areas of biomass (i.e., grid-connected power generation using biomass cogeneration technology), solar (i.e., grid-connected roof top PV, solar smart demonstration house and hybrid diesel/PV for the Nature Education Research Center at Endau Rompin National Park), and landfill gas (i.e., utilization of landfill gas for power generation in Puchong and Taman Beringin). Malaysia also mentioned a project “Center for Training and Education in Renewable Energy and Energy Efficiency” (CETREE) implemented by the USM and Curriculum Development Center, Ministry of Education Malaysia.

The U.S. federal government has a number of programs to encourage the use of renewables on Native American lands, particularly for off-grid electricity supply. There are also studies to indicate how the resources on Native American lands can be used to generate renewable energy supply for nearby off-reservation loads as a business opportunity for Native Americans.

Brunei, Hong Kong, Japan and Korea replied that there are no renewable-energy enterprise or business development-related programs or activities for specific sustainable development areas in their economies. Canada, Singapore and Thailand did not answer this question.

B3.3. Major barriers and issues for providing adequate delivery mechanisms for the use of renewable energy for sustainable development

The member economies were asked to identify major barriers and issues for providing adequate delivery mechanisms for the use of renewable energy for sustainable development around the following areas: (a) financing; (b) import tariffs; (c) unfavorable government policy; (d) lack of knowledge about the technology; (e) lack of physical infrastructure; and (f) others.

As shown in Table 13, six member economies (including Korea, Indonesia, Malaysia, the Philippines, Thailand and the U.S.) mentioned issues related to *financing* as a barrier to providing adequate delivery mechanisms for renewable use in their economies. The other barriers include lack of supporting policies from the government (mentioned by China, Indonesia, Malaysia and Thailand), high cost of renewable energy technologies (mentioned by Australia, Brunei, Japan and Malaysia), lack of information/knowledge about technologies (mentioned by Australia, Indonesia and Malaysia), lack of human capacity (i.e., lack of local expertise, manufacturers and maintenance mentioned by Malaysia), and lack of physical infrastructure (identified by Indonesia and Malaysia). Canada and the U.S. mentioned the existence of unfavorable government policies that creates a non-level playing field for renewable energy system.

Table 13: Barriers and Issues for Providing Adequate Delivery Mechanisms

Australia	<ul style="list-style-type: none"> • High up-front capital cost of renewable energy. • Although consumers are aware that renewable technologies exist, they often lack an understanding of renewable energy options.
Brunei	<ul style="list-style-type: none"> • Grid supply is widely available and renewable energy technology is not cost effective.
Canada	<ul style="list-style-type: none"> • Lack of a level playing field for renewable energy systems as compared to conventional fuel systems.
China	<ul style="list-style-type: none"> • Renewable energy needs strong government policies and financial support to be commercialized.
Hong Kong	<ul style="list-style-type: none"> • The study is being undertaken to identified barriers and issues.
Indonesia	<ul style="list-style-type: none"> • Lack of financial sources. • No tax (import tariff) exemption. • Lack of government supporting policies. • Lack of knowledge about the technology especially in rural people. • Limited transportation infrastructure in rural areas thus transportation costs are high.
Japan	<ul style="list-style-type: none"> • Relatively high costs as compared to existing commercial power sources. • Physical limitations of conversion efficiency of wind and PV power generation. • Inappropriate locations of renewable energy resources. • Issues related to wind power generation such as noises, blanketing and unattractive scenery.
Korea	<ul style="list-style-type: none"> • Financing and unfavorable government policies.
Malaysia	<ul style="list-style-type: none"> • Lack of infrastructure to deliver technologies especially in rural areas. • Lack of awareness and information. • Lack of education and R&D in renewable energy technology. • Lack of local expertise for renewable energy project, feasibility study and system design. • Lack of local manufacturers/agents and maintenance network. • Lack of national/local assessments. • Limited proven technology. • Small equipment capacity and low demand of product. • Low market for value added product from biomass. • Lack of appropriate finances/credit mechanisms. • Energy pricing without including the external costs of energy use. • Lack of enough incentives for renewable energy. • Perceived risks. • High system costs as compared to conventional fuel system.
Mexico	<ul style="list-style-type: none"> • None

Table 13: Barriers and Issues for Providing Adequate Delivery Mechanisms (Continued)

New Zealand	<ul style="list-style-type: none"> • Not answered
Philippines	<ul style="list-style-type: none"> • Limited or untapped partnerships for financing renewable energy projects. • Limited or untapped mechanisms for seed fund management, guarantee fund management, rediscounting window, project packaging and management, and grassroots organization and networking. • Limited bankable projects. • No support for discounted import tariffs or untapped incentive schemes for the importation of renewable energy technologies.
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Difficult to finance a high investment renewable project. • Long lead-time requirement and complicated procedure for a request for import tariff exemption/reduction. • Most government policies usually stop short of providing meaningful support.
USA	<ul style="list-style-type: none"> • Financing • Unfavorable policies that create a non-level playing field for renewables. For example, federal subsidies are available for oil and gas exploration, and the true lifecycle costs of fossil energy (including cleanup after their use) are typically not factored into the cost of their use.

B3.4. Key information barriers that prevent delivery mechanisms from being put into place

The survey asked the member economy to identify key information barriers that prevent delivery mechanism from being put in place such as (a) knowledge of the renewable resource; (b) knowledge of the technology and its characteristics; (c) capacity of in-country institutions to provide technology and information assistance; (d) knowledge of technology sources (including existing in-country capacity to provide technology services); (e) knowledge of the in-country capacity to service and maintain renewable technologies; (f) knowledge of financing and fee collection requirements; and (g) others.

Knowledge of financing and fee collection requirements was identified most (by four economies including China, Korea, Indonesia and Thailand) as a key information barrier that prevents delivery mechanisms from being put in place. Knowledge of the in-country capacity to service and maintain renewable technologies was identified by China, Indonesia and Korea as a key information barrier. Knowledge of the technology and its characteristics, lack of capacity of in-country institutions to provide technology and information assistance and lack of knowledge of technology sources were mentioned by China and Indonesia. Australia also mentioned the problem related to knowledge of technology sources that it is difficult to rapidly access to maintenance of renewable

energy systems in remote sites in its economy. China, Indonesia and Korea stated that knowledge of renewable sources is one of their key information barriers while Mexico mentioned that for its economy, it is not as much about the knowledge of resource sites as the knowledge of the total potential of the resources. The other barriers include lack of information, awareness and/or understanding of renewable energy systems and renewable industry (pointed out to different extents by several economies including Australia, Japan, Malaysia, Mexico, New Zealand, the Philippines and the U.S), and lack of training for maintenance and operation of renewable energysystem (identified by Mexico). Key information barriers are shown in Table 14.

Table 14: Key Information Barriers

Australia	<ul style="list-style-type: none"> • There is a need for a better understanding of the renewable energy industry and improved collection of economic statistics for the industry including its size, contribution to GDP, employment, sales (including exports), and forecast growth rates. • There is a need to identify and communicate the full range of benefits that the renewable energy industry can provide to the community. • It is difficult to rapidly access maintenance of renewable energy systems in remote sites, and repairs may often take some time. • Warranties on some remote generating systems have not been honored.
Brunei	<ul style="list-style-type: none"> • Not applicable
Canada	<ul style="list-style-type: none"> • None
China	<ul style="list-style-type: none"> • Ranked the key information barriers in order as following: Capacity of in-country institutions to provide technology and information assistance; Knowledge of financing and fee collection requirement; Knowledge of the in-country capacity to service and maintain renewable technologies; Knowledge of technology sources; Knowledge of the technology and its characteristics; and Knowledge of the renewable resource.
Hong Kong	<ul style="list-style-type: none"> • None
Indonesia	<ul style="list-style-type: none"> • Knowledge of the renewable resource such as potential and possibility of development of local energy resources. • Knowledge of the technology and its characteristics especially in rural communities. • Capacity of in-country institutions to provide technology and information assistance. • Knowledge of technology sources (including existing incountry capacity to provide technology services). • Knowledge of the in-country capacity to service and maintain renewable technologies. • Knowledge of financing and fee collection requirements.

Table 14: Key Information Barriers (Continued)

Japan	<ul style="list-style-type: none"> • Lack of awareness and data on new energy in regional areas. • Lack of recognition and understanding of various support systems by business entities intending to develop renewable energy. • Lack of public relations associated with the support systems offered by the government and other agencies.
Korea	<ul style="list-style-type: none"> • Knowledge of renewable resources. • Knowledge of the in-country capacity to service and maintain renewable technologies. • Knowledge of financing and fee collection requirements
Malaysia	<ul style="list-style-type: none"> • Lack of awareness and information. • Lack of education and R&D in renewable energy technologies.
Mexico	<ul style="list-style-type: none"> • Although potential sites of some resources are identified, there is a lack of knowledge of total potential of renewable energy resources. • Lack of R&D for which current Mexican technology could be enhanced. • Lack of training for maintenance and operation of systems.
New Zealand	<ul style="list-style-type: none"> • Information barriers on technical renewable topics.
Philippines	<ul style="list-style-type: none"> • Lack of information structures that should enable the full potential of stakeholders to undertake renewable energy policy, market and project development. • Lack of an information dissemination programs to reach rural targets.
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Knowledge of financing and fee collection.
USA	<ul style="list-style-type: none"> • No major information barriers. However, there is still a large portion of the population that is not knowledgeable about the value of renewables.

B3.5. Analytical tools assisting in performing the appropriate background studies to facilitate the creation of delivery mechanisms

The main national energy-planning model used in the Region is MARKAL. LEAP is used in some economies including Indonesia, the Philippines and the U.S. The village level models—HOMER and ViPOR—are used in China, the Philippines and the U.S. Canada uses RETScreen, an analytical tool developed by the Natural Resources Canada Energy Diversification Research Laboratory (CEDRL). RETScreen consists of a standardised and integrated renewable energy project analysis software that can be used world-wide to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of renewable energy technologies. Table 15 provides the list of analytical tools used in the APEC region.

Table 15: List of Analytical Tools Assisting in the Creation of Delivery Mechanisms

Australia	<ul style="list-style-type: none"> • MARKAL
Brunei	<ul style="list-style-type: none"> • None
Canada	<ul style="list-style-type: none"> • RETScreen
China	<ul style="list-style-type: none"> • HOMER • ViPOR • Models developed by local institutes
Hong Kong	<ul style="list-style-type: none"> • MARKAL
Indonesia	<ul style="list-style-type: none"> • MARKAL • LEAP (but not including renewable energy)
Japan	<ul style="list-style-type: none"> • Not answered
Korea	<ul style="list-style-type: none"> • MARKAL
Malaysia	<ul style="list-style-type: none"> • No information available
Mexico	<ul style="list-style-type: none"> • None
New Zealand	<ul style="list-style-type: none"> • Not answered
Philippines	<ul style="list-style-type: none"> • LEAP • HOMER • ViPOR
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Some. However, they provide merely general information about energy resources and some possible potential.
USA	<ul style="list-style-type: none"> • Many analytical tools. New tools are required to adequately simulate the performance of a distributed generation system.

B3.6. Public or private institutions, and non-government organizations working on renewable-energy delivery mechanisms

Brunei, Korea and Mexico stated that there were no organizations working on renewable-energy delivery mechanisms in their economies. Other member economies listed the types of institutions that are working on renewable-energy delivery mechanisms in their economies. In most economies, the governments seem to play a larger role in working on renewable-energy delivery mechanisms in their economies than the private sector. The private sector plays an important role in this area in the economies like Australia and the U.S where the renewable energy industry is more established. Australia, Canada, China, Indonesia, Japan, the Philippines and Thailand identified the work of NGOs, and the Philippines and Thailand identified the work of international organizations and/or foreign institutes, on renewable energy delivery mechanisms in their economies (see Table 16).

Table 16: Institutions and NGOs working on Renewable Energy Delivery Mechanisms

Australia	<ul style="list-style-type: none"> • Numerous. See http://renewable.greenhouse.gov.au/reid/org_detail_search.html
Brunei	<ul style="list-style-type: none"> • None
Canada	<ul style="list-style-type: none"> • Several industry associations (NGOs). • Several provincial government organizations. • Natural Resources Canada of the Government of Canada.
China	<ul style="list-style-type: none"> • Many research institutions. • Some NGOs. • Chinese Renewable Energy Industries Association.
Hong Kong	<ul style="list-style-type: none"> • The answer is not clear.
Indonesia	<ul style="list-style-type: none"> • Some institutions. • Some NGOs.
Japan	<ul style="list-style-type: none"> • Government Agencies (previously identified). • Various organizations (previously identified). • NGOs.
Korea	<ul style="list-style-type: none"> • None
Malaysia	<ul style="list-style-type: none"> • Malaysia Energy Center.
Mexico	<ul style="list-style-type: none"> • None
New Zealand	<ul style="list-style-type: none"> • Not answered
Philippines	<ul style="list-style-type: none"> • Various government agencies. • Research centers. • NGOs (listed earlier). • International organizations—Asian Development Bank, Global Environmental Facility, Intergovernmental Panel on Climate Change, United Nations Development Programme, and World Bank. • Foreign institutes—National Renewable Energy Laboratory (U.S.), United States Agency for International Development (U.S.), and German Agency for Technical Cooperation (Germany).
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • DANCED of Denmark and AEA of Britain are officially working on renewable energy studies in Thailand. • Some NGOs.
USA	<ul style="list-style-type: none"> • Private sector entities—over 500 renewable energy businesses.

B3.7. Assistance of existing donor programs/projects in the diffusion of renewables and supported the creation of delivery mechanisms

China, Indonesia and the Philippines commented that the existing donor programs/projects have supported the creation of markets and assisted with private sector participation in the renewable energy sector. Indonesia also mentioned that some

activities in these programs/projects increase local incomes. China mentioned two successful projects—the World Bank/Global Environment Facility China Renewable Energy Development Project and the United Nation Development Program/Global Environment Facility capacity building project. The WB/GEF project has resulted in promoting the quality standards, capacity building and market creation in the renewable energy sector in China, and the UNDP/GEF project has focused on pilot projects, training, information dissemination and policy study.

On the other hand, Thailand, in reference to a World Bank sponsored feasibility study on renewable energy in Thailand conducted by AEA of Britain, mentioned that “the information appeared in the report was rather general and not quite positive about PV roof top grid connected program”.

Malaysia mentioned a UNDP/GEF Grant, and Mexico mentioned its \$12 millions 8 MW biogas plant, of which \$5 millions has been donated by the World Bank. Both projects are at initial stages and results are not yet known.

Australia, Brunei, Canada, Hong Kong, Korea and the U.S stated that there are no donor programs/project that have assisted in the diffusion of renewable energy and supported the creation of delivery mechanisms in their economies. Japan, New Zealand and Singapore did not answer this question.

Part C: Background on Possible Collaborative Activities within APEC

C1. Is institutional (public and/or private) capacity building for renewable-energy programs needed?

As shown in Table 17, China, Korea, Malaysia, Mexico, the Philippines and Thailand stated that there is a need for institutional capacity building for renewable energy programs in their economies. On the other hand, Australia, Canada and U.S replied that they already have such programs in place, and institutional capacity building is not a constraint to the renewable energy industry in their economies. Brunei and Japan did not provide a clear answer. Brunei stated that there is no national renewable energy program in its economy, but did not provide an opinion on whether or not one is needed. Similarly, Japan simply replied that the examples of programs for reducing costs/technological development and promotional cases of innovative new and renewable energy from all over the world are indispensable.

Table 17: Response of the Member Economies on a Need for Institutional Capacity Building for Renewable-Energy Programs

Australia	<ul style="list-style-type: none"> • No
Brunei	<ul style="list-style-type: none"> • There is no national renewable energy program.
Canada	<ul style="list-style-type: none"> • No
China	<ul style="list-style-type: none"> • Yes. There is a need in the programs such as policies, standards and test, training, and information dissemination.
Hong Kong	<ul style="list-style-type: none"> • Not known at present.
Indonesia	<ul style="list-style-type: none"> • Not answered
Japan	<ul style="list-style-type: none"> • The examples of programs for reducing costs/technological development and promotional cases of innovative new and renewable energy from all over the world are indispensable.
Korea	<ul style="list-style-type: none"> • Yes.
Malaysia	<ul style="list-style-type: none"> • Yes. A two-year training program aimed at building up strong capacity in the government and related agencies is already in place.
Mexico	<ul style="list-style-type: none"> • Yes.
New Zealand	<ul style="list-style-type: none"> • Not answered
Philippines	<ul style="list-style-type: none"> • Yes. Institutional capacity building is needed both for public and private sectors for renewable energy programs
Singapore	<ul style="list-style-type: none"> • Not answer
Thailand	<ul style="list-style-type: none"> • Yes. The need is in the area of rural electrification, PV technology and RESCO.
USA	<ul style="list-style-type: none"> • No

C2. Is there a need to develop renewable-energy industry organizations within your economy?

Australia, Canada, Japan, and the U.S. replied that there is no need to develop renewable energy industry organizations in their economies because they already exist. However, the U.S. mentioned that in some cases better financing arrangements are needed to assure that small businesses can succeed. Australia mentioned a number of industry organizations that represent different components of the renewable energy industry in its economy. Among many others, one is the Sustainable Energy Industry Association (SEIA), which was an amalgamation of many associations and organizations in the Australian renewable energy sector. SEIA was set up to represent the interests of those involved in all aspects of sustainable energy including both renewable energy and energy efficiency.

On the other hand, Brunei and Hong Kong responded that there is no need to develop renewable energy industry organizations in their economies because the renewable energy industry is not important for their economies.

China, Korea, Mexico, the Philippines and Thailand replied that renewable energy industry organizations are needed. China mentioned a need of more organizations like the Chinese Renewable Energy Industries Association (CREIA). Mexico stated that its current renewable energy industry is pretty small, so it is a priority to boost the creation of new solid enterprises. Philippines commented that capacity building programs should be pursued in this regard on a sustained train-visit scheme and not on a one-shot approach. Capacity building especially on rural beneficiary communities of community based renewable energy projects should be given a priority. Finally, Thailand responded that widespread PV use (both for rural stand alone and grid connected in urban areas) is expected in the economy. To make such development sustainable, a plan to develop an industry organization would, logically, be required.

Indonesia, Singapore and New Zealand did not answer this question. Malaysia replied that this question is not applicable to its economy.

C3. In what way is your economy currently working with other APEC economies in a collaborative manner on new and renewable-energy technology development?

The current collaboration among the member economies is mainly in the form of aid and assistance from the developed economies to developing economies. Examples are projects funded by Canada, Japan, New Zealand and the U.S. Australia has worked with other economies to promote greenhouse gas mitigation. Korea mentioned collaboration with China in organizing seminars on new and renewable energy.

Australia participates in sustainable energy supply and use initiatives with other economies. The International Greenhouse Partnerships Program targets Australian industry and host country agencies for the promotion of greenhouse gas mitigation projects. These projects provide relevant experience and contribute to achieving international agreement on cost-effective, open, transparent and equitable Clean Development Mechanisms and Joint Implementation arrangements. In addition, Australian manufacturers have supplied and installed major PV based rural electricity supply systems in member economies including Philippines and Indonesia. This will provide opportunities for local manufacture in the long run. Longer-term opportunities in the region will include joint ventures, technology licensing, provision of specific components, and servicing the industry. Servicing includes all aspects of project management, financing, infrastructure development information dissemination and training.

Canada has funded, through the Canadian International Development Agency (CIDA), private sector companies and universities to work with other APEC economies in a wide range of activities including new and renewable energy projects.

Japan's New Energy and Industrial Technology Development Organization (NEDO) is involved in several collaborative projects with other member economies. These include:

- Research Cooperation Project on Practical Use of Locally Adaptable Photovoltaic Power Generation Systems (PRC);

- Demonstrative Research on a Hybrid System of Photovoltaic Power Generation and Micro Hydropower Generation (Vietnam);
- Demonstrative Research on Grid-connected Photovoltaic Power Generation Systems (Thailand);
- Demonstrative Research on a Photovoltaic Power Generation System for Battery Charging Stations (Thailand); and
- APEC Energy R&D and Technology Transfer Seminar (annually).

New Zealand provides various aid and assistance programmes throughout the Pacific region through its Ministry of Foreign Affairs and Trade. Where these aid programmes involve provision of electricity, renewables are a key focus (e.g., village electrification with wind/solar/diesel hybrid systems).

The U.S. has collaborated with several developing APEC economies through specific APEC-supported and co-financing activities, by providing technical and analytical assistance to support renewable energy projects. These include resource assessment studies throughout APEC, island village power assistance in Thailand, rural electrification and rural energy modeling in China, and evaluation of retrofitting diesel minigrids with wind in the Philippines. In addition, the U.S. has several major activities on-going in a number of APEC economies:

- China: The U.S. has signed a protocol agreement with the Chinese government to work in several areas, including gridconnected wind, rural solar electrification, biomass co-generation and policy development.
- Philippines, Korea, China and Mexico: The U.S. is working with these economies to identify financing and policy mechanisms to transfer clean energy technologies from developed to developing economies as part of the Technology Cooperation Agreement Pilot Project.
- Philippines: The U.S. has just recently completed the USAID-funded Philippines Renewable Energy Program, which provided extensive information on resource assessment and policy reform to the Philippine government.

Korea mentioned collaboration with China in organizing China-Korea seminars on new and renewable energy.

C4. Are there other APEC economies that have technology or experiences relevant to meeting sustainable-energy priorities such as those in your economy?

The majority of the member economies agreed in the benefits of sharing experiences from other economies. Australia, Canada, Japan and the U.S. were most mentioned as having technologies or experiences relevant to meeting sustainable energy priorities in other member economies (see Table 18).

Table 18: Response of the Member Economies on Sharing Technologies and Experiences to Meet Their Sustainable Energy Priorities

Australia	<ul style="list-style-type: none"> • Yes. Where appropriate Australia will seek to gain access to renewable energy technologies from other APEC economies through imports and technology diffusion.
Brunei	<ul style="list-style-type: none"> • Not answered
Canada	<ul style="list-style-type: none"> • Yes. From Australia, U.S. and Japan for the most part, and other economies for off-grid applications.
China	<ul style="list-style-type: none"> • Need to be identified.
Hong Kong	<ul style="list-style-type: none"> • Yes. From Australia, Japan, Canada and the U.S.
Indonesia	<ul style="list-style-type: none"> • Not answered
Japan	<ul style="list-style-type: none"> • Yes. From the U.S. for some specific cases of introducing renewable energy.
Korea	<ul style="list-style-type: none"> • No
Malaysia	<ul style="list-style-type: none"> • Not applicable
Mexico	<ul style="list-style-type: none"> • Yes. From experiences regarding supply of electric energy in the rural sector, technologies based on PV water pumping, and those to meet the applications of ice production, lighting, and use of livestock biomass waste in heat generation processes.
New Zealand	<ul style="list-style-type: none"> • Not answered
Philippines	<ul style="list-style-type: none"> • Yes. From Thailand, Malaysia, and Indonesia, to name a few, for lessons learned.
Singapore	<ul style="list-style-type: none"> • Not answered
Thailand	<ul style="list-style-type: none"> • Yes. From experiences and lessons from other member economies. The studies such as AED and Winrock are very valuable for other APEC members.
USA	<ul style="list-style-type: none"> • Yes. From collaboration with other APEC economies in resource assessment methodologies, rural electrification models, and participation in technical workshops and forums.

Part D: Suggestions for Collaborative Activities

D1. What would be the most beneficial type of renewable energy-related collaborations within APEC to address needs, issues and barriers to the use of renewable energy technologies for sustainable development in your economy?

Regarding a preference in the type of collaborations, collaborative R&D is the most preferred among the member economies. Five economies (including Australia, Canada, Hong Kong, Mexico, and the U.S.) identified this as being beneficial in addressing needs, issues and barriers to the use of renewable energy technologies. Hong Kong and Thailand preferred collaboration on the presentation of case study experiences. Australia and Thailand mentioned the benefit of collaboration with planning tools, and Hong Kong and China identified the importance of collaboration on joint project development. Besides the collaboration on joint project development, which is its first choice, China

also mentioned its preference for training programs and business development forums. Malaysia and the Philippines stated the importance of all six suggested collaborations, and Korea identified the important on all, but creation of "smart subsidy" donor programs that result in sustainable renewableenergy business practices. Korea, Malaysia and the Philippines, however, did not state a preference on any particular type of the collaborations. The other collaborations mentioned in the Survey are related to information exchange and were suggested by Australia and Brunei. The list of suggested collaborations in APEC is shown in Table 19.

Table 19: List of Suggested Collaborations in APEC

Collaborative R&D	<ul style="list-style-type: none"> • Australia • Canada • China (6)* • Hong Kong • Korea • Malaysia • Mexico • Philippines • U.S.
Business development forums	<ul style="list-style-type: none"> • China (3)* • Korea • Malaysia • Philippines
Training programs	<ul style="list-style-type: none"> • China (2)* • Korea • Malaysia • Philippines
Joint project development	<ul style="list-style-type: none"> • China(1)* • Hong Kong • Korea • Malaysia • Philippines
Presentation of case study experiences	<ul style="list-style-type: none"> • China (5)* • Hong Kong • Korea • Malaysia • Philippines • Thailand
Creation of "smart subsidy" donor programs that result in sustainable renewable-energy business practices	<ul style="list-style-type: none"> • China (4)* • Malaysia • Philippines

Table 19: List of Suggested Collaborations (Continued)

Planning tools	<ul style="list-style-type: none"> • China (7)* • Australia • Korea • Malaysia • Philippines • Thailand
Others—Information dissemination	<ul style="list-style-type: none"> • Australia • Brunei

Note: *China ranks its priorities for collaborations from high (1) to low (7).

Regarding collaborative R&D, Australia mentioned that although it has little need for inward renewable-energy-related collaborations, it is capable and interested in providing outward collaborative projects. Canada is interested in collaborative R&D especially as it relates to emerging technologies in all the new and renewable energy areas identified and case study experiences. Malaysia commented that collaboration must consist of members from “similar” regions to partner, and build the capacity and know-how in system design. Mexico identified specific areas in which the collaboration should be profitable including: technical assistance in building processes for policy guidelines; support in the setting up of national promotion and development programs; technical advise in specific renewable energy applications in the rural sector; and establishment of agreements on technical interchange. Finally, the U.S. is most interested in supporting collaborative activities through private sector forums and workshops that involve topics such as policy development, financing, micro enterprise development, rural energy modeling, distributed generation interconnection standards and analysis, resource assessment, and a variety of technology transfer mechanisms. Some specific proposed examples by the U.S. are:

- Renewable energy policy development
 - Case studies of successful policy and tariff reform.
 - Development and use of renewable energy planning tools (HOMER, ViPOR).
 - Country-specific renewable energy technology characterization.
- Renewable energy resource assessments
 - Update the APEC regional survey.
 - Economy-specific GIS-based resource assessments.
 - Regional resource assessments.
 - Collaboration with other programs (e.g. the United Nations Environment Programme’s (UNEP’s) GEF-funded Solar and Wind Energy Resource Assessment project).
- Renewable energy projects and systems for specific applications
 - Rural micro-enterprise development, including the use of computer-based wireless communication.
 - Health clinics and education centers.
 - Agricultural development, including water pumping and animal husbandry.
 - Distributed energy resource evaluation for strengthening existing grid infrastructure and optimizing grid utilization.

- Renewable energy information dissemination, capacity building and infrastructure development
 - APEC-wide internet-based network for routine exchange of pertinent information to: officials responsible for energy supplies, educators and trainers, and installers, operators and maintainers of renewable energy systems.
 - APEC-wide network of certified training centers, personnel exchange, distance training, installation and maintenance standards, and private sector affiliation.
 - APEC-wide internet-based trade and services show.
 - APEC-wide, internet-based renewable energy financing clearinghouse network, commercial banks, equity funds, investment houses, rural energy services companies (RESCOs), and standardized application requirements, procedures and forms.

This internet-based information system should be linked with other ongoing or planned activities, such as UNEP's Sustainable Technologies Alternatives Network, which is currently under development.

Regarding the collaboration on the presentation of case study experiences, Hong Kong stated that it would be beneficial since it will help to overcome the reluctance of private and public financial institutions to invest in renewable energy projects. Thailand commented that this collaboration (and planning tools) should be the priority, since if it is successful, other collaborations would follow automatically. Finally the Philippines suggested collaborations on international seminars/workshops and study tours to present case study experiences.

For the collaboration on planning tools, Australia identified the collaboration on development and exchange of information on strategic technology planning for the renewable energy industry, e.g. technology road mapping. Malaysia commented that there is a need to establish proper planning tools. Renewable energy should be planned not just to create interest but for the future as well. In addition the Philippines suggested that training courses on the most relevant and latest energy planning tools should include applications in the home economies. Monitoring of training course effectiveness could be a sequel in this regard.

Malaysia commented that collaboration on joint project development is beneficial as it will help to build the capacity through sharing of experiences among member economies. The Philippines suggested that for the collaboration on joint project development, a priority should be based on validated needs assessment.

On the collaboration on training programs, Malaysia suggested training on all levels such as engineers, technicians, designers, bankers, etc. In a similar manner, the Philippines stated a need for training on institutional scientists and engineers exchange programs including graduate student research and apprenticeship, postgraduate degree and non-degree programs, universities and colleges that host the Affiliated Non-Conventional Energy Center (ANECs) as well as the Department of Energy's officials.

The collaboration on the creation of "smart subsidy" donor programs that result in sustainable renewable-energy business practices is preferred by China, Malaysia and the Philippines. Malaysia commented that such programs would help to accelerate the utilization of renewable energy and also increase the awareness level of the public. Large business enterprises can provide support by setting up a "smart subsidy fund". Philippines mentioned that for community-based renewable energy projects, this type of collaboration could have a sense of validity for pre-start up processes like project preparatory activities (pre-feasibility and feasibility study preparation).

The other collaboration suggested by Australia and Brunei is basically an information exchange. Brunei suggested a continuation of the information sharing activity in APEC. In addition, Australia suggested an expansion of the APEC Virtual Center for Environmental Technology Exchange to promote the dissemination of information and technology concerning renewable energy issues in the region (see www.apec-vc.org.au).

Regarding the issues on time frame, Thailand suggested that its need has yet to be determined. Finally, Mexico commented that issues such as time frame, scope of collaboration and the specific economies to collaborate with should be agreed to as a result of bilateral or multilateral negotiation.

Indonesia, Singapore and New Zealand did not answer this question.