Promotion of Energy Efficiency and Renewable Energy in Low Carbon Model Town of APEC through Distributed Energy Source – Identification of Potential, Challenges and Solutions

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1. Objective

The project aims to study and identify the potential, challenges and solutions for application of distributed energy sources in promoting energy efficiency and renewable energy in low carbon model towns of APEC. This responds directly to the declaration by the Energy Ministers in Ninth meeting of APEC Energy Ministers at Fukui Japan in promoting energy efficiency and renewable energy technologies, and in implementing APEC low-carbon model town project.

2. Background–What is Distributed Energy Sources and their Benefit

Distributed energy refers to a variety of small, modular power generating technologies that can be combined with load management and energy storage systems to improve the quality and/or reliability of the electricity supply. They are "distributed" because they are placed at or near the point of energy consumption, unlike traditional "centralized" systems, where electricity is generated at a remotely located, large-scale power plant and then transmitted down power lines to the consumer.

Implementing distributed energy can be as simple as installing a small, stand-alone electricity generator to provide backup power at an electricity consumer's site. Or it can be a more complex system, highly integrated with the electricity grid and consisting of electricity and thermal generation, energy storage, and energy management systems. Consumers sometimes own the small-scale, on-site power generators, or they may be owned and operated by the utility or a third party.

Distributed energy encompasses a wide range of technologies including wind turbines, solar power, fuel cells, microturbines, reciprocating engines, load reduction technologies, and battery storage systems. The effective use of grid–connected distributed energy resources can also require power electronic interfaces and communications and control devices for efficient dispatch and operation of generating units.

Distributed energy technologies are playing an increasingly important role in the energy portfolio. They can be used to meet baseload power, peaking power, backup power, remote power, power quality, as well as cooling and heating needs.

Distributed energy also has the potential to mitigate congestion in transmission lines, reduce the impact of electricity price fluctuations, strengthen energy security, and provide greater stability to the electricity grid.

Distributed power generators are small compared with typical central-station power plants and provide unique benefits that are not available from centralized electricity generation. Many of these benefits stem from the fact that the generating units are inherently modular, which makes distributed power highly flexible. It can provide power where it is needed, when it is needed. And because they typically rely on natural gas or renewable resources, the generators can be usually made as quieter and less polluting than large power plants, which makes them suitable for on-site installation in some locations.

The use of distributed energy technologies can lead to improved efficiency and lower energy costs, particularly in combined cooling, heating and power (CHP) applications. CHP systems provide electricity along with hot water, heat for industrial processes, space heating and cooling, refrigeration, and humidity control to improve indoor air quality and comfort.

Grid-connected distributed energy resources also support and strengthen the central-station model of electricity generation, transmission, and distribution. While the central generating plant continues to provide most of the power to the grid, the distributed resources can be used to meet the peak demands of local distribution feeder lines or major customers. Computerized control systems—using phone lines or wireless technologies—make it possible to operate the distributed generators as dispatchable resources, generating electricity as needed. In addition, emerging smart grid technologies are making it easier for utilities to operate distributed generators as dispatchable resources.

3. Relevance of Distributed Energy to APEC Fora

Electricity production in all the APEC fora relies heavily on central power plants. However, there is great energy loss in the transmission of energy from central power plants to the end users and the loss can be as high as 5 to 8 %. The use of distributed energy, putting the power production plant close to the end users, will effectively eliminate all such transmission loss and greatly enhance the overall energy efficiency. The division of central power plants to a number of smaller distributed energy located close to end users can also much reduce the possible impact of natural disaster to the power supply and thus greatly enhance regional energy security. Development of on-site renewable energy source as well as the smart grid technology is also the foundation of setting up distributed energy sources.

Furthermore, dividing the central large-scale power generation facilities according to the power generation type and energy use (for example: the cold energy use of liquefied natural gas, the waste water generation of urban and rural area and decompression of generation in urban and rural water and gas grid) into smaller distributed energy facilities which closer to the end users could also reduces the loss caused by natural disasters and greatly improve the regional energy security. Small-scale renewable energy generation facilities and the development of smart grid technology have laid the foundation for the distributed energy.

At the 9th APEC Energy Ministers meeting, held in Fukui, Japan, the Ministers discussed and made a declaration on Low carbon paths to Energy Security : Cooperative Energy Solutions for a Sustainable APEC and emphasised that such solution should be integral to the APEC Growth Strategy. Among the messages the Ministers noted improving energy efficiency is one of the quickest, greenest and most cost effective ways to address energy security, economic growth and climate challenges at the same time, and instructed the EWG to continue its assessment of renewable energy options.

Introduction of low-carbon technologies in city planning to boost energy efficiency and reduce fossil energy use is vital to manage growing energy consumption in urban areas; the Ministers have therefore launched an APEC Low-carbon Model Town project to present successful models for coordinated usage of advanced low-carbon technologies.

At the APEC informal leadership meeting of the Nineteenth, Chinese President Hu Jintao responded to the Summit theme “closely linked to the regional economy" and expressed the commitment of China in promoting Asia-Pacific regional economic growth, regional economic integration, green growth, energy security, regulatory cooperation and other issues. This project proposal meets the Summit theme needs.

Most APEC fora have been going through rapid urbanisation and relied heavily on central power stations in supporting the power demand in the cities, especially for developing economies like China, Indonesia, Malaysia, Thailand. Any interruption to the operation of this central power station, by natural disaster or other causes, may lead to severe impact to the energy security of the cities. The use of distributed energy will effectively reduce the possible damages arising from disruption in the operation of the central power plants. Therefore, in planning of low-carbon model towns, due consideration should be given in the application of distributed energy for the objective of improving energy efficiency, promoting renewable energy and enhancing energy security.

4. Barriers to the installation of distributed generation technologies and their possible solutions

There are a number of barriers and factors needed to be addressed before distribution generation technologies can be widely applied in APEC fora. The three major factors to be addressed are (i) the impact of the distributed power sources to the integrity and reliability of the grid; (ii) the perception of the less cost effective operation of the distributed generation technologies due to loss of economic of scale in comparison of central power plants; (iii) the absence of proper tariff system to facilitate the trade between distribution energy suppliers and the main power utilities. In the following sections, these barriers and the possible means with examples to address them are discussed.

4.1 Grid interconnection

Grid interconnection is usually considered as the most significant barrier to the installation of distributed generation technologies.

Electric utilities have understandably always placed a high priority on the safety of their workers and the reliability of their electrical systems. Faced with the interconnection of potentially large numbers of distributed generators owned and operated by non-utilities, some members of the utility industry have perceived distributed generation as a threat to both. This has led some utilities to place overly conservative restrictions on interconnected systems, creating added costs that may make an installation economically unfeasible.

Typical requirements include equipment that prevents power from being fed to the grid when the grid is de-energized (for power line maintenance, for example), manual disconnects that are easily accessible to utility personnel, and power quality requirements such as limits on the interconnected system's effects on "flicker" and other types of distortion.

Systems may also be required to automatically shut down in the event of electrical failures — to accomplish this, protective schemes at the grid interface may include a synchronizing relay, protection against under- and over-voltage, protection against under- and over-frequency, phase and ground over-current relays, ground over-voltage relays, and more.

Even more restrictive (and thus more expensive) requirements can include an isolation transformer for the system and liability insurance against worst-case scenarios of damage to utility equipment and harm to utility personnel.

To overcome the interconnection barrier, and to lower costs for all parties — most importantly, the buyer of the system — efforts are underway to establish standards for grid interconnection.

For example, at USA, the Institute of Electrical and Electronics Engineers (IEEE) of USA has developed a series of standards that address interconnection. The base standard — IEEE 1547, "Standard for Distributed Resources Interconnected with Electric Power Systems" — provides requirements relating to the performance, operation, testing, safety considerations, and maintenance of the grid interconnection. Additional standards in the series address interconnection system testing, applications, monitoring, information exchange and control, intentional islanding, and network systems. The standards are widely regarded as one of the most comprehensive documents in addressing the grid interconnection barriers to distributed resources. The readers of this report may wish to refer to the IEEE 1547 Series website for more information whilst an extract from the website is extracted at Annex 1 for ease of reference.

However, it is sometimes quite a complicated task to navigate the many interconnection requirements for distributed generation equipment. Therefore, some regulatory authorities in APEC fora have prepared some guideline to simplify the process. Like the U.S. Department of Energy (DOE), it has made this process a little easier by producing the following guide: “DOE Energy Savers: Connecting Your System to the Electrical Grid — A guide for homeowners and small businesses interested in installing a renewable energy system and connecting it to the electrical grid”. An extract from the front page of the relevant DOE website is given at Annex 2 for ease of reference.

Similar guideline is also given in other APEC fora like Hong Kong, China to facilitate grid connection. Guideline entitled "Technical Guidelines on Grid

Connection of Renewable Energy Power Systems (2007 Edition)" is made available to the public, which extends the applicable capacity limit of the original guidelines from 200kW to 1MW. A copy of the Technical Guidelines can be downloaded from the website of the Electrical and Mechanical Services Department (EMSD) of the Government of Hong Kong, China.

The wider application of smart grid can also enhance flexibility in network topology and thus will can help in addressing the grid interconnection barriers of the distributed energy sources. The use of the promising smart grid technology in next-generation transmission and distribution infrastructure will allow us to be better able to handle possible bi-direction energy flows, allowing for distributing energy sources. As the traditional grids were designed for one-way flow of electricity, but if a local sub-network (through the application of distributed energy sources in it) generates more power than it is consuming, the reverse flow can raise safety and reliability issues. The provision of smart grid is able to manage these situations.

4.2 Mis-concept about Economies of Scale

Historically, central plants have been an integral part of the electric grid, in which large generating facilities are specifically located either close to resources or otherwise located far from populated load centers. These, in turn, supply the traditional transmission and distribution grid which distributes bulk power to load centers and from there to consumers. These were developed when the costs of transporting fuel and integrating generating technologies into populated areas far exceeded the cost of developing T&D facilities and tariffs. Central plants are usually designed to take advantage of available economies of scale in a site-specific manner, and are built as “one-off,” custom projects.

In fact, these economies of scale began to fail in the late 1960s. By the start of the 21st century, discussion started on whether central plants were still be able to deliver competitively cheap and reliable electricity to more remote customers through the grid, because the plants had come to cost sometimes less than the grid and had become so reliable that nearly all power failures being originated in the grid. In many cases, the grid has been becoming the main driver of remote customers’ power costs and power quality problems, which became more acute as our digital and ICT equipment required extremely reliable electricity. Efficiency gains no longer must come from increasing generating capacity, but sometimes be generated from smaller units located closer to sites of demand.

For example, coal power plants are built away from cities to prevent their heavy air pollution from affecting the populace. In addition, such plants are often built near collieries to minimize the cost of transporting coal. Thus, most fuelled power plants are too far away for their waste heat to be economically used for heating buildings.

Apart from renewable energy such as solar or wind, most of the distributed energy sources are now fuelled by gases. Low pollution is a crucial advantage of combined cycle plants that burn natural gas. In addition to giving electricity from these combined cycle plants, the plants also provide heating and/or cooling to the nearby district. The low pollution of these plants permits them to be near enough to the consumers and thus can make good use of the heat from the power generation as district heating and cooling.

With the distributed energy sources are being more well received, they are being put under mass-produced and carry the advantage of being small and less site-specific. Their development gradually arose out of:

1. concerns over perceived externalized costs of central plant generation, particularly environmental concerns,
2. the increasing age, deterioration, and capacity constraints upon transmission and distribution of bulk power,
3. the increasing relative economy of mass production of smaller appliances over heavy manufacturing of larger units and on-site construction, and
4. Along with higher relative prices for energy, higher overall complexity and total costs for regulatory oversight, tariff administration, and metering and billing.

Capital markets now more and more come to realize that right-sized resources, for individual customers, distribution substations, or microgrids, are able to offer important but little-known economic advantages over central plants. Smaller units may be able to offer greater economies from mass-production. These increased value—due to improvements in financial risk, engineering flexibility, security, and environmental quality—of these distributed energy sources may often more than offset their perceived cost disadvantages. Distributed energy sources, vis-à-vis central power plants, must be justified on a life-cycle basis. However, it is still always the case that many of the direct, and virtually all of the indirect, benefits of distributed energy sources are not captured within traditional utility cash-flow accounting and this demands a change to make the real financial benefit of the distributed energy sources be more easily identified.

In fact, while the levelized generation cost of distributed energy sources is more expensive than conventional sources on a kWh basis, this does not include a complete accounting for the negative externalities associated with conventional fuels. The additional premium for distributed energy sources is rapidly declining as demand increases and technology progresses.

Furthermore, it is clear that distributed energy sources can effectively reduce the amount of energy lost in transmitting electricity because the electricity is generated very near where it is used, perhaps even in the same building. This also reduces the size and number of power lines that must be constructed.

4.3 Need of Proper Tariff System to facilitate trading of electricity between Distributed Energy Suppliers and Central Power Utilities

In order to give sufficient incentive to support the investment in distributed energy sources, there must be proper tariff system in place to facilitate the trading of the generated electricity between the distributed energy suppliers and the central power utilities.

A feed-in tariff (FIT) is a policy mechanism designed to accelerate investment in distributed energy sources. It achieves this by offering long-term contracts to distributed energy producers, typically based on the cost of generation of each technology. Technologies such as wind power, for instance, are awarded a lower per-kWh price, while technologies such as solar PV and tidal power are offered a higher price, reflecting higher costs.

In addition, feed-in tariffs often include "tariff degression", a mechanism according to which the price (or tariff) ratchets down over time. This is done in order to track and encourage technological cost reductions. The goal of feed-in tariffs is to offer cost-based compensation to distributed energy sources in particular those renewable energy producers, providing the price certainty and long-term contracts that help finance renewable energy investments.

4.3.1 Description of feed-in tariff

FITs typically include three key provisions:

- Guaranteed grid access
- long-term contracts for the electricity produced
- purchase prices based on the cost of generation

Under a feed-in tariff, eligible distributed energy suppliers (which can include homeowners, business owners, farmers, as well as private investors) are paid a cost-based price for the renewable electricity they produce. This enables a diversity of technologies (wind, solar, biogas, etc.) to be developed, providing investors a reasonable return on their investments. This principle was first explained in Germany's 2000 RES Act:

“The compensation rates...have been determined by means of scientific studies, subject to the provision that the rates identified should make it possible for an installation – when managed efficiently – to be operated cost-effectively, based on the use of state of the art technology and depending on the renewable energy sources naturally available in a given geographical environment.”

As a result, the tariff (or rate) may differ to enable various technologies to be profitably developed. This can include different tariffs for projects in different locations (e.g. rooftop or ground-mounted for solar PV projects), of different sizes (residential or commercial scale), and sometimes, for different geographic regions. The tariffs are typically designed to ratchet downward over time to both track, and encourage, technological change.

FITs typically offer a guaranteed purchase agreement for electricity generated from renewable energy sources. These agreements are generally framed within long-term (15–25 year) contracts.

As of 2011, feed-in tariff policies have been enacted in over 50 countries, including Algeria, Australia, Austria, Belgium, Brazil, Canada, China, Cyprus, the Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Iran, Republic of Ireland, Israel, Italy, Kenya, the Republic of Korea, Lithuania, Luxembourg, the

Netherlands, Portugal, South Africa, Spain, Switzerland, Tanzania, Thailand, and Turkey.

In 2008, a detailed analysis by the European Commission concluded that *"well-adapted feed-in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity"*. This conclusion has been supported by a number of recent analyses, including by the International Energy Agency.

4.3.2 Application of FIT in some APEC Fora

4.3.2.1 Australia

In Australia, feed-in tariffs had been introduced by the States in 2008 in South Australia and Queensland, 2009 in the Australian Capital Territory and Victoria and 2010 in New South Wales, Tasmania and Western Australia. A uniform federal scheme to supersede all State schemes has been proposed but not yet in place.

4.3.2.2 Canada

Ontario introduced a feed-in tariff in 2006, and revised it in 2009 and 2010, increasing from 42¢/kWh to 80.2¢/kWh for micro-scale (≤10 kW) grid-tied photovoltaic projects, and decreasing to 64.2¢/kWh for applications received after 2 July 2010. Ontario's FIT program also includes a tariff schedule for larger projects up to and including 10MW solar farms at a reduced rate. As of April 2010, several hundred projects have been approved, including 184 large scale projects, worth $8 billion all together. By April 2012, the FIT rate was decreased again, to 54.9¢/kWh, for applications received after 1 September 2011. (Ontario Power Authority Feed-in Tariff program for renewable energy refers)

4.3.2.3 China

In China, as of August 2011 a national feed-in tariff for solar projects was issued, and is about US$0.15 per kWh.

A fixed feed-in tariff is fixed for new onshore wind power plants in a move that aims to help struggling project operators to realise profits. The National Development and Reform Commission (NDRC), China's economic planning agency, announced recently four categories of onshore wind projects, which according to region will be able to apply for the tariffs. Areas with better wind resources will have lower feed-in tariffs, while those with lower outputs will be able to access more generous tariffs.

The tariffs per kilowatt hour are set at 0.51 yuan (US 0.075, GBP 0.05), 0.54 yuan, 0.58 yuan and 0.61 yuan. These represent a significant premium on the average rate of 0.34 yuan per kilowatt hour paid to coal-fired electricity generators.

4.3.2.4 Thailand

In 2006, the Thai government enacted a feed-in tariff that provides an adder paid on top of utility avoided costs, differentiated by technology type and generator size, and guaranteed for 7–10 years. Solar receives the highest, 8 baht/kWh (about US cents 27/kWh). Large biomass projects receive the lowest at 0.3 baht/kWh (at about 1 US cent per kWh). Additional per-kWh subsidies are provided for projects that offset diesel use in remote areas. Under the FIT program, the application of renewable energy has been successful expanded in Thailand. As of 2010 March 1364 MW of private sector RE was online with an additional 4104 MW in the pipeline with signed PPAs. Biomass makes up the bulk of this capacity: 1292 MW (online) and 2119 MW

(PPA only). Solar electricity is second but rapidly catching up, with 78 MW online and signed PPAs for an additional 1759 MW.

4.3.2.5 The United States

The first form of feed-in tariff was implemented in the US in 1978 under President Jimmy Carter who signed the National Energy Act (NEA). The Act included five separate Acts, one of which was the Public Utility Regulatory Policies Act (PURPA). The purpose of the National Energy Act was to encourage energy conservation and the development of new energy resources, including renewable energy such as wind, solar and geothermal power.

Within PURPA was a provision that required utilities to purchase electricity generated from qualifying independent power producers at rates not to exceed their avoided cost. Avoided costs were designed to reflect the cost that a utility would incur to provide that same electrical generation. Different interpretations of PURPA prevailed in the 1980s: some utilities and state utility commissions interpreted avoided costs narrowly to mean avoided fuel costs, while others chose to define "avoided costs" as the "avoided long-run marginal cost" of generation. The long-run costs referred to the anticipated cost of electricity in the years ahead. This last approach was adopted by California in its Standard Offer Contract No. 4. Another provision included in the PURPA law was that utilities were prevented from owning more than 50% of projects, a clause that was introduced to encourage new participants to enter the electricity generation industry.

In order to comply with PURPA, certain states began offering Standard Offer Contracts to renewable power producers. California's Public Utility Commission established a number of Standard Offer Contracts, including Standard Offer No.4 (SO4), which made use of fixed prices, based on the expected long-run cost of generation. The long-run estimates of electricity costs were based on the belief that oil and gas prices would continue to increase. This led to an escalating schedule of fixed purchase prices, designed to reflect the long-run avoided costs of new electrical generation. The adoption of PURPA also led to significant amounts of renewable energy generation in states such as Florida, and Maine.

4.3.3 Development of FIT in non-APEC economies

4.3.3.1 Germany

In Germany, FIT scheme was first introduced in 2000. The Erneuerbare-Energien-Gesetz (EEG) law is reviewed on a regular basis and the 2012 version is currently in force. Its predecessor was the 1991 "Stromeinspeisegesetz". As of May 2008, the cost of the program added about €1.01 (USD1.69) to each monthly residential electric bill. In 2012 the additional costs have risen to €0.03592/kWh.

Feed-in tariff rates for PV electricity vary depending on the size and locations of the systems. Since 2009, there are additional tariffs for electricity immediately consumed rather than supplied to the grid with increasing returns if more than 30% of overall production is consumed on-site. This is to incentivize a demand side management and help develop solutions to the intermittency of solar power.

4.3.3.2 Switzerland

Switzerland introduced the so called "Cost-covering remuneration for feed-in to the electricity grid (CRF)" on 1 May 2008.

The CRF applies to hydropower (up to 10 megawatts), PV,, wind energy, geothermal energy, biomass and waste material from biomass and will be applicable for a period of between 20 and 25 years, depending on the technology. The implementation is done through the national grid operator.

4.3.3.3 India

India's inaugurated its most ambitious solar power program to date on 9 January 2010. The Jawaharial Nehru Natiional Solar Mission (JNNSM) was officially announced on 12 January 2010. This program aims to install 20,000 MW of solar power by 2022. The first phase of this program aims to install 1000 MW by paying a tariff fixed by the Central Electricity Regulatory Commission (CERC) of India. While in spirit this is a feed in tariff, there are several conditions on project size and commissioning date. Tariff for solar PV projects is fixed at Rs. 17.90 (USD 0.397/kWh). Tariff for solar thermal projects is fixed Rs. 15.40 (USD 0.342/kWh).

5. Promotion of Distributed Energy Sources in China – Experience Sharing

5.1 Current Policy of China in Promoting Distributed Energy Sources

While distributed energy has received wider attention in the world, the China government has also stressed the importance of the distributed energy sources and put it as one of the focused areas of the government in promoting energy efficiency and conservation in China of China. China Premier Wen Jiabao stated in his government work report 2012 that the Government's main task will accelerate the transformation of economic development, and promote the strengthening of energy management, the development of smart grid and distributed energy, energy performance contracting, government green energy procurement.

In recent years, in order to promote the development of distributed energy sources, China government has introduced a series of policies. In October 2011, the National Development and Reform Commission, Ministry of Finance, Ministry of housing construction, and the National Energy Bureau jointly issued guidelines on the development of natural gas distributed energy, pointed out that in order to promote energy efficiency and energy savings , in the "second five" period, China will build about 1000 nos of distributed energy sources projects and will also construct 10 nos demonstration regions provided with distributed energy sources showing its typical characteristics. By 2020, the installed capacity of distributed energy sources will reach 50 million kilowatts in China. The guidelines clearly proposed that the implementation of the policy of distributed energy sources in China will focus on the regions of sufficient energy demand and the application of distributed energy sources will combine with the development of solar, wind, geothermal and other renewable energy sources.

In November 2011, World Alliance for Decentralized Energy (WADE) established WADE China in Beijing. The WADE China will conduct quantitative analysis and assessment, policy makers and stakeholders to understand the economic and environmental benefits of distributed energy sources in China, thus promoting the rapid development of distributed energy resources in China. At present, China is studying in formulating a series of polices in promoting distributed energy sources in China, including “Management Guideline of Grid connection for Distributed Energy Sources”, "Interim Provisions for Management of the Pilot Projects of Distributed Energy Sources “, "Interim Provisions for Management of financial incentives of Distributed Energy Sources "etc. It indicates that the distributed energy in China will enter into a rapid development stage.

5.2 Potential of Distributed Energy Sources in China and Some Examples

In a study conducted by WADE in 2010 to evaluate the benefits of combined heat and power (CHP) and clean distributed energy sources (DE) generation to China, it estimated that the total technical potential for clean DE and CHP within the five target regions (Shanghai, Liaoning, Shandong, Jiangsu and Sichuan) is to be 143.7 gigawatts (GW) of electric generating capacity. This represents 38 percent of the 371.5 GW increase in central station generating capacity projected to be required in these five regions between 2010 and 2030. Deployment of CHP/DE can save energy and CO2 emissions by displacing coal-based central station generation with more efficient coal, natural gas and waste fuel/waste heat CHP and distributed energy located at or close to the users. Energy savings from CHP/DE results both from the avoidance of coal consumption at the central station power plant, and the avoidance of coal and some natural gas that would have been used to generate needed thermal energy at the point of use. The total energy savings resulting from full deployment of the 143.7 GW of CHP/DE potential in the four provinces and Shanghai amounts to about 6.3 billion GJ annually in 2030. This equals an energy savings of about 19 percent over an energy future that relied solely on central station generation.

Noting the great potential of distributed energy sources in energy saving, the China Government has been implementing many new projects on distributed energy sources and gradually achieved significant results. Some off the projects are listed below:

First List of Gas Distributed Energy Demonstration Projects in China

Number	Project Name	Project Location	Project Size
1	Huadian Taizhou Medicine City Building Distributed Energy Station	Jiangsu	4000kW
2	CNOOC Tianjin Industrial Base Distributed Energy Project	Tianjin	4358kW
3	CNPC Scientific Innovative Base (Beijing Gas)Energy Center Project	Beijing	13312kW
4	Huadian Hubei Wuhan Creative World Distributed Energy Station	Hubei	19160kW

6. Way Forward

A workshop was organized at China in Dec 2012 to share the study finding and a field visit will also be organized to demonstrate some established distributed energy sites. The response in the Workshop towards the development of distributed energy sources in APEC fora was very encouraging. It is expected with the growing understanding on the benefit of the distributed energy sources in promoting energy efficiency and conservation and capacity building in APEC, there is high potential for wider use of distributed energy sources in APEC

7. Conclusion

Noting the rapid urbanisation of many APEC fora, how to achieve a sustainable growth in an innovative way is a great challenge to many APEC economies. The adoption of distribution energy in the urbanisation is certainly one of the innovative means to achieve sustainable growth as directed by the APEC leaders. The use of distributed energy sources in promoting energy efficiency and renewable energy, when linked with the development of smart grid technology, may achieve synergy effect and greatly enhance the potential benefit of both schemes. At present the World Energy Council (WEC) are working on the policy needed to implement the smart grid technology. The WEC findings on smart grid technology will also help to address some issues such as regulatory barriers that may have impact to the application of distributed energy sources.

There were a number of APEC project with focus on the application of renewable energy sources and smart grid technology. Development of on-site renewable energy source as well as the smart grid technology is also the foundation of setting up distributed energy sources.

APEC is the also the only forum where leaders, ministers and working level government officials in the Asia and Pacific region share knowledge and coordinate activities on a broad range of issues related to economic growth and sustainability. As such, it is the most appropriate forum to be studying many issues involved in implementing the benefits of the energy security, energy efficiency as well as clean energy, and the most appropriate forum to be promoting implementation of the findings.

It is hoped that with this study, the ASPEC for a will have a better understanding on advantages of the application of distributed energy sources in APEC fora and a concerted effort would then be built up to further expand its application in APEC fora to capitalise its benefit in enhancing energy efficiency.

Annex 1

IEEE 1547 Series of Interconnection Standards

(An extract from the website of IEEE Standards Association, USA)

Welcome to the website for the SCC21 1547 Series of Interconnection Standards. The IEEE standards development process is open and voluntary and operates under a consensus process. The best way to participate in standards development is to attend Work Group (WG) meetings. All WG meetings are open meetings.

The USA Federal Energy Policy Act of 2005 calls for state commissions to consider certain standards for electric utilities. Under Section 1254 of the act: "Interconnection services shall be offered based upon the standards developed by the Institute of Electrical and Electronics Engineers: IEEE Standard 1547 for Interconnecting Distributed Resources With Electric Power Systems, as they may be amended from time to time."

The IEEE SCC21 1547 Series of Interconnection Standards proves to be a benchmark milestone for both the IEEE standards consensus process and a model for developing further national standards dedicated to the ongoing success of our nation's electric power system.

Annex 2

Connecting Your System to the Electricity Grid

(An extract from the front page of DOE Energy Savers: Connecting Your System to the Electrical Grid)

While renewable energy systems are capable of powering houses and small businesses without any connection to the electricity grid, many people prefer the advantages that grid-connection offers.

A grid-connected system allows you to power your home or small business with renewable energy during those periods (diurnal as well as seasonal) when the sun is shining, the water is running, or the wind is blowing. Any excess electricity you produce is fed back into the grid. When renewable resources are unavailable, electricity from the grid supplies your needs, thus eliminating the expense of electricity storage devices like batteries.

In addition, power providers (i.e., electric utilities) in most states allow net metering, an arrangement where the excess electricity generated by grid-connected renewable energy systems "turns back" your electricity meter as it is fed back into the grid. Thus, if you use more electricity than your system feeds into the grid during a given month, you pay your power provider only for the difference between what you used and what you produced.

Your local system supplier or installer should know about and be able to help you meet the requirements from your community and power provider.

The sections below will help you learn about some of the issues involved in connecting a small renewable energy system to the grid:

- Equipment required to connect your system to the grid
- Grid-connection requirements from your power provider
- State and community codes and requirements