

Development of Renewable Energy in Open Electricity Markets

Ngan H.W. and Engriwan W.
Department of Electrical Engineering
The Hong Kong Polytechnic University Hong Kong
E-mail: eehwngan@polyu.edu.hk

Abstract – The role and participation of renewable energy in competitive markets are key issues for sustainable energy development. A number of basic concerns, such as government policy, regulatory and incentive measures have yet to be resolved. In this connection, discussion on development of renewable energy in the context of promoting sustainable use of energy including incentives, acceptance, market and policy measures as well as a case review for possible promoting the use of RE in the future Hong Kong electricity market reform is presented in the paper.

Index Terms – RE, renewables, open electricity market

I. INTRODUCTION

OPEN electricity markets and regulations are operating differently all over the world but they share one common influence over the roles of renewable energy and energy efficiency. As the energy sector changes from state monopolies to private companies providing services under the supervision of regulators, market and regulatory developments affect the role of renewable energy (RE) and energy efficiency. In a competitive marketplace, whether the changes are meant to encourage or discourage renewable energy and energy efficiency activities depend on many factors. This paper discusses development of renewable energy, energy efficiency and competitive markets in the context of a sustainable energy framework. It is worth to note that consumer preference of sustainable energy such as wind and solar forms a basis of success in open electricity markets. Without which, it makes renewable energy difficult to participate in the markets due to greater generation costs and incomplete costing to the environmental impacts of other forms of energy. In fact, when competitive markets are created after the deregulations, utilities have to compete for different forms of energy in light of rapid development of new technology, new environmental targets and other aspects of new market conditions. In the United States, for example, the open electricity markets have been embraced to introduce competition for renewable energy and energy services, and to lower the price of that energy or service (Gardner, 2002). As for the EU countries, these competitive markets are being encouraged to lower energy prices, maintain industrial competitiveness, and develop an internal European

market like “Green” market (Johansson and Turkenburg, 2004).

Through regulatory frameworks, utilities may make non-economic decisions for renewable energy or energy efficiency. These decisions do not necessarily increase utilities’ revenues. Specific examples include requirements that utilities promote demand side management to reduce overall energy demand and that utilities purchase renewable generation at regulated prices that exceeds their usual costs of generation. As mentioned, the main issue for sustainable energy development and use is the role and participation of renewable energy and energy efficient uses in open electricity markets. Conditions in these markets should encourage renewable energy and energy efficiency. Either reliance on consumer preference or positive measures from regulator or both should be included to ensure the roles of renewable energy and energy efficiency. Which positive measures compatible with open electricity markets remain top considerations in the design. Market forces and the resulting lower energy prices may also discourage energy efficiency measures. Hence, as a strategic review on the issues, the paper outlines development of renewable energy and reports on measures for introducing renewable energy and energy efficiency that are compatible with the open markets.

II. ROLE OF RE IN OPEN ELECTRICITY MARKETS

The overall value of RE is perceived quite differently in competitive electricity markets. RE usually costs more to produce than other forms of energy which may explain the fact that even strong investments exist in renewable technology, the RE has not been able to capture a good share in open electricity markets. However, the value of RE has been appreciated significantly especially at a period when fossil fuel prices become more volatile and more concern paid on the environmental impact brought along by the traditional energy consumption patterns. An obvious challenge in promoting the use of RE is to ensure this value be reckoned and treasured as a reflection of the environmental security and social values. In fact, consumer preference and reduction of greenhouse gases are important factors in North American and European markets.

RE can be defined as energy with low impact on the environment where its role and participation in competitive energy markets are key issues for sustainable energy development. Apart from consumer preference, government and regulators have to take positive measures to ensure the role of RE be compatible with the competitive markets such as RE quotas to be achieved within certain period like increase the use of renewable energy in Latin America to 10% as a share of total by 2010. The European Union proposes that countries attain the goal of using renewable energy for 15% of their energy needs. However, how renewable energy sources should be promoted is still open for discussion, such as:

- Can market reform help?
- Will Quota systems introduced by some countries facilitate the growth?
- Will such policies and measures unleash or constrain the power of the market?
- What are the related regulatory issues?
- What are the views of regulators in different regions of the world?

III. INCENTIVES FOR DEVELOPING RE

Electricity prices are no longer determined by regulators in the open electricity market but simply determined by the market mechanism. In which, RE serves as alternative electricity source and in the power pools in the UK, for instant, competition between different types of electricity generation is encouraged and utilities have equal access to the pool irrespective of their source of electricity. However, by simply having the right of access does not mean enough incentives provided to dispatch RE in priority to other forms of energy. Part of the reason is due to the high generation cost of RE in relation to fossil fuel energy.

The market incentive comes from a belief that affordable modern energy services for everyone are a key to sustainable development throughout the world (Eichhammer, 2004). In this regard, RE has an enormous potential for further development and can play a major role in meeting the growing demand for energy services. A market-based approach in the treatment of all energy sources will ensure the most efficient solutions but regulators are central to the smooth functioning of energy markets at all levels. The World Energy Council (WEC) proposes ten policy actions to achieve sustainable energy development by 2020. One of the most fundamental actions called for "Keeping all energy options open so that cleaner fossil fuel technologies, nuclear power, hydroelectric and other renewables maintain or increase their share of the global energy mix". WEC believes that the development and use of renewables

and distributed generation should be part of a global energy strategy.

The European Union (EU) Directive on the promotion of electricity produced from renewable energy sources in the internal electricity market adopted in September 2001 is one such example. According to this Directive, EU member states shall have their own national indicative targets (of renewables) at 12% share of gross national energy consumption by 2010 and 22% share of electricity generation by 2010.

Based on the same incentive, the German Parliament adopted the Renewable Energy Law (REL) - the 'Law for the priority access of electricity from renewable energy sources'. The REL combines elements of the 1990 Electricity Feed Law and a flexible quota on the electricity supplier level. The overall objective of the law is to contribute towards doubling the share of renewable energy in the electricity market from 5 to 10% by 2010.

Government supports for research and development in renewables, technology and skills transfer and effective private-public cooperation are important incentives to advancing the potential for renewables in countries like the budget spent in member government of the International Agency Countries (IEA) as shown in Fig.1. The cost of renewable energy technologies remains high, although in the long run prices continue to fall. Some forms of renewable energy are now as competitive as other forms of energy under some market conditions. However, it is expected that further price reductions are needed for renewables to compete broadly with the least costly fossil-fuel alternatives. Consumers' choices may be rationalized if appropriate price signals are attributed to value the environmental and social benefits of renewable energy.

	Budget by Technology 1974-2002 (million US\$)	Shares in Energy RD&D 1974-2002	Budget by Technology 1974-1986 (million US\$)	Shares in Energy RD&D 1974-1986	Budget by Technology 1987-2002 (million US\$)	Shares in Energy RD&D 1987-2002
Nuclear Fission	137 529	47.3%	84 866	53.6%	52 663	39.7%
Fossil Fuels	36 842	12.7%	20 559	13.0%	16 284	12.3%
Nuclear Fusion	30 562	10.5%	15 948	10.1%	14 615	11.0%
"Other" Technologies	29 212	10.0%	10 599	6.7%	18 613	14.0%
Renewable Energy	23 550	8.1%	13 317	8.4%	10 234	7.7%
Solar Heating & Cooling	3 024	1.0%	2 140	1.4%	885	0.7%
Solar Photo-Electric	6 354	2.2%	2 717	1.7%	3 636	2.7%
Solar Thermal-Electric	2 555	0.9%	1 889	1.2%	666	0.5%
Wind	2 910	1.0%	1 445	0.9%	1 465	1.1%
Ocean	754	0.3%	626	0.4%	128	0.1%
Biomass	3 578	1.2%	1 495	0.9%	2 083	1.6%
Geothermal	4 088	1.4%	2 867	1.8%	1 221	0.9%
Large Hydro (>10 MW)	93	0.0%	0.00	0.0%	93	0.1%
Small Hydro (<10 MW)	49	0.0%	0.18	0.0%	49	0.0%
Conservation	23 479	8.1%	8 607	5.4%	14 872	11.2%
Power & Storage Technology	9 844	3.4%	4 344	2.7%	5 500	4.1%
Total All Energy	291 020	100.0%	158 240	100.0%	132 781	100.0%

Fig.1 Budget spent on RE from IEA Countries

IV. MARKET ACCEPTANCE OF RE

There have been mixed reviews in terms of the penetration and acceptance level of RE. Depending on

the type of renewable energy, some of them are widely available at low cost (Sonneborn, 2004). For example municipal solid waste (MSW), a kind of bio-energy, can be used to produce heat or electricity where its technology has been proven and cost effective. However, since the Kyoto convention in 1997, MSW has not gained much popularity due to its contributions to the emissions of greenhouse gasses particularly CO₂ (González et al., 2005). Wind energy, another kind of renewable energy is seen to be increasingly competitive. Europe is the leader for wind energy with a predicted total capacity of 75,000 MW by 2010 (EWEA, 2003). While Hong Kong has experimented with wind energy at its Po Toi island, it will be awhile before commercialized wind energy is possible. The main obstacle here is the huge land that is needed to place the wind turbines and grids. Even so, wind energy has been found to revitalize regional economies elsewhere by creating opportunities for wind turbines markets, jobs, etc. (AWEA). Moreover, the costs have decreased appreciably over the past decade as indicated by the 20% increase of generating capacity globally in 2004 (EWEA).

Photovoltaic or solar energy has gained significant RE market share recently with the 20-35 per cent increased investment last year alone while its generating costs have been dropping to their 1980s level. Hong Kong has experimented with photovoltaic energy for several years with solar panels installed at the rooftop of some government buildings. But since photovoltaic energy generation depends on clear weather with less cloud, the future of the photovoltaic energy generation is uncertain given the high pollution level and high population density in Hong Kong. Nevertheless, the success of photovoltaic energy generation at remote places is quite high (SEIA).

V. MARKET AND POLICY MEASURES FOR PROMOTING RE

At present, most RE cannot compete on its own and its existence still relies on different market and policy supports. One approach that has been adopted by some EU countries is to introduce a “Green” market to secure the development of renewable technologies and to compensate for the benefits that the renewable energy generates to the environment (Kristina, 2005). For example, the tradable renewable energy credits such as CO₂ permit that sets quotas for the allowable CO₂ emission and penalties for exceeding the limit. Similarly, in the US, the tradable renewable energy credits (REC) awards utilities based upon the total amount of energy generated from renewables (Menz, 2005). Utilities have taken the advantages of REC by appealing to consumer preferences for green power and by turning RECs into cash to assist in the financing of renewables projects

with the premise that renewables development is more costly than traditional power sources.

Renewable portfolio standards or RPS is the most important factor shaping renewable markets today. For example, California’s RPS requires that retail sellers of electricity procure 20% of their retail sales from approved renewable energy sources by 2017. By compelling producers and distributors to generate minimum amount of energy for renewables, RPS forces growth in the renewable market and encourages rapid renewables development.

Other policies and measures being used for promoting renewable energy in open electricity markets include corporate tax incentives, production incentives, grant programs, and loan programs. In the US, corporations can receive certain tax credits and deductions when purchasing and installing renewable energy equipment. Moreover, utilities receive payments in exchange for the renewable energy credits generated by renewable energy systems. Though the amount of grant and loan varies from states to states, the fundamental idea is to promote the research, development and use of renewable energy technologies. A summary of the RE policies being implemented in various countries is outlined in Fig. 2.

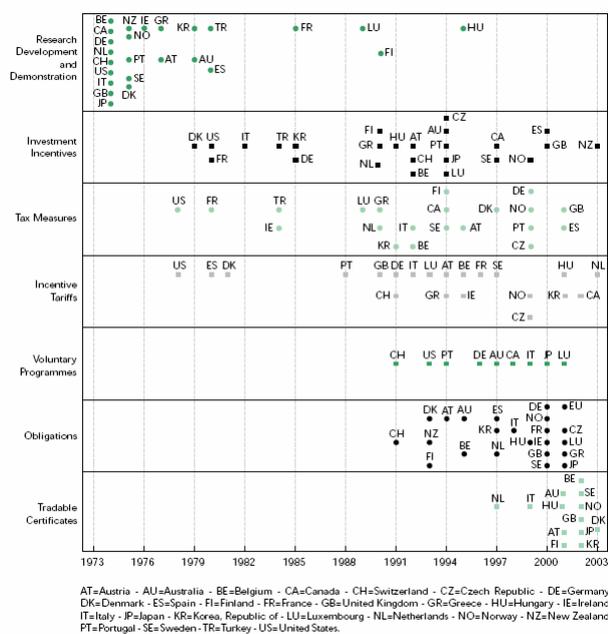


Fig. 2 RE policies in different countries

VI. A CASE REVIEW: IMPLICATIONS OF RE DEVELOPMENT IN HONG KONG

The ESI reform in Hong Kong and China will undoubtedly assume an important role to play on renewable energy and energy efficiency. Though both utilities in Hong Kong have promoted Demand Side Management (DSM) to improve energy efficiency, more should be done along this line in formulating the

future Hong Kong's ESI. The major obstacle is to encourage consumer preference over renewable energy by having a proper understanding on the social costing implications.

RE can be seen as providing benefits to society, a positive externality when comparing to other forms of electricity generation. In the absence of appropriate markets to start with, there is a divergence between the social benefits and the private benefits of supplying the RE. A more pro-active measure is to impose a minimum level of supply of renewable electricity desired. To ensure the actual supply of electricity claimed to be of a 'renewable quality', a certification scheme would need to be introduced and a follow-up stage is to make the certificates tradable when a sort of "Green Energy" market is available. The basic mechanism behind tradable certificates can also be extended to cover the cross border area in Mainland China. Through time, it creates incentives to reduce the cost of providing renewable electricity. First, the threat of new entrants in the market for certificates means that companies need to keep their costs as low as possible. Second, the incentive to sell certificates if a firm finds a new way to provide renewable electricity at lower costs creates a demand for the development and introduction of new renewable technologies. Promoting the use of the RE is not a one time effort but it should be supported by continuous government efforts to combat pollution and reward incentives for contribution to the environment perseverance.

VII. CONCLUSION

The long term success of RE depends on the correct energy policy taken by the government, utilities' willingness to invest in RE projects, consumers' preferences for "Green" products and services, and incentives to encourage the production and use of RE. This paper highlights the development of RE across the region with emphasis on the roles of RE and energy efficiency in open electricity markets. Once the roles are defined, incentives can be constructed accordingly where consumer acceptance for RE determine the success of market policies and measures.

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REFERENCES

- Eichhammer, R.H.W., et al., 'How to promote renewable energy systems successfully and effectively', *Energy Policy*, Volume 32, Issue 6, April 2004, pp. 833 – 839..
- Gardner M., 'Energy Efficiency', *Conservation and Renewable Resources Forum*, 2002
- González, P., Hernández F. and Gual, M., 'The implications of the Kyoto project mechanisms for the deployment of renewable electricity in Europe', *Energy Policy*, Volume 33, Issue 15, October 2005, pp. 2010-2022
- Johansson T.B. and Turkenburg W., 'Policies for renewable energy in the European Union and its member states: an overview', *Energy for Sustainable Development* Vol. VIII No. 1, March 2004
- Kristina E., 'Public and private attitudes towards "green" electricity: the case of Swedish wind power', *Energy Policy*, Volume 33, Issue 13, September 2005, pp. 1677 - 1689
- Menz, Fredric C., 'Green electricity policies in the United States: case study', *Energy Policy*, Volume 33, Issue 18, December 2005, pp. 2398 – 2410
- Sonneborn, C.L., 'Renewable energy and market-based approaches to greenhouse gas reduction opportunity or obstacle?', *Energy Policy*, Volume 32, Issue 16, November 2004, pp. 1799 – 1805.