한국신·재생에너지학회 2009년도 추계학술대회논문집 pp.270~280

Promotion Policies of Renewable Energy: Lessons from the Korean Experience for the Vietnamese Case

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Abstract : New and renewable has the potential to play an important role in providing energy with sustainability to Vietnamese people. Over the past few years, the Vietnamese government has promulgated several policies in an effort to promote the use of new and renewable energy. However, the development of new and renewable energy in Vietnam is still stagnant, the share of new and renewable energy in total commercial energy is insignificant. The study aims to analyze the developments in renewable energy policies and prospects for Vietnam based on the Korean experience in promoting new and renewable energy. By referring to the policy instruments adopted by the Korean government as well as the results of these policy, recommendations and proposals are provided in order to overcome the barriers to the new and renewable development in Vietnam

Key words : New and renewable energy, barriers, policy

Nomenclature

CDM : Clean Development Mechanism
Wp: Watt-peak
TOE: Ton of oil equivalent
TWh : Teta watt hour
MW: Megawatt

Subscript

NRE: New and Renewable Energy
EVN : Electricity of Vietnam
MPVI: Master plan for power development in the period of 2006-2015 with prospect to 2025
MOIT: Ministry of Industry and Trade of Vietnam
TPES: Total Primary Energy Supply
IE: Institute of Energy
NEDO: New Energy and Industrial Technology Development Oganization
Development Organization
GDP: Gross Domestic Product
SMHs: Small and Micro hydroelectric
KEPCO: Korea Electric Power Corporation
IEA: International Energy Agency
UNDP: United Nations Development Programme
WB: World Bank
ADB: Asian Development Bank
JICA: Japan International Cooperation Agency
PV: Photovoltaic; KRW: Korean Won

1. Introduction

In 2007 new and renewable energy (NRE) including hydropower contributed 18.2 percent of the global electricity generation, about 2.5 percent of global heat consumption (excluding the use of traditional biomass) [8]. However, only a limited set of countries have implemented effective support policies for NRE which led to an acceleration in NRE diffusion in recent years. If effective policies were adopted in many more countries, this potential could be exploited more rapidly and to a much larger extent [4]

Vietnam has relatively rich and multiform NRE resources, which can be use for generation of electric power to the national power grid. These available NRE resources could potentially contribute to satisfy the rapid increase of electricity demand, mitigate polluting emission and enhance energy independence and security in Vietnam over the 2010-2030 period [32]. However, there is only small portion of them that has been exploited so far. The few renewable projects connected to the national power grid are of two types, small hydro and biomass. There are no

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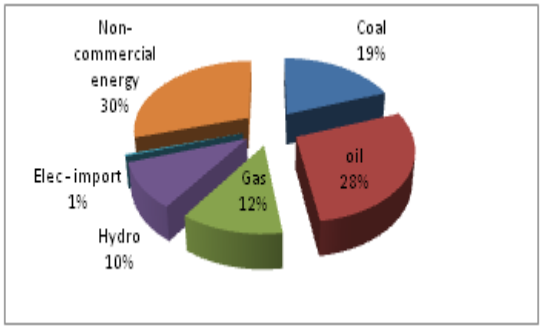
grid-connected projects on solar, wind or geothermal power. The share of electricity produced by NRE resources in total electricity production of the national grid is very small. Recently, the Vietnamese government has issued some important legal document in an effort to develop the use of NRE in Vietnam. Nevertheless, the legal framework still seems to have difficulties in promoting NRE development. In this regard, this study attempts to suggest some recommendations to put forward an effective policy for NRE in Vietnam based on the Korean experience.

2. 2 The Vietnamese Energy Sector

2.1 Overview

In 2007, total primary energy supply (TPES) was 50.2 million tone of oil equivalent (TOE), 29.6 percent of which was non-commercial energy. This indicated a total increase of 39 percent from the year 2000 or a 10.4 percent of the annual growth rate. Biomass energy for most part is not commercially traded, but it is an important source of energy in the residential sector in rural areas. In fact, biomass energy has been the predominant energy source in Vietnam for a number of years, accounting for over 50 percent of the country's TPES in the past.

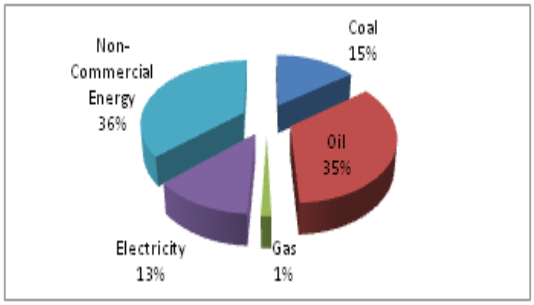
Fig. 1 Primary energy supply of Vietnam in 2007



Source: Ministry of Industry and Trade of Vietnam

Total commercial energy consumption including biomass has grown rapidly from only 4.2 million TOE in 1990 to 25.9 million TOE in 2007. The average growth rate is 11.7 percent over period of 1990-2007. Three largest energy consumption sectors are Industry, Transport and Residences; Agriculture and Commerce & Services take a small share.

Fig 2. Final energy consumption in 2007

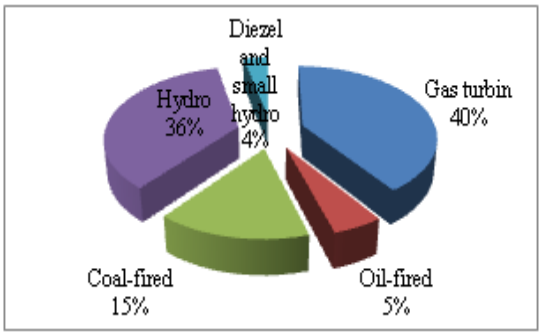


Source: Ministry of Industry and Trade of Vietnam

2. 2 The Power Sector

The power sector in Vietnam is governed by the Electricity of Vietnam (EVN), a utility wholly owned by the government. Commercial electricity for economics sectors increased from 6.2 TWh in 1990 to 58.35 TWh in 2007 with average growth rate of 14.1 percent per year, far exceeding the GDP growth rate of 7.7 percent in the same period. Total generating capacity on the system by the end of 2007 was 12,682 MW with 66,773 GWh of electricity production. The EVN facilities accounted for an approximately 77.2 percent, the remainder was owned by other local and foreign Independent Power Producers.

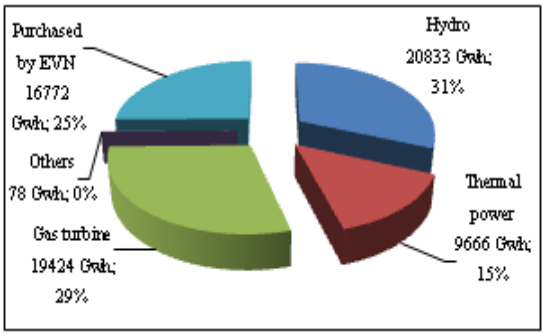
Fig.3 Generating capacity in 2007



Source: Ministry of Industry and Trade of Vietnam

Despite some considerable efforts such as the strong development of independent power plants (IPPs), the increase of power import from China or reducing the share of hydropower in power system, serious power shortages have been seen since late 1990s. A part of the reasons for this power shortage was the decrease of hydropower output due to drought conditions, but the main and fundamental reason was the lack of reserve margin against peak demand. Futhermore, the delay of construction progress of some plants made the situation even more serious. Power shortage was especially high and grave in 2005 with 237.7 GWh and with 372 GWh in 2007 (MOIT 2008)

Fig. 4 Power generation structure



Source: Ministry of Industry and Trade of Vietnam

It is expected that power demand in the coming period will keep increasing at a significant rate due to electrification, urbanization and population growth as well as economic and industrialization. According to the MPVI, the electricity demand will increase by 15 percent per annum in the low -demand scenario and by 18 percent per annum in the high-demand scenario

over the period of 2010-2030 [22]. Such a rapid development would raise a number of challenges concerning the availability of energy resources and environmental degradation. Vietnam has planned to import energy from other countries and to intensify the development of NRE and nuclear power. To ensure the provision of electricity, the Vietnamese government is also carrying out the restructuring of the power market which includes the revision of electricity tariff, the equitization in the power sector and the institutional reform. The road map which has been approved by the Prime Minister specifies that the power market in Vietnam will be established through market. Phase I-*generation market*-starts in 2009, phase II-*wholesale competitive marke*t-in 2017 and phase III-*Retail market*- in 2024.(MOIT 2006)

3 New and Renewable Energy in Vietnam

3.1 Potential of NRE Resources

NRE potentials are commonly classified in different categories of theoretical potential, technical potential, or economic potential. The theoretical potential is defined at the maximum energy that could be exploited in a region considering only thermodynamic constraints, assuming others such as cost, reliability etc. that may hinder its application do not exist. Technical potential is defined by the energy that could be yielded using existing technology, and this depends on the date of assessment. Economic potential refers to the case when a technology was to be used in an environment free from market failures and distortions. Economic potential is the energy that could be yielded using economically feasible installation [10]

Small and Micro hydroelectric (SMHs): Vietnam has 2400 rivers 10 km or longer. The hydro energy economic potential is estimated at 84 TWh per year. Technical potential of SMHs in Vietnam is 4015 MW with 1050 stations, accounts for 10-12 per cent of total hydro power resource. Further, Vietnam has abundant resources of micro hydroelectric. The technical potential of micro hydroelectric are as follows: (i) Installed capacity ranges from 0.1-5 KW per station: there are 1 millions places with total installed capacity about 50-100 MW (ii) Installed capacity ranges from 5-100 KW per station: there are 2500 places with total installed capacity about: 100 MW to 150 MW (iii) Installed capacity ranges from 100-10000 KW per station: there are 480 places with total installed capacity approximate 738 MW, located in 23 provinces (IE) [24].

Solar Energy: Located in the tropical and monsoon zones, Vietnam has access to year-round solar energy sources, particularly in the northwestern, central country. In the southern and central areas, solar radiation levels range from 4 to 5.9 KWh/m^2/day uniformly distributed throughout the year. The solar energy in the North estimated to vary from 2.4 to 5.6 KWh/ m^2/day

Wind energy: The data of wind energy measures for the whole country is not available. Consequently, there are big differences in the wind energy potential. Theoretically, Vietnam has approximately 513 GW of capacity. Excluding restrictions on the exploitation of the potential of large scale wind energy [32]. About 31000 km2 of land can be available for wind development in which 865 km2 equivalents to a wind power of 3572 MW has a production cost less than 6 Uscents/KWh [11].

Geothermal Energy: There is a potential for geothermal energy in Vietnam since it has more than 300 hot-water areas, with a surface water temperatures ranging from 30^{o}C to 105^o. Primary estimation of total Vietnam geothermal potential is about 340 MW

Biomass: The potential of biomass resources in Vietnam is huge, only agriculture by-products are 70 million tons, approximately 20 million TOE (IE). There are four types of biomass energy that can be used for power generation: husk in rice husk plants, sugar refuse cane in sugar mills, coffee shells and wood refuses with a potential of 1000-1600 MW

Tidal Energy: Base on geographical and geological features, 18 places which have the potential for tidal energy have been specified. However, the prospect of tidal energy potential of Vietnam is not very promising. There are only some appropriate places for small tidal power plants. Moreover, It is suggested that some areas need surveying in more details.

3.2 Legal Framework for NRE Development in Vietnam

Since 1960s, NRE has been studied in Vietnam. From 1960 to 1990, there were two renewable programs which were led by the Government: (i) Program of small hydroelectric development for rural and mountainous areas from early 1960s to late 1980s; (ii) NRE program 52C from 1985-1990 which conducted studies and had small pilot projects for most of NRE forms such as small hydroelectric, solar energy, wind energy, biogas and improved stove. However, the development of NRE was still insignificant until late 1990s due to some reasons: (i) the intermittent studies and the lack of a close direction (ii) the lack of legal framework and an appropriate and synchronized policy for NRE development (iii) the high and the complicated technology cost of NRE projects.

There was no official studied program on NRE until 1993. Several related projects on rural electrification and the provision of purified water restarted the NRE development in Vietnam. Further, some programs were conducted by the support of international organizations such as UNDP, WB, ADB and JICA etc. In 1999, the Government launched a Renewable Energy Action Plan (REAP) with the support of World Bank. REAP is grounded in various Government documents, including the 2001-2010 Master Plan of Power Development. REAP focuses on rural electrification of remote areas as a near-term opportunity to scale-up renewable energy technologies, including micro-hydro, wind, biomass, and solar photovoltaic. It establishes goals for renewable energy-based electrification for the hundreds of thousands of households not covered by EVN's grid

expansion planning. REAP comprises five components: (i) individual renewable energy systems for households and institutions; (ii) off-grid village hydro schemes; (iii) grid-based renewable energy schemes; (iv) policy and institutional capacity building; and (v) technology improvement and resource assessment. It is a two- phase, 10-year program with a Phase 1 target of adding 25-50 MW of renewable energy capacity, providing access to more than 35,000 households (MOIT)[35].

Electricity Law came into force in 2005, which states that: (i) investment incentives, preferential pricing, and preferential taxes for development of NRE resources are to be provided through Ministry of Finance (MOF); (ii) individuals and organizations are encouraged to utilize renewable energy when providing electricity access to rural and mountainous areas.

In 2007, several legal frameworks supported for NRE development have been issued including:

(1) The Master plan for Power development 2006-2015 with prospect to 2025 which set the goals for NRE development: **(i)** 100 per cent communes access to electricity in 2015; **(ii)** Have an additional 2451 MW in 2015 and 1600 MW in 2025 of grid-connected NRE capacity.

(2) The Decision No 130/2007 of the Prime Minister on some mechanisms and policies for CDM projects: **(i)** CDM project investors can get preferential treatment including preferential taxes, land utilization or land lease price, depreciation of fixed asset, investment credit of the Government; **(ii)** Products of CDM projects can be subsidized which is in the priority fields; **(iii)** CDM projects can get financial support for its establishment and construction

(3) The National Energy Strategy of Vietnam to 2020 and vision up to 2050 sets main objectives for new and renewable energy development as follows: **(i)** Strive for increasing the share of new and renewable energy to 3 percent of total primary commercial energy in 2010; 5 percent in 2020 and 11 percent in 2050 **(ii)** Complete agricultural and mountainous energy programs. The number of households used commercial energy for cooking will be 50 percent in 2010 and 80 percent in 2020; 95 percent agricultural households will access to electricity in 2010, approximately 100 percent in 2020 **(iii)** Considering a government fund for renewable energy development in order to support the industry

(4) The Decision No 177/2007 of the Prime Minister on the approval of the Master plan for bio-fuel development to 2015 with prospect to 2025: **(i)** 100 000 tons E5 and 50 000 tons B5 will be produced to meet 0.4 percent domestic petroleum demand by 2010; **(ii)** 250 000 tonnes of ethanol and vegetable oil will be produced to meet 1 percent of the country's petroleum demand by 2015

In addition, there are some important documents were issued in 2008:

(1) Circular No 58/2008 regulates subsidized price for the products of CDM projects: **(i)** Electricity produced from wind energy, solar energy, geothermal energy and tidal energy; **(ii)** Electricity produced by methanol recapture from refuse disposal sites and coal production tunnels. The subsidy price can be calculated as follow: The real selling price subtracted from the generation cost plus the average profit.

(2) The Decision No 18/2008 on the regulation of the list of avoidable cost and the selling contract sample: (i) Stipulations regarding the price of small grid-connected NRE power plants; (ii) The regulations applied for organizations, individuals which sell and purchase the electricity of small NRE power plants.

3.3 Status of Current Development

Small and micro hydroelectric power:

Vietnam has built and operated over 500 small hydroelectric stations of which capacity type ranged from 5 KW to under 50 KW are 362 stations with total capacity of 4709 KW; from 50 KW to under 100 KW are 28 stations with total capacity of 1681 KW; capacity ranged from 100 KW to under 10 000 KW are 117 stations. About 150 000 micro stations (0.2 - 5 KW) with total 60 MW of capacity has been used at remote areas.

There are 49 grid-connected small hydro power plants with total capacity of 64 MW and over 300 off-grid connected mall hydro power plants with total capacity over 70 MW. In 2006 total small hydropower capacity was about 135 MW with electricity production of 172 million KWh. In the future, there are two ways for small hydropower development: develop grid-connected mall hydro power plants or hybrid systems. Main problem with small and micro hydroelectric power development of Vietnam is the depletion of resources. Most of small hydroelectric powers resources will be exploited by 2020

Solar energy: Up to 2005, Vietnam had about 2300 small unvented solar water heaters at households. Each heater is estimated to save 600-1000 KWh per year. In the last three years, water heating by solar energy has grown rapidly. According to Institute of Energy in 2008, there are about 61000 unvented solar water heaters in Vietnam, 50 percent in the South, 42 percent in the North of Vietnam. Total electricity saved is over 36.6 GWh.

Solar battery equipments were used in Vietnam since 1992 at remote areas. So far, solar system equipments have been mainly imported. There are four types of systems in Vietnam: (i) Individual systems: The capacity of the system depends on each area and real power demand of households. The capacity of the each system is about 50-75 Wp; (ii) Center of Communes systems: the capacity from 200- 2000 Wp;(iii) Solar battery systems in combination with a diesel generator- hybrid systems (iv) Off-grid connected solar systems.

Currently, there are about 800 individual systems in the South, 165 systems in the Middle of Vietnam and 25 center of communes systems. Two hybrid systems which have biggest capacity so far: (i) the first project in Gia Lai province with 100Kw solar cells + 25 KW of small hydro power. This project began operation in 1999 funded by NEDO; (ii) the second project Kon Tum province with 7kw of solar cells + 2Kw of wind power generation funded by Tokohu Electricity

Company, Japan. This project began operation in 2000 provided electricity for 42 householders; (iii) Solar system with capacity of 154kWp at National Conference Center, Hanoi which has been operated since 2006. Total solar battery for power generation is about 1,25 MW

Although Vietnam has gained significant results on solar energy application, studies on solar energy are still spontaneous, do not have development plan and specific policy. The price of solar facilities are still high compared to people's income. Solar energy application has two main barriers:(i) high investment cost (import price of 8.0-8.5 US/Wp plus transportation cost of 5-7 percent). (ii) Low average capacity of solar cell makes it vulnerable when high electricity demand happened.

Wind energy: Wind power application has not been developed it is only at the preparation phase. Currently, there are 1000 wind motors, with small capacity types (< 200 KW) and 120 wind motors for water pumps. Some of bigger projects have stopped operation because of the dependence on foreign repair and maintenance. Total capacity of wind power in Vietnam is 1.23 MW. A total of 170 MW wind power will be installed by 2020.

Biomass energy:

1)Thermal energy: Biomass is an important energy resource of Vietnam. There are about 70 percent people using biomass as their main a energy resource. Biomass is also used as combustibles in local industries such as brick, ceramic production, food processing, electricity and steam production. Biomass consumption in Vietnam is about 38 million tons, equivalent to about 13.5 million TOE, accounts for about 38 percent of total final energy consumption. However, the low efficiency of traditional burning stove (8-15 percent) has made the use of biomass ineffective, and also causing air pollution.

Table 1 New and renewable energy in 2005

Unit: KTOE

Sources	Consumption	%
Commercial energy	21800	61.7
Heat energy from RE	13 515.8	37.6
Biomass	13513	99.9
Solar energy	0.645	0.01
Biogas	0.160	
Total	35 315.8	100.0

Source: Institute of Energy, Vietnam

2)Biogas :There are about 80 000 units in Vietnam, 95 percent for cooking and 5 percent for lighting, energy produced about 500 KTOE per year.

3)Bio-fuel: Resources to produce bio-fuel (ethanol) are mainly from sugar, cane juice and cassava. For spirit production from sugar, the efficiency of this process is not high, the cost of spirit price is more expensive than in other countries. Vietnam is also planning to produce domestic ethanol with 6 projects each of which has capacity about 100 million liters per year from cassava. Ethanol gasoline has been in pilot programs.

4)Power generation: The capacity of power generation from biomass is 150 MW. Electricity is mainly produced from 43 sugar mills. Some grid-connected plants are selling electricity at the highest price of 4.04 US cent/kWh. Waste is also used to produce methanol and electricity. There is one power station with capacity of 750 KW, the selling price is 4 US cent /kWh. Among about 130 husk rice plants, some are using husk to generate electricity and operating as off-grid stations.

Table 2 New and renewable electricity in 2005

Sources	Capacity MW	share %
Traditional	11360	97.47
NRE	287.48	2.53
Biomass	150	1.32
Solar energy	1.25	0.011
Small hydro	135	1.18
Wind electricity	1.23	0.008

Source: Institute of Energy, Vietnam

One of the biggest problems for biomass power plants is that all investors have to negotiate with EVN for an agreement of electricity price. The sugar–cane supply is not stable because of the low sugar-cane price and the competition of sugar import, making difficulties for the development of grid-connected projects. Husk rice plants are at small scale and disperse. Therefore, the cost for collecting husk becomes expensive, making electricity price higher.

In 2005, electricity production from NRE was 265.57 GWh, approximately 0.45 percent total electricity production. The share of NRE over total generating capacity reduced from 3.1 percent in 2002 to 2.5 percent in 2005.

3.4 Barriers to NRE Development

Barriers can be explored and analysed at several levels so that measures to overcome a barrier can be identified easily, and consistent with their dimension [10].

3.4.1 Market Failure

High controlled energy sector*:* Electricity generation, transmission and distribution in Vietnam are mostly provided by EVN, a stated –owned monopoly established in 1994. The governmental monopoly makes it restricted for private sector participation, especially for NRE investors. Although Independent Power Producers take a significant share of electricity production in Vietnam, a power purchase agreement has to be arranged with EVN in advance resulting in some difficulties for the investors

Lack of awareness and information**:** Lack of information on technology, prices and their effectiveness for potential investors community and household make the deployment of NRE difficult. Further, the inadequate resource and market data to plan a major program and to develop projects, lack of data on renewable energy

resources are also causing difficulties for planning programs, projects. At present, the data on renewable energy resources such as potential of wind, solar, small hydro energy resources are available but dispersed in many places and not enough for making an overall program to develop projects at concrete sites. For small hydropower, some sites were identified but their data are not detailed enough for preparing a detailed action plan. For wind energy, the data is not sufficient and not appropriate.

High investment requirement: Cost price of renewable energy devices is still high while income of rural households is low. This contracdiction is a big obstacle for off-grid NRE development.

3.4.2 Market Distortion

Favourable treatment to conventional energy: The domestic price of coal and natural gas for power generation is lower than market prices. In fact, the Vietnamese government is giving fuel subsidies to keep the electricity price low as a welfare measure for the poor and low income consumers in the country.

Non-consideration of externalities: Negative externalities such as pollution and damage from conventional energy are not included in pricing in Vietnam even if the efficiency of most thermal power plants only ranges from 28-32 per cent (EVN). Therefore, positive impacts of NREs are not valued.

3.4.3 Institutional Barriers

Lack of institutions and mechanism: The new regulation on financial support facilitates for the NRE penetration. However, biomass and small hydroelectric projects do not receive financial support while wind power, solar power and geothermal and tidal projects can have such supports. In fact, the investment costs of these NRE resources are much higher than that of biomass or small hydroelectric even taking into account the sales of the Certified Emission Reduction (CEFs). Further, this regulation may lessen the effectiveness of NRE project. Since the financial support covers the difference between generation cost plus reasonable profit and the sale (include the sale of selling CERs), there is no encouragement for investors to maximize the sales of CERs. The financial support will be paid by the environmental protection fund. However, the regulation do not give the ceiling subsidies and the procedure of subsidized allocation. Futhermore, there is no regulation on the competition of electricity price. Therefore, the effective projects have not been encouraged.

For rural electrification program, it needs to define suitable subsidy mechanism for rural communities. However, private investors meet difficulty in investing in power generation because: (i) procedures for establishment and operation of a private business are still complicated, changeable and some times not consisted; (ii) legal system in Vietnam is not sufficient and harmonious, low affordability for implementing contracts, business procedures and agreements (iii) there is no equality as local private and foreign investors usually don't have favorable conditions as those for the state owned enterprises in terms of seeking contracts, approval and licensing or borrowing loan from banks.

A mechanism is required to determine and channel an appropriate subsidy to rural communities. Full subsidy from the Government and some international organizations will reduce responsibilities of communities for operating, maintaining and repairing and not encourage people in off-grid rural areas self- invest in renewable energy.

The financing resources and their accessibility as well as measures to encourage investment and development of technologies through taxation (tax favourable, exemption or without tax) are not transparent because of complicated administrative procedures.

Unstable macroeconomic environment: Economic downturn last year also has resulted in the reduction of investment in NRE sector.

Lack of R&D: Lack of complete technologies manufactured within the country. Auxiliary devices, control units locally manufactured have quality lower than available systems imported from foreign countries

Lack of professional institutions: Lack of commercial enterprises supplying renewable energy electric equipment and services. Import of high quality equipment or joint venture investment to improve domestic equipment quality is needed to support rural electrification program, especially NRE projects.The services for installation of equipment, after sale services, including training are not available

3.4.1 Economic and Financial Barriers

Economically not viable: High generation costs of electricity makes NRE projects uncompetitive. The new policy on the support for CDM project can somehow solve this problem. However, the way to specify some terminologies such as average profit and real generation cost may hinder the positive impact of this policy

Financial institutions: More transparency is required in the implementation of the business licensing and regulatory frameworks, to encourage formation of such business. Publicly and privately owned business needs to be treated equally in terms of project approval and access to financing

Inadequate access to capital*:* Banks are still afraid of lending for renewable electricity projects due to difficulties in cost recovery. Further, the procedure to get a loan is quite complicated.

3.4.1 Technical Barriers

Lack of standard, codes and certification: Promulgation of equipment standards is not sufficient Provision of hot water by solar energy is quite popular in Vietnam. However, Vietnam do not have the quality control system of devices, operational standards and certifications for solar cells or unvented solar water heaters while these standards and certifications is an important part in order to have firm systems for households

Human resources: Labor resources as well as

managing and operating skills for stand-alone off-grid power projects in communes and villages are very weak. This is the reason developing projects ineffectively and reducing their lifetime. The shortage of consulting and technical services for NRE technology, especially maintenance and repair services after installation are the reasons that lower the length of NRE projects and also make them ineffective.

3.4.1 Social, Cultural and Behavioural

Knowledge level of people in rural areas is low, so there are many difficulties in approaching new renewable electricity technologies

4. Case study: An overview of the Korean experience

4.1 History of NRE Policy in Korea

The initial effort dates back to 1987 when the Korean Government introduced the New and Renewable Energy Development and Promotion Act in an attempt to further reduce Korea's dependence on imported fossil fuels, especially petroleum. The act encouraged installing waste-incineration facilities that generate heat and power and residential solar heaters for home water heating. It also promoted small hydro-electric plants and facilities to use methane gas. The act constituted the initial framework for the development of new and renewable technologies in Korea. To 1990, NRE contributed a modest share to primary energy consumption with approximately 0.4 percent [5]. Over ninety per cent of this amount came from the burning of waste and biomass, principally by industry. The main obstacle to increase use of NRE at that time was the lack of economic competitiveness with more conventional forms of energy. This was due, at least in part, to the government's policy of restraining increases in the price of conventional forms of energy.

In 1997, the Korean Government amended the Promotion Act for New and Renewable energy development that made the legal basis of new and renewable dissemination. There are 11 types of NRE included in the Promotion Act of NRE: Solar Thermal, Photovoltaic, Marine Energy, Geothermal, Wind energy, Hydro, Fuel Cell, Waste, Bio fuel, Hydrogen and synthetic fuel from coal liquefaction gasification. Between 1988 and 1998, public money was invested in around 300 projects in eleven research areas including photovoltaic, bio-energy, waste energy, wind power, solar, ocean and geothermal power, hydrogen and small hydro projects. (Fuel cells and clean coal use were also funded). Higher oil prices in 1999 and 2000 and the government's growing interest in measures to mitigate greenhouse gas emissions in the 1990s again drew policy-makers'attention to NRE [7].

In 1999, renewable energy represented *2.3* million TOE (included hydroelectric) of Korea's TPES although the economic feasibility of several renewable energies in Korea had yet to be established. The costs of generating electricity from NRE were still too high to compete with conventional power generation without some kinds of financial support. The potential of NRE was not assessed and Korea still lacked of the market expansion plans for NRE. The development of technology was still slow that is, Korea needed a sustainable technological development leading to reduced costs. Further, strong government support needed to enable the private sector to invest in NRE and to facilitate the market support deployment technologies. For example, investment in solar thermal energy infrastructure should have been enhanced, and a demonstration project of solar thermal energy technology should have been launched.

In December 2003, the government set two targets for penetration of NRE, targets of 3 percent of TPES in 2006 and 5 percent of TPES in 2011. These targets, along with technology-specific targets, were detailed in the government's Second Basic Plan for National Energy. To achieve these targets, the government passed the Second Basic Plan for New and Renewable Energy Technology Development and Dissemination, which was modified from the Basic Plan for Alternative Energy Development and Dissemination. The targets called for an increase in the share of renewable energy provided from sources such as wind and solar, and a reduced share provided by waste. The Ministry of Commerce, Industry and Energy (MOCIE) is principally responsible for new and renewable energy development and dissemination, in co-operation with the Ministry of Environment (MOE) and KEPCO. The government hlamas been planning to invest over KRW 6 trillion (KRW 9.1 trillion, including loans) between 2004 and 2011 to achieve its percent NRE supply target for 2011.The Korean government has designated hydrogen fuel cells, PVs and wind as areas to receive the largest share of government support of up to 70 percent. Funding in the form of loans is focused mostly on solar photovoltaic and biomass.

The third Basic plan for NRE in Korea in 2008 was set up to raise the ratio of NRE (including large hydro power) in primary energy from 2.6 per cent of the year 2008 to 11 per cent of the year 2030. In other words, Korean government plans to make 1.2 per cent share of total electricity generation supply and 7.7 per cent share in 2030 using renewable energy sources. The Korean government will achieve a 44-fold increase in the use of of photovoltaic energy, compared with the levels seen in 2007. The use of wind power will jump 37-fold, biofuels 19-fold, and geothermal power 51-fold. The government intends to achieve these goals by stimulating domestic demand and supporting the development of core technologies which include thin-film solar cells and large wind turbines. For domestic demand, the introduction of the Renewable Porfolio Standards and the enforcing increased use of NRE in public buildings will be included

4.2 Main Adopted Policy Instruments

In electricity sector, one of the Korean government's principal means of promoting NRE is through a

differentiated feed-in tariff programme. The government guarantees fixed rates for five years for small hydropower, biomass and waste, and guarantees the rates for 15 years for wind and PVs. The tariff for PVs is nearly seven times larger than the rate paid for wind, which receives the second-highest subsidy.

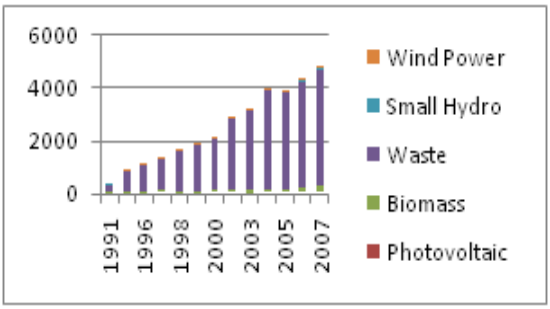
In addition to the feed-in tariff, other means has also been used to directly support NRE deployment has been used such as a direct support, tax benefit and R&D funding. Between 1996 and 2004 the government provided KRW 234.8 billion in direct support for the construction and operation of renewable power plants, with the aim of providing 31 765 TOE in energy savings per year [9]. The government provides the funds required for the construction and operation of facilities for new and renewable energy, such as solar thermal energy and photovoltaic energy. The range of the government's support is up to 100 percent of the required funds, and the support conditions include 2.0 percent of the annual percentage rate and a ten-year redemption period via amortization after a five-year deferment period. For companies making investments in new and renewable power generation facilities, a one-time deduction of 10 percent of the investment amount can be made from the builder's individual income or corporate tax. In addition, 65 percent of the customs levied on 26 different items in four categories (solar thermal energy, photovoltaic energy, wind power and fuel cell energy) can be deducted.

The government budget in 2008 for NRE were 241 billion KRW, which is 119 percent increase from previous year. The PV R&D budget in the same year were 19 billion KRW, and for wind power were 56.8 billion KRW [15]. The significant government funding has helped reduce business risk at the initial stage and speed up technology development by domestic manufacturers to cope with global competition.

4.3 Results

Some significant achievements has been acquired through the efforts made by the Korea government. In 2002, the government set an upper limit of support for NRE at 250 MW for wind and 20 MW for solar. The guaranteed feed-in tariff is granted on a first-come, first-served basis up to the limit. The government has paid KRW 11.7 billion in subsidies since the programme began in 2002, up through 2004, to 110 MW of renewable power (40 different power plants). The total power generated by the support system was 664,662 MWh as of the end of April 2005 . To promote solar power in the building sector, both to reduce domestic fossil fuel use and to develop a long-term export market, the government is supporting the construction of 100 000 homes that rely on solar photovoltaic power for some of their power needs. To meet this goal, the government has provided subsidies totalling KRW 72.8 billion to 332 projects between 2001 and 2004, and the total established capacity is 837 kW, from which 285 toe per year of energy are expected to be saved, equivalent to about KRW 120 million in oil imports per year. In 2002, to promote the dissemination of new and renewable energy, the government passed legislation requiring that all newly built public buildings (including federal and local government buildings) with over 3 000 m2 of gross area allocate over 5 percent of their construction costs to the establishment of new and renewable energy facilities. In 2004, the government provided KRW 5 billion to ten model businesses, the energy production capacity of which is estimated to be 805 TOE. New markets, valued at KRW 100 billion to KRW 200 billion, are expected to be created from this development annually [9].

However, Korea's share of NRE in its TPES is the lowest of all International Energy Agency (IEA) countries in 2007. Over 90 percent of the 4.84 Mtoe of NRE in Korea's 2007 TPES came from combustible renewable and waste. The remainder came from biomass (5.2 percent), wind, geothermal and solar (2.6 percent) and small hydro [17]. Although the share of NRE in Korea's TPES remains quite low, it has been increasing at a relatively fast rate since the early 1990s, rising at an annual rate of over 7 percent over the last decade. The largest increase was in combustible renewable and waste, which grew at nearly 8 percent per year. Over the same period, hydro grew at nearly one percent per year and solar and wind grew at over one percent per year.



Source: Korea Energy Economics Institute

Fig. 5 Renewable production in Korea 1991-2007

Wind power: At the end of 2008, the cumulative installed capacity was 236 MW. The new installation of 43 MW indicates the current difficulty caused by the increased price of imported wind turbines and existing barriers of limited onshore sites and public acceptance issues. However, the Korean wind industry is growing rapidly, especially in the development of wind turbines and components. Even though existing wind farms have been gaining experience in operation and maintenance, the repair or exchange of parts is still in the hands of foreign manufacturers. For demonstration projects or stand-alone small wind installations of less than 50 KW, the government subsidies to local government up to 70 to 80 percent.

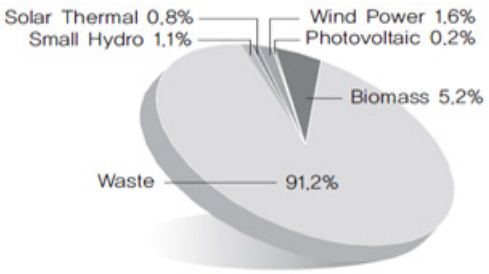


Fig. 6 The share of NRE in Korea in 2007

Source: Korea Energy Economics Institute

Solar (photovoltaic) energy: Photovoltaic system technology, which is now entering the utilization phase, has been installed on a number of small, isolated islands, resulting in 0.2 percent of the total NRE resources in 2007 mainly due to their high cost. The new installed photovoltaic power systems have reached 42.9 MW in 2007 and the cumulatively 77.6 MW by the end of 2007.Under the 100 roof-top program, 7,313 systems with a total capacity of 9,245 KW were newly installed in 2007. The share of grid-connected distributed system increased to 92 percent of the total cumulative installed power from 83 percent in the previous year. Further, 1045.6 PV energy will be installed in 2018.

Landfill gas utilization: The development of landfill gas recovery utilization is still in the incipient stage despite its high potential. 14 large-scale landfill sites, which are estimated to have gas generation potential of $647{,}000^3$per day, are presenting an attractive picture for the development of this type of energy.

Waste incineration utilization: Waste incineration plant is generating electricity using residual heat of incineration utilization. 30 units were operated and total output generation was 99 GWh in 2003. Now, the exclusive refuse derived fuel thermal power plant system is developed and electric power supply will be introduced via mixed coal and refuse derived fuel source. Subsequently, 58.8 MW waste incineration utilization will be installed in 2011.

5. Discussion and Conclusion

In the past, Korea also has similar problems like Vietnam in the development of RE such as the lack of complete assessment of NRE resources and the assessment of the cost – effectiveness of NRE or the lack of economic competitiveness with more conventional forms of energy. A move to more market oriented pricing of energy would be likely to improve the economic competitiveness of renewable forms of energy and increase the likelihood of their adoption. In fact, the reform of the power market has had positive impacts on the development of NRE in Korea. The establishment of the Korea Power Exchange (KPX) has facilitated the way of buying electricity production from NRE. The e assessment of the resources which has an important role in the development of NRE should be taken carefully. Korean case also suggested that the evaluation of policy instruments is very necessary.

The Korean experience shows that the feed-in tariff is one of the main policy tools to achieve its NRE target. NRE electricity generators bid into the KPX. The government compensates eligible renewable energy generators for any shortfall between the pool price and the feed-in tariff. This policy ensures that all technologies regardless of cost have an equal opportunities to receive feed-in tariff and supply renewable power. Although there has been some criticisms on this existing policy in Korea, these differential feed-in tariff are provided so that technologies at different stages of cost and development an attain critical mass and sufficient market penetration to become economic. Further, this feed-in tariff also encourages NRE producers to reduce generation cost in order to get higher profits. The financial supports of Vietnam are quite different. It is likely that the price subsidy systems in Vietnam will not be effective as the feed-in tariff system. Further, the direct support is very important because of the high investment cost. Investors may not have enough capital to overcome this barrier. Considering Vietnam's context, the financial support at initial stage is crucial due to the low income per capital in comparison with Korean people, especially it is very important for off-grid NRE development and rural electrification program in Vietnam. However, the direct support such as providing fund for construction and operation of NRE is not mentioned in the policy instruments of Vietnam. As a result, financial mechanism of Vietnam has not effectively encouraged the NRE development.

It is obviously that Korea did not meet its target for 3 percent of TPES to be supplied by NRE in 2006.Furthermore, this will make meeting its 2011 target even more challenging than originally projected. It is necessary for Korea to step up its NRE promotion policies and modify the implementation of existing policies so that government policies and funding bringing the largest gains in the supply of NRE. To ensure the 2011 target, the Korean government should establish a detailed timetable, with monitoring at regular intervals so that policies can be revised and strengthened if interim milestones are not met.

The development of NRE in Vietnam in 2008 was still stagnant (MOIT). The new financial support for NRE in 2008 seemed not to bring positive signals. It is difficult for Vietnam to meet the target for 3 percent of total primary commercial energy supply to be supplied by NRE in 2010. In this context, it is necessary to consider some changes of the existing NRE policy:

- Establishing development plan for each type of NRE: The assessments of the resources are not adequate. Therefore, it is necessary to examine the master plan, add a potential survey project and establishing suitable master plan for each resource in order to create favourable conditions for RE development.
- Efficiently using biomass energy: To efficiently use biomass energy, it is necessary to adopt measures:(i) Stably supply biomass energy resources; (ii) Develop energy conversion technology for biomass utilization; (iii) Establish the distribution system;(iii) Intensify the coordination and cooperation within and between various

ministries, agencies, institutes

- Vietnam lacks an adequate technical infrastructure to achieve the expansion of renewable energy technologies. The indigenous industry should be encouraged as well as technology transfer from abroad. Sufficient skilled and trained workers to construct, operate and maintain the facilities are not available; therefore special recruitment and training will be required
- Product standardization is one of measures that EVN can take to promote NRE. The commercial success of NRE technologies is vitally dependent on adoption and enforcement of appropriate standards and codes. Minimum performance standards in term of durability, reliability and thermal performance are also necessary for market penetration.
- Innovative and sustainable financing programs for renewable energy technologies should be established. Other than using the Environmental Protection Fund, the government should consider setting up a renewable energy development fund, especially for lending to small investors at attractive terms and conditions

Further, the lessons from the Korean experience need to be taken into account:

- The price subsidies for electricity production from NRE should be considered to change into the feed-in tariff system which was proved to be efficient in Korean case. Although Vietnam may not afford such a large funding, the use of feed-in tariff will avoid the drawbacks of the current policy. It is unlikely for Vietnam to mobilize big fund for NRE development. However, a more effective financial support should be established which included various financial instruments such as direct support and tax benefit. It is also important to have a transparent procedure to get such support.
- A comprehensive survey on the potential of NRE should be made. Database of NRE need to be collected, updated. These information is important for the establishment of NRE development
- A detailed timetable, with monitoring at regular intervals should be established so that the 2010 target can be achieved
- Vietnam need to subsidize for R & D of NRE. Since R&D activities always contains risks and its sucess is precarious, the government's support is very necessary. Developing R&D activities is the only way to be independent of foreign suppliers and reduce the investment capital as well as the electricity price of NRE plants.
- By referring to Korean case, it is suggested that all new and big building in Vietnam should be required to have NRE facilities with a specified capacity or investment cost
- Hastening the reform of power market and establishing the domestic market for NRE will contributed to the development of NRE

References

[1] Asia Pacific Energy Research Centre," New and Renewable Energy in the APEC region", 2004

[2] Asia Pacific Energy Research Centre," APEC Energy Overview 2007", Energy Working Group January 2008

[3] Australian Business Council for Sustainable Energy,"Renewable energy in Asia: The Vietnam Report- 2005," 2005

[4] International Energy Agency," Deploying Renewables- Principles for Effective Policies" 2006

[5] International Energy Agency,"Energy Policies of the Republic of Korea" 1992 Survey

[6] International Energy Agency,"Energy Policies of the Republic of Korea" 1994 Survey

[7] International Energy Agency,"Energy Policies of IEA countries – The Republic of Korea 2002 Review," 2002

[8] International Energy Agency,"Key World Energy Statistics," 2009

[9] International Energy Agency,"Energy Policies of IEA countries – The Republic of Korea 2006 Review," 2006

[10] J.P Painuly,"Barriers to renewable energy penetration; a framwork for analysis," Renewable Energy 24 (2001) 73- 89

[11] Khanh Q. Nguyen,"Wind Energy in Vietnam: Resource assessment, development status and future implications" Energy Policy 35 (2007) 1405-1403

[12] Khanh Q. Nguyen,"Internalizing externalities into capacity expansion planning: The case of electricity in Vietnam," Energy Policy 33 (2008) 740-746

[13] Khanh Q. Nguyen,"Alternatives to grid extension for rural electrification: Decentralized renewable energy technologies in Vietnam," Energy Policy 35 (2007) 2579-2589

[14] Khanh Q. Nguyen,"Impacts of wind power generation and CO_2emission constrains on the future choice of fuels and technologies in the power sector of Vietnam," Energy Policy 35 (2007) 2305-2312

[15] Korea Institute of Energy Research (KIER)),"Pholovoltaic Technology Status and Prospects," 2008

[16] Ministry of Knowledge and Commerce, "National Basic Energy Plan, Korea (2008-2030)", 2008

[17] Ministry of Knowledge Economy & Korea Energy Economics Institue,"Energy Info. Korea 2008", 2008

[18] Ministry of Commerce, Industry and Energy of Korea, "Energy Policies of Korea," 2004

[19] Ministry of Knowledge Economy of Korea, "The 4th Basic Plan of Long-Term Electricity Supply and Demand (2008-2022)," December 2008

[20] Ministry of Industry and Trade of Vietnam, "National Energy Policy of Vietnam 2006-2025 period and vision up to 2050", 2006 *(in Vietnamese)*

[21] Ministry of Knowledge and Economy & Korean Energy Economic Institute (KEEI), "Yearbook of Energy Statistic," 2008.

[22] Ministry of Industry and Trade of Vietnam, "Master plan for power development in the period 2006-2015 with prospect to 2025," Institute of Energy, 2005 *(in Vietnamese)*

[23]Ministry of Industry and Trade of Vietnam,"Annual report of Electricity of Vietnam 2008," 2008*(in Vietnamese)*

[24]Ministry of Industry and Trade of Vietnam,"Quantitative feasibility study on using solar energy, small hydroelectric power and biomass energy at industrial scale," Pham Khanh Toan, Institute of Energy *(in Vietnamese)*

[25] Ministry of Industry and Trade of Vietnam,"The Decision No 177/2007 of the Prime Minister on the approval of the Master plan for bio-fuel development to 2015 with prospect to 2025," 2007*(in Vietnamese)*

[26] Ministry of Industry and Trade of Vietnam,"The Decision No 130/2007 of the Prime Minister on some mechanisms and policies for CDM projects," 2007 *(in Vietnamese)*

[27] Ministry of Industry and Trade of Vietnam,"The Circular No 58/2008 regulates subsidized price for the products of CDM projects", 2008 *(in Vietnamese)*

[28] Ministry of Industry and Trade of Vietnam,"The Decision No 18/2008 on the regulation of the list of avoidable cost and the selling contract sample", 2008

[29]Ministry of Industry and Trade of Vietnam,"Electric Law", 2005 *(in Vietnamese)*

[30]Ministry of Industry and Trade of Vietnam,"Vietnam energy database 1985-1999", KHCN09 National Energy Policy of Vietnam, 2001 *(In Vietnamese)*

[31] Njeri Wamukonya, "Legislative and Policy Instruments for promotion of Renewable energy in the power sector"Paper to be presented at the Parliamentarian Forum on Energy Legislation and Sustainable Development. Draft 2005

[32] Nhan T. Nguyen, Minh Ha-Duong,"Economic Potential of Renewable Energy in Vietnam's power sector" Energy Policy 37 (2009) 1601-1613

[33] Sooyoung Jun, Seungmoon Lee, Jin-Won Park, Suk-Jae Jeong, Ho-Chul Shin,"The assessment of renewable energy planning on CO_2 abatement in South Korea," Renewable Energy 35 (2010) 471-477

[34] World Bank in Vietnam,"Power strategy: Managing growth and reform," 2006

[35] World Bank and Electricity of Vietnam," Promotion of Renewable energy, Energy efficiency and Greenhouse Gas Abatement," 2005

[36] World Future Council,"Feed –In tariff- Boosting Energy for our Future" 2008