Renewable Energies of Daegu City, Korea

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1. Overview : SC Korea and Daegu

Sustainable energy system is central to current concerns about sustainable development, affecting global atmosphere and economic development. Fossil fuels and nuclear energy is facing a transition stage to a sustainable energy system relying increasingly on renewable energy sources and energy efficiency.

Since the early 1970s, Asia has grown faster economically than any other region in the world. Korea typifies recent Asian economic experiences. Korea's rapid economic growth was accompanied by rapid growth in energy use. While the rest of the world has increased its annual energy consumption by 2.5%, Korea has been expanding its use levels by 10.3% annually since 1985.

In this respect, the key question facing Korea is whether this increase will occur within a sustainable energy path, or whether it will reproduce the past of the already industrialized countries. There is increasing evidence that a sustainable development hinges upon this choice. It is critical for policy makers and planners in Korea how the country de-links economic growth from energy consumption through solar energy or other alternative energy sources and efficiency improvement.

Because of rapid urbanization in S. Korea, cities consume over 80% of total national commercial energy use. The role of cities in energy policy is increasingly becoming important in reducing energy use and introducing solar and renewable energy sources.

With an international project of Solar City task, Solar City Korea task is to systematically introduce solar and other renewable energy sources, technologies and industries. The task will focus on rethinking of planning tools and the determination of sustainable urban emissions targets, and ways of promoting urban business and industry in solar and other renewable energy technology systems.

Solar and other renewable energy technologies in Korea are in a very early stage of deployment. Current market penetration is largely driven by government initiatives rather than market conditions, only in very limited cases like remote areas.

Deployment will only be increased if technology improvements deliver the cost reductions and performance improvements. "Solar City Korea" task is highly expected to open the possibility of commercialization of solar and other
renewable energy technologies.

Since the idea of Solar City introduced in S.Korea, Daegu City has led SC Korea in developing its SC plan and pursuing the reduction of energy consumption and introduction of solar energy sources with other alternative energy sources. The work of Solar City Daegu is the outcome of incorporating national and international SC workshops. It is based on numerous researches and meetings carried out in a number of best organizations and specialists in the area of energy, urban design, finance and public policy. The record of SC Daegu and related informations will be found at http://www.rieee.org

II. Current Status of Renewable Energy

In Korea, renewable energy (RE) was defined as an energy which was not coming from the fossil fuels: Roof top photovoltaic (PV), wind power, bio-energy, waste energy, solar energy, fuel cells, ocean energy, coal utilization, geothermal energy, etc. Given the government's estimation, the maximum share of renewable energy source to the total energy demand is expected to be 2% in the year 2006.

<Table 1> Total Energy Use and Renewable Energy (unit: million TOE)

<table>
<thead>
<tr>
<th></th>
<th>1989</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total energy use</td>
<td>82</td>
<td>181</td>
<td>193</td>
<td>198</td>
</tr>
<tr>
<td>RE</td>
<td>0.2</td>
<td>1.9</td>
<td>2.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Share (%)</td>
<td>0.26</td>
<td>1.05</td>
<td>1.1</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Source: MOCIE, South Korea.

From 1989 to 2001, growth rate of renewable energy was gradually increasing (annually 22.7%). But the relative impact of renewable energy sources is still very insignificant, accounting for only 2.4 million TOE, or a 1.2% share in 2001. Among the renewable energy in 2001, waste energy mainly derived from the burning of industrial waste such as wood items, pulp, plastics was accounted for 93.9%, and bio-energy accounted for only 3.3%. Solar water heater and industrial waste incineration systems have been commercialized and disseminated. Also, photovoltaic power generation systems developed have been employed in some small island regions.

<Table 2> Renewable energy in Korea by source (As of the end of 2001)

<table>
<thead>
<tr>
<th>Source</th>
<th>Share(%)</th>
<th>Dissemination Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Thermal</td>
<td>1.6</td>
<td>- Residential Solar Hot Water System : 1,850,000 units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Solar heating system: 3,000 units</td>
</tr>
</tbody>
</table>
Photovoltaic 0.3 - Photovoltaic for Island & Special Purposes : Total 4,151kW Hodo(1000 kW), Hahwado(60 kW)

Bio Energy 3.3 - Facilities using Methane : 99 units

Waste Energy 93.0 - Facilities using Waste Energy : 433 units

Small Hydro Power 0.8 - Small Hydro Power Plant : 25 units (37 MW)

Wind Power 0.1 - 170 kW, 80kW at muan - 100 kW, 30kW, and 20kW at Wuyong - 250 kW at Jungmoon

Source: MOCIE, S.Korea, 2002.5

<table>
<thead>
<tr>
<th>Year</th>
<th>Total energy use (TOE)</th>
<th>Renewable energy (TOE)</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>4,350,000</td>
<td>17,742</td>
<td>0.41</td>
</tr>
<tr>
<td>1997</td>
<td>4,372,000</td>
<td>17,562</td>
<td>0.40</td>
</tr>
<tr>
<td>1998</td>
<td>3,825,000</td>
<td>20,865</td>
<td>0.55</td>
</tr>
<tr>
<td>2000</td>
<td>4,679,751</td>
<td>18,560</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Source: Research Institute for Energy, Environment and Economy (RIEEE), Kyungpook National University

In addition to very small rate, renewable energy is experiencing decreasing in dissemination and use. Like national situation, waste energy accounted for more than 67% of total renewable energy use in 2000. The use of PV, solar thermal and wind power is very low, 0.8%, 10.4%, 0% respectively. But recently solar energy is leading the growth of renewable energy. The installation of solar hot water systems has increased constantly until 1997 but since then stagnated because of system maintenance failures.

<Table 4> Solar hot water systems in Daegu

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<thead>
<tr>
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<tbody>
<tr>
<td>unit</td>
<td>322</td>
<td>1,604</td>
<td>3,675</td>
<td>849</td>
<td>562</td>
<td>154</td>
</tr>
</tbody>
</table>

<Table 5> PV system installed in Daegu
III. Solar City Daegu Initiative

Daegu City has given great efforts to make Green City. Especially, the City has produced good results in lowering the summer temperature by establishing downtown parks and planting lots of trees. And the City is replacing diesel inner-city buses with CNG buses.

Since idea of Solar City was introduced, Daegu City has worked hard to systematically introduce solar and other renewable energy sources, technologies and industries on a city-wide scale, within the context of other measures such as environmental, economic and spatial planning programs. Through Solar City Daegu Project, the City has intention to find a path towards an economically and ecologically appropriate energy system while also taking into account limited financial and human resources as well as incomplete insight into the future development economic, technical conditions.

SCDP includes ambitious investment projects aimed at research, development and dissemination that is suitable to help introducing solar and other renewable energy technologies in Daegu city

1. Key targets

1) Change in consciousness & institution

Driving energy conservation movement
- Spreading the energy conservation and high-efficiency appliances
- Enlarging a present institution such as ESCO project, voluntary agreement(VA).
- Cooperating with citizen's groups such as Citizen's Solidarity for Solar City Daegu. Increasing the use of public transportation
- The motorcar is emitting 73% out of regional air pollutants.
- Magnifying an use of public transportation by the transportation card system, restriction of autocar, etc.

Energy-saving construction & urban plan
- Use of environment-friendly building material in case of new building
- Removal of energy wasteful factor by use of an proper insulating material.

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<tbody>
<tr>
<td>capacity</td>
<td>-</td>
<td>-</td>
<td>15</td>
<td>19</td>
<td>21</td>
</tr>
</tbody>
</table>
· Considering environment & energy conservation policy in case of urban plan.

2) Supply of Alternative Energy

 Enhancement of solar and renewable energy portion to total energy supply to 2%
· Supply of solar heating and PV system in all sectors
· Demonstration project such as green village and solar school.
· Supply of hydrogen, fuel cell and wind power
· Supply of CNG inner-city bus
· Change all the inner-city bus (1834) into CNG bus by 2007
· A supporting step to promote the CNG bus supply.
  - Granting of the subsidy of 22,500 thou. Won per CNG bus
  - Financing supporting (700 million Won) by national expenditure in building of a charging station: 17 spots, 11.9 billion Won

 Supply of LPG truck
· Change diesel truck into LPG truck by remodeling engine.
· Supply 1000 truck by 2004 : 3 billion Won
  - Considering the supporting policy such as subsidy to the remodeling cost etc.

 Magnifying distribution of city-gas
· Reduction of environment pollution by fuel substitute (change diesel into clean energy)
· 622 million _ by year in 2000 _ 1,099 million _ (76.7% increase) in 2005
  Strengthening the standard of heavy oil containing sulfur : 0.5% _ 0.3% (2001 july)

3) Greening project

 Driving the urban greening project
· Absorbing GHG & mitigating the highest temperature during the intense heat of summer
· Construction of a environmentally friendly forest city in harmony between the nature and human
· Planting 4,000 thou. trees from 1996 to 2000 by 'the embellishing green Daegu project'
  - Increase 37.3% of the green zone : 100.73_(1995) _ 138.29_(2000)
· Planting 1,000 thou. trees by year from this year to 2006

 Propelling the restoration project of ecological nature
· Completion of the Daegu tree garden
· Constructing eco-park in the Dalsung, Ansim marshy, Donghwa river
2. List of Investment Projects

1) Institution Building

Center for Solar City Daegu (CSCD), which is already established by Daegu City and Kyungpook National University, will research and plan for the development and dissemination of solar and renewable energy technologies and industries. The center's important functions divide into four main parts: policy research and project implementation, international cooperation, support to technologies and industries, institutionalization of citizens participations.

The Center is particularly putting its efforts in institutionalizing citizen's participation in SCDP. With the help of the center, 24 NGOs in Daegu united to organize Citizen's Coalition for Solar City Daegu (CCSCD). CCSCD already organized and will initiated SC Daegu projects. But Now CCSCD is suffering difficulties to bring together citizens' power because of insufficient experience and knowledge on promoting renewable energies, authoritarian
communications, pursuit of political power and so on.

Figure 2. Citizen’s Coalition for Solar City Daegu

And the Center has developed international cooperation relationships with Center for Energy and Environmental Policy at University of Delaware, Sustainable and Peaceful Energy Network Asia, Sustainable Energy Development Authority (Sydney, Australia) and others. Besides, the Center hosted several seminars or workshops: “Solar City: Theory and Practice,” “Solar City and Energy Transition,” “Solar City Daegu and Renewable Energy in Asia,” and “Renewable Energy policy and Solar City Task.”

To evaluate and give a priority to the 2002 Daegu PV projects suggested, the Center assembled the Evaluation committee of Solar City Daegu. According to the priorities given by the committee, Daegu City is advancing the projects.

2) Solar Thermal Utilization

Solar thermal system projects include 10,000 residential solar hot water systems, 2,000 residential solar heating systems, 5 solar heating systems for public welfare facilities, 10kW dish type solar thermal generation and so on. Through disseminating solar thermal systems as a symbol of Solar City, Daegu City is expecting to be able to supply her community the proved technology, create market demand for solar energy and vitalize local economy.

3) PV systems

Daegu city plans to apply photovoltaic systems to various facilities. At first,
the city is installing photovoltaic streetlights for night lighting at parks, walks, physical facilities (golf course, swimming pool), and inside roads by 1,000 units. And the city will construct and operate PV power generation plant with annual generation 2,857 MWh at sewage disposal plants, athletic villages for summer Universiade, sports centers, physical facilities, public parking lots.

In 2002, the city will install totally 182kWp PV systems to sewage disposal plant(60kWp), university campuses(53kWp, 20kWp), public buildings(20kWp, 5kWp), and apartment houses(24kWp). These projects were evaluated by the Evaluation committee of Solar City Daegu in terms of linkage to local energy policy, reflection of locality, GHG reductions, effectiveness, after management etc.

<Table 6> PV projects in 2002(Budget Confirmed)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Organization</th>
<th>Site</th>
<th>Capacity (kWp)</th>
<th>cost sharing(million won)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>total (thou. dollar)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>central</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>governent</td>
</tr>
<tr>
<td>1</td>
<td>Daegu City</td>
<td>Sinchun sewage disposal plant</td>
<td>60 1,255 (965.4)</td>
<td>878.5(70) 376.5(30)</td>
</tr>
<tr>
<td></td>
<td>(Center for Solar City Daegu)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Kyungpook National University</td>
<td>Library, Dormitory</td>
<td>53 895 (688.5)</td>
<td>626.5(70) 268.5(30)</td>
</tr>
<tr>
<td>3</td>
<td>Donggu of Daegu City</td>
<td>Office of Heandong</td>
<td>20 300 (230.8)</td>
<td>210(70) 90(30)</td>
</tr>
<tr>
<td>4</td>
<td>Center for Nakdong river environment, Keimyung University</td>
<td>Environmental education center</td>
<td>20 300 (230.8)</td>
<td>168(56) 72(24) 60(20)</td>
</tr>
<tr>
<td>5</td>
<td>Yoojin construction company</td>
<td>Apartment complex</td>
<td>3*8 360 (276.9)</td>
<td>214.2 (59.5) 91.8(25.5) 54(15)</td>
</tr>
<tr>
<td>6</td>
<td>Daegu Heung Sa Dahn (NGO)</td>
<td>building</td>
<td>5 75 (57.7)</td>
<td>52.5(70) 22.5(30)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>total</td>
</tr>
</tbody>
</table>

Total: 6 projects 3,185 (2,450) 2,450 921.3 114

4) Solar energy complex

Solar energy complex project includes Green Villages, Solar Schools, Solar Villages. Green Village project is to create with 50 houses installed PV, solar...
heating system, and energy efficient equipments. This project will conduct with close link to demonstration project of National Government Green Village plan. Solar School is aiming at apply solar hot water/heating system and natural lighting to elementary schools. These projects are expected to induce inspired citizens to participate voluntarily in SCDP; have publicity and spill-over effects by activating dissemination of solar and other renewable energy.

5) Other Renewable Energy

Daegu city also has plan to utilize waste energies: small hydropower using head of water discharged from sewage treatment plant; waste heat from dyeing factories; Landfill Gas (LFG), generating 117 thousand _/day(7.8 MW/day); Refuse Derived Fuel(RDF).

IV. Solar Campus Initiative(KNU)

Universities will play important roles in networking and clustering renewable energy sources. Networking and Clustering is considered as very important in order to exchange experience and increase effectiveness in promoting renewable energy sources. And Universities must be realized as enormous energy consumers with a great potential for the application of renewable energy sources. Installing renewable energy systems and Teaching renewable energy within all relevant disciplines in Universities will have great impact on development strategies of small and medium company, industries, local government, as well as educational effects to future decision-makers and opinion leaders.

In this context, Kyungpook National University is pursuing Solar Campus program which promote installing solar energy systems in the university campus and further network of universities and research institutes pioneering renewable energies.

Kyungpook National University established and has been implementing Solar Campus plan. In 2001, solar hot water system with 120 collectors scale was installed by the initiative of Research Institute for Energy, Environment and Economy and with help of the University and Korea Energy Management Corporation. Investment support for installing PV systems of the University was decided by Daegu City in May 2002. Evaluation committee of Solar City Daegu project gave a high grade to Solar Campus plan of Kyungpook National University Because the plan have great potential in terms of effectiveness, networking, after management and so on.
1) Solar thermal collectors

The great heat demand and resulting high annual costs for fossil fuels is inducing the university to use solar energy. A large part of hot water demand of the university could be met applying solar thermal water heating.

Solar thermal collectors installed at gymnasium of Kyungpook National University (collecting area: 237.6 square meters) is supplying 329,380 kcal per day which cover 36.6% of daily heating loads (annual average: 900,000 kcal/day). The university has a plan to connect the solar thermal system with cooling system.
2) PV systems

Due to the great surface of large-scale properties like university buildings, the potential area to be covered by PV arrays is enormous. In 2002, Kyungpook National University will apply PV systems to various facilities such as library, dormitory, waterspout, streetlight, clock tower, pedestrian sign and so on.
3) Future works

It will be important in advancing Solar campus program to constitute a common knowledge basis on all relevant aspects of promoting renewable energies and implementing renewable energy projects at university level. The information and specific experiences includes “success-stories” on installing renewable energy systems, focusing not only on technical aspects but also motivation and administrative, legal, and economic aspects. The knowledge on promoting renewable energies and implementing renewable energy projects at university level shall be disseminated throughout Korean universities. Through seminars and workshops related “Solar Campus,” Kyungpook National
University could be networking hub of the universities which pioneering in research and dissemination of solar and other renewable energies in Korea.

V. Challenges for Solar City Initiatives

1) Financing

The availability of low-cost end-user financing is a key to opening up and accelerating the market adoption of renewable energy system in Daegu. The key financing issues involve the cost of money, the ease of obtaining low-cost funds, and institutional complexities that hinder financing and market growth.

Financing includes all of the factors necessary for third-party capital (investment, loans, leases, etc.) to be made available for renewable energy systems. It includes economic viability and attractiveness, system quality and reliability, guarantee and warranties, technical standards, system lifetime and residual value, insurance, and tax matters.

Information from around the world suggests that 2% to 5% of PV purchasers buy for cash, while the other 95% to 98% require some form of third-party financing. The economic nature of solar energy systems is the installation of capital-intensive equipment to harvest the Sun's energy, as an alternative to burning fossil fuels or purchasing energy from the local utility. Financing converts the high up-front cost of a solar system into monthly payments, making it affordable and comparable to the monthly payments for utility service.

The immediate impact of lower-cost, longer-term financing is apparent at least in the case PV. The provision of lower-cost, longer-term financing can have a greater and more immediate impact on the affordability of PV systems than research and manufacturing programs.

2) Significant Change in Price Policy for Renewables

Korea government (Ministry of Commerce, Industry and Energy, MOCIE) announced its price policy on May 29th, 2002 to finance renewables which will fundamentally change the speed of commercialization renewables in Korea. The basic idea is to support the difference between generation price and sales price for electricity generated from renewable energy sources such as PV, wind power, small hydropower, landfill gas (LFG) etc. The policy titled as "guide line for standard prices of renewable energy generation" which will guarantee the full cost recovery of electricity from renewable energy sources, compare with average cost of conventional generations. Through these financial supports for renewables, Korea government expected that S. Korea will make ready to actively cope with international environmental regulations such as UNFCCC.
Accordingly, each purchasing price of Korea Electric Power Corporation (KEPCO) is 716.40 won/kWh for PV, 107.66 for wind power, 73.69 for small hydropower respectively. LFG generation will be guaranteed 65.20 won for the capacity of less than 20MW, 61.80 won for the capacity of 20MW-50MW. MOCIE will apply these standard prices for 5 years from the day sold at electricity market, considering the fluctuation of oil price, technology development and so on. The current average cost of electricity consumption is around 45 won which is 1/15 of solar subsides.

**<Table 7> Purchasing prices for renewables in 2002**

<table>
<thead>
<tr>
<th>Source</th>
<th>PV</th>
<th>wind power</th>
<th>small hydropower</th>
<th>landfill gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard price</td>
<td>716.40(55)</td>
<td>107.66(8.3)</td>
<td>73.69(5.7)</td>
<td></td>
</tr>
<tr>
<td>(won/ kWh)</td>
<td></td>
<td></td>
<td></td>
<td>less than 20MW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>65.20(5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20-50MW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61.80(4.7)</td>
</tr>
</tbody>
</table>

(): cents if 1300 won/dollar
source: MOCIE, Korea, 2002.5.

Korea became 4th country which is implementing the full cost rating for electricity from renewable energy sources, following Germany, Japan and United States. According to MOCIE, it is expected that this financial supporting system will accelerate the creating of renewable energy industries and the epoch-making expansion of renewable energy supply.

3) Institutional Changes

Still, the government need initiate to synthesize diverse approaches at least within energy field into a more comprehensive renewable policy. It is to apprehend the interrelated complex of energy issue, and later to implement renewable energy policies. In many developing countries, numerous programs and technical approaches could not achieve their goals in reality, because of the lack of investment of capital with systematic approach. Integration of energy efficiency policy with overall economic, environmental and spatial development will be the next area.

Solar City initiative needs a broad and deep support from both the highest policy making level and at the grassroots level, for which institutional capacities should be formed: solar energy and alternative energy unit within the government and utilities, research and educational institutions, and professional groups. Further, NGOs and public interest groups are also powerful sources of support for this path. The government can provide financial assistance for the development of public interest groups and professional societies and associations.

It will be Solar City and Solar Campus initiatives in local level like Daegu City that can help to overcome the most powerful institutional barriers and to implement new path. The inertia of existing organization to support energy
supply options-dynamic conservative force—is still dominant not only in the concept of policy makers but in the organizational structures.

VI Concluding Remarks

Solar City Daegu and Solar Campus Initiatives are very ambitious and moves very fast toward realization of green city project. Based on Solar Campus project, the Solar City Daegu project will expand its project from demonstration to market commercialization.

While energy required for regional economic development will continue to grow in Daegu, there is considerable area to practice better energy management and to transit energy sources from fossil fuel to renewable energies.

This indicates that there is still considerable scope for the reduction of greenhouse gas emissions by undertaking programs and transferring technologies that are consistent with the city objective of sustainable growth. The challenge for policy makers is to find as many areas as possible where such consistency and complementary exist, between growth and environmental protection goals.

Understood as soft energy path as a problem in political economy, it becomes clear that energy transition will not take place simply by the force of recognition of Solar City Task's social, environmental, or economic benefits. These changes will alter not simply the form and appearance of the political economy of energy but the structure of social valuation that drives it. We are necessary to put our conscious effort into changing social structure, not leave our future only to market.