

# *The Solar City Daegu 2050 Project: Visions for a Sustainable City*

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*The Solar City Daegu 2050 Project (SCD 2050) represents a comprehensive model for shaping the future of this city of 2.5 million residents with a mixed industrial and services economic base. Its specific aims are as follows: realization of a carbon footprint consistent with standards of global sustainability and equity; the development of a renewable-energy – based urban community and economy; and the pursuit of economic development that meets the needs of Daegu's citizens in a manner that is culturally and ecologically sound. A long-term master plan like SCD 2050 is necessary to reach these transformative goals. At the same time, 50-year planning enables the citizens of Daegu to envision their city's intergenerational future. SCD 2050 cannot simply lead to an urban energy transition. Conscious efforts to change social structure will also be essential to realizing the plan's goals.*

**Keywords:** *sustainable city; solar city; renewable energy; Solar City Daegu 2050; urban planning*

## **Overview**

The Solar City Daegu 2050 Project (SCD 2050) began in 2000 with the commitment to systematically spur a transition to renewable energy sources, technologies and industries on a large scale. Early on, the project adopted sustainable and equitable emissions targets along the lines initially argued by Byrne, Wang, Lee and Kim (1998) and adopted by the International Solar Cities Initiative. The goal of an emissions rate equal to 3.3 tons of CO<sub>2</sub> equivalent (molecular) per person per year reflects the results of the second assessment report of the Intergovernmental Panel on Climate Change (1996). Daegu gave priority to alternative fuels

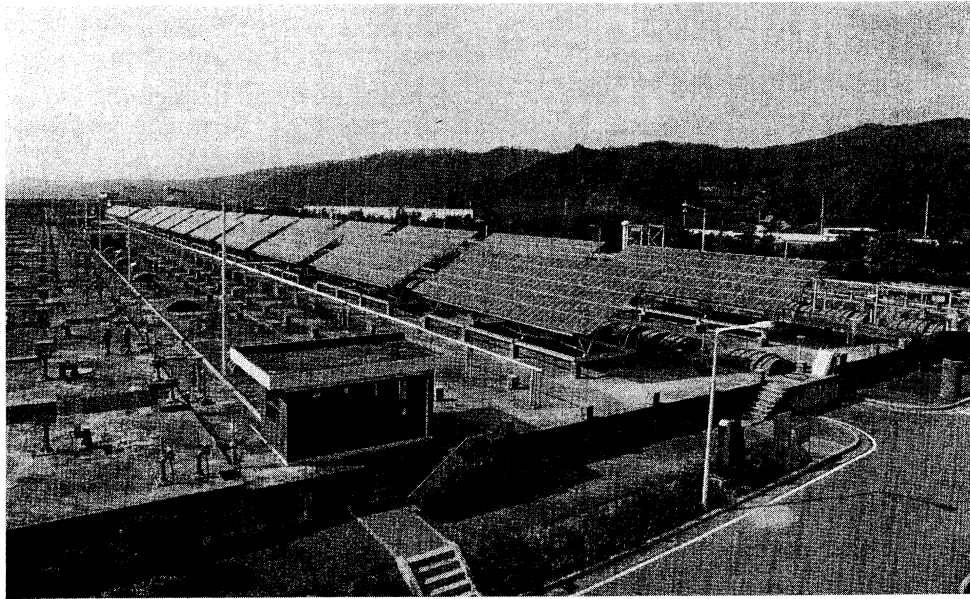
to reduce city emissions as a means of linking its local development to global needs and goals.

SCD 2050 is a master plan that advances a multi-dimensional effort to transition to an economically, ecologically and culturally appropriate future, taking into account the unavoidably incomplete insights that guide planning of a long-term future.

Daegu's initial interest in the solar city concept derives from a cooperative program called the Solar Heating and Cooling Implementing Agreement Task 30 of the International Energy Agency (IEA). At the first and second IEA Task 30 workshops held in Sydney and Berlin in 2000, Daegu expressed its interest in becoming a solar city and presented its many green projects for IEA consideration. The third workshop, held in the Hague in November 2000, was organized as an official ancillary event of the Sixth Conference of the Parties to the U.N. Framework Convention on Climate Change (UNFCCC). In the workshop, Daegu's thinking on greenhouse gas emissions reduction scenarios was presented.

In 2003, Daegu joined the International Solar Cities Initiative (ISCI), which was created at a workshop in Daegu to shepherd the movement's development.<sup>1</sup> At the 2003 workshop, ISCI selected Daegu to host the First International Solar Cities Congress in 2004. With city support, ISCI's logo and a "Song of Solar Cities" was penned.

Participation in this Solar Cities Congress was larger than expected. More than 2,000 participants—mayors, city representatives, scientists, businesspersons and NGO leaders—from 19 cities around the world gathered for the Congress. The Congress featured a four-part program: Solar Cities Mayors Summit, Solar Cities Conference, Solar Cities Business Forum and Solar Cities Citizens Forum. The Congress adopted the "Daegu Declaration," which



**Figure 1. Shincheon Sewage Plant: PV 479kWp**

announced the commitment of participating city representatives, institutes and organizations to achieving sustainable development and climate protection through the application of renewable energy and the efficient use of energy.

### **Solar City Daegu Project**

SCD 2050 is the near-term project that has committed the city to increase renewable energy use to 5% by 2010 and to develop and promote new and renewable energy industries within its borders. It includes public investment for research of renewable energy technology and systems and applied its findings by installing photovoltaics and solar hot water systems on public facilities, using the wealth of solar energy available to the city. The City of Daegu and Kyungpook National University have established the Center for Solar City Daegu, which plays a key role in initiating many projects, building institutional capacity to develop policies and enlisting business and citizen participation.

Currently, solar hot water systems installed at public facilities as a result of the ISCI-endorsed initiative cover 3,891 m<sup>2</sup>. Through the dissemination of solar thermal systems as a symbol of SCD 2050, the effort has created vigorous market demand for the technology and vitalized the local economy by attracting solar thermal businesses to its jurisdiction. The city's efforts have led to 32 large thermal systems constructed on private buildings. The city has also promoted PV system

development, including a 479kWp unit to power its sewage disposal plant (see Figure 1). Other public sector projects include the following: university campuses have purchased 166kWp of building-integrated PV; a city water purification facility has an 80kWp PV unit; the city's convention center (EXCO) has installed 60kWp of PV; elementary and high schools have built PV systems with a total capacity of 76kWp; and public parks are using 12kWp of PV. Finally, the headquarters of an NGO is now powered by a 5kWp PV system. In addition, the city has built two small hydropower units (259 kW) and shifted 1,700 public buses from diesel to natural gas. The city is harnessing other renewable energy technologies, including wind power, and is investigating the use of LFG.

Planned solar energy projects include Green Villages, Solar Schools and Solar Villages. The Green Village project is scheduled to create 50 houses powered by PV, and solar heating systems using high efficiency equipment. This project is closely linked with other residential and urban development projects. The projects are expected to have spillover effects by activating builders' interest in solar and other renewable energy options.

### **Solar City Daegu 2050**

The SCD 2050 master plan foresees long-term, continuous sustainable development at the municipal level. To achieve this vision, three dimensions of urban life are addressed in an integrative manner:

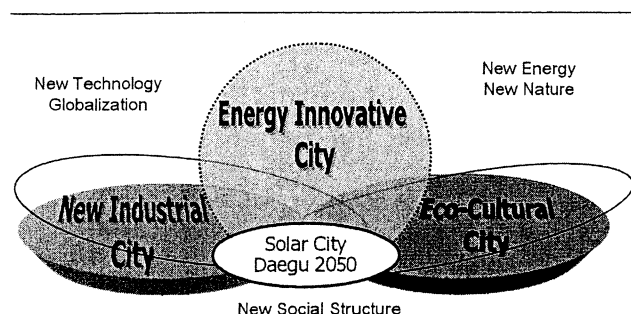


Figure 2. Three-Dimensional Urban Plan of Solar City Daegu 2050

energy innovation, new industrial structures and eco-cultural development (see Figure 2).

The objective of the Energy Innovative City is the development of an innovative energy system involving demand side management and renewable energy use. The objective of the New Industrial City is the creation of new industries and new employment opportunities through intensive promotion of the solar and hydrogen economy. The objective of the Eco-Cultural City is a clean natural environment and a healthy community and vibrant culture.

### The Energy Innovative City

Key projects of the Energy Innovative City are to reduce residential energy costs, introduce green buildings, promote PV solar roofs and construct solar villages. The purpose of the Energy Cost Saving Project is to emphasize energy conservation and to enable citizens to participate directly in energy planning (see Rifkin, 2003, and Scheer, 2002, for comprehensive proposals in this direction, and REN 21 Renewable Energy Policy Network, 2005, for an inventory of current efforts). The project encourages citizens' voluntary efforts to reduce energy use, to join together in managing small-size CHP and district generation, and to introduce hybrid and fuel cell vehicles.

The Green Building Project seeks to minimize energy consumption and peak loads in public and private buildings through the use of renewable energy (BIPV) and high efficiency envelopes and technologies. All public buildings will be greened and all new nonpublic buildings will be obliged to meet citywide standards (with financial support from the city government). A Daegu Green Building Certificate will be established to confirm and promote a building's accomplishments. The project expects to save energy, improve

indoor environments and diffuse energy-efficient and renewable energy technologies.

The 10,000 Solar Roof Project aims to accelerate residential PV use through the standardization of PV roofing systems. Ten thousand 3kW solar roof systems will be mounted on detached homes and apartment buildings. In addition to current financial support (70% of installation cost) from the Ministry of Commerce, Industry and Energy (MOCIE), Daegu will support an additional 10% of the installation cost. A low-income household energy assistance program will be introduced with this project and make use of solar, thermal and PV options.

The Solar Village Project intends to build model urban villages that are environmentally sustainable and energy self-sufficient. The villages will be designed to circulate resources and energy in the complex and to use diverse new and renewable energy sources. New energy services will be provided by distributed supply systems. The model village will receive government incentives to use energy-efficient technologies.

An Energy Innovation Center will be established by expanding the Center for Solar City Daegu. The new center will lead the whole SCD 2050 project with the purpose of finding integrative and synergistic initiatives. It will be responsible for building a database of solar city policies and strategies, researching implementation options and conducting evaluation and management reviews of solar city projects. It will also initiate international cooperation with other solar cities participating in ISCI. The center will develop an integrated approach for diffusing renewable energy technologies and industries, promoting public awareness and analyzing policy options.

### The New Industrial City

Key projects of the New Industrial City include building an energy-efficient industrial structure by promoting emergence of energy services companies (ESCOs), a recycling industry and renewable energy industry.

Building an energy-efficient industrial structure will maximize energy efficiency in the industrial sector and encourage growing use of new and renewable energy technologies. The project will employ voluntary agreements with companies for achieving energy efficiency improvement targets and for using renewable energy sources. In addition to current financial support (70% of installation cost) from MOCIE, SCD 2050 will support an additional 10% of the installation cost of renewable energy technologies.

A project for the Promotion of Energy Saving and Recycling Business aims to invest in energy service and recycling companies. Construction of a recycling complex in the Sung-seo industrial complex will be tasked to reuse 100% of industrial wastes generated in the complex. Project financing and private investment incentives will be provided for ESCO/recycling companies and overseas business.

A city-based renewable energy industry will be attracted through incentive programs for new technology businesses. Priority for city purchase of products of local companies will be instituted. The Energy Innovative City project will be linked through this project to the New Industrial City initiative.

An Ecological Tourism Belt is to be created linking the renewable energy system and environmental initiatives of SCD 2050. The Shincheon sewage plant will be an anchor for this new tourism complex, as will PV, solar thermal and wind power installations. An education and publicity center will be located in this belt to showcase the linkages between science, industry and environmental protection that can be forged to promote a solar city transition (Schmitz-Borchert & Jung, 2002).

### **The Eco-Cultural City**

Key action plans for the Eco-Cultural City are to promote a healthy city life and the U-solar city concept. Building eco-roads such as bicycle and pedestrian-friendly roads will support the Healthy City Project, whereas solar-powered communications systems will underpin the U-solar city effort.

Citizens' concern for improved quality of life led to the prioritization of the Healthy City Project, which combines health and environmental improvement. The program will improve indoor and outdoor environments throughout the city. It is also important to build healthy civil society through community activities that build public awareness.

A Life-Style Transformation Project is highlighted in the 50-year plan to change social consciousness about the living environment. An education program on life style changes will be linked with diverse education initiatives identified in the SCD 2050 plan.

Ubiquitous Solar City refers to the creation of an infrastructure for linking solar city projects via fast-developing information and communication technologies. Construction of an integrated electronic information system will facilitate civil society discourse on pathways to a healthy urban environment.

## **Planning Methods to Support Solar City Daegu 2050**

Using backcasting methodology (Swahn, Löwendahl & Eek, 2004; Treffersa, Faaija, Spakmanb & Seebregtsc, 2005), urban visions and target projects are being defined. The 50-year plan will be evaluated and modified every 5 years based on backcasting exercises (see Figure 3). An implementation plan will be developed every 10 years through which the solar city projects will be prioritized.

### **Business-As-Usual Projection and the Solar City Daegu 2050 Planning Scenarios**

The Research Institute for Energy, Environment and Economy (RIEEE) at Kyungpook National University has developed a forecasting model to measure the city's progress against a business-as-usual (BAU) trajectory. To date, alternative scenarios have been constructed by the RIEEE team to benchmark the effects of city energy initiatives. In the future, a BAU case and scenarios will be designed to address goals of the New Industrial City and the Eco-Cultural City. The RIEEE team's analysis of effects is presented to city planners, policy makers and the public for comment and debate.

The Energy Innovation Model, which examines all end-use sectors in Daegu, is analyzed: industry, transportation, residential and commercial, and public sectors. The electricity sector is excluded because it is currently not under the planning authority of Daegu. The base year in the model is 2003 and the target years are 2050 and 2055.

It requires appropriate data to successfully build a sustainable energy plan. Using official projections of the national government to establish macroeconomic and energy trends, the RIEEE team conducts medium- and long-term forecasts of Daegu energy demand and CO<sub>2</sub> emissions from 2003 to 2055. The macrodata trends currently in the model are shown in Table 1.

In the past, energy consumption in Daegu increased dramatically along with a rapid gross regional product (GRP) growth rate. The energy demand was expected to increase continuously. Total final energy demand in Daegu is projected in the BAU case to increase from 4,595.8 thousand in 2003 to 12,511.5 thousand TOE in 2055. Such a substantial increase is mainly attributable to expanding demand in the residential and commercial

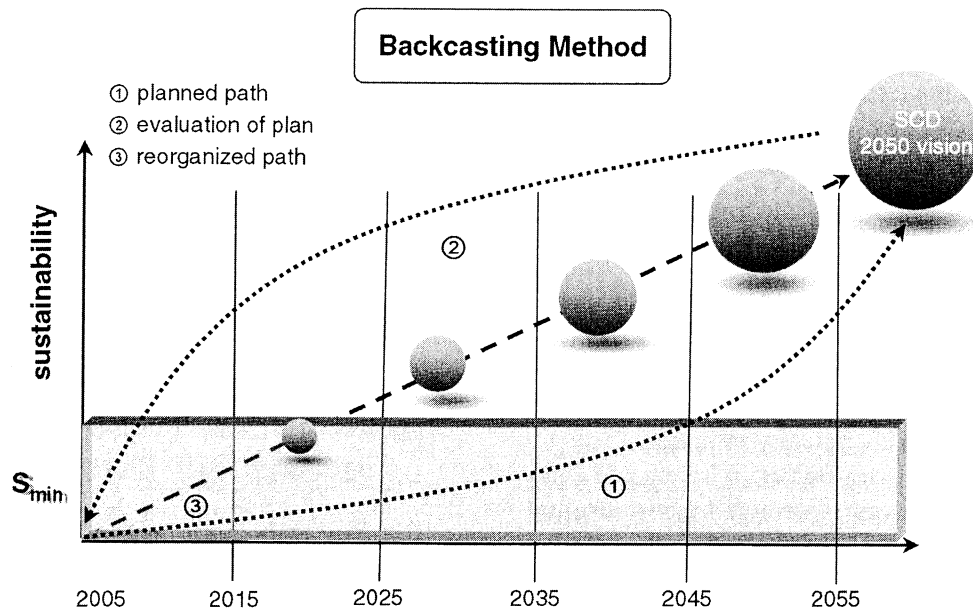


Figure 3. Illustration of the Backcasting Method Used for Solar City Daegu 2050 (SCD 2050)

Table 1. Business-As-Usual Projections of Major Indicators for Solar City Daegu 2050

|                          | 2003    | 2010    | 2020    | 2030    | 2040    | 2055    | 03-55 |
|--------------------------|---------|---------|---------|---------|---------|---------|-------|
| GRP (2000 billion won)   | 22,038  | 31,010  | 45,902  | 61,689  | 75,198  | 101,207 | 3.0%  |
| Population (1000)        | 2,545.0 | 2,660.8 | 2,663.5 | 2,589.9 | 2,300.0 | 1925.0  | -0.5% |
| Household (1000)         | 845.2   | 948.1   | 997.9   | 1,020.1 | 952.5   | 859.4   | 0.1%  |
| Population per household | 3.01    | 2.81    | 2.67    | 2.54    | 2.41    | 2.24    | -0.6% |
| Total vehicles (1000)    | 820.5   | 1,009.1 | 1,230.1 | 1,499.5 | 1,827.9 | 2,460.1 | 2.1%  |

Note: GRP = gross regional product.

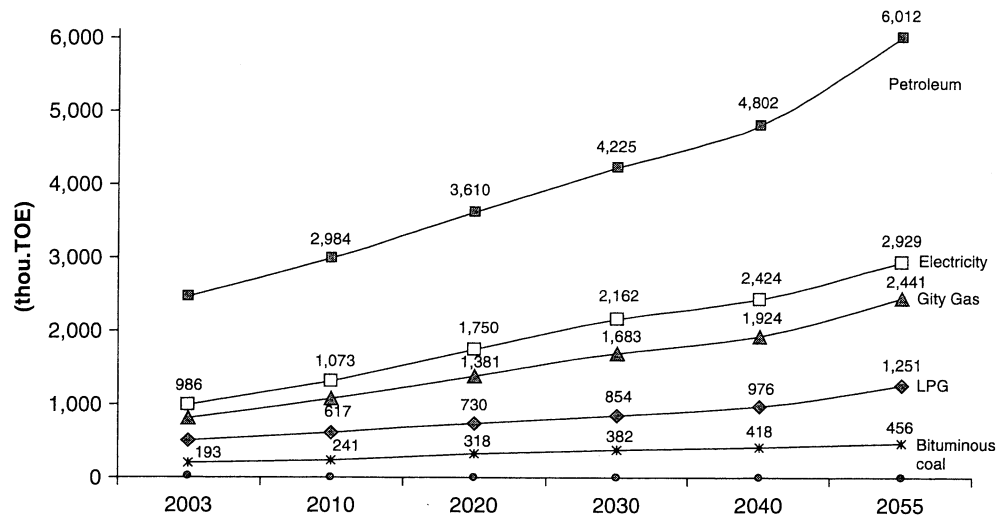
sectors. Their share of total energy consumption is expected to be 41.1% by 2055.

The fuel mix in Daegu is also expected under BAU conditions to change significantly. The share of coal is expected to decline, whereas city gas and electricity will increase rapidly, leading their shares of energy supply to be 19.5 and 23.4, respectively (see Figure 4 for details).

Due to continued industrialization of Daegu's economy, total energy use in the industrial sector is projected to increase from 1,404.0 thousand TOE in 2003 to 3,898.3 thousand TOE in 2055 (see Figure 5). Energy demand for transportation has been growing very rapidly in the past decade, as the number of vehicles and traffic volume have greatly increased. Total energy demand in the transportation sector is projected to increase from 1,276.0 thousand TOE in 2003 to

2,884.8 thousand TOE in 2055 (see Figure 5). Daegu experiences four distinct seasons and this climatic condition is a key factor affecting energy consumption patterns in the residential and commercial sectors. Total residential energy demand is projected to increase from 1,773.8 thousand TOE in 2003 to 5,136.8 thousand TOE in 2055 (see Figure 5).

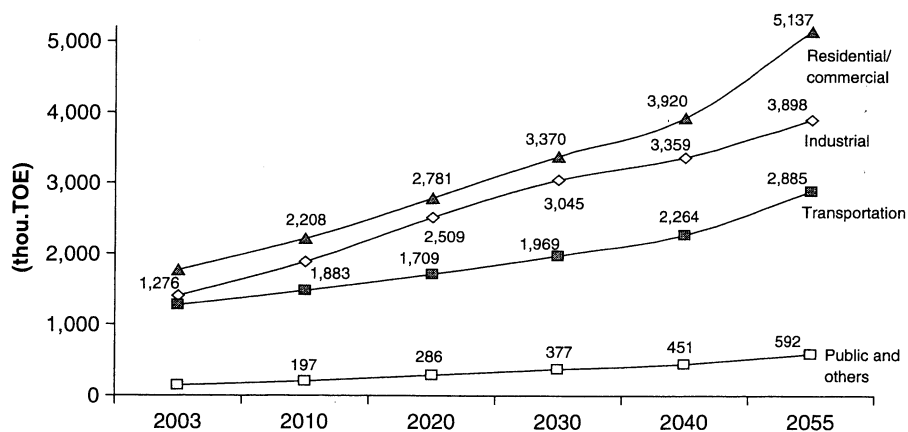
Continuous industrialization, high population density and rapid urbanization are expected to increase Daegu's CO<sub>2</sub> emissions. The major reason for CO<sub>2</sub> emissions growth is the continued use of energy sources such as coal and oil under BAU conditions. As the amount of these fuels is expected to increase steadily with economic growth, CO<sub>2</sub> emissions will reach 1.9 times their 2003 level in the year 2030, and 2.7 times that level in the year 2055. The average annual growth rate of CO<sub>2</sub> emissions



**Figure 4. Business-As-Usual Fuel Use for Solar City Daegu 2050**

Source: RIEEE Forecasting Model.

Note: LPG = liquefied petroleum gas.



**Figure 5. Business-As-Usual Energy Demand by End-Use for Solar City Daegu 2050**

Source: RIEEE Forecasting Model.

under BAU conditions is expected to be 1.9% through 2055. Per capita CO<sub>2</sub> emissions are also expected to increase at an average annual rate of 2.4% through 2055. However, it is expected that CO<sub>2</sub> intensity with respect to GRP (CO<sub>2</sub>/GRP) will decrease from 0.15 in 2003 to 0.09 in 2055, as energy intensity generally declines from 0.21 to 0.12 in 2055 (see Table 2).

Two opportunities to lower energy demand in comparison with the BAU case have been investigated to date. They are the Energy Efficiency Scenario described by the Joint Institute for a Sustainable

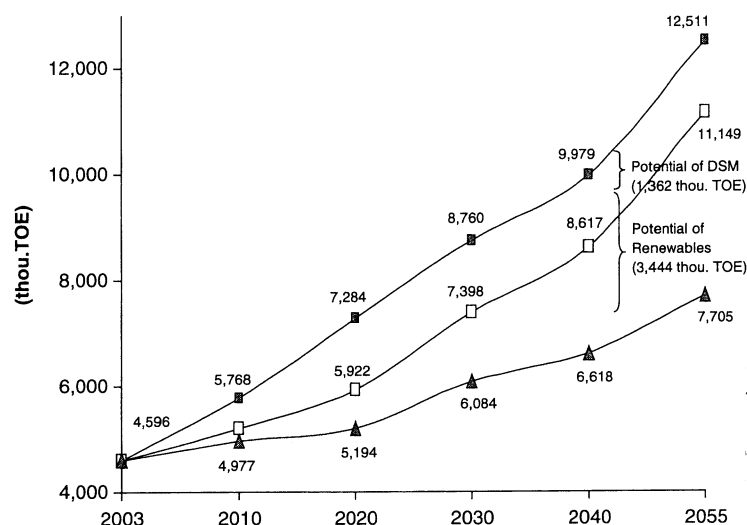
Energy and Environmental Future (JISEEF I; see Byrne, Wang, Kim & Kim, 2004) and a Renewable Energy Scenario based on Daegu's SCD 2050 plan.

According to the JISEEF I scenario, energy efficiency's potential to reduce energy demand for the year 2055 is 1,362 thousand TOE. In Daegu's case, we assumed the same potential for energy efficiency as a national case analyzed by JISEEF under its Modest Policy Commitment Scenario.<sup>2</sup> As a result, a reduction in energy consumption of 10.9% (1,362 thousand TOE) is expected from energy efficiency by the year 2055. In the Renewable Energy Scenario,

**Table 2. Forecast of Environmental Indicators Under Business-As-Usual Conditions for Solar City Daegu 2050**

|                                   | 2003   | 2010   | 2020   | 2030   | 2040   | 2055    | 03-55 |
|-----------------------------------|--------|--------|--------|--------|--------|---------|-------|
| GRP (billion won, constant price) | 22,038 | 31,010 | 45,902 | 61,689 | 75,198 | 101,207 | 3.0%  |
| Population (thou.)                | 2,545  | 2,661  | 2,664  | 2,590  | 2,300  | 1,925   | -0.5% |
| Final energy demand               | 4,596  | 5,769  | 7,285  | 8,760  | 9,995  | 12,512  | 2.0%  |
| CO <sub>2</sub> (thou. TC)        | 3,451  | 4,282  | 5,394  | 6,483  | 7,424  | 9,344   | 1.9%  |
| CO <sub>2</sub> /capita           | 1.36   | 1.61   | 2.03   | 2.50   | 3.23   | 4.85    | 2.4%  |
| CO <sub>2</sub> /GRDP             | 0.15   | 0.14   | 0.12   | 0.11   | 0.10   | 0.09    | -1.1% |
| CO <sub>2</sub> /TOE              | 0.75   | 0.74   | 0.74   | 0.74   | 0.74   | 0.75    | 0.0%  |
| Energy intensity                  | 0.21   | 0.19   | 0.16   | 0.14   | 0.13   | 0.12    | -1.1% |
| Energy use per capita             | 1.81   | 2.17   | 2.73   | 3.38   | 4.35   | 6.50    | 2.4%  |

Note: AAG [= ?]; Average Annual Growth rate TC Ton of Carbon TOE [= ?].

**Figure 6. An Alternative Energy Scenario for Solar City Daegu 2050**

Note: DSM = Demand Side Management

renewable energy potential in Daegu for the year 2055 is 3,444 thousand TOE, or 27.5% of BAU energy use.

According to RIEEE's initial research, although energy required for regional economic development will continue to grow in Daegu, there are opportunities to practice better energy management and to transition from fossil fuel to renewable energy. If the Alternative Energy Scenario mapped in Figure 6 is pursued, there would be considerable scope for reduction of greenhouse gas emissions by undertaking programs and transferring technologies that are consistent with the city's objective of sustainable development. The challenge for policy makers is to find as many areas as possible where complementary economic, energy and environmental goals exist.

The SCD 2050 plan seeks to capture these opportunities in a systematic way by setting targets (see

Figure 7). SCD 2050 calls for an increase in the ratio of renewable energy production to total city energy demand from 6% to 15% and 30% for 2015, 2030 and 2050. And SCD 2050 establishes energy savings of nearly 10%, 30% and 50% over BAU forecasts for 2015, 2030 and 2050, respectively. These efforts will cut CO<sub>2</sub> emissions by 50% in 2050. The Energy Innovation vision of SCD 2050 is to create an urban energy system that meets the ISCI standards for global sustainability and equity while serving present and future generations' needs for a vibrant and healthy Daegu.

## Conclusion

SCD 2050 offers a long-term master plan for pursuing policies that can realize the major changes and transitions in Daegu's metabolism if it is to offer a

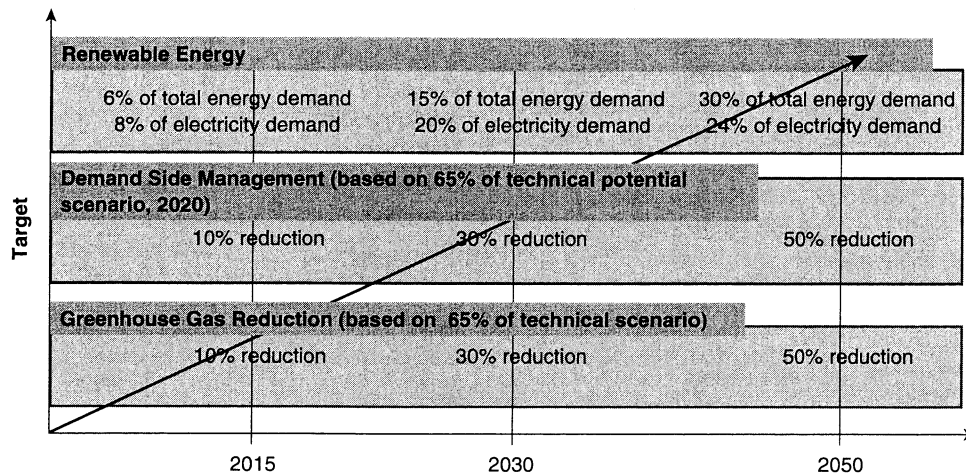


Figure 7. Major Energy and Greenhouse Gas Targets for Daegu Under Solar City Daegu 2050

viable way of life for its citizens. The plan synthesizes diverse approaches to meeting the city's needs within a comprehensive policy strategy. By themselves, numerous programs and approaches cannot achieve long-term goals because they lack an integrated vision to guide investment of capital and human energy. The integrating ideas of SCD 2050, by contrast, are able to nurture an overall economic, energy, cultural and environmental development of the city.

Daegu City will need to develop a new institutional basis for adopting the programs and policies of its solar city project. International collaboration between Daegu and other solar cities is also needed to learn new approaches and to build support for the global objectives of SCD 2050. Daegu's strong commitment to renewable energy dissemination for a sustainable world is the city's first significant step in contributing to the international solar cities movement while serving the needs of its citizens. Making conscious efforts to change social structure, rather than leaving Daegu's future only to market forces, is the next major challenge in pursuing the vision of SCD 2050. It will be a daunting task to realize needed changes of this kind. Yet, the building consensus in support of SCD 2050 provides firm grounds for hope for Daegu's future.

### Notes

1. The International Energy Agency's Task 30 initiative did not receive final approval for its solar city initiative and is no longer in existence.

2. The Joint Institute for a Sustainable Energy and Environmental Future (JISEEF) forecasts a much larger potential for energy efficiency—nearly a 29% savings under its Full Implementation Scenario and 19% savings under its Major Policy Commitment Scenario (Byrne, Wang, Kim & Kim, 2004, pp. 44, 277). However, the Research Institute for Energy, Environment and Economy team chose JISEEF's least aggressive Modest Policy Commitment Scenario because national policy is required in many cases to realize JISEEF's findings and, so far, the national government has shown a willingness to provide only modest policy support for energy efficiency.

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