

Current Work & Future Trends for Sustainable Buildings in South Korea

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1. Status of National or Regional Development for Performance Targets of SB

With recent, unprecedented climate changes from global warming becoming more adverse worldwide, discussions by the international community for establishing an appropriate response policy against climate change has become more urgent. The Fourth IPCC Assessment Report, "Climate Change 2007," warns of threats to the survival of humanity from changes to the climatic environment, where global warming is no longer a problem afar off, but requires our awareness as a serious threat today, such that the supreme importance of such an awareness requires handling not at a national or regional level, but as a global response.

Korea belongs to the second group of nations requiring mandatory reduction of greenhouse gases starting in 2013, with mandatory reduction of greenhouse gas emissions for all industries, but especially for building production activities, which consume a great deal of energy and produce an inordinate amount of waste, that it has become a part of major efforts focused for greenhouse gas reduction. In order to maintain buildings environmentally friendly, research is necessary to develop building technologies which are ecologically sustainable, and to accurately determine the influence on the environment from building related activities through its entire life cycle, including its architectural design, construction, operation, and demolition, to devise a suitable plan, with environmental demand reduction and quality of life enhancement as the goals, using the latest eco-friendly technologies, such as raw material reduction, energy saving, longer life, and recycling, in shifting architectural activities from the existing focus solely on development, toward a new paradigm of sustainability. Moreover, ecologically friendly policy making for architectural buildings, such as raw material reduction, energy saving, waste reduction, and durability improvements, must be studied for sustainable reduction of environmental demand, while improving performance as a living environment. To this end must be established a quantitative assessment methodology (LCCO₂ Assessment & Living Environment Performance Assessment) for the life cycle of a building.

2. Status of Adoption of Policies (Taxes, Programs, Regulations)

In Korea, a joint task team was established by the government in April, 1998 following the climate change accords, with the prime minister as the chairperson. The steering function for R&D concerning the climate change accords is led by the Ministry of Education, Science and Technology, with active funding for research recently by the Ministry of Land, Transport and Maritime Affairs. The Korean government has been implementing various systems and policies for sustainable environmental demand reduction, through ecologically friendly policies for buildings, such as raw material reduction, energy saving, waste reduction, and durability improvements. These sustainable building related systems and policies have now been in place for several years after their respective implementation, where experience gained over the time period is spurning more effective systems and policy development through revisions of assessment subjects and incorporation with compatible systems. Figure 2-1 shows the major policies under implementation in Korea for performance assessment of sustainable buildings and policies for environmental demand reduction.



Figure 2.1 Sustainable building related policies in Korea

2.1 Building Energy Efficiency Rating Certification System

In order to achieve sound energy savings for buildings, a building energy efficiency rating certification system has been in place for newly constructed multi-family apartment housing of more than 18 units, to provide accurate information on energy being used by each building, in promoting investment toward energy saving technology, and to help visualize economic advantages. This certification system assesses a building's rates of ventilation, exterior heat loss, solar heat absorption, heat loss index, interior heat absorption, heat loss index for each single unit, heating load, heating energy usage, and energy savings rate for each single unit, in dividing the total energy savings rate into three classifications (Class 1: 33.5% or Better, Class 2: 23.5% ~ Less Than 33.5%, Class 3: 13.5% ~ Less Than 23.5%), and providing long term low interest loan (Energy Usage Rationalization Fund) for buildings of Energy Efficiency Rating Class 2 or better.

2.2 Housing Performance Rating Disclosure System

Since 9 January 2006, Korea has implemented a Housing Performance Rating Disclosure System for the purposes of ascertaining quality supply of housing as a nation, while promoting increase in the supply of ecologically friendly housing. The system was introduced through a revision to the housing ordinance of 2005.1.8 (2006.1.9 implementation), whereby housing providers must disclose housing performance rating information regarding five areas of noise, structure, external environment, living space environment and fire safety, under twenty odd categories, as assessed by a designated authority, when notifying invitation for tenancy on housing to become available. This system protects the rights of the consumer in allowing the potential resident to become objectively informed of the quality and performance of the housing for selection before moving in, and motivates the housing provider to build for reliable construction, and ultimately serves as a catalyst for improvement of the national housing construction technology and industry.

The system was implemented in two phases, where the number of units required for disclosure of performance ratings were 2,000 units or more for the two years 2006 & 2007, and 1,000 units or more starting in 2008. Performance ratings are assessed from Level 1 through 5 based on plan documentation, with the Minister of Land, Transport and Maritime Affairs responsible for notification of regulations regarding details of performance rating assessments. The notification order delineates implementation standards for the selection, approval procedure, method and detailed evaluation subjects by item, for the assessment organizations to conduct the housing performance rating system. Figure 2.2 introduces detailed evaluation categories for each item of performance under assessment. The five performance categories are as enacted in the ordinance for noise, structure, external environment, living space environment and fire safety, with detailed sub categories as set forth within the regulations.

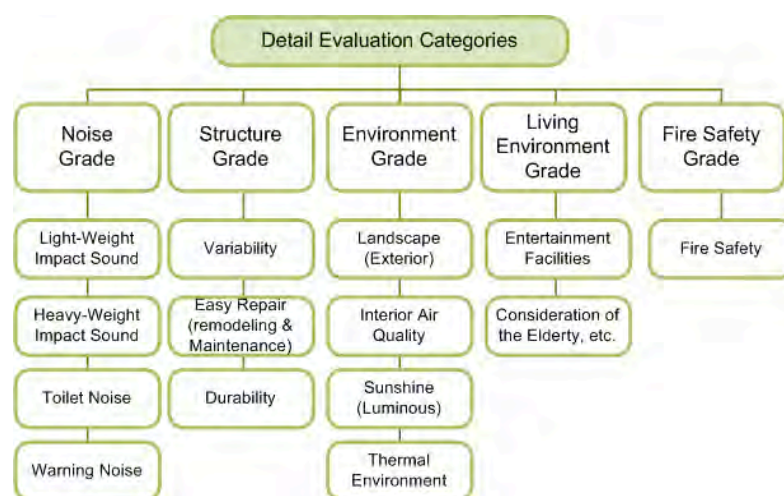




Figure 2.2 Detailed evaluation categories of HPRDS

2.3 Green Building Certification System

The original Green Building Certification System was implemented in 2002, with the Ministry of Land, Transport and Maritime Affairs taking turn every two years with the Ministry of Environment to operate a jointly adopted plan, then with the revision to the construction ordinance in 2005.11.8, the system was overseen as certification based on law. The construction ordinance empowers the Ministers of Land, Transport and Maritime Affairs and of Environment to jointly implement a green building certification system for the purposes of realizing sustainable development, and promoting the construction of natural resource frugal, nature friendly buildings, and to enact joint regulations under the Ministries of Land, Transport and Maritime Affairs and of Environment as necessary for certification body selection standard and procedure, and application procedure for approval as a certification body.

Types of facilities for approval under the green building certification system include multi-family housing units, office buildings, mixed-use residential buildings, schools, retail markets and lodging facilities. The certification body issues a certificate to the approved facility under the name of the certification body itself, for already constructed buildings as a norm, but a pre-certification system is in place for the building construction approval stage based on the contents of the plans only. In order to ascertain fairness of action among certification bodies, and to assure their equitable application of certification standards, the results of assessments by the certification bodies are evaluated by a certification evaluation committee comprised of experts from other certification bodies, or experts directly belonging to the certification evaluation committee. As shown in Table 2.1, the certification ratings are classified into two grades, with First Grade and Certification Grade, and a different emblem issued for each, respectively.

Table 2.1 Certification ratings

Certification Grade	Score	Emblem	Note
First Grade Green Building	Above 85		100 (extra 20 points)
Certification Grade Green Building	Above 65 - below 85		

2.4 Evolution of the Certification System

- 2000. 1_12 Test Certification System Implementation
(Superior Living Environment Housing Certification, Green Building Certification)
- 2001. 1_12 Integration of Test Certification System
(Development of Operations Plan and Multiple-Family Housing Assessment Index)
- 2002. 1.1 Green Building Certification System Implementation (Multiple-Family Housing)
- 2002. 1.21 Designation of Certification Body
(Korea National Housing Corporation's Housing & Urban Research Institute, Korea Institute of Energy Research, Crebiz Certification Institute)
- 2003. 1. 1 Expansion of Certification (to Office Building, Mixed-Use Residential Building)
- 2005. 3. 1 Expansion of Certification (to Schools)
- 2005. 3. 9 Introduction of Incentive System (3% Construction Cost Rebate for Pre-Certification)
- Housing Supply Regulation, Article 13.3 (Sale Price Major Item Disclosure)
- 2005.11.8 Regulatory Standard Enacted under Construction Ordinance, Article 58 (Certification of Green Building)
- Ministry of Land, Transport and Maritime Affairs and Ministry of Environment currently jointly preparing enforcement order
- 2006. 4.11 Multi-Family Unit Housing Certification Index Revision & Implementation
- 2006. 8.24 Designation of Certification Body (Korean Institute of Educational Environment)
- 2006. 9. 1 Expansion of Certification (to Retail Markets, Lodging Facilities)

3. Status of Adoption of SB by the Investment Community

3.1 Case Study: Application of Eco-Friendly Elemental Construction Technology for Reduction of Building Life Cycle Environmental Demand (LCCO₂)

Recently in Korea, there has been an increase in green technology applications for various types of construction, especially in the application of energy reduction technology such as insulation quality improvements and natural lighting, together with a gradual increase in renewable energy applications such as solar energy. With these sustainable technology applications for buildings, however, their quantitative assessments of how much energy savings are being achieved is not forthcoming, due largely to the absence of an assessment metric having been developed for the quantitative measurement of these sustainable technologies' energy saving effects for building applications. But in 2007, an environmental demand analysis program was developed in Korea for an entire life cycle of a building, where the program was then utilized to measure the energy savings effects of a building with sustainable technology applications, as introduced hereunder.

(1) General Specifications

A new construction located in Seoul, Youngdeungpo-Gu, Yeoido-Dong, an annex building to the National Assembly covering a total area of 76,689.04 m² on 2 basement levels and 10 floors, built of steel concrete, with steel structuring.

(2) Sustainable Building Applications Technology

- _ Construction Phase: Construction material reduction through green technology applications such as 50MPa, 35MPa High Strength Concrete, Micro Piling, TU Composites, and Dry Walls.
- _ Operating Phase: Ground Thermal Heat Pump, Solar Energy Heat Storage Tank, Dual External Insulation, energy saving installations applications to reduce environmental load during operations.
- _ Applications Program: SUSB-LCA ver. 1.0 (SUStainable Building Life Cycle Assessment)
Developed by: Sustainable Building Research Center (ERC)
- _ Assessment Conditions: Building Life Cycle Environmental Load Assessment
Assessment Period: 40 Years, Building Life Cycle: 40 Years

(3) Environmental Load (LCCO₂) Assessment Results

Compared with existing buildings, the CO₂ output during construction phase for buildings with sustainable technology applications were measured to be 486kg- CO₂/m² vs. 472kg- CO₂/m², respectively, showing a 2.93% reduction in CO₂ for green applications. For the operations phase, CO₂ output levels were measured to be 2,883kg- CO₂/m² vs. 2,459kg- CO₂/m², respectively, showing a reduction of 14.68% for sustainable applications. Added together, for the life cycle of the building, it shows CO₂ output of 3374kg- CO₂/m² vs. 2937kg- CO₂/m², respectively, for the building built with sustainable technology applications to achieve a 13% reduction in CO₂ output.



Figure 3.1 Subject Building

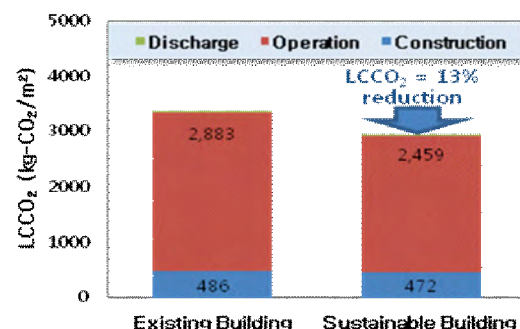


Figure 3.2 Life Cycle Environmental Demand Assessment Results

4. Status of Education and Training in SB

Education and training in Korea regarding ecologically sustainable building construction can be divided into perspectives from a university or a social education. For the universities, course studies related to sustainable building construction are being expanded, with departments being realigned to graduate masters and doctorates for sustainable building technology. From a social perspective, examples are of research centers for sustainable construction and various NGO's related to the environment offering environmental awareness education for both construction related personnel as well as the general public.

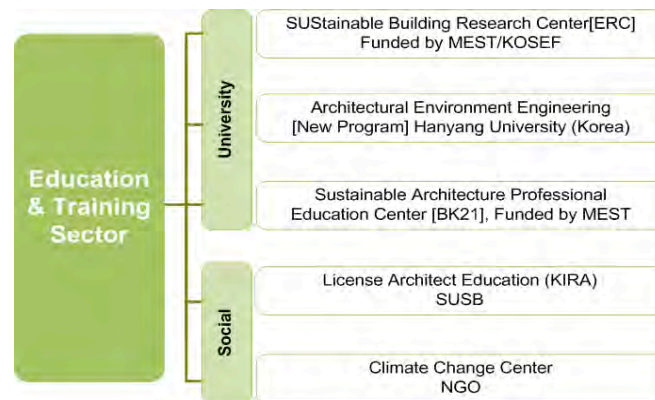


Figure 4.1 Education and Training for SB in Korea

4.1 SUSustainable Building Research Center [ERC]

On 1 June 2005, the SUSB-Research Center (Sustainable Building Research Center) was selected by the Ministry of Education, Science and Technology's Korea Science and Engineering Foundation as an Outstanding ERC (Engineering Research Center) for research related to green building construction. The research center restructured Hanyang University's existing school of architecture into a course of study in sustainable construction, requiring the completion of sustainable subject as a graduation requirement for the university regardless of one's major course of study, and conducts joint international video conference education with Germany's EnEd for green building construction.

These sustainable construction related courses focus on lowering a building's demand on the environment, and on improving quality of life. In addition, Hanyang University has introduced a new major course of study with a degree program in green construction, to add to the existing architecture and architectural engineering majors programs, an architectural environmental engineering degree, with three "Teams" thereunder, for "Quality of Life," "Environmental Demand," and "Productivity," to offer education and graduate thesis guidance, together with the educational steering committee.

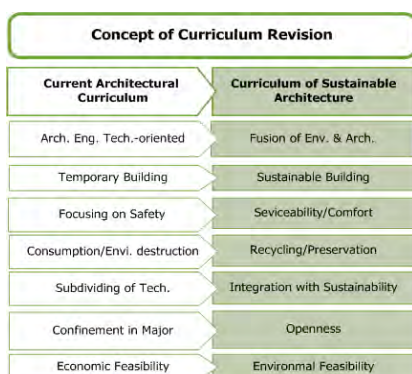


Figure 4.2 Curriculum revision of SB

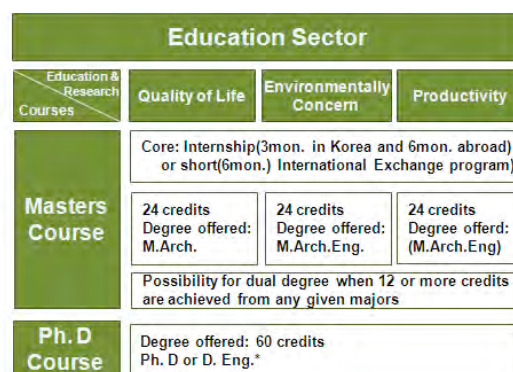


Figure 4.3 Architectural Environmental Engineering Degree

Moreover, the SUSB-Research Center has been striving to expand national technological infrastructure for sustainable building, and to serve as the educational venue for joint technological innovations, by regularly sponsoring refreshers for sustainable construction, centered around construction companies and architectural professionals, to facilitate technological advancement and availability of sustainable building.

4.2 Sustainable Architecture Professional Education Center [BK21]

Sustainable Architecture Professional Education Center (SAPEC) is a green construction education business team selected for the second phase of BK21. To preserve the earth environment while improving human quality of life, without negatively impacting the future generation's ability to fulfill its needs, while fulfilling current generation's needs, architectural development ideologies pursued from viewpoints of quality of life, environmental impact, and construction productivity. Education of architectural technology, combining sensible architectural design technology with state of the art construction engineering technology, an inseparable merger of green building research and education to realize three specialized objectives of improving quality of life, reducing environmental impact, and improving productivity. In addition, to produce human resources with international competitiveness in the green, tall building market, and for technology development, SAPEC has introduced a new educational program based on the existing major study disciplines of architecture and architectural engineering, by organically combining design and engineering into an architectural environmental engineering major, as shown under Figure 4.4.

4.3 Climate Change Center [NGO]

In Korea's Climate Change Center, the government, regional authorities, the industry, and citizenry come together to raise awareness for global warming, and to cooperate for the purpose of seeking a response plan and solutions for the climate change problem. It also has a goal of forming a global network through international partnerships toward the preparation of a response system against the climate change problem. One of the major enterprises undertaken by this climate change center is the education arm for people from the government, industry, and the citizenry, and includes the following.

- _Installation of a climate change leadership course: provide educational opportunities for enterprise chiefs and various industry leadership, opinion leaders to promote awareness change.
- _Education for climate change response personnel_professionals: A discussion type education for technical experts from the government, industry, regional authorities, and NGO's, to form a network of expertise and promote understanding among organizations.
- _Citizens' Climate Change Forum: Sponsorship of public lectures by experts from various fields on an ongoing basis.
- _Youth Eco Leadership Education: Raise young people's awareness for the environment through on-scene visits to climate change venues in Korea and abroad.

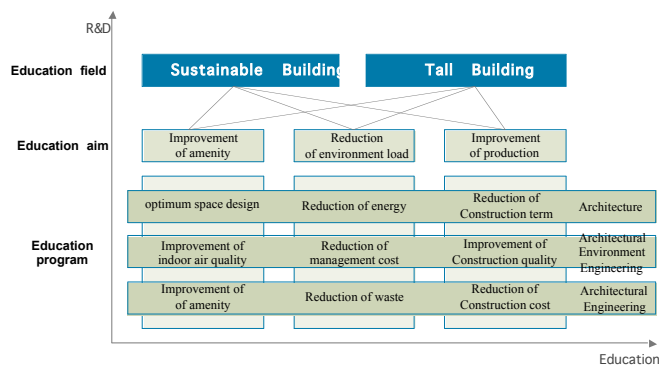


Figure 4.4 Education program of SAPEC

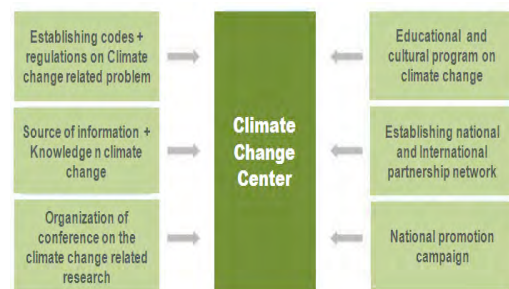


Figure 4.5 Contents of the program - NGO

5. Status of Adoption of New SB Technologies and Techniques

In order to sustain a building to be “sustainable” over duration, further research for sustainable production is necessary to accurately assess its effects on the Earth environment, including from its design, construction and operation to its demolition, over the entire life cycle of the building, and to come up with a response plan. As shown in Figure 5.1, such a building life cycle can be designed on a Closed Loop basis, with goals for environmental demand reduction and livability improvement, using state of the art green techniques for raw material reduction, energy savings, longer life cycle, and recycling. There is a need to steer building construction activities from the existing mindset of ever increasing growth to a new paradigm of sustainable growth. For the purpose of preserving the Earth environment, research is needed for improving the quality of the living environment while reducing demand on the environment, using green technology policies for raw material reduction, energy savings, waste material reduction, and increased durability. What is needed is a quantitative assessment metric for the life cycle of a building (LCCO₂ & living environment performance assessments). For these purposes, a number of research projects are underway in Korea under government sponsorship for ecologically sound building construction. Figure 5.2 shows areas of research for sustainable growth building led by the Korean government.

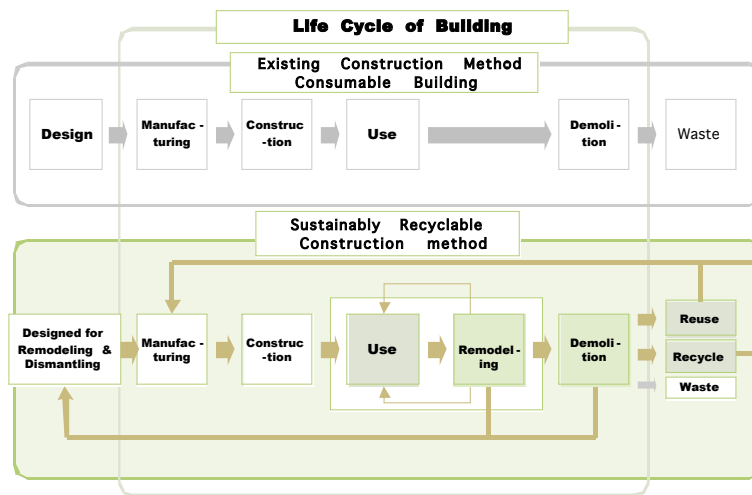


Figure 5.1 Sustainable, recyclable construction method



Figure 5.2 Education and training for new SB technologies and techniques in Korea

5.1 Sustainable Building Research Center [ERC]

The SUSB-Research Center (Sustainable Building Research Center) is the sole Outstanding Engineering Research Center (ERC) in the field of architecture in Korea, designated on 1 June 2005 by the Ministry of Education, Science and Technology's Korea Science and Engineering Foundation. SUSB-Research Center's chartered mission is to develop architectural engineering technology for protecting the Earth environment and improving quality of life, in establishing an sustainable building construction technology system of world renown.

To such an end, research and development efforts are underway with key technologies for optimal planning and resource reduction, demand reduction and energy savings, modularization – automation and waste material reduction, durability improvements and maintenance LCC reduction. sustainable technologies thus developed are incorporated into a university curriculum through the Technology Academy and the Environment Academy, to raise environment technicians of high caliber, and transferred to the industry for application, under a regulatory framework, and expanded to a social movement for the environment.

The ultimate research objective for the SUSB-Research Center, in preserving the Earth environment and improving the human quality of life, is to integrate various key construction technologies to build a sustainable high rise building (30-story residential building) of world renown. In terms of numbers, the stated research goals are first, to reduce environmental demand to cap CO₂ production for a 38% reduction for the life cycle of the building (LCCO₂), and second, to improve living environment performance by 30% for the life cycle of the building (quality of life improvement). For this purpose, SUSB-Research Center has established deliverable goals for the entire life cycle of a building, from design, construction, operation and maintenance to demolition, for each area of activity for building production, such as resource saving manufacturing technology, energy saving environmental technology, waste reducing construction technology, and improved durability operation and maintenance technology, with research integrated across disciplines. The 38% reduction in LCCO₂ and the 30% improvement in living environment performance as the stated objectives of this research shall be achieved through the development of technologies for the life cycle of the building, for each area of CO₂ reduction and living environment performance improvement, simultaneously with the development of assessment indices and programs for the quantitative analyses of the developed technologies, and through validation processes involving feedback for each phase of the research.

_Final Research Goals: *Realization of sustainable high rise building by combining various technologies for the purpose of environmental conservation with improved quality of life.*

_Quantitative Final Research: *Reduction of total CO₂ by 38% through the life cycle of building
Improvement of amenity by 30% through the life cycle of building*

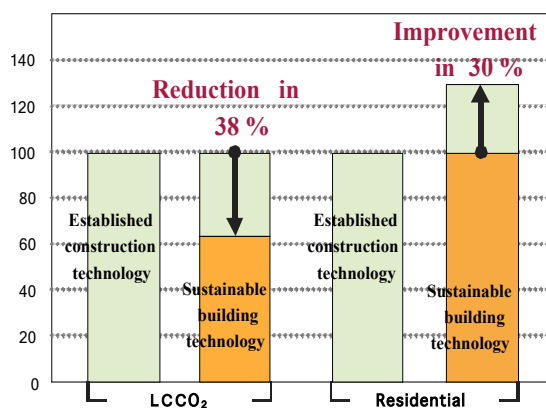


Figure 5.3 Technical goals of SUSB

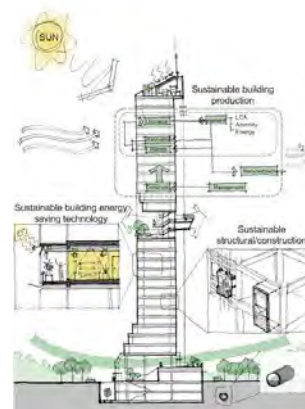


Figure 5.4 Prototype research method

_ Assessment Programs Development for Building Environmental Demand & Quality of Life

For the purpose of meeting objectives for quantitative assessment, SUSB-Research Center developed a building life cycle environmental demand assessment program (SUSB-LCA ver. 1.0) and a building resident human quality of life assessment program (SUSB-SAM ver. 1.0). For the SUSB-LCA ver. 1.0, input conditions of the building's resource usage by type of material, energy usage for the operational duration, and waste material produced for the demolition phase, allow the calculation for the life cycle of the building for LCE (Life Cycle Energy), LCCO₂ (Life Cycle CO₂) and LCC (Life Cycle Cost). It is possible to assess for comparison against existing buildings in reductions of LCE (Life Cycle Energy), LCCO₂ (Life Cycle CO₂) and LCC (Life Cycle Cost) for buildings constructed with sustainable engineering technologies.

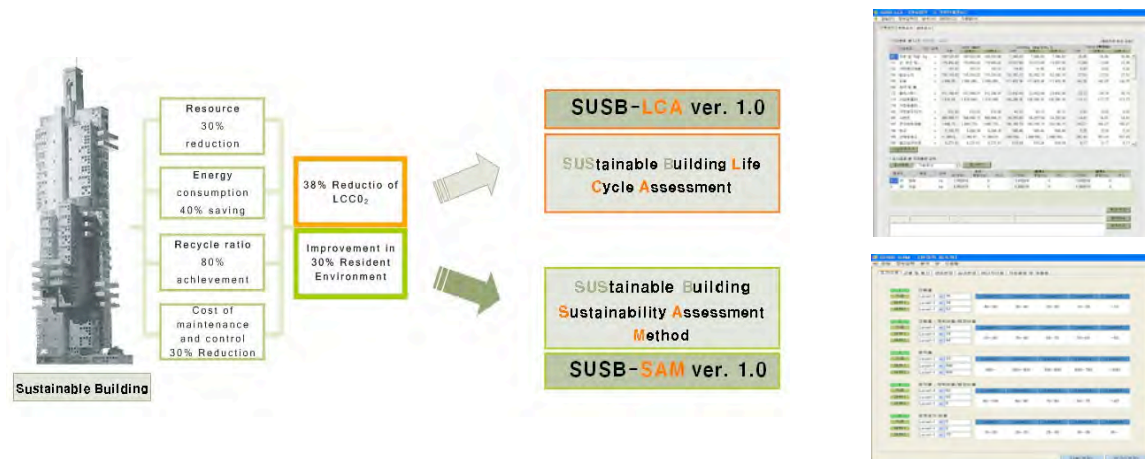


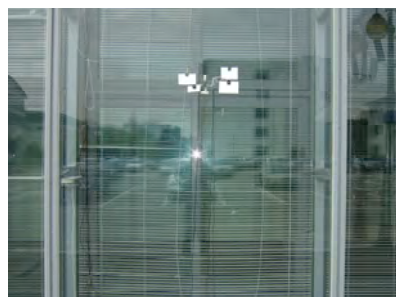
Figure 5.5 SUSB-LCA ver.1.0 & SUSB-SAM ver.1.0

_ Test Bed for Performance Assessment of Sustainable Building

SUSB-Research Center has built a Wind Environmental Laboratory as a Test Bed for various sustainable technologies developed at the center, including its dual external surfacing technology. This test bed measures in real time air movement and temperature change within the wall gap, to analyze data collected, in designing an optimal dual surfacing system to minimize energy usage. The wind test equipment at the facility can also be used to assess a city's heat island effect and wind current movements, as well as to test a high rise building's wind pressure and vibration effects.



(a) Wind environment laboratory



(b) Air current & temperature measurement



(c) Wind testing

Figure 5.6 Wind environmental laboratory

5.2 Center for Sustainable Housing

The Center for Sustainable Housing (CSH) was founded for the purpose of developing model apartment housing of low energy construction and sound environmental technology, to be built in New Town developments under policies for balanced national growth, in promoting sustained growth for the new town communities, and for the establishment of a system for the government to provide policy incentives for a low-energy eco-friendly public apartment market, for continual research and development and market application. Therefore, its research and development had as its purpose the design of model sustainable apartment for the construction market, low energy sustainable apartment infrastructural program (SH-2011 Program), and the establishment of the CSH in support thereof. The SH-2011 is a national program under a new concept to promote the establishment of a low-energy/ sustainable market, and the supply of related products and housing real estate. With a technological goal for 'Low-Energy Sustainable Apartment,' it provides policy support to meet stated objectives, with new goals asserted from time to time, in order to accelerate technical advancement, and to lead the low energy sustainable construction industry for the nation.

5.3 Bio Housing Research Institute

Bio housing research group appointed by Korean ministry of education in August 2005 is part of bio housing development research that combines environment-friendly material and cutting-edge construction technology. It is carrying out vigorous activities to develop industrial brand that can maximize the value of regional characteristics of natural resources of Kwangju, Jeonnam.

5.4 Construction Waste Recycling Research Center (Funded by MLTM)

Long life housing research group is appointed by Korean ministry of construction and transportation as part of construction core technology research and development in 2005 and is carrying out research on foundation technology and development of Korean long life standard model with durability and alterability until 2010. "Construction waste recycling real rate is 80%" is the ultimate object of research. To meet it, procedure is divided into 3 steps. These are production of construction waste, processing and recycling. To make it realize, set three goals about research and development.

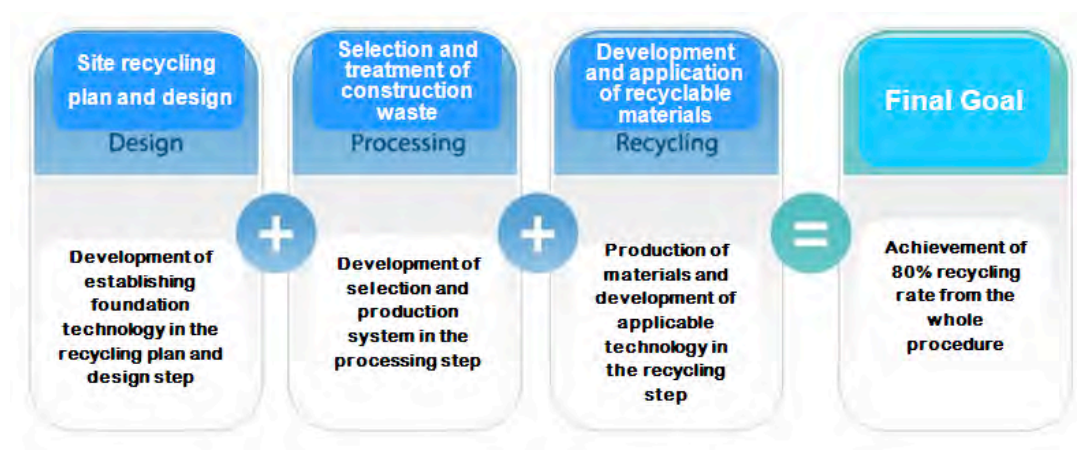


Figure 5.7 Prototype research method

6. Status of Adoption of SB Whole-Building Performance Rating Systems

6.1 The Environment-Friendly Housing Certification (KOEAM 2000)

The Korea National Housing Corporation's Housing & Urban Research Institute conducted a three year national research project from 1996 for the Ministry of Land, Transport and Maritime Affairs, to develop an assessment model for performance ratings of housing projects on their standards of synergy with the environment, together with a plan to utilize it as a certification system. The MLTM had also seen the need for a development of housing which are in harmony with the environment, and assigned the project for a systematic plan to the Urban Research Institute toward a seminal examination of assessment methodology and procedures necessary for a housing certification system. The Urban Research Institute conducted a pilot assessment of eco-friendly housing in February of 2000 with twelve domestic construction companies for new housing projects, toward validation of the eco-friendly housing assessment model developed through the national research project in actual application. The results of these pilot assessments were applied in updating the evaluation metrics and standards for the housing assessment model, to ultimately complete the "Superior Living Environment Housing Pilot Certification Assessment Model" with input by experts from the government and outside. In September 2000, the "Superior Living Environment Housing Pilot Certification" system was implemented to grant certification for eight of the projects.

6.2 Green Building Pilot Certification System

In order to prepare an operational structure and operating regulations for the certification system, the Korea Management Association Registrations and Assessments, Inc. (KMAR) conducted a green building pilot certification program in 2000, with results from a study by the 'Environmental Policy Research Committee' as a basis, in developing operational procedures with related regulations for the green building certification system, using the pilot certification program's actual assessment applications to tweak problems associated with its operations and technology. To this end, KMAR was contracted for consignment service by the Ministry of Environment for the performance of a green building pilot certification program.

6.3 Green Building Certification Criteria (GBCC)

Since the Green Building Certification Standard bill was announced in 1997 by the Green Building Technology Research Committee, eco-friendly building certification systems have been studied by the Korea National Housing Corporation's Housing & Urban Research Institute, Crebiz Certification Institute, the Korea Institute of Energy Research and the Korea Institute of Construction Technology. Then, following a process of integration for the green building certification system by the Ministry of Land, Transport and Maritime Affairs and the Ministry of Environment, the certification standard for apartments was implemented on 1 January 2002 (Revised 2006.4.11). At present, certification standards are in effect for mixed-use residential and office buildings (2003.1.1), schools (2005.3.1), and retail markets and lodging facilities (2006.9.1). Regardless to the type of usage for the building, the assessment criteria for the GBCC are divided into 4 areas (_ Land Usage & Transportation _ Energy_Resource & Environmental Demand _ Ecological Environment _ Interior Environment), and 9 subcategories (_ Land Usage _ Transportation _ Energy _ Materials & Resources _ Water Supply _ Air Pollution _ Maintenance _ Ecological Environment _ Interior Environment), with each item graded independently. Again, without regard for the type of usage for the building, if the rated score (normalized to a scale of 100) falls between 65 to 84 inclusive, a rating of "Excellent" is granted, and 85 or better a "Superior" rating. As for its proliferation, the GBCC as of 2006.3.31 had certified 85 cases, but by 2006.12 had significantly increased to 204 cases. Perhaps such was the reason behind the enactment of Article 58 in 2005.11.8 to the Construction Act (Certification of Green Buildings), and the revision, implementation on 2006.2.24 to Article 13 of the Regulation Related to Housing Supply (Introduction of an Incentive System for the Green Building Certification of Apartments). Other proposals are on the table for further strengthening green building certification systems in Korea, with systematic plans for facilitation of eco-friendly buildings as

public facilities through incentives, along with the development of programs dedicated to the green building certification system. Table 6.1 shows areas and subcategories for GBCC of apartment buildings as revised on 2006.3.12.

Table 6.1 Assessment items for GBCC-Multiple-family housing

Assessment areas	Subcategories	Assessment items
Land Usage & Transportation	Land Usage	1. Ecological Value
		2. Land Usage
		3. Effect on Nearby Land
	Transportation	1. Reduction in Transportation
Energy_Resource & Environmental Demand	Energy	1. Energy Usage
		2. Energy Savings
	Materials & Resources	1. Resource Savings
		2. Resource Recycling
	Water Resource	1. Water Recycling
		2. Water Resource Savings
	Air Pollution	1. Global Warming Prevention
	Maintenance	1. Systematic Management
		2. Effective Management
		3. System Adaptability to Change
Ecological Environment	Ecological Environment	1. Green Area within Site
		2. Nature Area within Site
Interior Environment	Interior Environment	1. Air Environment
		2. Heating Environment
		3. Noise Environment
		4. Livability
		5. Considerations for Elderly

_ Certification results by years

Year	2002	2003	2004	2005	2006	Total
Certification results	3	4	14	33	163	217

_ Certification results by building type of usage

Building type	Multiple-Family Housing	Office building	Mixed-use Residential building	School	Total
Certification results	171	32	7	7	217

_ Case Study: Green Building Certification

The first case among apartments to receive a “SUPERIOR” rating through the Green Building Certification System (Both Pre-Certification & Main).

(1) Building General Information



_ Building Name	: IPARK Samsungdong		
_ Location	: 87 Samsung-dong Gangnam-gu, Seoul		
_ Constructor	: Hyundai Development Company		
_ Surface Area	: 32,259_	_ Bulk Index	: 296.32%
_ Building Area	: 2,960.50_	_ Landscape Ratio	: 50.63%
_ Total Floor Area	: 146,482.92_	_ Number of Households	: 449
_ Building to Land Ratio	: 9.18%		

(2) Notes on Assessment for Green Certification

Assessment areas	Notes
Land Usage & Transportation	<ul style="list-style-type: none"> _ Easy access to city center (approx 800m distance to the COEX) _ Bicycle route & parking available _ Exclusive pedestrian walkway (length 350m) _ Easy access to mass transportation – subway & bus _ Integral community center
Energy_Resource & Environmental Demand	<ul style="list-style-type: none"> _ Flexible floor plan for the duration of life cycle _ Food waste drain & Other scrap waste storage facility installed _ Ultra high speed (Class 1) data communication with apartment contents accessible through the internet _ Water usage reduction (ultra water saving toilet) & Drainage _ Use of eco-friendly material (Eco Mark, GR Mark Products) _ Application of new construction technology & industrialized construction techniques _ Water reclamation installation (used to feed a stream)
Ecological Environment	<ul style="list-style-type: none"> _ Aquatic biotope (brooks, ponds) and terrarium biotope built in _ High green herbage ratio of 50% _ Continuous green tract of land along the length of complex _ Ecologically sensitive artificial green landscaping: green biological revetments, retaining walls
Interior Environment	<ul style="list-style-type: none"> _ Use of materials with low volatile organic compound fumes _ Individual room temperature control units on all apartments _ Good sound insulation of walls between units _ Good sunlight illumination of each unit interior



Figure 6.2 Biotope terrarium



Figure 6.3 Automatic room temperature control unit

7. The Future Trend on Sustainability in South Korea

Future trends for sustainable buildings in Korea are discussed. First, as shown under Figure 7-1, future trends for sustainable building related joint activities by the industry, the academia, and R&D will be discussed by categorizing them under titles of Government (Policy & Regulation), Research, Education, & Project. Data indicates trends for an sustainable building to be changing from current concept of Green Building to a notion of Sustainable Building, with elements of social, economical and city planning mixed in, thereby requiring research in this direction.

For the Government Sector, in keeping up with these trends of the time, transition is required from the current green building certification system to an assessment system for sustainable buildings, with consideration at a level of an entire region of buildings for their eco-friendly performance, for introducing sustainable performance assessment and development, in taking the city together with building constructions. Indeed these efforts surpass regional or even national undertaking, requiring an international alliance type sustainable networking systems to become effective. Currently in many countries of the world, CO₂-Neutral cities have been promulgated, with myriad of effort underway to rein in further increase. CO₂ reduction technology development and their assessment for building constructions will no doubt take an important position for the realization of carbon neutral cities. Recently, MACCA, the Korean Multifunctional Administrative City Construction Agency for the new administration capital to be built in South Chungcheong Province's YeonGi-Gun declared MAC to be built as a CO₂ neutral city, and active research has been underway in concert with sustainable building research institutes. The details of these R&D efforts are introduced below under 7.1 Sustainable Multifunctional Administrative City - CO₂-Neutral City.

For the Research Sector then, transition is required from the current qualitative type assessment technology development at the level of green buildings, to quantitative type assessment technology development for metropolitan and national scale, sustainable building levels. For the Education Sector as well, education confined to a region or a university, and architectural venues, must be opened up to form international networks for sustainable education, tapping into various learning systems to transition into to a global educational era on the environment. Finally, for the Project Sector, it is also deemed timely for transition from building level projects to nation-wide projects, illuminating tall buildings, as seen with keen interest the world over, to be dissociated from the excessive energy demand constructions of the past, to hasten research for environmentally sustainable tall building technology, through the development of sustainable building engineering technologies and assessment methodology.

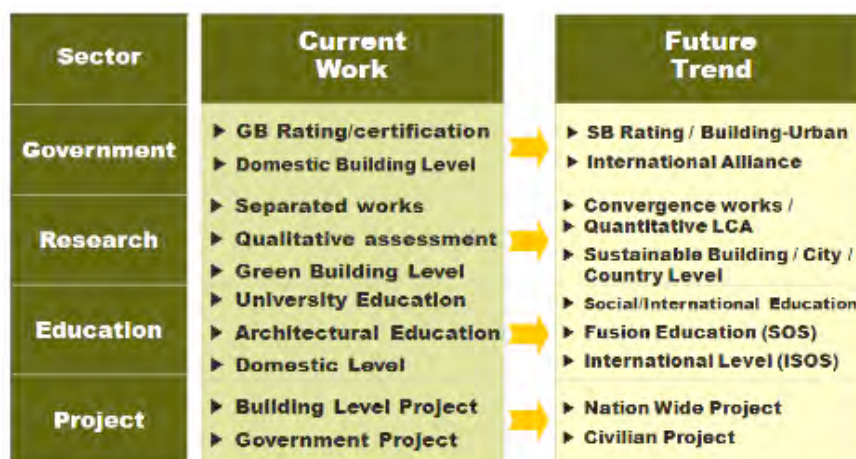


Figure 7.1 Future trend for sustainability in south korea

7.1 Sustainable Multifunctional Administrative City - CO₂-Neutral City

The Multifunctional Administrative City for Korea is a national project to alleviate concentration around the capital city of Seoul, toward the furtherance of equitable growth as a nation. As an administrative capital, the government of Korea has planned a new city of 500,000 population to be located in YeonGi-Gun of South Chungcheong Province (150km from Seoul). For completion by 2030, the MAC is to be built as an environmentally friendly city tailored to the characteristics of Korea from the planning stage on, for transportation, energy and other areas of reductional applications, with thorough management systems to save approximately 32% on energy expenditure, and reduce CO₂ output by 25%. MACCA, the Multifunctional Administrative City Construction Agency in charge of the undertaking has declared MAC as a CO₂-Neutral City, and has been striving to develop technology and international networking necessary for this objective. Currently, environmentally friendly building research institutes in Korea are engaged in research projects to define tangible applications for the realization of MAC as a CO₂-Neutral city.

_ Construction Period:	2005-2030
_ Area:	73.14 km ²
_ Population:	500,000

Vision	Realization of CO ₂ neutral city, Sustainable city international engineering science government city; world's leader in sustainable-related industry	
Aim	_ 32.8% reduction in energy consumption	
	_ 25% reduction in CO ₂ emission	
	_ Establishing the HUB, international Sustainability center	
	Stage 1	Building level construction of sustainable building
	Stage 2	Urban level construction of sustainable building
	Stage 3	Global level common network and establishing a HUB



Figure 7.2 Map of Multifunctional Administrative City



Figure 7.3 Sustainable international network

7.2 LCCO₂ Quantitative Assessment - Building, Urban, National & Global Levels

Today the world over, efforts are being made for environmental demand reductions such as in the development of CO₂-Neutral City at metropolitan and national levels. To achieve this goal, new developments are necessary to expand upon technologies for assessment of environmental loads at a building construction level, to enable quantitative assessment of total environmental demand at the level of an entire city or even a country. Accordingly, transition is inevitable from current development for qualitative assessment technology at a green building level, to that of quantitative assessment technology levels at par with city wide and national scale sustainable buildings. Aware of this paradigm change, as just introduced in 7.1 above, Korea has been conducting research for technology development to enable the measurement not only at the building level for the construction of CO₂-Neutral City, but at a metropolitan level for quantitatively assessing environmental demand toward load reduction.

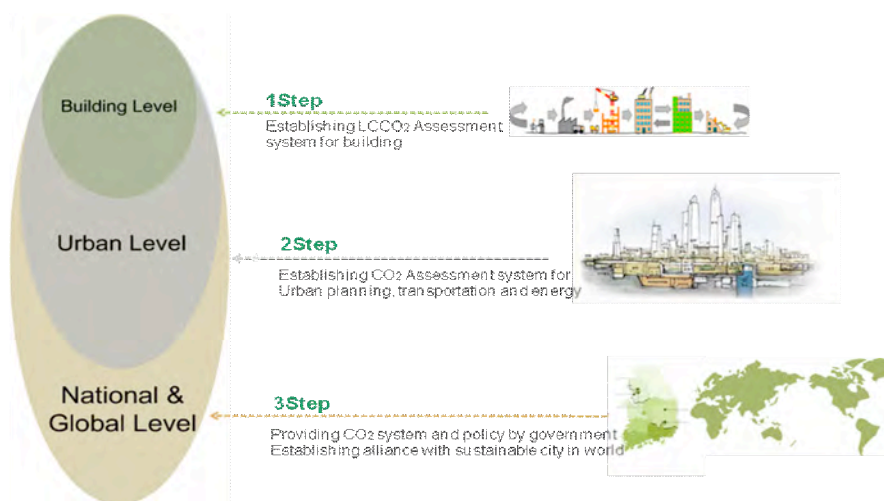


Figure 7.4 Levels of Assessment and Networking: Building, Urban and National/Global

7.3 International Sustainability Educational Network – ISOS (International School of Sustainability)

It is necessary to raise specialized human resources with competitiveness for the international arena, through the establishment of an international sustainability friendly educational network centered around architecture. At present, in Korean educational institutions (Hanyang University, Seoul National University, KAIST, etc.), through interdisciplinary studies across fields, internationally capable, specialized personnel are being trained, and are also striving to raise their university's standing in the world.



Figure 7.5 International Sustainability Education Network

7.4 Sustainable Tall Building

Recently, international demand for tall buildings has been rising exponentially. Korea is one of the countries where tall building construction is progressing actively, and comes in fourth in the world for buildings rising over 100 stories high. Demand for such schemes of vertical urban development using very tall buildings is expected to increase for some time. However, such large buildings have become known as being antagonistic to the ecologically friendly trend for buildings, for their excessive energy usage during the construction phase and thereafter through its operation. But recent applications of sustainable technology to these tall buildings are attempting an image makeover as part of the sustainable family of buildings with reduced environmental demands. Some of the sustainable applications technology are double-skin, and wind and solar type renewable energy. Further development is necessary for sustainable building technology of various means for application to tall buildings, along with a method of assessment.



Figure 7.6 Sustainability and tall building

8. Conclusion

This paper has discussed current situation for environmentally friendly building construction in Korea from the standpoints of public policy, education, research, and with examples of cases for application. It has also touched on the future trend for sustainability friendly building construction in Korea, from governmental policy, education, research and projects perspectives. Sustained environmental viability is the subject of discussion for our global community today, and transition of architectural building constructions toward an sustainability industry for the sake of preserving our Earth environment is now a critical necessity.

To this end, pro-environmental international network should be formed with sustainable building at its center, with information exchange for each country's policies and eco-friendly technology, for the building sector to rise to the challenge of protecting our Earth together.