

Energy Simulation Input Data Gathering of Public Buildings

Utilizing the National Database

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ABSTRACT

This study intends to select database which enables the estimation of user information, building information resulted from such user information and energy information without separate input for developing the reference building model of public building energy policy simulator in Korea. The simulator which intended to be developed in future could be divided into the statistical model and simulation model, and the establishment of database utilizing the ISO13790-based ECO2 program as the simulation engine was analyzed.

KEYWORDS

National Energy Database, ECO2, Energy Simulation Input Data, Data Gathering, Public Building Energy

INTRODUCTION

The Korean government announced its plan to raise the target to reduce the greenhouse gas emission from buildings by 26.9% by 2020 on July 2015, reinforcing the energy design standards for new buildings and the energy efficiency remodeling promotion policy for existing buildings. Such reinforcement of policies requires the securing of the market's execution power and securing of technological and economic validity as well as the establishment and provision of information enabling building owners to judge such validity are required for the securing of execution power.

EU and advanced countries such as U.S. have developed and provided a reliable national system to support decision making of relevant personnel including public building energy policy makers and building managers on efficient building energy usage and maintenance. In case of Korea, the speed of policies for building energy efficiency is fast but the understanding of market is generally low, and the government service system to support decision making for effective public building energy management is still not provided yet.

Therefore, the purpose of this study is to suggest the building energy simulation input data collection measures using building energy-related national database to carry out the role of providing autonomous ecosystem for energy efficiency in public buildings.

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Analysis of Database Requiring Energy Simulation

Building energy-related national database is provided by various subjects such as building information and energy usage information. However, building energy consumption is influenced by various factors and the pattern of energy usage also changes due to the interaction between those factors. Also, the level of influence from such factors also varies according to the purpose of building and it is very difficult to predict such level due to too many types of variables and wide variations.

ECO2 is the Quasi-steady analysis-based building energy performance analysis tool and this tool is mainly utilized for the evaluation of residential and non-residential building energy efficiency level in Korea. ECO2-OD is the ECO2 tool designed for the office, and this tool simplified the calculation of energy performance by simplifying the building shape to the office building. Energy Plus is a representative dynamic analysis tool provided by DOE that is applied to all buildings, and this program is developed for analyzing detailed energy analysis.

The input data of simulation tools such as ECO2 includes main factors and the performance of the equipment required for quantitative effect-analysis of building energy performance index for each element technology classified into the improvement of insulation performance of building envelope, replacement and new installation of high efficiency facility system, new and renewable energy and the installation of energy management system (Kim et al 2015).

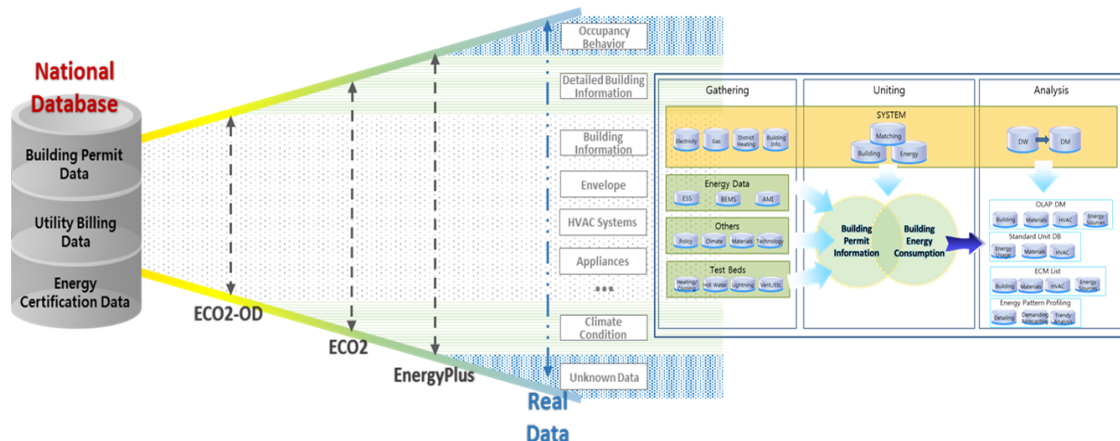


Figure 1. Required data level and database design (Lim et al 2016)

The accuracy of the building energy simulation result is decided by various input data. However, the reliability level demanded by the user according to the utilization purpose of the user and level of data collection may be reflected in such accuracy and it should be utilized properly.

Designing of National Integrated Building Energy Database Utilizing National Database

Various analysis methodologies using the normative model have been suggested until now as the process for the evaluation of building energy performance and scenario analysis (Yoon et al 2014; Heo et al 2015). However, a high degree of uncertainty of model parameter due to a difficulty in the collection of model input information is pointed out as a disadvantage.

The advantage of database suggested in this study is to establish the normative model easily and promptly as possible by integrating scattered building information (building energy usage information, building register information, material information, energy efficiency certification information, weather information) (based on the NPEMS). In addition, it enables model calibration (Bayesian calibration, etc) based on the mapping actual energy usage data of each building establishment of reliable model and risk-based scenario analysis finally.

The expandability of data establishment was provided by matching the public building-related data with the large capacity building data provision guide of the open system to the private sector and ‘building management PK’ of building administration system "Seumteo", and the level of utilization was also improved by mapping the energy consumption date of previously established building ledgers and the building energy efficiency level certification data.

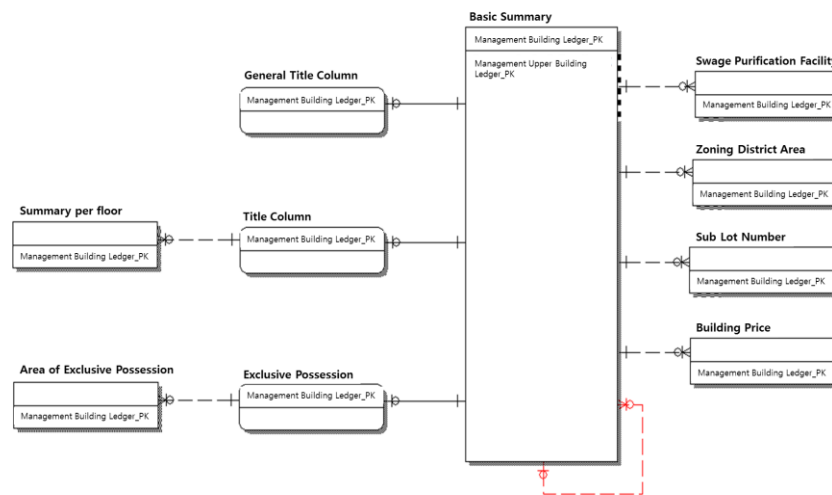


Figure2. Building ledger table relationship diagram

Currently, there are various government-affiliated organizations but they all collect and manage building-related information for different purposes to each other. The frame to integrate and manage scattered source data was prepared and designed to enable the application of advanced statistical techniques (big data analysis, machine learning, etc) This study aims to develop and utilize various statistical models and standard engineering model (ECO2, etc) for the public building as the support tools for energy policy decision-making through such frame.

Table1. National Database Sources and Suggetion of Database

Previous information collection status			Suggested Database	
Ministry	Agency	Retained information	Purpose of information collection	Utilization of collected information
Ministry of Land, Infrastructure and Transport	Korea Appraisal Board	Building energy consumption	Calculate energy consumption unit for each building purpose and establish	Energy consumption information

		greenhouse gas emission quantity inventory for home and business		
	Seumteo (e-AIS)	Building ledger and energy efficiency level certification	Basic statistical data for national building status analysis	Basic information of building including area, height and address
	Spatial Information Industry Promotion Institute (V-world)	3D shape of buildings	Provide the national spatial information open platform	Building envelope and form information
	Korea Infrastructure Safety and Technology Corporation	Quarterly energy consumption	Review energy consumption and manage energy performance	Energy performance information
Ministry of Strategy and Finance	Statistical geographic information service	2D plane of buildings	Provide the open platform which converges spatial statistical information and various external information to support spatial decision making for small areas	Building form information
Ministry of Trade, Industry and Energy	Korea Energy Agency	Monthly greenhouse gas emission and energy consumption	Establish the rational energy usage promotion plan for public agencies, check the result and manage the greenhouse gas emission and energy consumption targets	Greenhouse gas emission information
Ministry of Environment	Korea meteorological administration	Weather information for each area	Provide national weather service	Climate information near buildings

Additional matching data of building management PK in this system are building energy saving design standards and building energy efficiency level data, and the data can be utilized as the analysis factor to classify for what purpose data on the bill shown as total energy usage amount were used.

Table 2. Database establishment explanation table

No.	Classification	Contents	Components
1	PNU target list	"Site location and lot number" list of the extraction target	KEY_NO, PNU, City, Gun, Gu codes, legal Dong code, site/mountain, main lot number, sub lot number
2	Building information	Extract only information from all building ledgers	KEY_NO, PNU, building_PK10), upper_building_PK, general/collection classification, ledger type, building name, Dong name, Room No. name, main/sub classification, purpose, structure, roof, total floor area, ground floor, basement level, approval date of use, serial number
3	Energy consumer information	Location information of energy consumer (meter)	KEY_NO, PNU, energy_agency code, energy_unique number, building name, Dong name, floor name, Room No. name, whole address, serial number
4	Energy consumption information	Monthly consumption information of energy consumer	energy_agency code, energy_unique number, year and month of consumption, consumption, unit
5	Building energy matching information	Matching information between building ledgers based on energy consumers	UFID11), energy_agency code, energy_unique number, building_type_classification, building_PK, matching_type_code

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The number of main certification data of energy efficiency level in Korea is 239 cases and the number of buildings mapped with current PK-energy efficiency level information and energy consumption information for 2 years is 95 cases. Among these, the number of cases that include the detailed information of target agencies for public energy usage rationalization is 20 cases, and the number of cases that include energy consumption information for 1 year is 24 cases.

Table 3. Number of samples for analysis

Agency information	PK information	Energy efficiency level information	'14 energy consumption information	'15 energy consumption information	# of data
○	○	○	○	○	20
○	○	○	○		0
○	○	○		○	4
○	○	○			17
○		○	○	○	2
○		○	○		0
○		○		○	0
○		○			9

O	O	O	O	75
O	O	O		1
O	O		O	4
O	O			55
	O	O	O	19
	O	O		1
	O		O	0
	O			32
Total				239

In order to organize input data required in the simulation based on the above data, it was designed to collect the building purpose and energy consumption according to the building address information entered on the building ledger information or building management PK(Primary Key) value and extract and collect simulation input factors from the energy efficiency implementation results according to the building energy efficiency level certification, building energy saving design standards and public building energy efficiency rationalization regulations.

The public agency information, building address, energy efficiency level, energy consumption information and weather information were mapped through the above frame. It was designed to enable the establishment of the statistical model through the above database framework and automatic creation of the engineering model (ECO2) through appropriate converter and interface designing, and the finally organized collection data as shown in the following table

Table 4. Form of finally organized collection data

Agency information			Building address information			Energy efficiency certification information	Energy consumption information	Weather information
Classification of agency	Affiliated agency	Agency code	PK	Address	Parcel address			
Central administrative agency	Board of Audit and Inspection of Korea	1040000	11110-900000000	112, Bukchon-ro, Jongno-gu, Seoul, Korea	25-23, Samcheong-dong, Jongno-gu, Seoul, Korea	Omitted	Omitted	Omitted
Central administrative agency	Daegu regional office of the Ministry of Patriots & Veterans Affairs	1180000	27290-100215511	301, Hwaam-ro, Dalseo-gu, Daegu, Korea	1035, Daegok-dong, Dalseo-gu, Daegu, Korea	Omitted	Omitted	Omitted
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CONCLUSION AND IMPLICATIONS

In order to convert the established database into building energy simulation input data, the database was established by connecting and collecting each database from the input list required for carrying out the simulation, and each matching data are as shown below.

Table 5. ECO2 required input item list on architectural Field

	<i>Classification</i>	<i>Item</i>	<i>Note (Input/DB/Default/ Formula)</i>
Architectural field	Basic information	Building name	DB
		Address of location	PK
		Area (Weather data)	DB
		Building purpose	DB
		Main lighting sources	Input
		Total floor area	DB
		Building area	DB
		Number of floors (above-ground, below-ground)	DB
	Input zone	Usage profile	DB
		Area	Default
		Ceiling height	Default
		Lighting	Input
	Input face	Building area size (Wall)	DB
		Window area	DB
		Solar transmittance	Default
		Thermal transmittance - Outer wall	Default
		Thermal transmittance - Roof	Default
	Thermal transmittance - Floor	Default	
	Thermal transmittance - Windows and doors	Default	

In this study, the building management PK database was established using previously established national public building data in order to develop the model which collected building energy simulation input data automatically and it was designed to be utilized for the simulation of normative model and engineering model.

It is scheduled to research a technology which implements the automatic counting model and converts data to simulation data based on this database collection frame additionally in future studies.

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