The Status of Energy Use & Information System in the Korea Building Sector

Oct 01 2015  Seung-eon Lee
1. Introduction
Market size and energy consumption of Korean building sector

![Graph showing construction orders in trillion KRW (Korea National Statistical Office)]

**Equations for Energy Consumption**

- **Energy for Residential Buildings**:
  \[ energy_{residential} = h \cdot \frac{p}{h} \cdot \frac{area}{p} \cdot \frac{energy}{area} \]

- **Energy for Commercial Buildings**:
  \[ energy_{commercial} = GDP \cdot \frac{area}{GDP} \cdot \frac{energy}{area} \]
Weather Condition of South Korea (Seoul)

Source: Towards nearly zero-energy buildings, Definition of common principles under the EPBD, Final Report (2013)
### Building Stock

#### By Building Types

- Residential: 66%
- Commercial: 17%
- Industrial: 4%
- School & Social: 10%
- Etc.: 3%

#### By Building age

- **Less than 10yrs**
  - Number of Buildings: 1,133,863
  - Floor Area: 884,658,593
- **10-15yrs**
  - Number of Buildings: 661,014
  - Floor Area: 663,990,856
- **15-20yrs**
  - Number of Buildings: 713,182
  - Floor Area: 534,191,807
- **20-25yrs**
  - Number of Buildings: 839,010
  - Floor Area: 620,565,288
- **25-30yrs**
  - Number of Buildings: 515,559
  - Floor Area: 253,446,553
- **30-35yrs**
  - Number of Buildings: 497,313
  - Floor Area: 159,729,921
- **More than 35yrs**
  - Number of Buildings: 1,978,819
  - Floor Area: 1,655,814
- **Etc.**
  - Number of Buildings: 572,528
  - Floor Area: 89,343,978

*(Unit: Number of Buildings, m², Year of 2014)*
Energy Consumption by Types in Commercial Buildings

- Energy Consumption by Types in Commercial Buildings

- Percentage of Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Office (Unit: TOE)</th>
<th>Retail (Unit: TOE)</th>
<th>Accommodations (Unit: TOE)</th>
<th>Restaurant (Unit: TOE)</th>
<th>Education (Unit: TOE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETC</td>
<td>1,419,814</td>
<td>381,687</td>
<td>188,446</td>
<td>1,272,694</td>
<td>260,645</td>
</tr>
<tr>
<td>Lighting</td>
<td>778,706</td>
<td>223,763</td>
<td>175,064</td>
<td>368,876</td>
<td>161,649</td>
</tr>
<tr>
<td>Facility</td>
<td>725,624</td>
<td>427,189</td>
<td>48,554</td>
<td>47,828</td>
<td>120,906</td>
</tr>
<tr>
<td>Cooling</td>
<td>1,480,513</td>
<td>914,769</td>
<td>383,755</td>
<td>679,805</td>
<td>244,414</td>
</tr>
<tr>
<td>Heating/hot water</td>
<td>2,519,010</td>
<td>1,435,146</td>
<td>894,882</td>
<td>735,376</td>
<td>602,895</td>
</tr>
</tbody>
</table>

- Percentage of Types:
  - Office: 42%
  - Retail: 19%
  - Accommodations: 10%
  - Restaurant: 21%
  - Education: 8%
37% Reduction by 2030

2012
Energy-Efficient House

- 50% Energy Reduction

2017
Passive House

- 90% Energy Reduction

2025
Zero Energy House

- 90% reduction in energy consumption in House
- No CO2 emission

Present

- 37% Reduction by 2030
- 80% reduction in energy consumption and CO2 emission in house

Korean Target for Reduction in Building Sector
Policies & Programs

Standard for Building Insulation & Energy – Efficient Designs

Building Energy Rating System

High Efficiency Equipment Certification Program

Energy Efficiency Standard & Labeling Program

Housing Performance Grading Indication System

G-SEED & Building Energy Rating System obligation for public buildings

Carbon Labeling

Eco-Labeling

Means the company and consumer respond to climate change

Product’s Carbon footprint - The mark signifies CO2
VISION : Spread of Common Building Treatment Market (Care & Treatment Service)

- Web-based Fundamental Audit
- Engineering-based Professional Audit

Step 01 Self-Diagnosis and treatment
- Main Agent
  - Building Owner
  - Architect
  - Occipant
- Audit
  - Comparing Monthly Heating and Cooling Cost
  - Recognition of Air Leakage
- Improvement
  - Change Indoor Setting Temp.
  - Seal up with Paper Weather Strip

Step 02 Clinic
- Main Agent
  - Building Owner
  - Architect
  - Energy Evaluation Specialist
  - Green Building Specialist
- Audit
  - Change Indoor Setting Temp.
  - Change Building and Facilities level Evaluation
- Improvement
  - Efficient Managing
  - Partial Remodeling

Step 03 General Hospital
- Main Agent
  - National Certification Institute
  - Specialized Consulting Enterprise
- Audit
  - Energy Grade Efficiency
  - Building and Facilities level Evaluation
- Improvement
  - Deep Retrofit
  - Full Remodeling

Step 04 Healthy Life

Vision of Building Energy Management in Our Research
2. Building Energy Information & Management System (BEI&Ms)
Introduction of National BEI&Ms
Construction Database of Building and Energy Matching Data

Building + Energy

Building Information

Utility Billing Data

Database

Various building information

Building energy consumption

Building energy statistic system

The amount of greenhouse gas emission in Seoul

building: 0.0 6.5
gas: 1.2
emission: 2.7 1.0
CO2: 5.5

Korea Gas Corporation

Suwon Gas Corporation

Korea District Heating Corporation

Korea Special City Gas Corporation

Korea Special City Gas Corporation
Offering Service of BEI & Ms

Building Energy Integrated DB

Building Energy Management System

Total 6.8 Million Buildings & 19 Million Households in South Korea

The target number of Buildings with Building Energy Integrated DB in the country

- 6.8 Mil Buildings
- 19 Mil Households
- Electricity: 19.70 Mil
- City Gas: 15.80 Mil
- District Heating: 0.50 Mil

Policy Support
Statistics Analysis
Common Use Portal
Nationwide Service

Energy Integrated Information

Green Building Portal
Consumption Certificate
Statistics
Decision Making Support
Map Information

In Progress

KICT KOREA INSTITUTE OF CIVIL ENGINEERING and BUILDING TECHNOLOGY
3. Upgrading Current BEI&Ms (Ongoing project)
Proposed NEW BEI & Ms for Upgraded System

- Electricity
- City Gas
- District Heating
- Water Supply

Real Energy

Current BEI&Ms

Existing Simulation

Proposed NEW BEI & Ms

Heating
Cooling
Hot water
Lighting
H.A. / O.A.

Calculated Energy
Proposed NEW BEI & Ms for Upgraded System

New BEI&Ms (Energy Efficiency Support System to New& Existing Building)

- Self Energy Audit Support Utilizing Building Energy Consumption
- Detailed Energy Efficiency Audit Support Utilizing Building Energy Requirements
- Benchmarking Program for Building Energy Performance Level
  - Algorithm Development for Estimating Detailed Building Energy Consumption
  - Benchmarking Program Development for Building Energy Performance Level
  - Guide for Betterment of Performance Development based on Building Energy Performance Level Analysis Result
- Building Energy Efficiency Portfolio Support System
  - ECM List per Problem Types
  - Standard Model/DB/Algorithm of Economic feasibility Evaluation for Dwelling
  - Standard Model/DB/Algorithm of Economic feasibility Evaluation for Non-Dwelling
  - Development of Portfolio Support Tool

Building Information Support for Autonomous Low-energy Construction Market

- Building Information DBMS
  - Development of Basic DB including Building Materials, Facilities, New Technologies, and Best Practice
  - Development of Smart DB (OLAP based Logical DB) for Conative Action of User Request Level
  - Sustainable Auto-Updates DB System
  - Public Certification Interlocking with Building Materials, Facilities, New Technologies

National Building Energy Integrated Support System (G.T)

Owner (User) Input (G.T)

Previous DB of Building Materials, Facilities, New Technologies

Overall Information of Evaluating Buildings (Metadata)
Building Energy Support System

BEI&Ms

General Building Information

Billing Data

Building Energy Support System

Reference Building Model

Engineers

Building Energy Audit

Building Owners

Building Energy Roadmap

Governners

Verification

Detailed Energy Consumption by Field Measurement

<table>
<thead>
<tr>
<th>Detailed Energy Consumption by building type</th>
<th>Heating</th>
<th>Cooling</th>
<th>Hot Water</th>
<th>Lighting</th>
<th>Ventilation</th>
<th>ETC</th>
</tr>
</thead>
</table>
Use of Building Information from the Building Permit Database

Definition of General and detailed information
- **General information** includes Building location, gross area, the year of construction, building type and so on
- It can be obtained from “BEI&Ms” and E-AIS(Electronic Architectural administration Information System, www.eais.go.kr)
- **Detailed information** provides U-values of wall and window, type and capacity of boiler and chiller, energy sources and so on
- It can be obtained from “Building Energy Efficiency Rating” which is conducted by Korea Energy Agency

Recommended Default by Building Energy Support System
- Correlation between general information and detailed information was evaluated
- If there is no correlation, average value or value from the regulation is recommended.
- If there is a correlation between main item from detailed information and gross area or construction year from general information, an equation is recommended.
## Set of Default and Intelligent Default

- **Default**: default constant (\(D\_\text{reg}\) : constant from the regulations, \(D\_\text{avg}\) : average value from statistic)
- **Intelligent Default**: equation by correlation (\(ID\_\text{area}\) : equation by gross area)

### Default and intelligent Default (draft)

<table>
<thead>
<tr>
<th>Item</th>
<th>Type</th>
<th>Constants or equations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Architectural factor</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U-value of external wall [W/m²K]</td>
<td>(D_\text{reg})</td>
<td>0.27</td>
</tr>
<tr>
<td>U-value of roof [W/m²K]</td>
<td>(D_\text{reg})</td>
<td>0.18</td>
</tr>
<tr>
<td>U-value of floor [W/m²K]</td>
<td>(D_\text{reg})</td>
<td>0.23</td>
</tr>
<tr>
<td>U-value of window [W/m²K]</td>
<td>(D_\text{reg})</td>
<td>1.50</td>
</tr>
<tr>
<td>Shading coefficient</td>
<td>(D_\text{avg})</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heating system Capacity [kW]</td>
<td>(ID_\text{area})</td>
<td>0.0705x* + 449.96</td>
</tr>
<tr>
<td>COP</td>
<td>(D_\text{avg})</td>
<td>3.55</td>
</tr>
<tr>
<td>Cooling system Capacity [kW]</td>
<td>(ID_\text{area})</td>
<td>0.0784x + 361.11</td>
</tr>
<tr>
<td>COP</td>
<td>(D_\text{avg})</td>
<td>3.04</td>
</tr>
<tr>
<td>Hot water system Capacity [kW]</td>
<td>(ID_\text{area})</td>
<td>0.0144x + 167.59</td>
</tr>
<tr>
<td>efficiency</td>
<td>(D_\text{avg})</td>
<td>93.38</td>
</tr>
<tr>
<td>Lighting [W/m²]</td>
<td>(D_\text{avg})</td>
<td>9.69</td>
</tr>
<tr>
<td><strong>Renewable energy</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross area of PV[m²]</td>
<td>(ID_\text{area})</td>
<td>0.0068x + 252.63</td>
</tr>
<tr>
<td>Geothermal Capacity of heat pump [kW]</td>
<td>(ID_\text{area})</td>
<td>0.0137x + 351.61</td>
</tr>
<tr>
<td>Heating COP</td>
<td>(D_\text{avg})</td>
<td>3.98</td>
</tr>
<tr>
<td>Cooling COP</td>
<td>(D_\text{avg})</td>
<td>4.65</td>
</tr>
</tbody>
</table>

* \(x = \text{gross area}\)
Set of simplified models and analysis of energy
- As most buildings do not have the detailed information, simplified models were suggested for simplified energy analysis.
- The simplified models consist of 1 thermal zone and can be calculated by general information and defaults.
- 10 sample commercial buildings in Seoul are selected to compare the results from ECO2* and the simplified model.
*ECO2 : static energy simulation base on ISO 13790, certified simulation by the government for building energy rating

Set of simple model (draft)

<table>
<thead>
<tr>
<th>Items</th>
<th>General Information</th>
<th>Architectural factor</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Profile</td>
<td>Story height</td>
<td>Infiltration</td>
</tr>
<tr>
<td>Properties</td>
<td>D_ref</td>
<td>D_ref</td>
<td>D_ref</td>
</tr>
<tr>
<td>Value</td>
<td>Small offices</td>
<td>3</td>
<td>[m]</td>
</tr>
</tbody>
</table>

Comparison of results from ECO2 and simple model

Heating △ Cooling ● Hot water ▲ Lighting × Ventilation
Thank you for attention

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