GEF

UNDP

Department of Alternative
Energy Development and Efficiency
MINISTRY OF ENERGY

Promoting Energy Efficiency in Commercial Buildings (PEECB)

PROGRESS REPORT #1

Submitted to :
Department of Alternative Energy Development and Efficiency

Prepared by :
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BRIGHT
management consulting
company limited

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ANNEXES

1. Project Summary

Bright Management Consulting Co.,Ltd. (BMC) has been contracted by DEDE on April 2013 as the project consultant on component 1, partly of component 2&3 and project management. **Currently, BMC has completed the work according to the term of reference with the overall percentage of actual completion at 11.16%. Details of completed works of each task are as followings,**

Table -1.1 Completed Works as of August 2013

Task	Work on progress	% Completed	Remark
PM : Project Management		**4.74%**	
	1.Project Management and Coordinating Activities		
	2.Target setting for the project		
	3. Preparation of 1st Public Seminar		
C-1 : Component 1		**6.28%**	
	1. Conduct situation analysis on Commercial Building EE Information		**Activity 1.1.1a**
	2. Design & Development of CBEEC		**Activity 1.1.1b**
	3. Assess the two(2) simulation model		**Activity 1.3.1a**
	4. Study and identify the overall training courses for EE technologies and practices and financial arrangement in commercial buildings		**Activity 1.4.1 a&b**
C-2 : Component 2		**0.14%**	
	1. Review existing specific energy consumption index		**Activity 2.2.2a**
	2. Review existing M&V scheme for completed projects in Thailand		**Activity 2.2.3a**
C-3 : Component 3		No activities in this period	
Overall completion		**11.16%**	

(Details of completed works have been provided in item 3: Key results and Annexes)

2. Project Objectives

1. To raise awareness on energy efficiency in commercial buildings in Thailand including the establishment of Commercial Buildings Energy Efficiency Information Center, the development of training programme and related activities and the development of Energy Simulation Software for Commercial Buildings in Thailand
2. To study and prepare policy frameworks, short and long term action plan to promote energy efficiency in commercial buildings including evaluation and revision of related policy on energy efficiency in commercial buildings
3. To demonstrate the application of energy efficiency technologies in commercial buildings and disseminate the successful results to other building

3. Key Results

Currently, the total of **11.16%** of actual work is completed for Project Management (PM), Component 1 (C1), Component 2 (C2) and Component 3 (C3) as summarized in Table 3-1:

Table 3.1 : The summary of work projection in 1st Progress Report (Q2-Q3)

Item	%Plan Q2	%Plan Q3	%Total Q2+Q3	%Actual Q2	%Actual Q3	%Total Q2+Q3
PM	4.06	0.68	**4.74**	4.06	0.68	**4.74**
Component 1	0.91	5.02	**5.93**	0.91	5.37	**6.28**
Component 2	0.00	0.14	**0.14**	0.00	0.14	**0.14**
Component 3	0.00	0.00	**0.00**	0.00	0.00	**0.00**
Total	4.97%	5.84%	**10.81%**	4.97%	6.19%	**11.16%**

Note: Detail of Work Plan & Progress is provided in Annex III

Detail of key results according to TOR 4.7-4.9 for Project Management (PM), Component 1 (C1), Component 2 (C2) and Component 3 (C3) as follows:

(TOR4.7) **Task 7** : The Consultant shall manage and facilitate all project activities according to the approved plan in Task 2 under the supervision of DEDE. The regular meeting with the DEDE's committee shall be set up to ensure the success of the project.

3.1 Project Management (PM) : Completed works = 4.74%

Details of completed works:

PM-1 Project Management and Coordination Activities

1. **BMC has coordinated with DEDE & UNDP** to clarify task details through several meetings and email communications. The second coordinating was organized on Friday 16th August 2013 at DEDE. The next coordinating meeting has been set on Monday 16th September 2013.

2. **The Project Board (PB)** of the PEECB Project has been formulated to supervise and monitor the project to ensure cooperative and effective implementation of the project. The structure of PB consists of representative from key agencies namely;
   1. Department of Alternative Energy Development and Efficiency –DEDE
   2. United Nations Development Programme –UNDP
   3. Office of Natural Resources and Environmental Policy and Planning – ONEP
   4. Energy Policy and Planning Office, Ministry of Energy – EPPO
   5. Department of Public Works and Town & Country Planning-DPT
   6. Pollution Control Department -PCD , Ministry of Natural Resources and Environment
   7. The Revenue Department-RD
   8. Department of City Planning, Bangkok Metropolitan Administrator-BMA-CPD
   9. Thailand Greenhouse Gas Management Organization (Public Organization) – TGO
   10. Thai Green Building Institute – TGBI

   The first project board (PB) meeting was held on 22 May 2013 at Boonrod-Nitipat Meeting Room, 11th Floor, Building 7, DEDE. The objective of the first meeting is to introduce the PEECB project and seeks the approval on the master plan and yearly plan from the board.

   The second project board meeting has been planned for Thursday 19th September 2013 to follow up the progress of the project and to finalize project target and criteria to select demonstration sites.

3. **BMC had conducted an inception report presentation** to DEDE's project committee on 15 July 2013. The meeting's objective was to report on the project strategies, working plan, staff plan, budgetary plan , completed works and current status of the project (as per TOR 4.1-4.5) and tentative planning for the next period of Y2013.

PM-2 Target setting for the project

BMC has prepared the project implementation strategies and planning in order to meet the project target. The project target aims to support the implementation of 20 Years Energy Efficiency Development Plan (EEDP Y2011 – 2030). There are 8 building types have been defined in the EEDP as followings;

1. Office Building
2. Department store
3. Retail & wholesale business facility
4. Hotel
5. Condominium
6. Medical Center
7. Educational Institution
8. Other general buildings

Each building type has been categorized by level of energy saving capability into 5 levels as shown in Table -3.2

Table -3.2 Net Energy Consumption Derived from Modeling each building type under each level of Energy Saving Capability

Building Type	Energy Consumption under Each Level of Energy Saving Capability ($kWh/m^2/y$)				
	Reference	BEC	HEPS	Econ	ZEB
Office building	219	171	141	82	57
Department store	308	231	194	146	112
Retail & wholesale business facility	370	298	266	161	126
Hotel	271	199	160	116	97
Condominium	256	211	198	132	95
Medical center	244	195	168	115	81
Educational institution	102	85	72	58	39
Other general buildings	182	134	110	66	53

Reference : 20 Year Energy Efficiency Development Plan (EEDP), DEDE

*The assessment of electricity saving potential is based on the comparison between the average energy consumption rate/space unit/year of individual building types at present, called the "**Reference** Case", and such a rate in the case where the minimum energy consumption efficiency standard of buildings, or "**Building Energy Code (BEC)**", is enforced, including the case where a higher standard in the future is enforced. The average energy consumption rate under the Reference Case is derived from the energy consumption modeling representing each building type, based on the official data from energy consumption inspection. Energy efficiency standards which are higher than the BEC comprise the following three levels;*

*(1) **HEPS (High Energy Performance Standard)** – the high energy efficiency standard of various system which can be achievable by using current technologies;*

*(2) **Econ (Economic Building)** – the target in the near future when the technologies of equipment and various systems are developed to be more energy efficient, but are still cost-effective; and*

*(3) **ZEB (Zero Energy Building)** – the long-term target when the need for external energy supply to the buildings is near zero because the energy demand of such buildings is very low and there is also on-site energy generation from renewable energy*

PEECB Project will stimulate the implementation of energy efficiency measures in the commercial buildings in order to move each type of buildings in Thailand toward higher level of Energy Saving Capability. According to 20Y EEDP, the target reduction of 34,493 GWh has been set in Y2030. In order to achieve this challenge target, more than 85% of each type of building need to be in Econ level and approximately 3-5% of each type of building should be achieve ZEB level. In this regard, PEECB target should be set to support and enhance this 20Y EEDP target. Detail achievement of each level of Energy Saving Capability will be identified in the next progress report. Target setting will then, be prepared for each component.

Table 3.3 Estimated percentage of commercial buildings achievement on each level of Energy Saving Capability according to 20Y EEDP

Level of Building Saving Capability	Estimated percentage of commercial buildings achievement		
	Short term (2011-2016)	Medium term (2017-2022)	Long term (2023-2030)
Reference	38%	10%	5%
BEC	30%	5%	2%
HEPS	30%	33%	3%
ECON	2%	50%	85%
ZEB	0%	2%	5%
Total	**100%**	**100%**	**100%**

PM-3 Preparation of 1st Project Public Seminar

The first (1st) Project Public Seminar has been planned for mid of October 2013. The objectives of the seminar are;

1. To inform all stakeholders regarding the detail of PEECB Project
2. To coordinate with all stakeholders and promote the development concept to set up "Commercial Building EE Information Center (CBEEC)
3. To inform all stakeholders regarding the development concept of energy efficiency policy for commercial building

The participants will be invited from representative of related government agencies, Architect and Engineering Professional Organizations, Building Developers, Building Designers and other related organization. Target number of participants is 150-200 persons.

(TOR4.8) Task 8 : The Consultant shall implement all activities as stated in TOR item 4.3. A yearly plan could also be revised as necessary but it shall be approved by DEDE's committee prior proceeding.

BMC has implemented and managed all activities in each component according to the Yearly Work Plan proposed in the Inception Report. Progress of each activity in each component can be summarized as follows;

3.2 Component 1 (C-1) Completed Works = 6.28%

Working plan (April-July 2013) as per yearly plan in the Inception report:

Project : Promoting Energy Efficiency in Commercial Building (PEECB)
Working Plan of Y2013 (B.E.2556)

Item	Details of Activiites/Sub-Activities	Y2013 (B.E.2556)									
		Q1	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
C1	COMPONENT 1 : Awareness Enhancement on Building EE Technologies and Practices										
	1.1 Establish Commercial Building EE Information Center (CBEEC)										
1.1.1	Activity 1.1.1 Establishment of the Commercial Building EE Information Center (CBEEC)										
1.1.1 a	Conduct of Situation Analysis										
1.1.1 b	Design and Development of the CBEEC										
1.1.1 C	Administration and Maintenance of the CBEEC										
1.1.1 d	Collaboration on Database of the CBEEC										
	1.2 A system of information exchange and dissemination on EE technologies and practices for commercial building stakeholders										
1.2.1	Activity 1.2.1 Promoting CBEEC as the information portal for the Commercial Bldg. Sector in Thailand										
1.2.1 a	Design effective promotional scheme										
1.2.2	Activity 1.2.2 Implementation of Awareness Raising Campaigns										
1.2.2 a	Review of Profiles and Level of Awareness of Target Audience										
1.2.2 b	Compilation and Production of Marketing and Promotional Tools and Materials										
1.2.2 c	Design and Implementation of Awareness Campaigns										
1.2.3	Activity 1.2.3 Implementation of Information Disclosure Program for Commercial Bldg. Energy Consumption										
1.2.3 a	Design Information Disclosure (ID) program & publication materials (link with C2.2)										
	1.3 Development and Promoted Energy Use Simulation Models for Commercial Building Design										
1.3.1	Activity 1.3.1 Assessment of the Utilization of Building Energy Simulation Models (BESM) in Thailand										
1.3.1 a	Assessment of the two (2) most popular simulation models										
1.3.2	Activity 1.3.2 Development of a Customized BESM for Commercial Buildings in Thailand										
1.3.2 a	Selection and Modification of BESM										
1.3.2 b	Preparation of Promotional and Training Program										
1.3.3	Activity 1.3.3 Implementation of Sustainable Promotional and Training Program on EE Commercial Building Design										
1.3.3 a	Conduct the BESM training courses										
	1.4 Completed training courses on EE technologies and practices, and financial arrangement for commercial buildings										
1.4.1	Activity 1.4.1 Capacity Building Need Assessment for Commercial Building Stakeholder										
1.4.1 a	Scoping Study on the Training Program										
1.4.1 b	Identification of Training Activities for Stakeholders										
1.4.1 c	Development of the Overall Training Program										
1.4.2	Activity 1.4.2 Design and Implementation of Training Courses on EE Technologies and Practices, and Financial Arrangement for Commercial Buildings										
1.4.2 a	Design of Technical Training Courses										
1.4.2 b	Design and Preparation of Training Materials										
1.4.2 c	Conduct of Training Program										
1.4.2 d	Certification and Quality Assurance Mechanism										
1.4.2 e	Training Program Monitoring and Evaluation										
1.4.2 f	Sustainable Follow-up Capacity Development Program Design										

C1-1 Activity 1.1.1a: Conduct situation analysis on Commercial Building EE Information

Current situation on Commercial Building EE Information

There are several and various types of data and information on Energy Efficiency in Commercial Building available in the market. Sources of these data and information are Department of Alternative Energy Development and Efficiency (DEDE), Professional Association of Engineering, Professional Association of Architect, Consultants, Experts, Product Suppliers, etc. However, there is no proper management system to centralize all these related data and information. DEDE has two contact centers that are responsible to provide information on Energy Efficiency to public. These two centers are 2E-Building Center and DEDE's One Stop Service. 2E-Building Center provides services on building design recommendation to comply with compulsory building code while DEDE's One Stop Service provides broad services on the issues regarding to energy conversation on commercial buildings and factories.

For private sectors, normally, data and information on Energy Efficiency in Commercial Building can be found through their organization websites, therefore, the details of information is still quite limited as the purpose of this information channel is for marketing of their products or services. There is no specific organization or website that provides details data and information on Energy Efficiency in Commercial Building.

Completed work on the review of current situation on Commercial Building EE Information provided in this Progress Report No.1 is also included the review of case study on promoting of energy efficiency in commercial buildings in Japan prepared by Nikken Seiki Research Institution (NSRI). Detail of information of Japan status is provided in Annex I of this progress report.

C1-2 Activity 1.1.1b: Design & Development of Commercial Building EE Information Center (CBEEC)

Initial Concept on the development of CBEEC

The establishment of Commercial Building EE Information Center, CBEEC could be designed into three phases as follows;

Phase I : Data and Information Preparation (October 2013 – December 2013)
Phase II : Establishment of CBEEC (January 2014)
Phase III: Operation and Maintaining of CBEEC (From February 2014)

Details of each phase are provided as follows;

Phase I: Data and Information Preparation

Existing Data and information related to Energy Efficiency in Commercial Buildings that are available in the market will be gathered and collected during this phase. Collection method will be through DEDE database and direct survey. Type of collected data and information will also be identified in this phase. Estimated time frame for this phase in during October – December 2013

Phase II: Establishment of CBEEC

CBEEC could be established firstly as virtual center through web based concept. The website of www.cbeec.co.th or others as appropriate will be registered. In parallel with the development of CBEEC website, the actual contact center will also be identified and established whether using existing contact center, 2E Building Center, or newly established contact center. The CBEEC website will be developed in parallel with the data collection works of phase I. Therefore, all collected data and information gathered in phase I will be made available for public on CBEEC website. The actual CBEEC contact center could be set up at Bright Management Consulting Co.,Ltd.'s office as an temporary office till the end of the project (April 2016) or at DEDE workspace as appropriate.

Phase III: Operation and Maintaining of CBEEC (From February 2014)

After the actual establishment of CBEEC contact center, the operation and maintaining of the center will be responsible by Bright Management Consulting Co.,Ltd. through the end of the project. The operation and maintaining of CBEEC will cover both the operation of contact center and CBEEC website.

The initial concept of Commercial Building EE Information Center can be summarized as shown in Table- 3.4

Table -3.4 Initial Concept of CBEEC Establishment

Sources of Information	Type of Information	Collection Method	Operational Concept	Tool to be developed
1. DEDE 1.1 Existing database 1.2 Completed project	1. Energy consumption of each type of commercial building 2. Data to analyze specific energy consumption (SEC) 3. EE Technologies information 4. Programming Software 5. Successful case studies	Direct Interview and Review	1. Web based 2. Contact Center attached to DEDE	1. Networking 2. Application for user interface
2. Professional Association	1. Standard and Criteria on Energy Efficiency 2. List of potential professionals	Focus group meeting and direct survey		
3. Consultants & Experts	1. List of potential technologies 2. List of potential consultants and experts	Focus group meeting and direct survey		
4. Equipment Suppliers	1. List of potential technologies 2. List of equipment suppliers of each potential technologies	Focus group meeting and direct survey		

C1-3 Activity 1.3.1a : Assess the two (2) most popular simulation models

Complying with new building energy code could save building energy use 10%-20% annually (Chirarattananon, Chaiwiwatworakul et al. 2010). However, energy conservation effort for commercial buildings in Thailand has been considered to have achieved limited success. Over the past 15 years of ongoing energy efficiency program, commercial building stakeholders are aware of energy conservation opportunities in their buildings. However, only simple and low cost measures have usually been implemented. In building design phase where energy efficient strategies could be effectively incorporated into the building, energy simulation tools could be used to investigate energy efficient design options and support decision making in selecting suitable strategies.

Building Energy Simulation Models (BESM)

The performance of a building is a result of complex processes. A better building design can reduce energy use by 30% compared to a conventional building design, while still provide an equal or better environment for its occupants. Barriers to achieve this goal is usually not technology constraints, but poor data to make informed decisions (Clarke 2001). Building simulation tools are created to help provide real world replication and predict how buildings and systems will perform once they are constructed and implemented, thus providing information for decision making. Building energy performance prediction tools are a series of complex mathematical models that address the dynamic interaction of building and system performances with building geometry, plan, components, system choices, climate conditions and occupant use patterns.

In early days, simple single-zone buildings used degree-hour or degree-day based calculations to predict energy used. These methods are based on steady heat flow concept and only applicable with residential and small commercial buildings. With the available of computers, simulation program with transient heat calculation methods has then been introduced to predict energy used in more complex buildings. The first program developed by the Automated Procedures for Engineering Consultants, Inc. (APEC) was the Heating and Cooling Peak Load Calculation (HCC) program (APEC 1967), which was used for calculating hourly peak and annual heating-cooling loads for heating, ventilating, and air-conditioning (HVAC) systems in buildings. The APEC members were later formed into the ASHRAE Task Group on Energy Requirements (TGER), and then developed the procedures for simulating the dynamic heat transfer through building envelopes, procedures for calculating psychrometric properties, and the algorithms for simulating the primary and secondary HVAC system components for determining heating and cooling loads for computerizing energy calculations (ASHRAE 1975).

The need for BESM is primarily driven by building energy law and standard in 1990s and sustainable building rating systems in 2000s which usually rely on ASHRAE Standard 90.1 Appendix G – Performance Rating Method, that buildings desire to elevate their performances beyond ASHRAE standard code have to use energy simulation software to calculate their energy performance compared with base case buildings. ASHRAE 90.1 listed eight criteria as requirements for acceptable BESM. These models must be able to handle 10 or more thermal zones, generate hourly data for 8,760 hours/year, account for thermal mass effects, model part load performance curve, model capacity and efficiency correction curve for mechanical heating and cooling, model air-side economizers with integrated control, and accommodate hourly variation in occupancy, lighting power, equipment power, thermostat set points, and HVAC system operation defined separately for each zone (American Society of Heating Refrigerating and Air-Conditioning Engineers Inc. 2007). ASHRAE 90.1 appendix G Performance Rating Method section G2.2.4 also states that the simulation

tool must be tested in accordance to ASHRAE standard 140 by the software provider. Example of programs listed in the standard are DOE-2, BLAST, and EnergyPlus. Qualified software for calculating U.S. commercial building tax deductions are Autodesk Green Building Studio, DesignBuilder, DOE-2.2, EnergyGauge, EnergyPlus, EnergyPro, EnerSim, eQUEST, Hourly Analysis Program (HAP), IES, Tas, TRACE700, and TRNSys (U.S. Department of Energy 2013). In additional to this list, Leadership in Energy & Environmental Design (LEED) rating system indicates some qualified tools for their rating systems which are DOE-2, eQUEST, Visual DOE, EnergyPlus, EnergyPro, HAP, TRACE700 ,and IES.

Green Building XML schema, developed by Green Building Studio, Inc. with funding provided by the California Energy Commission PIER Program and Pacific Gas and Electric, is an open schema to facilitate the transfer of building properties from building information modeling (BIM) programs to building energy analysis tools. The first version of Green Building XML schema or gbXML was released in 2000 (gbXML.org 2013). An examples of tools that use gbXML is Autodesk's Green Building Studio, a web-based energy modeling tool that uses a gbXML format and runs a DOE-2.2 engine. Conceptual Energy Analysis and Project Vasari, also offered by Autodesk, are the first BIM tools to directly export to DOE-2 and EnergyPlus.

In Thailand, BESM have been used in academics both to equip students with simulation skill and in building technology research in the past 20 years. In practice, buildings that use BESM in design phase are very rare. Few design firms have their own in-house energy simulators. BEC is one of the models being used widely because of the building code requirement that apply to some building groups. Apart from BEC, other BESM being used in academic or energy consultant firm mostly depends on programs that simulator has encounter when in their own higher education period and the software prices. Examples of BESM used in Thailand are VisualDOE, eQUEST, TRNSYS, Tas, Ecotect, EnergyPlus, and Ener-Win. Details of each model (Crawley, Hand et al. 2008) including BEC are as follows:

1. **BEC V1.0.5** http://www.2e-building.com/detail.php?id=14

BEC is an OTTV-based energy estimation model for commercial buildings in Thailand (Chirarattananon and Taveekun 2004) provided from DEDE. Parametric results used in BEC to estimate building energy use were derived using DOE-2.1E and then validated with metered energy used collected by DEDE from designated buildings in the country. BEC provides database for building envelope materials and building systems. It can calculate building energy use according to building envelope systems, lighting density, air-conditioning system size and efficiency, other building equipments and the total building energy use in accordance with Thailand building energy code.

2. VisualDOE 4.0 http://www.archenergy.com/products/visualdoe

VisualDOE is a window interface of DOE2.1E simulation engine. The U.S. DOE consistently supported development of the DOE program until the mid-1990s. VisualDOE takes care of writing the input file, running the simulation and extracting the results from the output file. No experience with DOE2.1E is necessary, but advanced users have the flexibility to modify the input files directly and still run the simulations from within VisualDOE. VisualDOE covers all major building systems including lighting, daylighting, HVAC, water heating, and the building envelope. Among the wide range of simulation results are electricity and gas consumption, electric demand, and utility cost. Through the graphical interface, users construct a model of the building's geometry using standard block shapes, using a built-in drawing tool, or importing DXF files. Building systems are defined through a point-and-click interface. A library of constructions, fenestrations, systems and operating schedules is included, and the user can add custom elements. VisualDOE is especially useful for studies of

envelope and HVAC design alternatives. Up to 99 alternatives can be defined for a single project. Summary reports and graphs may be printed directly from the program. Hourly results are available for detailed analysis.

3. eQUEST 3.64, August 2010, http://www.doe2.com/equest/

eQUEST® is a whole-building energy analysis software that uses the latest version of DOE-2 as a simulation engine. The DOE-2 building energy simulation and cost calculation program was initially released by the Lawrence Berkeley National Laboratory (LBNL) in 1978. The program has been updated continuously by LBNL in collaboration with James J. Hirsch and Associates, mostly under funding from the U.S. DOE until version 2.1E in 2003. Since then, James J. Hirsch and Associates has been continuing the development of DOE-2; the latest version is DOE-2.2. In DOE-2, the transient heat transfer calculation methods are used to simulate the dynamic heat transfer through building envelopes. From the literature, results from DOE-2 simulations were shown to vary from 10% to 26% from measured data (Haberl and Cho 2004). eQUEST was tested in accordance to ANSI/ASHRAE Standard 140-2007 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs, and it is qualified for use to evaluate building energy performance for government subsidy programs and building rating systems (U.S. Department of Energy 2013). It also meets all requirements for energy simulation software indicated in ASHRAE 90.1 Appendix G Performance Rating Method's guidelines for acceptable energy simulation software mentioned in section **Error! Reference source not found.**. eQUEST® is available for free from http://doe2.com/eQUEST/. Within eQUEST® graphic user interface, DOE-2.2 performs an hourly simulation of input buildings for 8,760 hours or one full year. It calculates hourly cooling load, heating load, and other energy loads such as lighting, domestic hot water, or other equipment. Users can model their buildings using "Building Creation Wizard" which quickly generates detailed building input files from simple building envelope and systems input.

4. TRNSYS 17.1, June 2012 http://www.trnsys.com/

Developed and released in 1975 by Sandy Klein as part of his PhD thesis, the TRaNsient SYstems Simulation Program (TRNSYS) is a simulation program with a modular structure that implements a component-based approach. TRNSYS components may be as simple as a pump or pipe, or as complex as a multi-zone building model. The components are configured and assembled using a fully integrated visual interface known as the TRNSYS Simulation Studio, while building input data is entered through a dedicated visual interface (TRNBuild). The simulation engine then solves the system of algebraic and differential equations that represent the whole energy system. In building simulations, all HVAC-system components are solved simultaneously with the building envelope thermal balance and the air network at each time step. In addition to a detailed multizone building model, the TRNSYS library includes components for solar thermal and photovoltaic systems, low energy buildings and HVAC systems, renewable energy systems, cogeneration, fuel cells, etc. The modular nature of TRNSYS facilitates the addition of new mathematical models to the program. New components can be developed in any programming language and modules implemented using other software (e.g. Matlab/Simulink, Excel/VBA, and EES) can also be directly embedded in a simulation. TRNSYS can generate redistributable applications that allow non-expert users to run simulations and parametric studies.

5. Tas 9.2.1.5 http://www.edsl.net

Tas is a suite of software products, which simulate the dynamic thermal performance of buildings and their systems. The main module is Tas Building Designer, which performs dynamic building simulation with integrated natural and forced airflow. It has a 3D graphics-based geometry input that includes a CAD link. Tas can import gbXML, INP and IDF files from 3rd party program Tas Systems is a HVAC systems/controls simulator, which may be directly coupled with the building simulator. It performs automatic airflow and plant sizing and total energy demand. The third module, Tas Ambiens, is a robust and simple to use 2D CFD package which produces a cross section of micro climate variation in a space. Tas combines dynamic thermal simulation of the building structure with natural ventilation calculations, which include advanced control functions on aperture opening and the ability to simulate complex mixed mode systems. The software has heating and cooling plant sizing procedures, which include optimum start. Tas has 20 years of commercial use in the UK and around the world.

6. EnergyPlus Version 8.0, April 2005 www.energyplus.gov

EnergyPlus is a modular, structured code based on the most popular features and capabilities of BLAST and DOE-2.1E developed by NREL. It is a simulation engine with input and output of text files. Loads calculated (by a heat balance engine) at a user-specified time step (15-min default) are passed to the building systems simulation module at the same time step. The EnergyPlus building systems simulation module, with a variable time step, calculates heating and cooling system and plant and electrical system response. This integrated solution provides more accurate space temperature prediction crucial for system and plant sizing, occupant comfort and occupant health calculations. Integrated simulation also allows users to evaluate realistic system controls, moisture adsorption and desorption in building elements, radiant heating and cooling systems, and interzone air flow. Many graphical user interfaces for EnergyPlus are available or under development, including Simergy, CYPE CAD MEP, DesignBuilder, EFEN, AECOsim Energy Simulator, Hevacomp, MC4 Suite, SMART ENERGY, EPlusInterface, COMFEN, Solar Shoe Box, and N++.

NREL is also developing OpenStudio which is an open source program to facilitate community development, extension, and private sector adoption. OpenStudio includes graphical applications which have the updated SketchUp Plug-in, the stand alone OpenStudio application, the ParametricAnalysisTool, RunManager, and ResultsViewer. The SketchUp Plug-in is an extension to the popular 3D modeling tool that adds OpenStudio context to the SketchUp program. The Plug-in allows users to quickly create geometry and assign space attributes using the built-in functionality of SketchUp including existing drawing tools, integration with Google Earth, Building Maker, and Photo Match. The OpenStudio application is a graphical energy-modeling tool. It includes visualization and editing of schedules, editing of loads constructions and materials, a drag and drop interface to apply resources to spaces and zones, a visual HVAC and service water heating design tool, and high level results visualization. Radiance can also be integrated into the simulation workflow. This is accomplished by using an annual Radiance simulation to measure daylighting, and then creating an electric lighting usage schedule for EnergyPlus. OpenStudio also gives the modeler integrated access to data from the Building Component Library. The ParametricAnalysisTool lets users modify a baseline OpenStudio model using OpenStudio measures to produce design alternatives. OpenStudio measures are specially formatted Ruby scripts and accompanying files for modifying energy models in OpenStudio or EnergyPlus format. RunManager facilitates queuing and running simultaneous EnergyPlus simulations, and ResultsViewer enables browsing, plotting, and comparing EnergyPlus output time series data.

7. Ener-Win Version EC, June 2005 members.cox.net/enerwin

Ener-Win, originally developed at Texas A&M University, simulates hourly energy consumption in buildings, including annual and monthly energy consumption, peak demand charges, peak heating and cooling loads, solar heating fraction through glazing, daylighting contribution, and a life-cycle cost analysis. Design data, tabulated by zones, also show duct sizes and electric power requirements. The Ener-Win software is composed of several modules— an interface module, a weather data retrieval module, a sketching module, and an energy simulation module. The interface module includes a rudimentary building-sketching interface. Ener-Win requires only three basic inputs: (1) the building type, (2) the building's location, and (3) the building's geometrical data.

BESM Validation Methods

Typical building energy simulation program contains hundreds of variables and parameters. The number of possible cases that can be simulated by varying each of these parameters in combination is astronomical and cannot practically be fully tested. For this reason the NREL validation methodology required three different kinds of tests:

- Empirical Validation—in which calculated results from a program, subroutine, or algorithm are compared to monitored data from a real building, test cell, or laboratory experiment.
- Analytical Verification—in which outputs from a program, subroutine, or algorithm are compared to results from a known analytical solution or generally accepted numerical method for isolated heat transfer mechanisms under very simple and highly defined boundary conditions
- Comparative Testing—in which a program is compared to itself, or to other programs that may be considered better validated or more detailed and, presumably, more physically correct.

The Department of Energy (DOE), through the National Renewable Energy Laboratory (NREL), worked with the International Energy Agency Solar Cooling and Heating Programme Implementing Agreement (IEA SHC) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to develop standard methods of test for building energy analysis computer software. The Building Energy Simulation Tests (BESTEST) were developed under IEA SHC Tasks 8,12 and 22 (Task 12 was a collaborative effort with the IEA Buildings and Community Systems Programme). ASHRAE recently published ANSI/ASHRAE Standard 140 now version 2007 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs, which parallels many of tests in the first IEA SHC BESTEST (Judkoff and Neymark 2006).

Detail of assessment comparison of these simulation models are provided in Annex II of this progress report

C1-4 Activity 1.4.1 a & b: Study and identify the overall training courses for EE technologies and practices and financial arrangement in commercial buildings

BHRD (Bureau of Human Resource Development) , DEDE is the main division for developing and conducting all energy efficiency and renewable energy training activities in Thailand. The training courses divided into 5 groups as following :

Existing Training Courses:
Group 1: Training courses on Energy Management for Energy Conservation in Factories & Buildings
Group 2: Training courses on Energy Saving Technologies (By Technology)
Group 3: Training courses on Energy Saving in Industrial Sectors (By sub-sector)
Group 4: Training courses on Energy Saving in Building Sectors (By sub-sector)
Group 5: Training courses on Energy Saving for Academic

The Analysis of all existing training courses can be summarized as follows;

Advantage	Recommendation
1. Training courses have been developed and delivered to target groups cover all major targets by sector and sub-sector.	1. All training courses should be reviewed to avoid the duplication in the contents. 2. According to the approved budget of each fiscal year, there is several training courses have been launched in the same period. In this regard, level of competency for each training course should be clearly identified to assist participants in selection the training course to attend. 3. Clear training path for each target group should be clearly identified.
2. Compulsory training courses have been developed and delivered cover both commercial buildings and factories	There is only compulsory training courses have been designed for technical person only (PRE: Person Responsible for Energy). Compulsory training courses for energy manager on energy management system should be considered
3. Training courses have been develop and delivered to the target groups cover technology application courses for specific energy consumed system.	Existing training courses have been designed focusing on individual technologies or individual equipment. Designing of technical courses using system or whole facility approach could be considered
4. Training courses have been developed for major energy users and academic.	There is no training courses for professional engineer and architect

Recommended on Training Courses for Commercial Building Sector:

The training courses for commercial building sector are recommended in collaboration with the 20Yrs' Energy Efficiency Conservation Plan as following:

⇒ **Short term action (Y2011-Y2016)**
The training courses shall be developed to enhance knowledge management for all stakeholders and preparing for the coming AEC in Y2015. Key success of demonstrated projects shall be developed for training courses and get involved with professional consultants, lecturers, institutes, associations. A target-based approach is then recommended for the systematic development.

⇒ **Medium term action (Y2017-Y2022)**
The training courses shall be developed to leverage the professional ability or competency of educational institutes/consultants/Associations. These key stakeholders will drive all participants towards the low carbon society in the long term action.

⇒ **Long term action (Y2023-Y2030)**
The training courses shall be high-lighted for the integration among government agencies and entrepreneurs or Non-profit organizations. Better understanding and perception in Net Zero Energy Buildings : NZEBs will be the market driven activities associated for long term achievements.

The 20Y Energy Efficiency Conservation Plan aims to promote the level of energy saving capability of commercial buildings by encouraging each commercial building to move from existing low efficiency level toward Building Energy Code- BEC level, High Energy Performance Standard- HEPS level, Economic Building- Econ Level and Zero Energy Building, ZEB. The training courses for commercial buildings sector should be designed and developed using the same approach as 20Y Plan. Table 3.5 summarizes the training concept recommend for each level of energy saving capability.

Table 3.5 Training approach for commercial buildings based on level of energy saving capability

Type of Building based on Level of Energy Saving Capability	Building Characteristics	Training Approach
BEC (Building Energy Code)	Buildings which design and operate equipment/system comply with the Minimum Performance Specified by Thai Law/Standard. ⇒ ENCON Act B.E.2535 ⇒ Ministerial Regulations of New Building Energy Conservation Design B.E.2552	**A. Review Existing Training Courses** - Integrate the design concept of BEC Building into Conventional and Senior PRE Training courses - Integrate the design concept of BEC Building into training courses on

Type of Building based on Level of Energy Saving Capability	Building Characteristics	Training Approach
		energy saving in Building Sectors group **B. Develop new training courses** - Develop specific training courses for professional engineer and architect on BEC Building - Develop training course on Building Energy Simulation Model Software - Develop training course on Measuring of Actual Building Performance - Develop guidelines and training course on M&V/MRV Practices
HEPS (High Energy Performance Standards)	Buildings which design and operate with the high energy efficiency standard of various system which can be achievable by using current technologies	**A. Review Existing Training Courses** - Integrate energy performance standards of each major equipment or system into existing training courses on energy saving technologies group and energy saving in building sectors group. **B. Develop new Training Courses** - Develop Advanced Energy Saving Technologies in Commercial Building Training Courses
ECON (Economic Buildings)	Buildings which design & operate with the technologies of equipment and various systems are developed to be more energy efficient, but are still cost-effective	**A. Review Existing Training Courses** - Integrate Econ Building

Type of Building based on Level of Energy Saving Capability	Building Characteristics	Training Approach
	or Green buildings which specially concern on energy & water consumption and material usage during design/installation/operation/maintenance phases according to LEED and/or TREES standard	Concept into existing training courses on energy saving in Building Sectors group - Integrate Econ Building Concept into existing Conventional and Senior PRE Training Courses **B. Develop new training courses** - Develop training courses on related green building certification standard such as LEED, TREES
ZEB (Zero Energy Building)	Building which design and operate with the need for external energy supply to the buildings is near zero because the energy demand of such buildings is very low and there is also on-site energy generation from renewable energy	**A. Review Existing Training Courses** - Integrate ZEB Building Concept into existing training courses on energy saving in Building Sectors group - Integrate ZEB Building Concept into existing Conventional and Senior PRE Training Courses **B. Develop new training courses** - Develop training courses on application of renewable energy technologies for commercial buildings

The recommendation on development of training courses should comply with the target to promote the level of energy saving capability for commercial buildings in short, medium and long term achievements. Target group for each training course should be analyzed in order to provide the appropriate level of training to each target group.

Table 3.6 Initial analysis on current availability of required training courses for each target group – commercial building sector

Training Course	Developer	Owner & Executive	Building Staffs Engineer & Technician	Designer Engineer & Architect & Consultants	Government Officer
Level of competency	1	1	3	4	2
BASIC Knowledge					
Concept and approach of Energy Conservation in commercial buildings	NA	NA	A	NA	A
Operation & Maintenance					
Energy Management System in commercial buildings	NR	NR	A	NR	NR
Specialized training on energy saving technologies	NA	NA	A	NA	A
Specialized training on energy saving in commercial buildings	NA	NA	A	NA	A
DESIGN Practice					
Specialized on buildings standard	NA	NA	NA	NA	NA
Specialized training on energy efficient building design	NR	NR	NA	NA	NA
ENERGY AUDIT Practice					
Energy Audit for identifying Energy Saving Measures	NR	NR	A	NR	A
Measurement & Verification	NR	NR	NA	NR	NA

Note : A = Training Courses are available but need to be reviewed
NA = Training Courses are not available and need to be developed
NR = Training Courses are not required
Meaning of level of competency
Level 1 = Non technical content is required
Level 2 = Non technical content is required and basic concept of technical content is required
Level 3 = Technical content is required but not to design level
Level 4 = Technical content is required up to design level

3.3 Component 2 (C-2) Completed Works = 0.14%

C2-1 Propose definition of "Commercial Buildings" for the PEECB Project

Commercial Buildings in the PEECB project :

Based on the target setting from 20yrs' Energy Efficiency Development Plan , the large buildings include existing buildings and new buildings under the ENCON Act B.E.2535 (Designated Buildings >1MW over 5,000 buildings). Moreover, the buildings which related to common activities in the society will ultimately affect the energy consumption in the country. Therefore, the commercial buildings in the PEECB project will cover 8 major types of building under ENCON Act B.E2535 as followings,

1. Office Building
2. Department Store
3. Retail & Wholesale Business Facility
4. Hotel
5. Condominium
6. Medical Center
7. Educational Institution

Other types of building may be considered to be included in the project if there are significant energy consumption compare to the 8 major types of building.

C2-2 Activity 2.2.2a Review the Existing Specific Energy Consumption Index (SEC)

DEDE has undertaken several Specific Energy Consumption (SEC) studies. SEC values are generally presented as an average values for each type of buildings and reflected by the energy policy or economic situation either in Thailand and global.

One of the official studies on SEC was conducted by DEDE & DANIDA & AIT for developing energy building code in Thailand. SEC is one of the energy indicators high-lighted in the study (From 113 sampling buildings spread over 4 regional areas and Bangkok).

SEC could also be represented as various intensity of energy usage by system e.g. air-conditioning system and lighting system where the specific figures will be able to analyze, keep tracking and also can be used as reference for government officers or policy makers.

Table A1.1 below is the summary result of SECs from the study :

Table A1.1 Energy indices of designated buildings

		All	Office	Hotel	Hospital	Department Store	Educational Institution
$SEC_1 = \frac{\text{Total energy consumption}}{\text{A/C area} + \text{Non A/C area}}$ [kWh/m^2 yr]	# of Data	94	43	4	8	35	4
	Min.	25.5	25.5	109.4	83.8	111.0	33.3
	Max	660.1	660.1	179.3	234.9	536.5	128.9
	Average	226.0	198.0	134.7	134.9	307.3	89.9
$SEC_2 = \frac{\text{Total energy consumption}}{\text{A/C area}}$ [kWh/m^2 yr]	# of Data	94	43	4	8	35	4
	Min.	94.7	94.7	170.1	138.5	157.7	128.9
	Max	1455.9	1455.9	364.5	372.6	1079.6	249.6
	Average	338.1	346.3	247.3	245.6	377.3	182.0
$SEC_3 = \frac{\text{A/C energy consumption}}{\text{A/C area}}$ [kWh/m^2 yr]	# of Data	94	43	4	8	35	4
	Min.	26.0	26.0	114.3	100.2	70.4	63.6
	Max	810.5	810.5	256.4	258.9	585.6	165.0
	Average	170.8	179.9	163.0	165.9	168.3	111.9
$SEC_4 = \frac{\text{Lighting energy consumption}}{\text{Total area(Including carpark)}}$ [kWh/m^2 yr]	# of Data	94	43	4	8	35	4
	Min.	4.8	4.8	16.8	7.77	8.34	12.3
	Max	141.2	94.5	32.0	32.9	141.2	17.5
	Average	34.3	24.7	25.1	20.0	52.5	14.9
$SEC_5 = \frac{\text{Lighting energy consumption}}{\text{Total area(Excluding carpark)}}$ [kWh/m^2 yr]	# of Data	94	43	4	8	35	4
	Min.	4.8	4.8	20.7	11.0	13.6	11.4
	Max	163.5	94.5	38.2	32.9	163.5	17.4
	Average	47.1	32.7	29.4	21.8	76.3	14.7

In general, SEC_1 shall be used as an indicator for whole building performance where other SECs could be used as normative reference for system or equipment performance. However, the Energy consumption ratio and utilize characteristics of each system in typical buildings e.g. office, hotel, hospital, Department store etc. are also given useful information through the SEC figures. For example, the average of SEC_3 for Hotel building is 163.0 kWh/m^{2}yr which lower than office building (170.8 kWh/m^{2}yr) while the air-conditioning system of hotel consumed about 66% compared to office about 52%. This possibly cause by the hotel has 24 hours of operation which building envelop could maintain their cooling capacity better than heat gain into the building in case of office building during non-working hours at night and weekend.

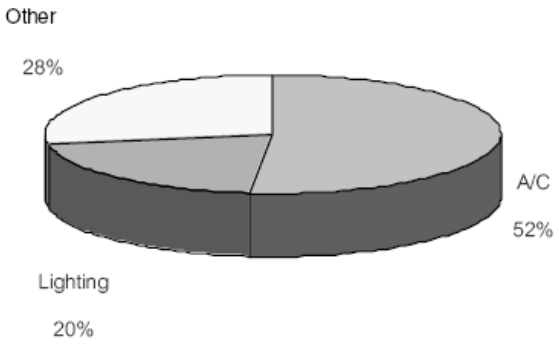


Figure C2-1 : Energy Breakdown of Office Building

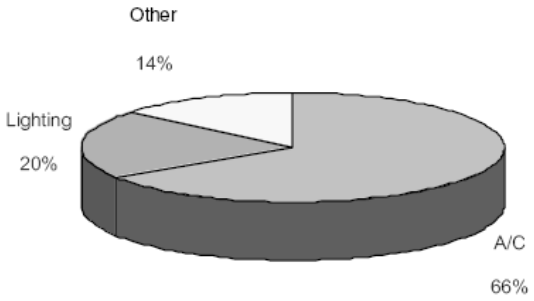


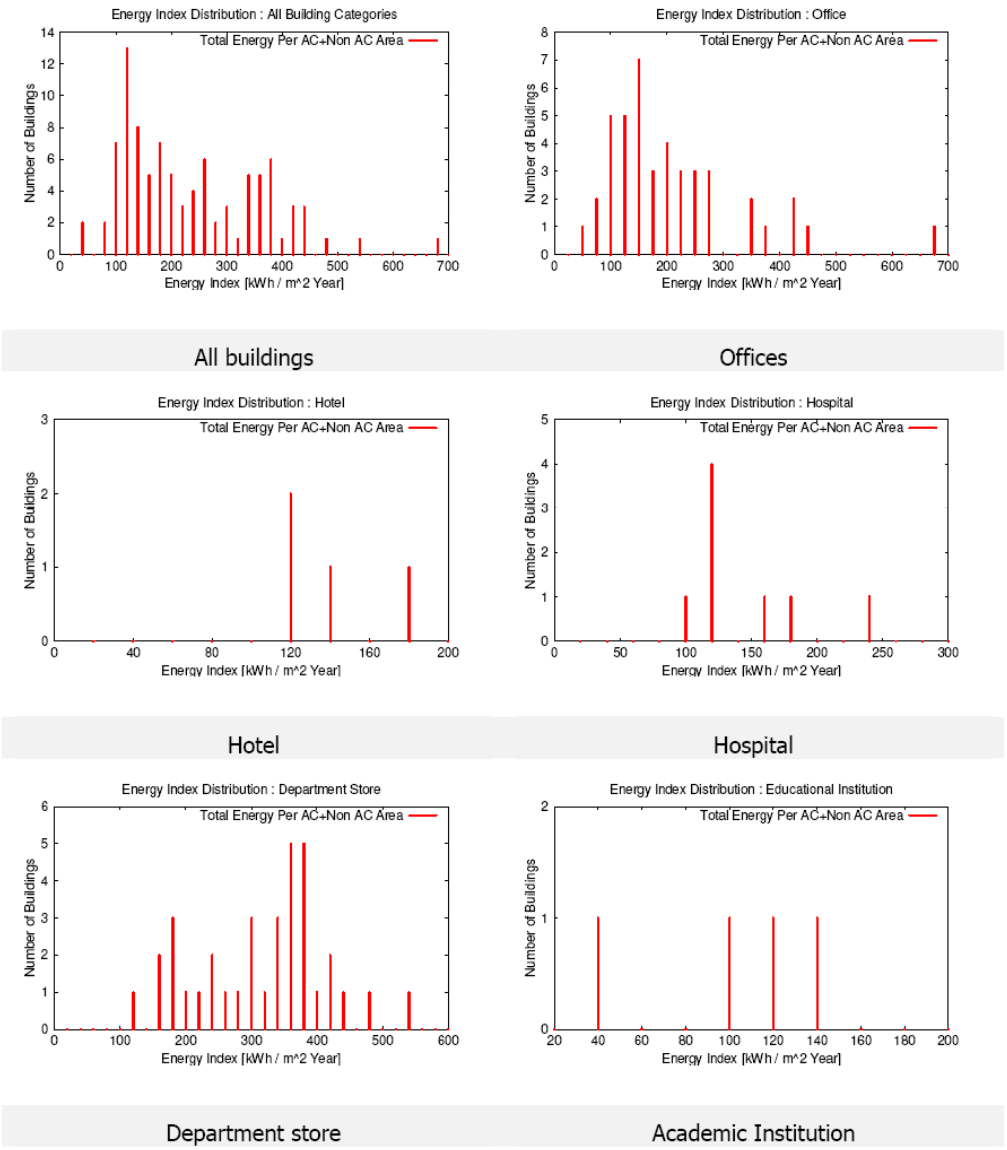
Figure C2-2 : Energy Breakdown of Hotel

For this reason, SEC shall be used as an indicator for design consideration of new buildings and operational consideration for existing buildings. The benchmarking of these figures shall be internally used by building engineers of their own building and/or externally used by all key stakeholders e.g. consultants, professional institutes, government agencies and policy makers to monitor the progress of the energy efficiency measures implementation.

The distribution of SEC for each type of building has shown as following bar charts:

Distribution of energy indices of designated buildings

Total electrical energy consumption per total floor area (excluding car park)



Any task required for the progression of SECs in different types of buildings (REF,BEC,HEPS,ECON,ZEB) above will be strongly highlighted in the target setting methodologies and action plan for component 1, 2 and 3.

Since the energy management report had been enforced by ENCON Act B.E.2535 (Revised B.E.2550), the numbers of SEC from each type of commercial buildings shall be interpret and up-to-date into building stock data as governed by BERC section, DEDE (Energy Regulation and Conservation Bureau).

Therefore, the 2nd progress report will summarized all SECs figures as DEDE's database using the up-to-date information from numbers of energy management reports submitted by all designated buildings/factories in Thailand.

C2-3 Activity 2.2.3 : Review Existing M&V Scheme for Completed Projects in Thailand

The M&V scheme of projects subsidized by DEDE are generally applied from IPMVP Option A, B or D where energy conservation measures (ECMs) are suitable for the verify savings.

The measurement and verification (M&V) process shall be incorporated with characteristics of each project. In addition, the scheme shall be able to monitor a sustainability of the project in terms of market penetration, user acceptance, business alignment etc. The following purposes have been analyzed from DEDE' projects implemented M&V scheme:

- **Increase energy savings**
  Accurate determination of energy savings gives facility owners and managers valuable feedback on their energy conservation measures (ECMs). This feedback helps them adjust ECM design or operations to improve savings, achieve greater persistence of savings over time, and lower variations in savings (Kats et al.1997 and 1999, Haberl et al.1996)

- **Document financial transactions**
  For some projects, the energy efficiency savings are the basis for performance-based financial payments and/or guarantee in a performance contract. A well-defined and implemented M&V Plan can be the basis for documenting performance in a transparent manner and subjected to independent verification.

- **Enhance financing for efficiency projects**
  A good M&V Plan increases the transparency and credibility of reports on the outcome of efficiency investments. It is also increases the credibility of projections for the outcome of efficiency investments. This credibility can increase the confidence that investors and sponsors have in energy efficiency projects, enhancing their chances of being financed.

- **Improve engineering design and facility operations and maintenance**
  The preparation of a good M&V Plan encourages comprehensive project design by including all M&V costs in the project's economics. Good M&V also helps managers discover and reduce maintenance and operating problems, so they can run facilities more effectively. Good M&V also provides feedback for future project designs.

- **Manage energy budget**
  Even where savings are not planned, M&V techniques help managers evaluate and manage energy usage to account for variances from budgets. M&V techniques are used to adjust for changing facility-operating conditions in order to set proper budgets and account for budget variances.

- **Enhance the value of the emission-reduction credits**
  Accounting for emission reductions provides additional value to efficiency projects. Use of an M&V plan for determining energy savings improves emissions-reduction reports compared to reports with no M&V plan.

- **Support evaluation of regional efficiency programs**
  Utility or government programs for managing the usage of an energy supply system can use M&V techniques to evaluate the savings at selected energy user facilities. Using statistical techniques and other assumptions, the savings determined by M&V activities at selected

individual facilities can help predict savings at unmeasured sites in order to report the performance of the entire program.

- **Increase public understanding of energy management as a public policy tool**

  By improving the credibility of energy management projects, M&V increases public acceptance of the related emission reduction. Such public acceptance encourages investment in energy-efficiency projects or the emission credits they may create. By enhancing savings, good M&V practice highlights the public benefits provided by good energy management, such as improved community health, reduced environmental degradation, and increased employment.

  It is envisaged that the projects in future shall be design for all M&V purposes mentioned above including all relevant activities aiming to in-line with the 20 yrs' energy efficiency development plan of DEDE as an indicative tools for the 4 strategic issues : Availability, Accessibility, Acceptability and Accountability.

Monitoring & Verifications (M&V) in Thailand:

The Monitoring and Verification (M&V) protocol previously developed by DEDE, as well as common approaches being adopted by ESCOs and EE consulting firms in Thailand and are mainly derived from 2 major international guidelines :

- IPMVP methodologies (Mostly used in energy efficiency projects)
- CDM methodologies (Mostly used in carbon credit projects)

IPMVP (International Performance Measurement and Verification Protocol)*

Efficiency Valuation Organization (EVO) publishes the International Performance Measurement and Verification Protocol (IPMVP) to increase investment in energy and water efficiency, demand management and renewable energy projects around the world.

The IPMVP promotes efficiency investments by the following activities:

- ⇒ IPMVP documents common terms and methods to evaluate performance of efficiency projects for buyers, sellers and financiers. Some of these terms and methods may be used in project agreements, though IPMVP does not offer contractual language.
- ⇒ IPMVP provides methods, with different levels of cost and accuracy, for determining savings either for the whole facility or for individual energy conservation measures
- ⇒ IPMVP specifies the contents of a Measurement and Verification Plan (M&V Plan). This M&V Plan adheres to widely accepted fundamental principles of M&V and should produce verifiable savings reports. An M&V Plan must be developed for each project by a qualified professional (e.g. Certified M&V Professional : CMVP)
- ⇒ IPMVP applies to a wide variety of facilities including existing and new buildings and industrial processes.

Benefits of Using IPMVP

IPMVP's history since 1995 and its international use bring the following benefits to programs that adhere to IPMVP's guidance.

- ⇒ **Substantiation of payments for performance**. Where financial payments are based on demonstrated energy savings, adherence to IPMVP ensures that *savings* follow good practice. An IPMVP-adherent saving report allows a customer, an energy user or a utility , to readily accepted reported performance. Energy Service Company (ESCOs) whose invoices are supported by IPMVP-adherent saving reports, usually receive prompt payments.
- ⇒ **Lower transaction costs in an energy performance contract.** Specification of IPMVP as the basis for designing a project's M&V can simplify the negotiations for an energy performance contract.
- ⇒ **International credibility for energy saving reports,** thereby increasing the value to a buyer of the associated energy savings.
- ⇒ **Enhanced rating under programs** to encourage or label sustainably designed and/or operated facilities.
- ⇒ **Help national and industry organizations promote and achieve resource efficiency and environmental objectives.** The IPMVP is widely adopted by national and regional government agencies and by industry organizations to help manage their programs and enhance the credibility of their reported results.

Though the application of IPMVP is unique to each project, certain types of users will have similar methods in their M&V Plans and implementation. The following are ways to use IPMVP :

- ☐ Energy performance contractors and their building customers
- ☐ Energy users doing their own retrofits and wanting to account for savings
- ☐ Facility managers properly accounting for energy budget variances
- ☐ New building designers
- ☐ New building designers seeking recognition for the sustainability of their designs
- ☐ Existing building managers seeking recognition for the environmental and quality of their building operations
- ☐ Emission reduction trading program designers
- ☐ Energy user's seeking ISO 50001 certification
- ☐ Etc.

IPMVP Option

IPMVP Option A & B (Retrofit Isolation) :

If the purpose of reporting is to help manage only the equipment affected by the savings program, *a measurement boundary* should be drawn around that equipment. Then all significant energy requirements of the equipment within the boundary can be determined. This approach is used as the *Retrofit Isolation Options* which categorized into :

- Option A : Retrofit Isolation (Key Parameter Measurement)
- Option B : Retrofit Isolation (All Parameter Measurement)

IPMVP Option C (Whole Facility) :
If the purpose of reporting is to help manage total *facility energy performance* , the meters measuring the supply of energy to the total facility can be used to assess performance and savings, The measurement boundary in this case encompasses the *whole facility*.

IPMVP Option D (Calibrated Simulation) :
If baseline or reporting period data are unreliable or unavailable, energy data from a *calibrated simulation program* can take the place of the missing data, for either part or all of the facility. The measurement boundary can be drawn accordingly.

The M&V scheme of projects subsidized by DEDE are generally applied IPMVP Option A ,B or D where energy conservation measures (ECMs) are suitable for the verify savings.

List of Major Implemented Project in Thailand having M&V process:

1. ESCO Revolving Fund by DEDE
2. Tax-incentive (Performance-based) by DEDE
3. Advanced Technologies Demonstration Project (Phase I & II) by DEDE
4. Demand Side Management by Bidding Mechanism (DSM Bidding) by EPPO
5. BEAT 2010 by EPPO

1. ESCO Revolving Fund

DEDE launches the program by using ENCON Fund for motivating the energy efficiency and renewable business in Thailand. The project appoints 2 fund managers: E for E (Energy for Environment Foundation) and ECFT (Energy Conservation Foundation of Thailand) providing the technical assistance & financing scheme for entrepreneur from industrial sectors and ESCOs in energy efficiency and renewable energy projects.

M&V Scheme :

Measurement & verification (M&V) is the key importance specifically in developing and determining viable energy efficiency or renewable energy projects e.g.

- Equity investment
- Carbon credit facility
- Technical assistance

Therefore, the M&V of this project is considerably applied for operational verification & saving verification. In general, IPMVP option A or B is applied.

2. Tax-incentive (Performance-based) program

M&V Scheme :

Measurement & verification (M&V) is the key importance specifically in determining tax-incentive calculation :

- Tax deduction = Cost savings x %tax rate (30%,25%,15%)

The M&V of this project is saving verification. In general, IPMVP option A is applied

3. Advanced Technologies Demonstration Project (Phase I&II)

M&V Scheme :

Measurement & verification (M&V) is the key importance specifically in determining energy saving calculation :

- Saving = Baseline – Post Audit

The M&V of this project is operational verification & saving verification. IPMVP option A is applied

4. Demand Side Management by Bidding Mechanism (DSM Bidding)

M&V Scheme :

Measurement & verification (M&V) is the key importance specifically in determining the calculation on energy price for bidding :

The M&V of this project is operational verification & Saving verification. IPMVP option A is applied

5. BEAT 2010 (Building Energy Awards of Thailand 2010)

M&V Scheme :

Measurement & verification (M&V) is the key importance specifically in determining energy efficiency index after implementing projects

The M&V of this project are both operational verification and saving verification. In general, IPMVP option A, B and C is applied

3.4 Component 3 (C-3) : No activities during progress report No.1 period

❖ There are no activities of this component during progress report No.1 period

(TOR4.9) Task 9: The Consultant shall submit the progress reports and other required reports within the project timeframe.

Submission of progress reports within Y2013

1. Inception Report to DEDE
   The inception report has been submitted to DEDE since 8 July 2013 with percentage of completed work at 5%
2. Progress Report No.1 is submitted to submit to DEDE with percentage of completed work at 11%
3. Progress Report No.2 is planned to submit to DEDE by October 2013 with percentage of expected work complete at 19%
4. Progress Report No.3 is planned to submit to DEDE by December 2013 with percentage of expected work complete at 25%

Detail of expected work complete of each component in each quarter is provided in Annex III of this first progress report

4. Expected Outputs in the next quarter (Progress Report No.2)

Expected outputs for Progress Report No.2 which is planned to submit to DEDE by October 2013 will consist of following work progress.

Project Management (PM)

PM-1 Organize PB meeting#2, PMU & Working Group meeting
PM-2 Conduct the 1st Public Seminar (Program Launch)

Component 1 (C-1)

C1-1 Activity 1.1.1b: Design & Development of CBEEC
C1-2 Activity 1.3.2a: Selection and Modification of BESM
C1-3 Activity 1.4.1c: Development of the Overall Training Program

Component 2 (C-2)

C2-1 Activity 2.2.1a: Data review of BESM (BEC) software
C2-2 Activity 2.2.2a: Review the Existing Specific Energy Consumption Index (SEC)
C2-3 Activity 2.2.3a: Review Existing M&V Scheme for Completed Projects in Thailand

Component 3 (C-3)

C3-1 Review application criteria for Demonstration Projects

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Part 1

Current Experiences of Advanced Energy Efficiency

by NIKKEN SEKKEI Research Institute

29, 30, May, 2013

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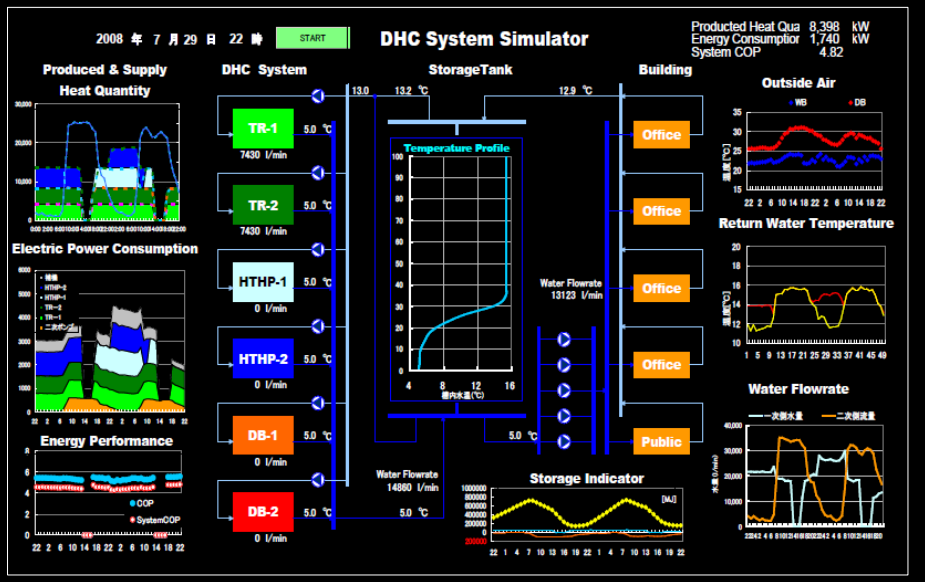

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Contents

1. Guideline of Green Building in Japan
2. Training Program & Technical Support
3. Energy Efficiency Technologies in Buildings in Japan
4. Smart Building and Smart City in Japan
5. Case studies by Simulation Tool for Building Energy Consumption

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1. Guideline of Green Building

Law & Guideline for Energy Saving and Environment of Buildings

National Energy Saving Law since 1979, revised 2012

<Tokyo Metropolitan City Government>
Manifest System of Building
Eco-efficiency since 2002
based on Environment municipal bylaw

CASBEE
for New Construction
for Renovation
for Households
for Urban Development
since 2001

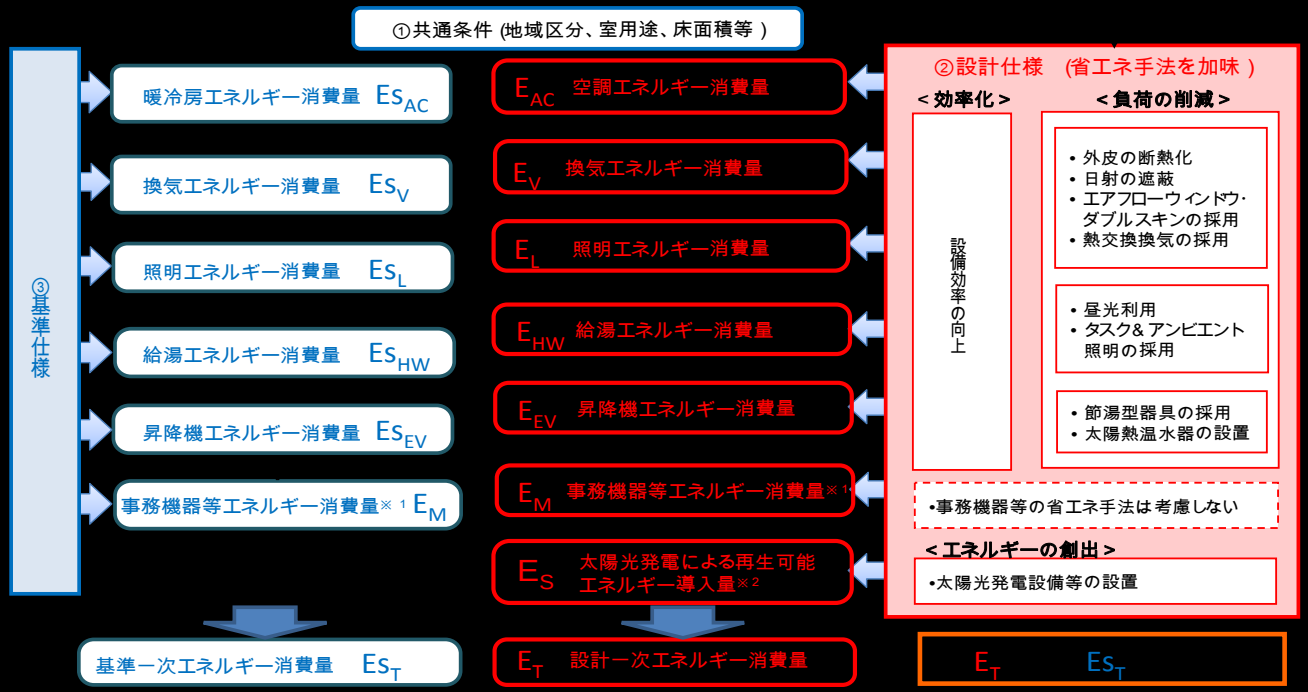
CASBEE of Local Government
(Nagoya, Osaka, Fukuoka, Yokohama, Kawasaki, etc.)

1. Guideline of Green Building

National Energy Saving Law (Since 1979, Revised in 2012)

1) Design & Construction stage :

- Submit 21 days before stating construction
- Total Floor area : over 2000m2 (New Built. Renovation)
  300m2 – 2000m2 (New Built)
- Evaluated by Perimeter Annual Load (PAL) and Primary annual energy consumption



Standard Primary energy consumption (Est)

Designed Primary energy consumption (Et)

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1. Guideline of Green Building

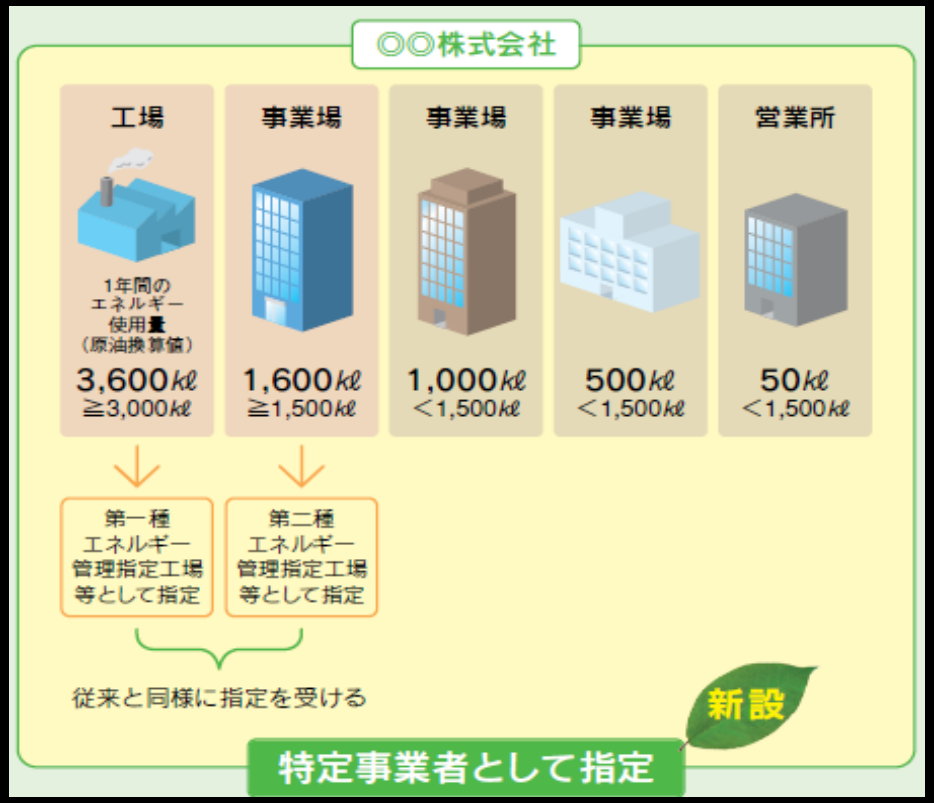
National Energy Saving Law (Since 1979, Revised in 2012)

2) Management stage :

Enterprises who consume following energy volume should submit the manifests.

Factory ; over 1500kL (Crude oil based)

Other building types ; over 3000kL



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1. Guideline of Green Building

National Energy Saving law (Since 1979, Revised in 2012)

「Energy saving indexes on Building types」

		HOTEL	HOSPITAL	SHOP	OFFICE	SCHOOL	RESTAU-RANT	HALLS	INDUSTRY
Eco efficiency	PAL [MJ/㎡年]	420	340	380	300	320	550	550	-
	CEC/AC	2.5	2.5	1.7	1.5	1.5	2.2	2.2	-
	CEC/V	1.0	1.0	0.9	1.0	0.8	1.5	1.0	-
	CEC/L	1.0							
	CEC/HW	配管長さ / 給湯量に応じて、1.5~1.9							
	CEC/EV	1.0	-	-	1.0	-	-	-	-
仕様基準		100 以上　※各項目とも、共通							

PAL : Perimeter annual load
CEC : Co-efficiency of Energy consumption, AC :Air Conditioning, V :Ventilating, L :Lighting, HW :Hot water,

CEC (Co-efficiency of Energy consumption) will be replaced by the index of annual energy consumption per m2(MJ/m2/year) in 2013.

Tokyo Metropolitan City Government

1) Design & Construction stage : Manifest System of Building Eco-efficiency (Since 2002)

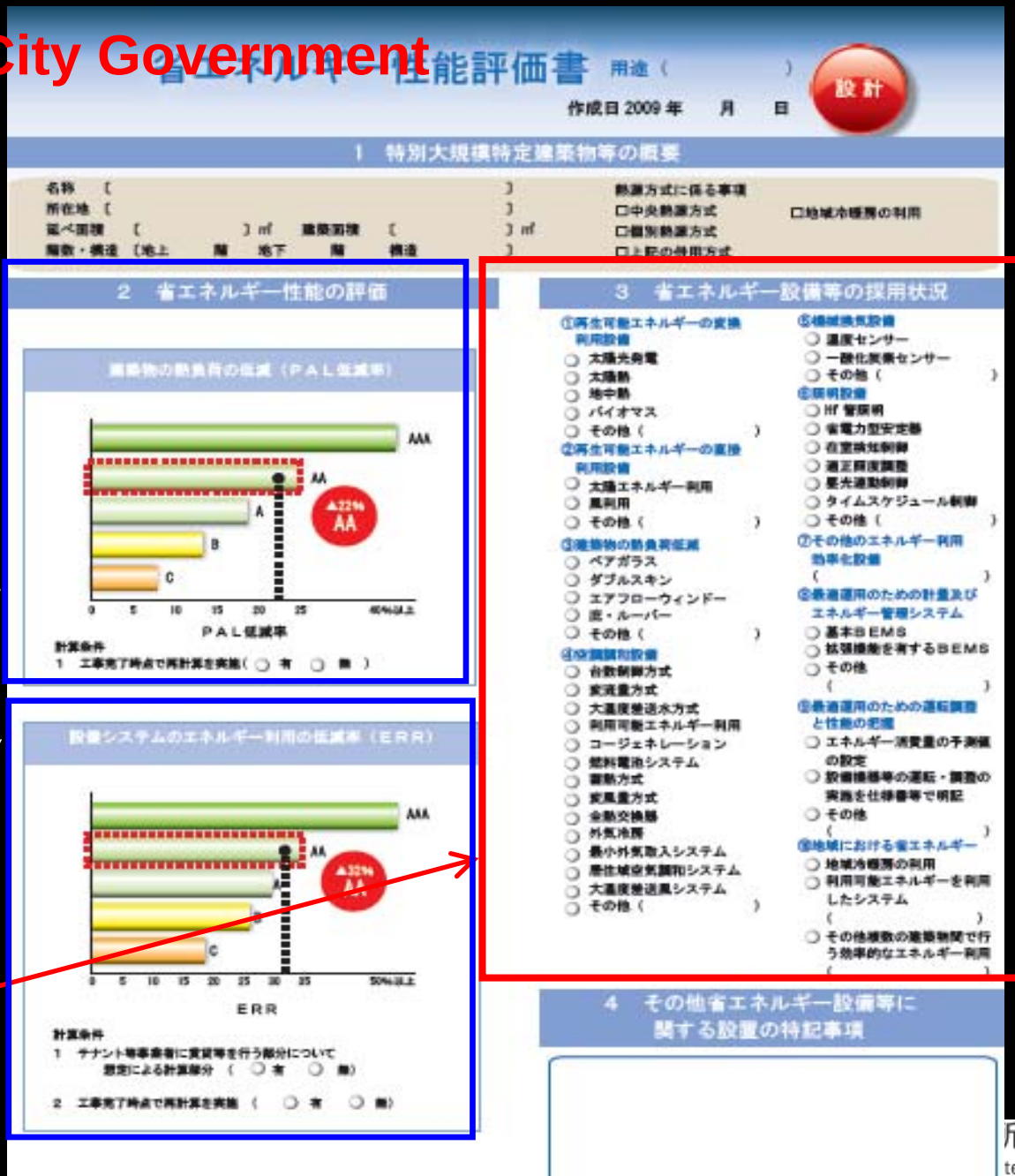
- Founded Manifest System of Building Eco-efficiency based on a Environmental Friendly Municipal bylaw since July, 2002.
- Should submit Manifest when New construction of buildings as follows
  1) Total floor are over 5,000㎡ : Obligation
  2) Total floor are over 10,000㎡ : Obligation and prepare additional low energy performance paper
- Manifests submitted to Tokyo City Government are listed up on Tokyo City's HP
- Target of environmental friendly
  1) Comprehensive energy saving (Heat load reduction, Low energy system, Renewable energy use)
  2) Appropriate usage of resources (Eco-materials, Long life, preservation Ozone layer)
  3) Preservation of natural environment (Water, Greenery)
  4) Mitigation of Heat Island phenomena

1. Guideline of Green Building

Tokyo Metropolitan City Government

Sample :

Low Energy Efficient Manifest



建物の断熱性能の評価と判定

建物の設備の総合省エネルギー効率の評価と判定

各種省エネルギー手法の採用の有無のチェック
※本計画でも、この部分を活

Tokyo Metropolitan City Government

1) Design & Construction stage : Manifest System of Building Eco-efficiency （Since 2002）

- **Requirement of energy saving performance in Manifest**

Evaluate energy saving targets by using PAL and ERR (Energy reduction rate of building equipments)

Revel 1　Over 10,000m2 building should be required

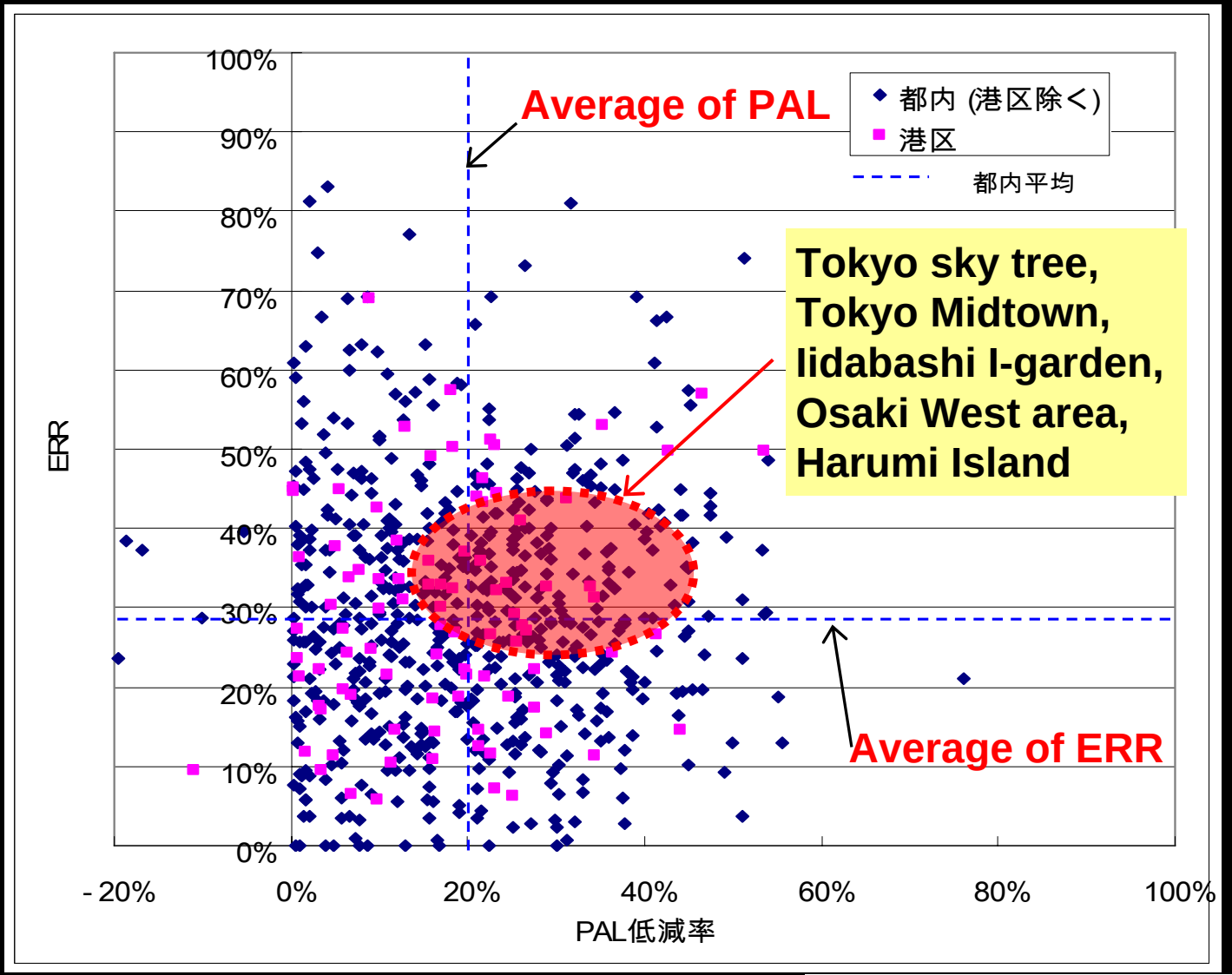
Revel 2

Revel 3　Base line for incentive to increase floor area ratio on big projects in CBD

Rank	Heat Efficiency of Wall (PAL)	Building equipment's Efficiency (ERR)	Level on Manifest
AAA	25% <	35% <	Level 3
AA	20 – 25%	30 – 35%	Level 2
A	15 – 20%	25– 30%	Level 2
B	10 – 15%	15 – 25%	Level 1
C	<10%	5 - 15%	Level 1

Tokyo Metropolitan City Government

Status of PAL & ERR on prior submitted manifests in Tokyo City



Tokyo Metropolitan City Government

2) Management stage : Manifest System for Measures against Global Warming

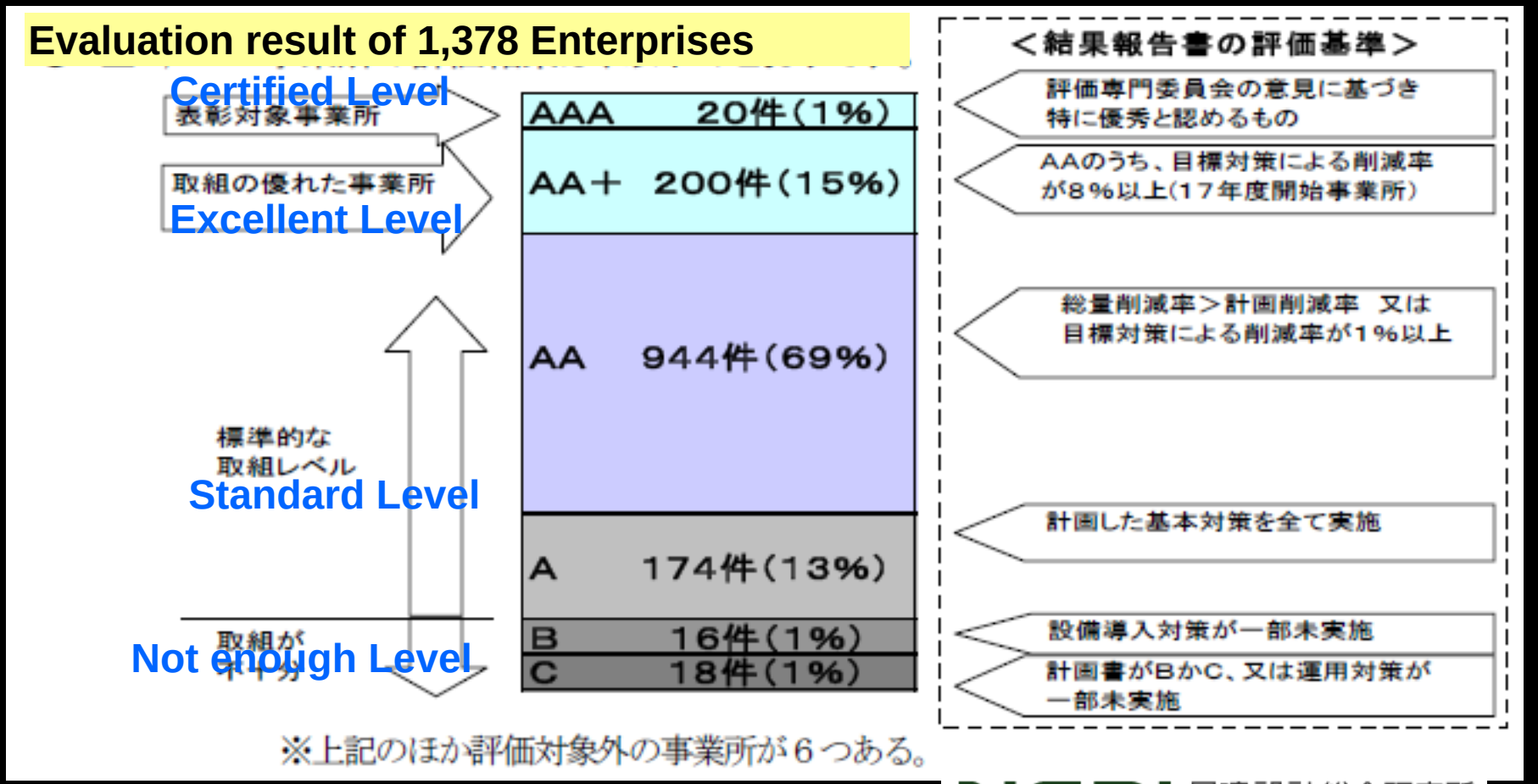
- Enterprise that consume 1500kl of energy including electricity power, thermal energy, and oil should submit this Manifest (and report about implementation) .
- The period of Monitoring and managing energy consumption is 6 years.
- Manifests and report should be described about setting low energy targets and energy saving plan on each year for 6 years.
- Total energy saving target should exceeds over 6% for 6 years.
- The reports should describe as follows ;
  1) Energy saving target and methodology on each year
  2) Result of energy saving on each year
  3) Annual CO2 Emission
- Tokyo City Government judges Manifests and implementation reports by ranking 5 grades (AAA, AA, A, B, C) .
- Manifests and reports submitted to Tokyo City Government are listed up on Tokyo City's HP

Tokyo Metropolitan City Government

2) Management stage :

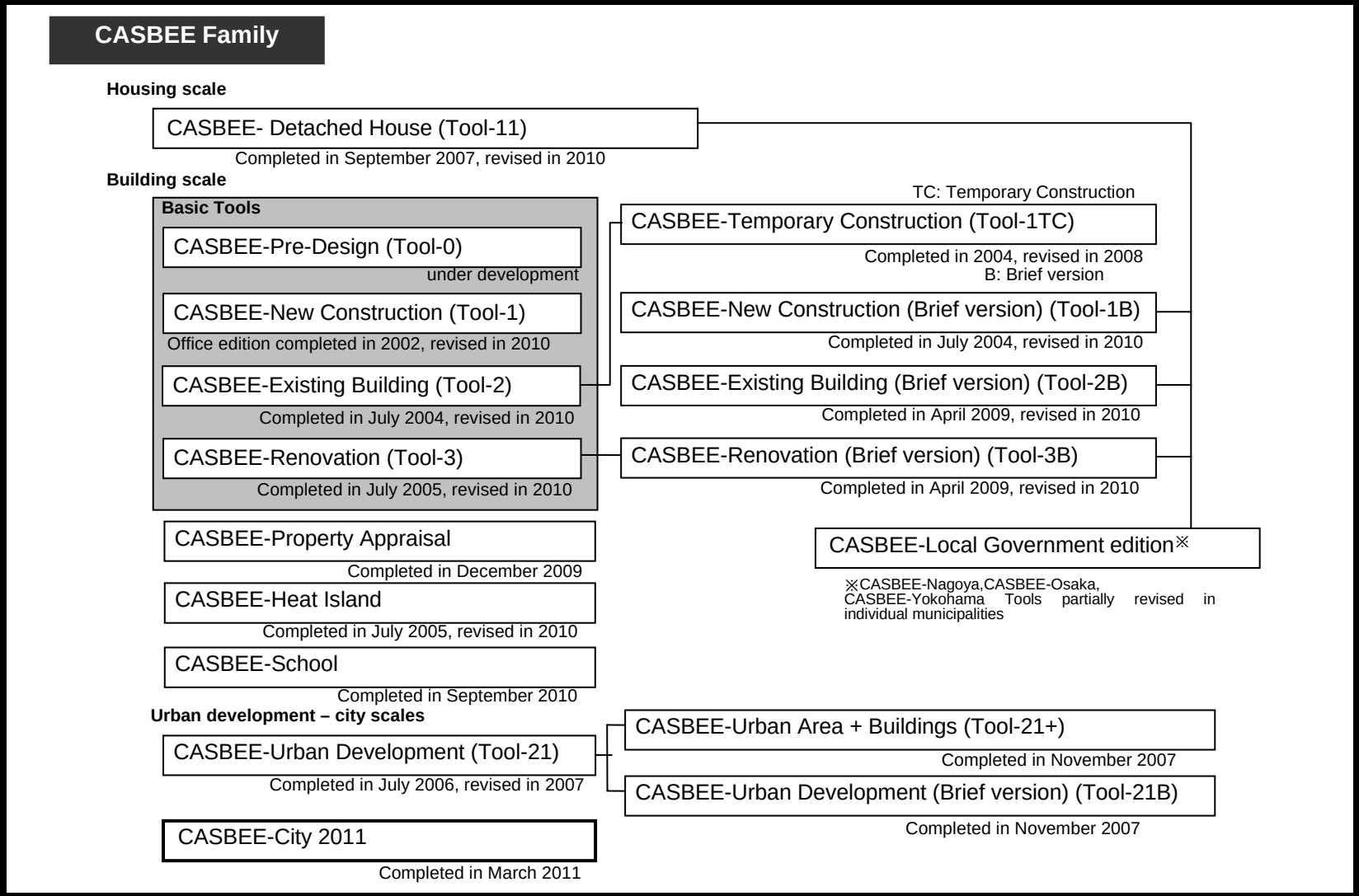
Manifest System for Measures against Global Warming

Result of CO_2 reduction by this Manifest from 2005 to 2009 of around 1378 enterprise



1. Guideline of Green Building

CASBEE ; Comprehensive Assessment System for Built Environment Efficiency



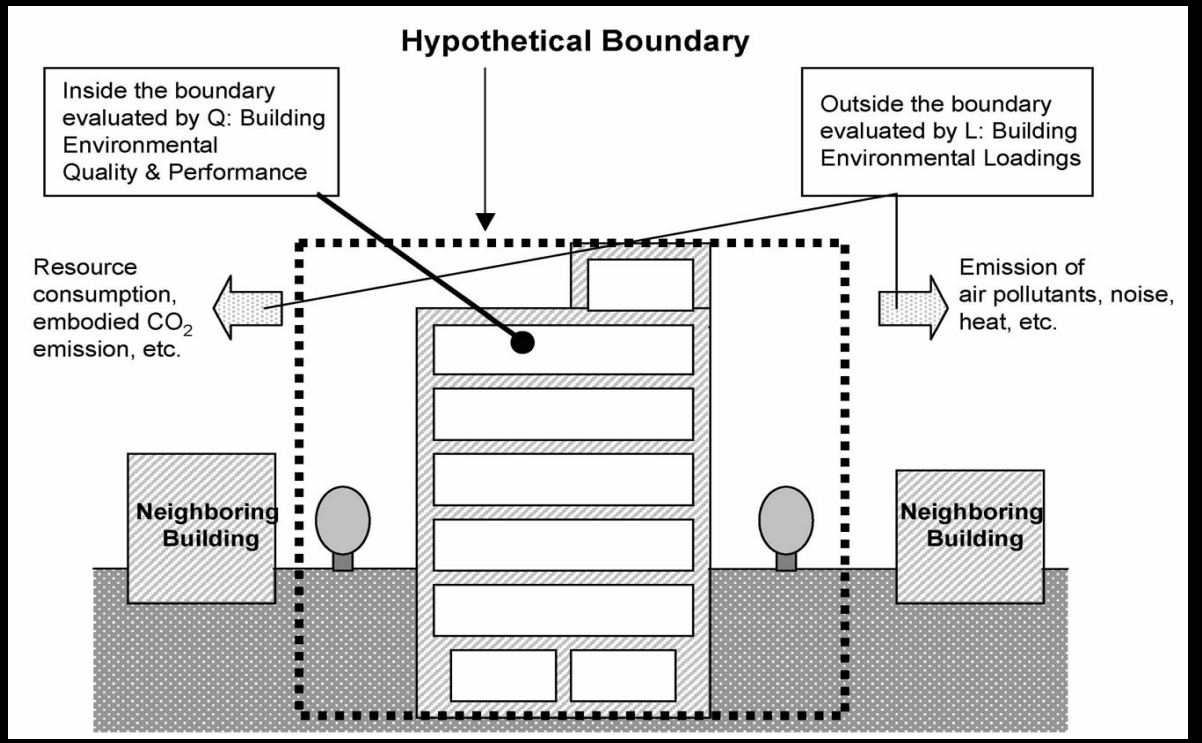
1. Guideline of Green Building

CASBEE ; Comprehensive Assessment System for Built Environment Efficiency

Under CASBEE there are two spaces, internal and external, divided by the hypothetical boundary, which is defined by the site boundary and other elements, with two factors related to the two spaces. Thus we have put forward CASBEE in which the "negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside (the public property)" and "improving living amenity for the building users" are considered side by side. \Under CASBEE, these two factors are defined below as Q and L, the main assessment categories, and evaluated separately.

- Q (Quality): Built Environment Quality Evaluates "improvement in living amenity for the building users, within the hypothetical enclosed space (the private property)."

- L (Load): Built Environment Load Evaluates "negative aspects of environmental impact which go beyond the hypothetical enclosed space to the outside."



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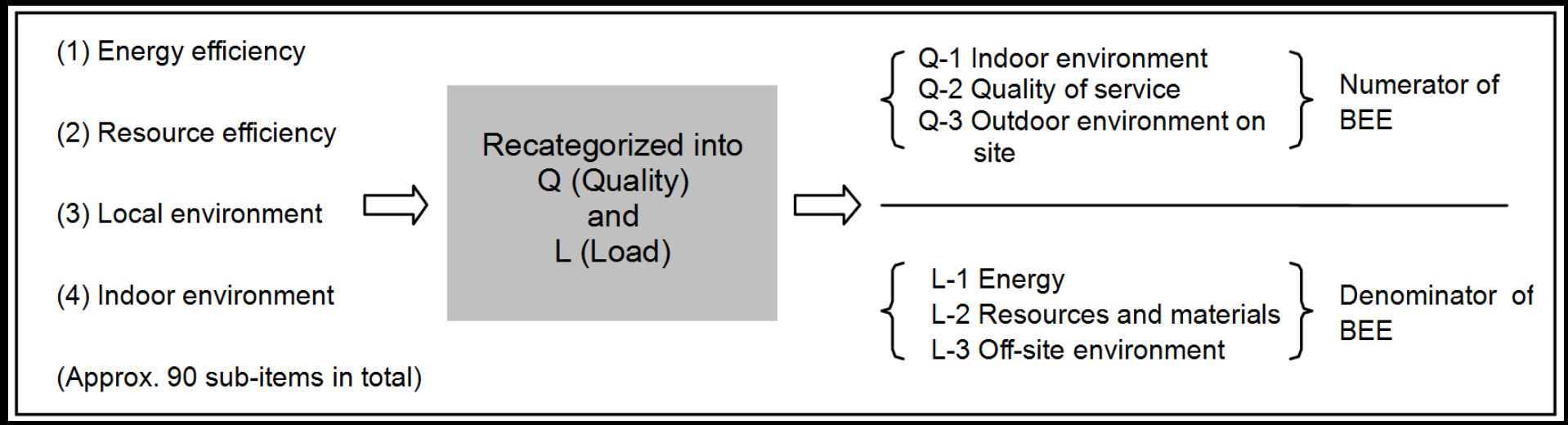
CASBEE

Four Target Fields of CASBEE and Its Rearrangement

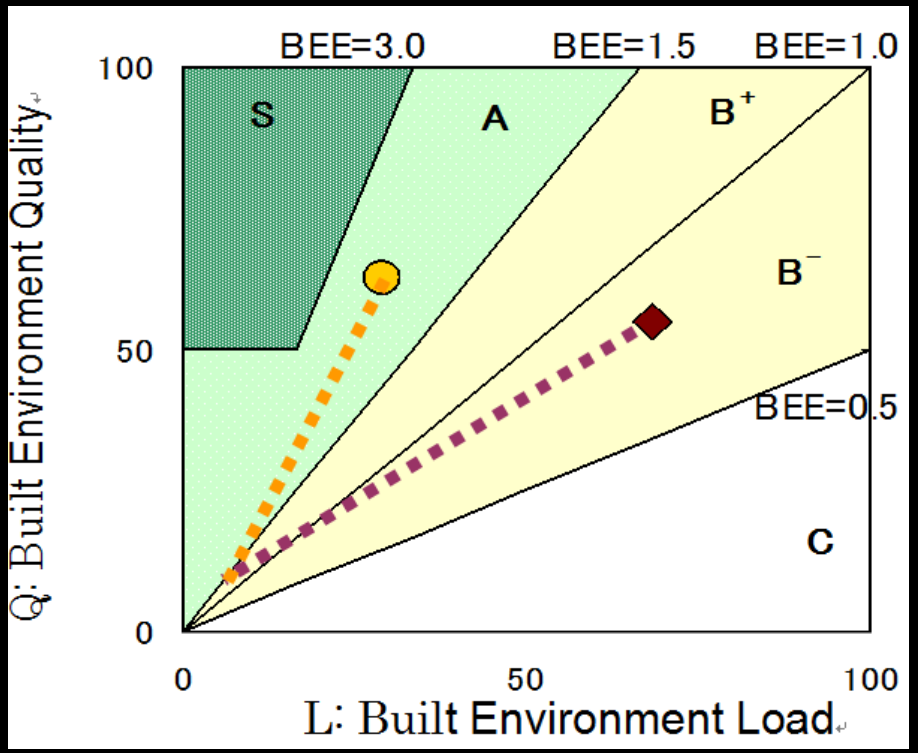
CASBEE covers the following four assessment fields: (1) Energy efficiency (2) Resource efficiency (3) Local environment (4) Indoor environment. These four fields are largely the same as the target fields for the existing assessment tools described above in Japan and abroad, but they do not necessarily represent the same concepts, so it is difficult to deal with them on the same basis. Therefore the assessment categories contained within these four fields had to be examined and reorganized. As a result, the assessment categories were classified as shown in Figure 4 into BEE numerator Q (built environment quality) and BEE denominator L (built environment load). Q is further divided into three items for assessment: Q1 Indoor environment, Q2 Quality of services and Q3 Outdoor environment on site. Similarly, L is divided into L1 Energy, L2 Resources & Materials and L3 Off-site Environment.



Classification and rearrangement of assessment items into Q (built environment quality) and L (built environment load)

CASBEE

$$\text{Built Environment Efficiency (BEE)} = \frac{\text{Q (Built environment quality)}}{\text{L (Built environment load)}}$$



Environmental Labeling Using Built Environment Efficiency (BEE)

As explained above, BEE (Building Environment Efficiency), using Q and L as the two assessment categories, is the core concept of CASBEE. BEE, as used here, is an indicator calculated from Q (built environmental quality) as the numerator and L (built environment load) as the denominator.

The use of BEE enabled simpler and clearer presentation of building environmental performance assessment results. BEE values are represented on the graph by plotting L on the x axis and Q on the y axis. The BEE value assessment result is expressed as the gradient of the straight line passing through the origin (0,0).

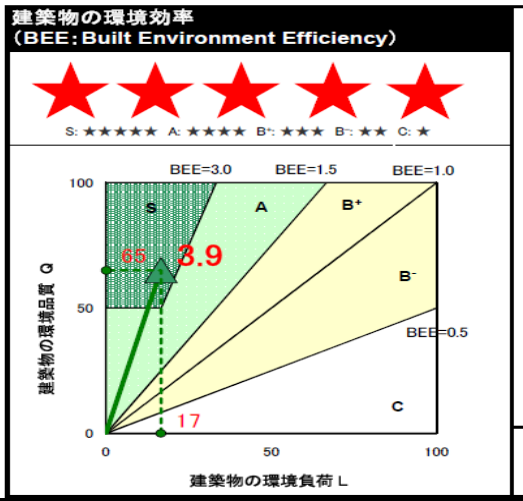
1. Guideline of Green Building

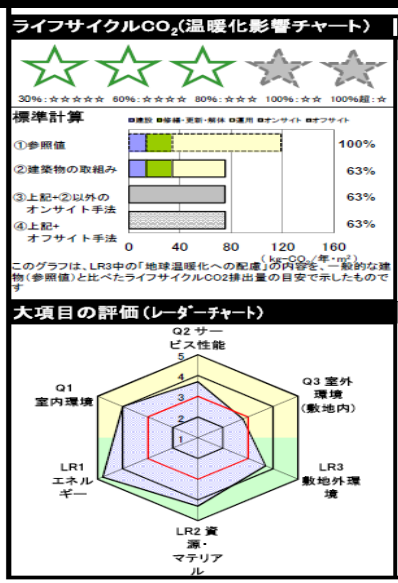
CASBEE

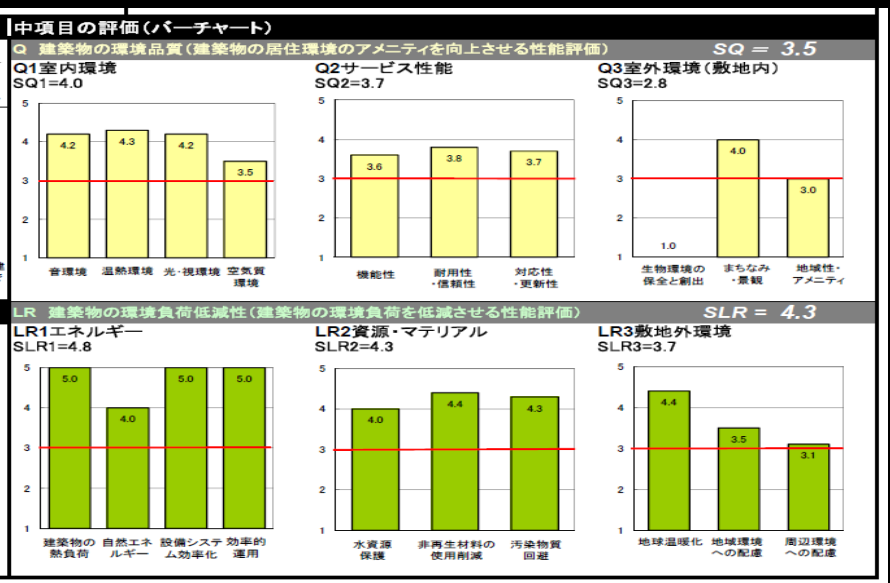
CASBEE Certified Buildings

As of February 2013, the number of CASBEE certified buildings is 196.

建物用途	事務所	敷地面積	387.43㎡
建設地	東京都中央区日本橋茅場町一丁目20番7,8号	建築面積	297.04㎡
気候区分	—	延床面積	2,869.95㎡
地域・地区	商業地域、防火地域	階数	地上10F、地下1F
竣工日	2013/5/10(予定)	構造	S造







2. Training Program and Technical Support

Training Program and Technical Support for Building Energy Management Staff

1) Official Training Meetings and Workshops :

Guidance for National energy Saving Law by MLIT

Guidance for Green Building Guideline of Tokyo Government

2) Qualified : Registered Energy Manager by METI

3) Diagnosis for Energy Saving (Dispatching Experts without fee)

4) Award system : Low Energy Award for Experts

5) Recognition system

: SEESER (Superior Enterprise Evaluation system in environmental Load Reduction) for Energy managers who succeeded in advanced energy reduction ; The Building Energy Manager's Association, Japan

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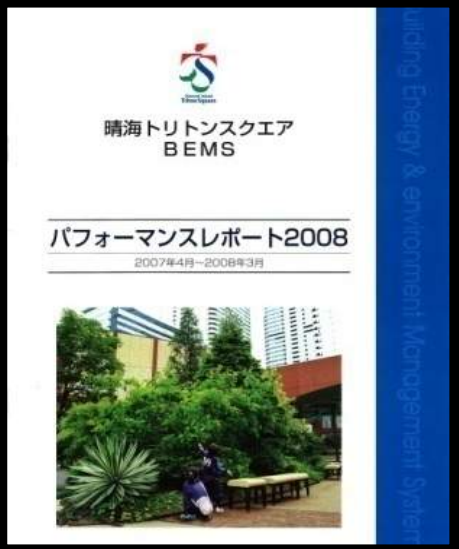
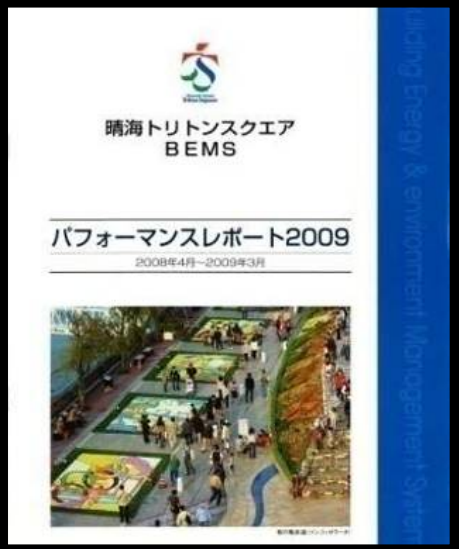
Supporting Low Energy Management in Harumi Triton by Nikken Sekkei

NSRI has been supporting low energy management over 10 years. The comprehensive challenges for energy reduction is reported every year!

Publishing Environmental Reports for 10 years





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Contents

1. Guideline of Green Building in Japan
2. Training Program & Technical Support
3. Energy Efficiency Technologies in Buildings in Japan
4. Smart Building and Smart City in Japan
5. Case studies for Simulation Tool for Building Energy Consumption

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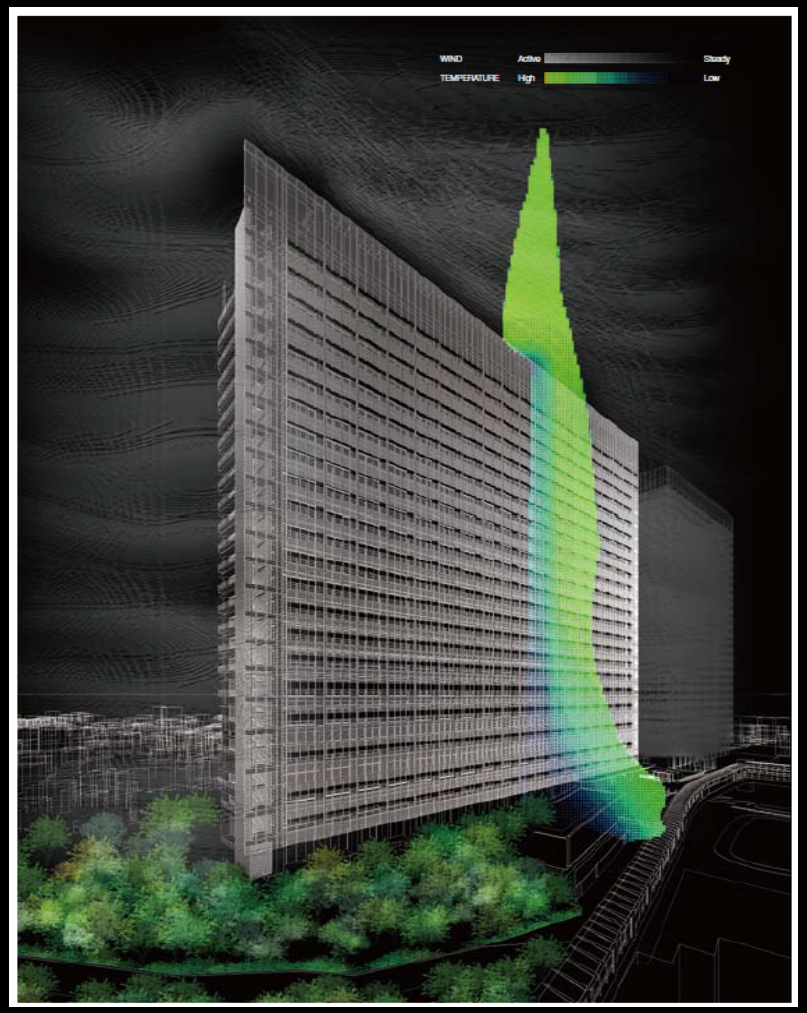
3. Energy Efficiency Technologies in Buildings in Japan

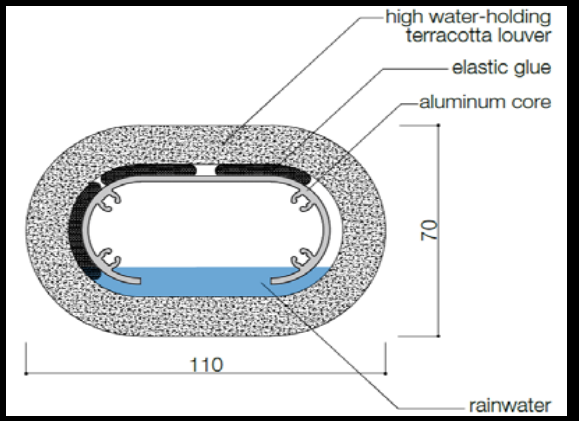
Sony's Osaki new building Project



Thermal environmental simulation around building façade. Cool air around 2 degree lower from façade goes down to ground revel

Evaporating façade System

Mock-up of unglazed ceramic screens



Section of unglazed ceramic pipe

Mock-up of unglazed ceramic pipe

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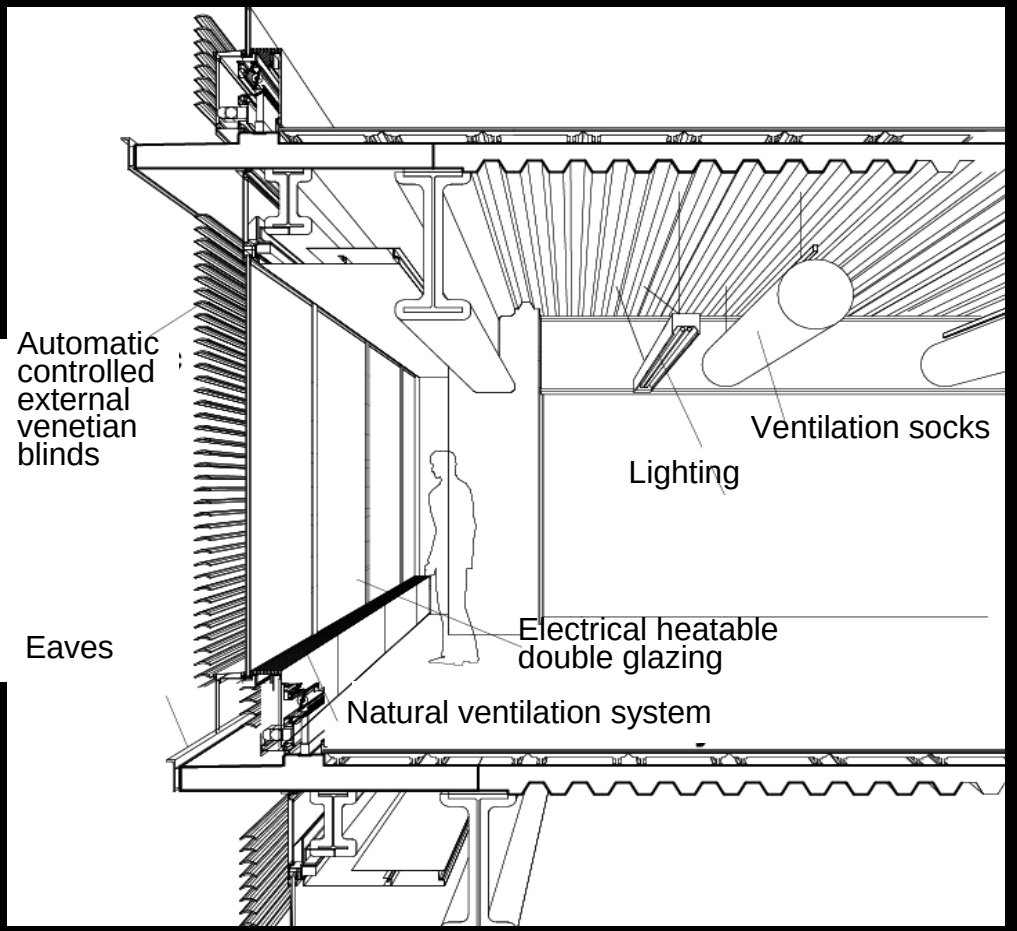
3. Energy Efficiency Technologies in Buildings in Japan

Nikken Sekkei Tokyo Building

Outside Louver (Automatic Movable angle)



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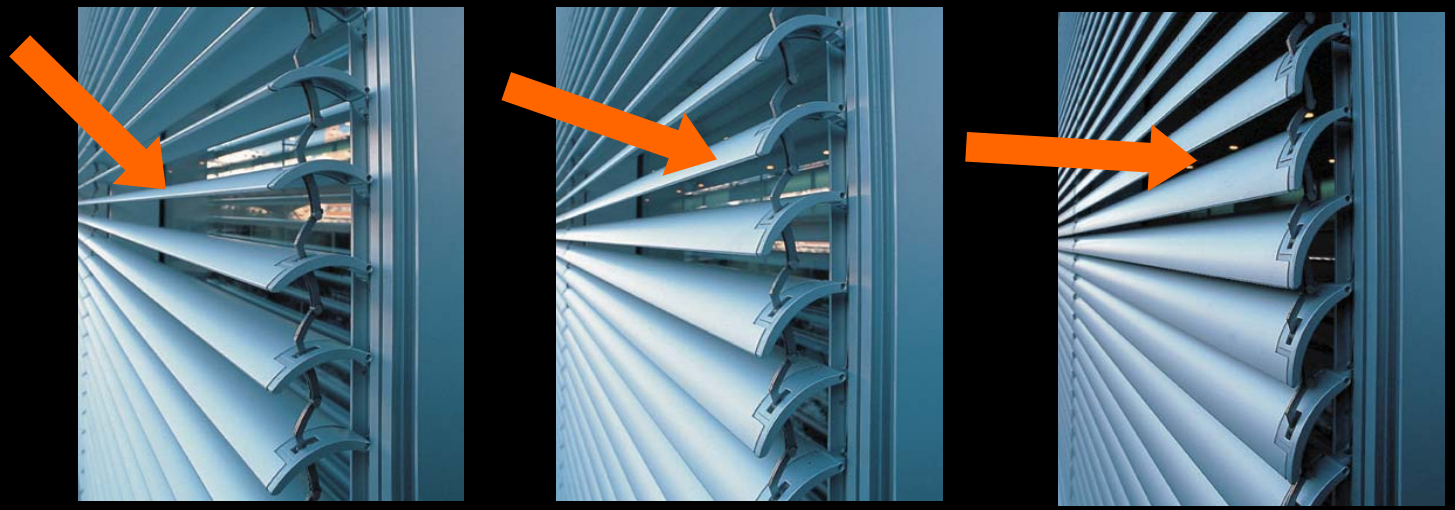
Nikken Sekkei Tokyo Building

Exterior daylight control louver reduces solar heat gain and enhances effective natural lighting.



Actual Energy consumption:

1500MJ/m² per year

-CO_2 emission

59kg-CO_2/m² per year vs Average of office in Tokyo 107kg-CO2

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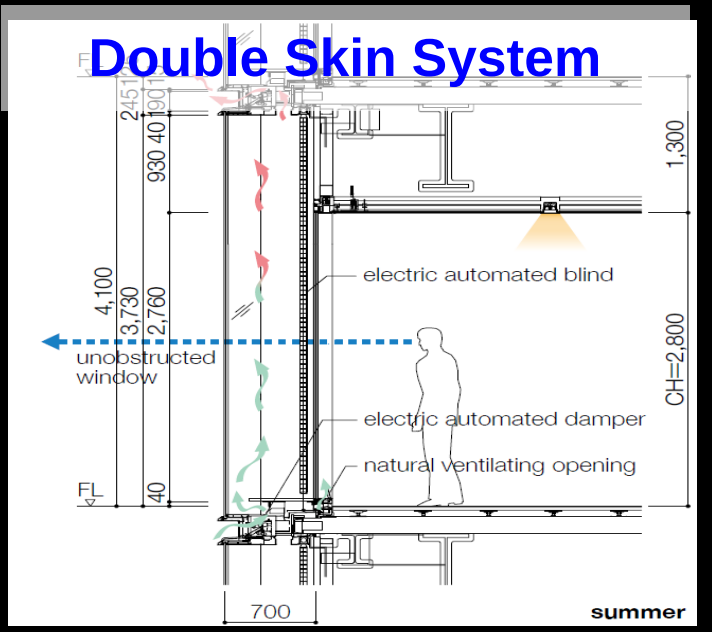
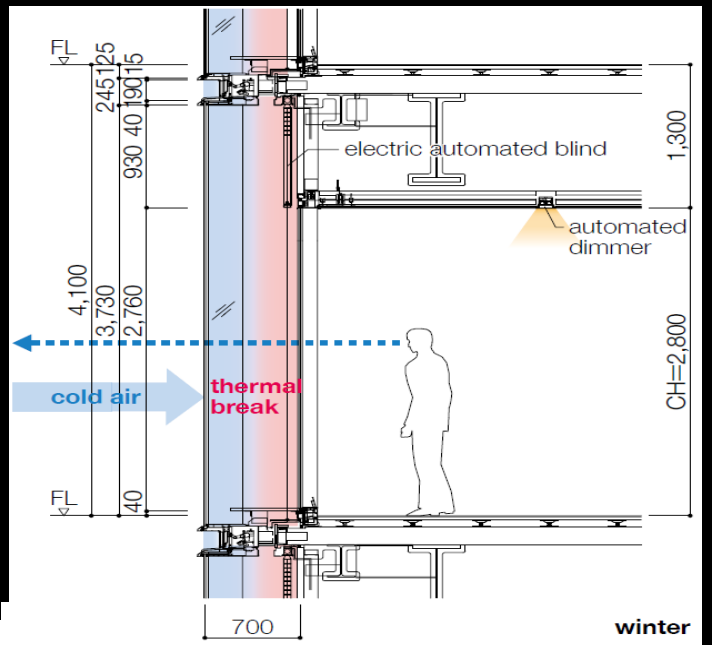
3. Energy Efficiency Technologies in Buildings in Japan

Chiba-ken Jichikaikan

Double Skin System



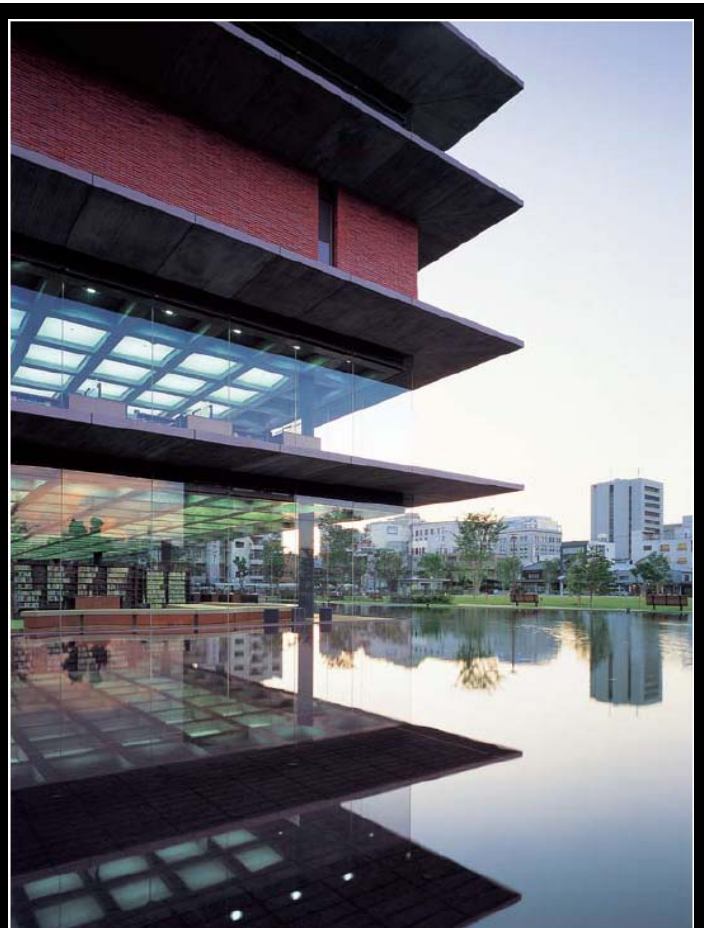


* The skins are opened and closed by sensors

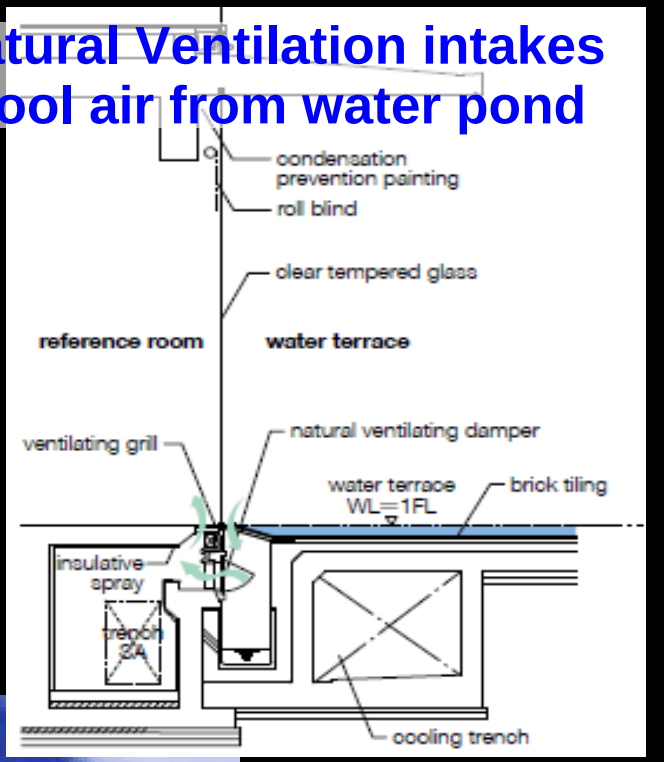
3. Energy Efficiency Technologies in Buildings in Japan

Fukuyama City Study Hall “Rose Community”

In the Fukuyama City Study Hall “Rose Community”, the building faces a large water terrace, and a passive cooling method is used whereby outside air in an 80m long supply trench located just below the water terrace is pre-cooled through evaporative cooling. The air is then drawn through the building through ventilating dampers, grilles and windows on the water terrace side.



Natural Ventilation intakes Cool air from water pond



Natural ventilation air intake detail.

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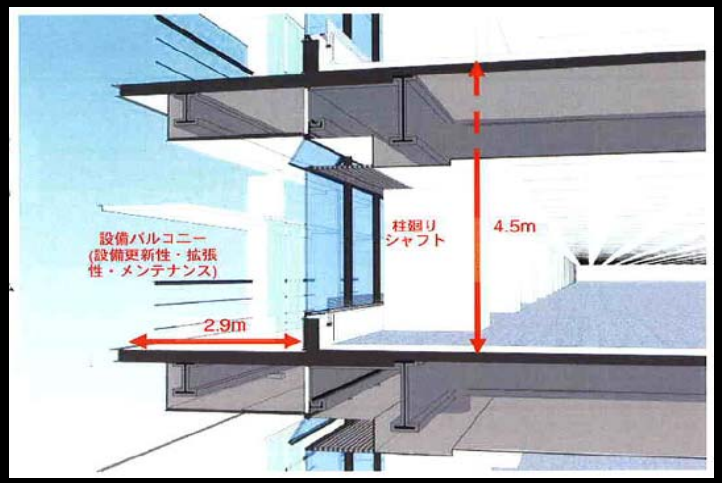
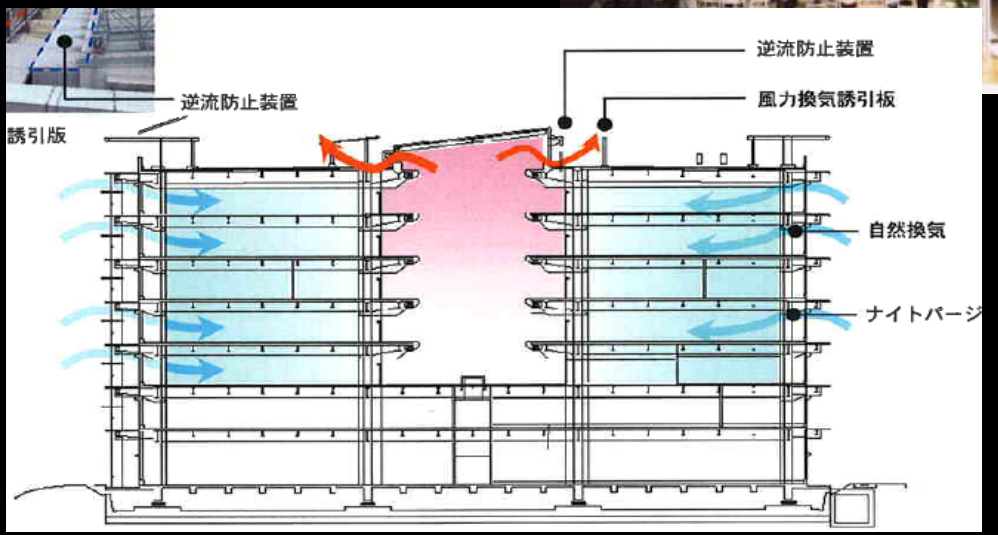
3. Energy Efficiency Technologies in Buildings in Japan

R&D Building
Honored Sustainable Building Award 2007(SB07) , MLIT

This is a IT company research building .
This building have adopted **over 100 low carbon measures** for load reduction, natural energy use, and high efficient mechanical and electrical equipments.





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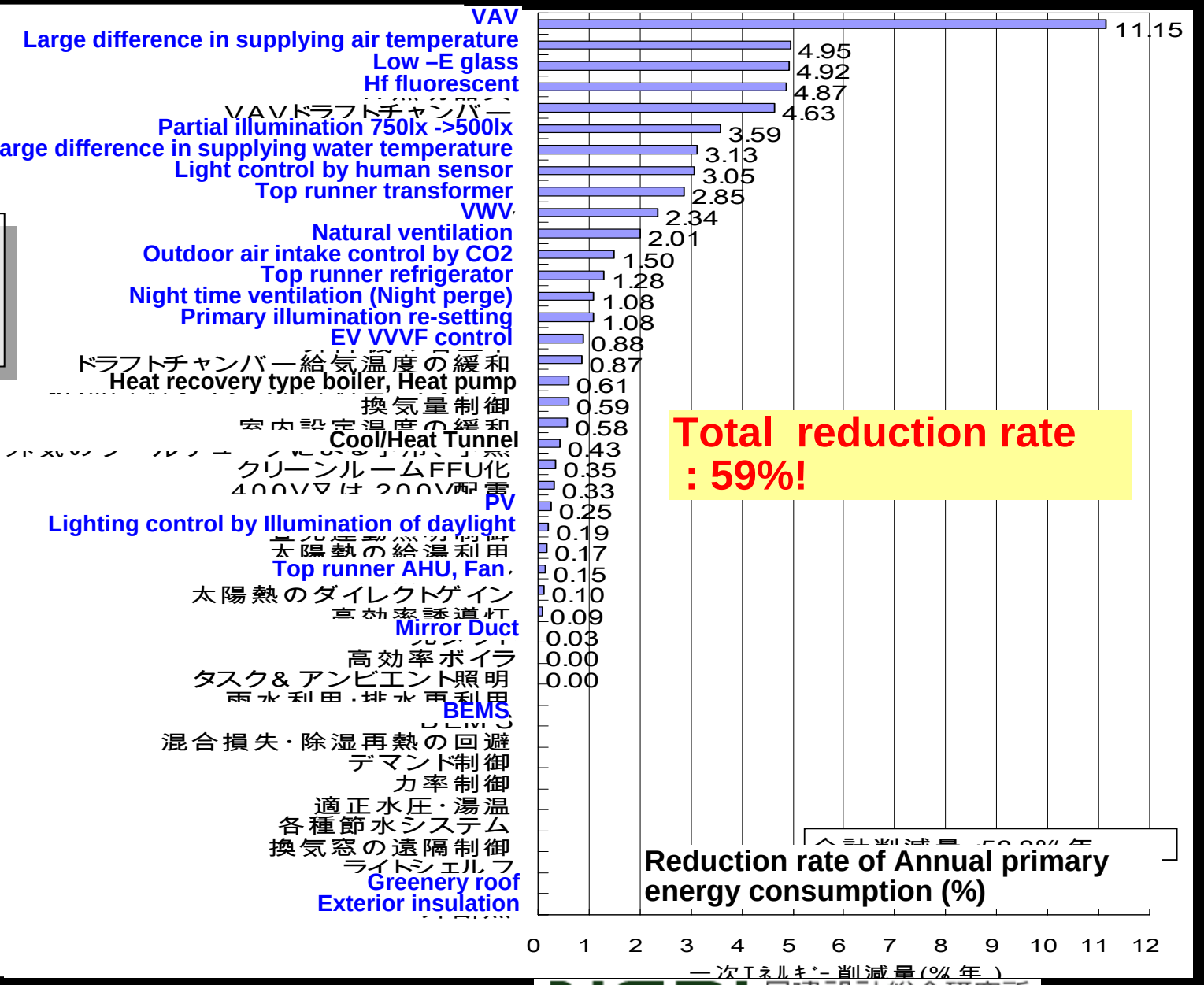
3. Energy Efficiency Technologies in Buildings in Japan

Comprehensive low carbon measures



Total reduction rate : 59%!

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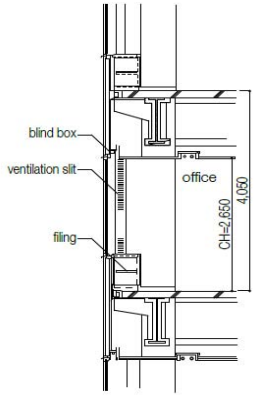
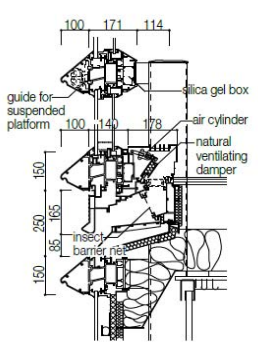
Skin Design #1
Wind Intake "Natural Ventilation"

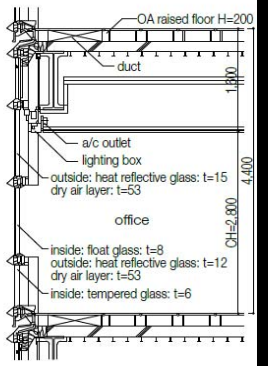
Tokyo Sumitomo Twin Buildings
1988



Detail

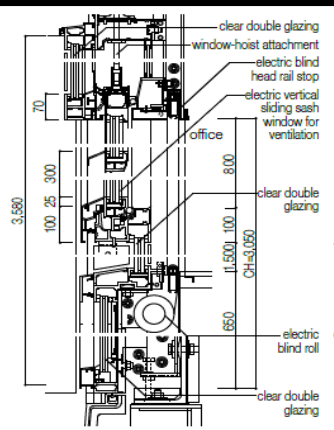
The San-In Godo Bank Headquarter Office
1997



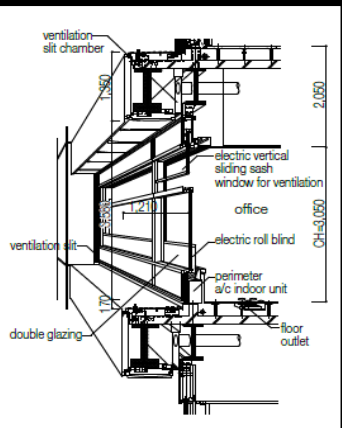


Detail

The Headquarters office of the Long-Term Credit Bank of Japan
1993

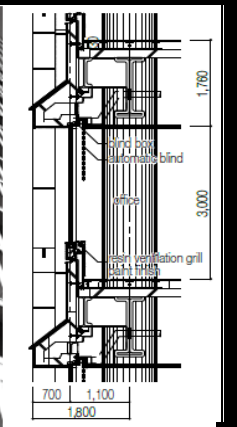


Detail



Perspective Detail

Nihon Seimei Marunouchi Building
2004



Detail

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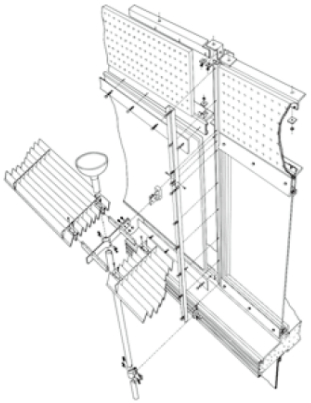
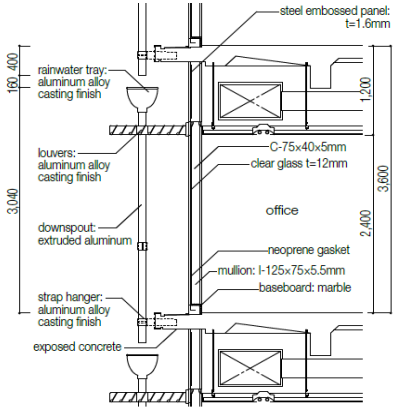
Skin Design #2
Control Light “Light Shelves” “Light Ducts” “External Louvers”

Palaceside Building
1966

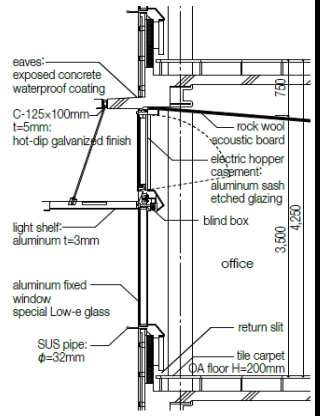


Axonometric
アクソメ



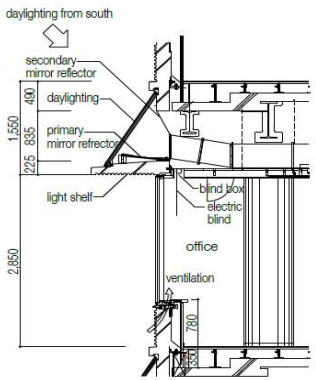
Detail
ディテール

Tokyo Gas Earth Port
1996



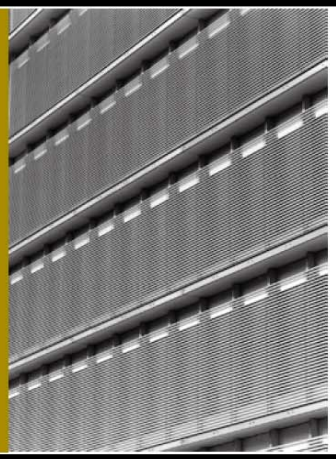
Detail

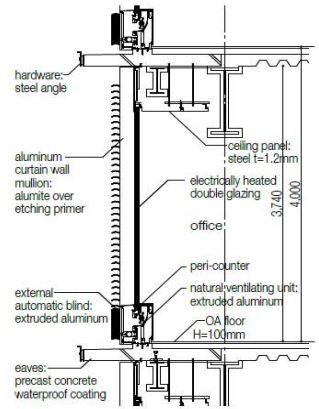
JAXA Tsukuba Space Center, Headquarters Building
2003



Detail

Nikken Sekkei Tokyo Building
2003





Detail

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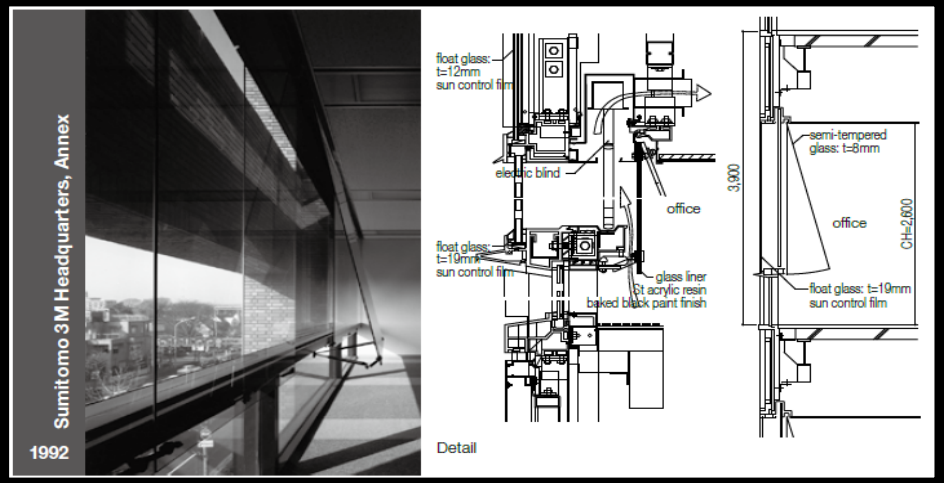
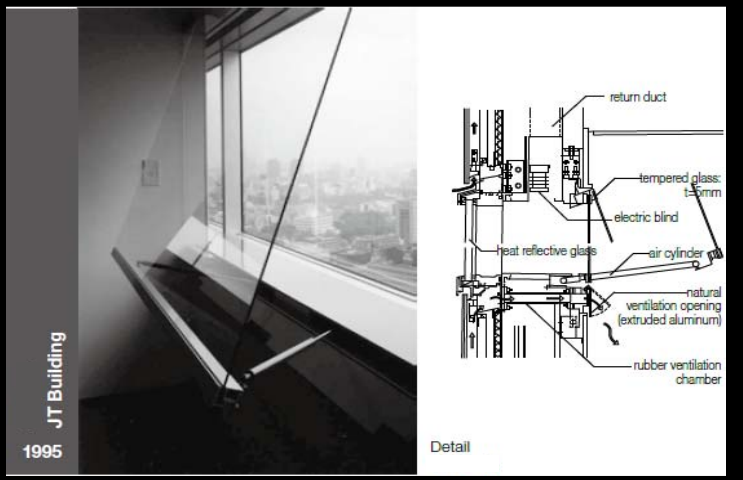
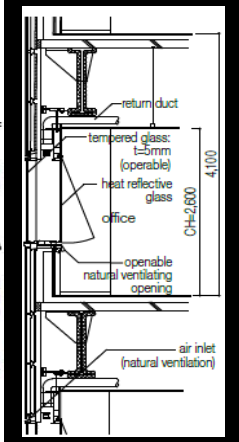
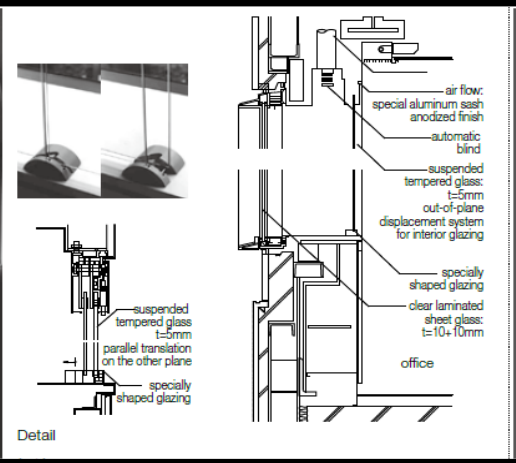
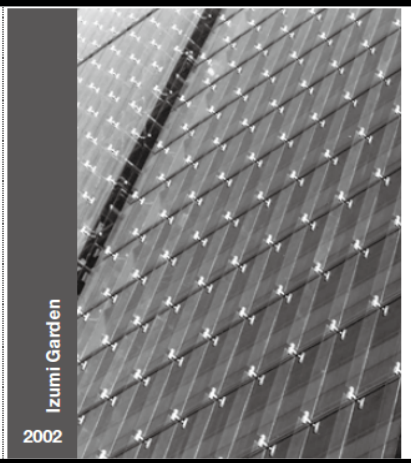
Skin Design #3
Environmental Load Reduction “Air Flow” “Air Barrier Fan”

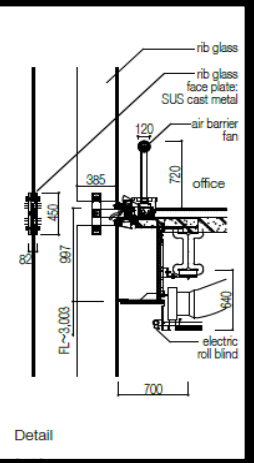












Contents

1. Guideline of Green Building in Japan
2. Training Program & Technical Support
3. Energy Efficiency Technologies in Buildings in Japan
4. Smart Building and Smart City in Japan
5. Case studies by Simulation Tool for Building Energy Consumption

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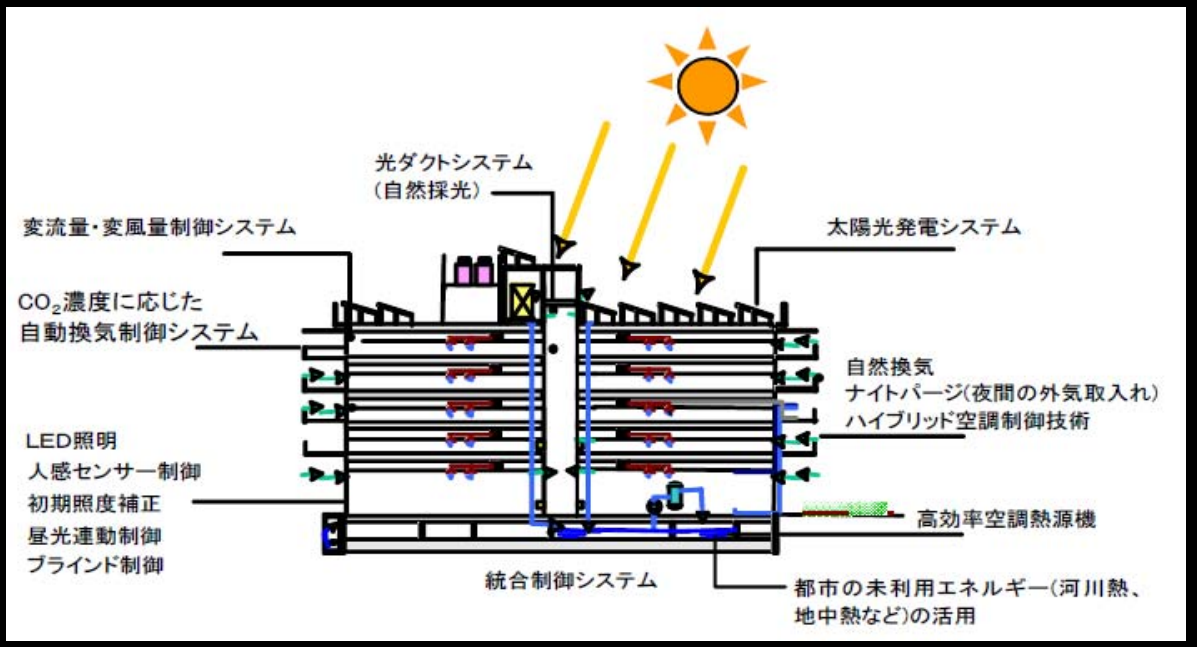
Tokyo Gas Earth Port Building as Zero Energy Building

The Earth Port is achieving Net zero energy consumption by energy saving and self energy supply

Founded in 1996 and Started renovation for ZEB since 2010

Image of Net Zero Energy



Tokyo Gas Earth Port Building as Zero Energy Building

(1) Heat : Combining sun heat, CGS, and other waste heat for low carbon AC system
(2) Lighting : Advanced natural day lighting system
(3) Electricity : Comprehensive electricity management system that controls PV and CGS

Solar Heat Collector

Wind Rower for
Natural Ventilation

Battery (Lt)

Gas engine CGS
Solar Heat Chiller
GHP Chiller
Desiccant type AC

PV

Natural
Ventilation
Natural Lighting

Sun shading
Louver

Atrium for
natural
ventilation

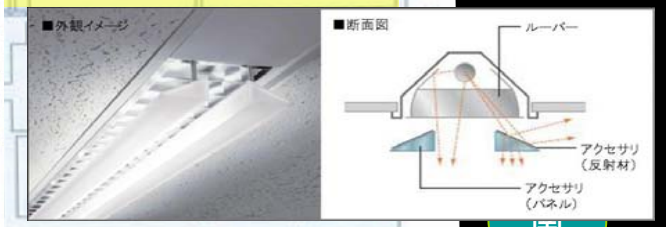
Low-e Glass

Brightness control
+LED for Task lighting

LED Lighting

浚渫土のレンガ

AC Chair system



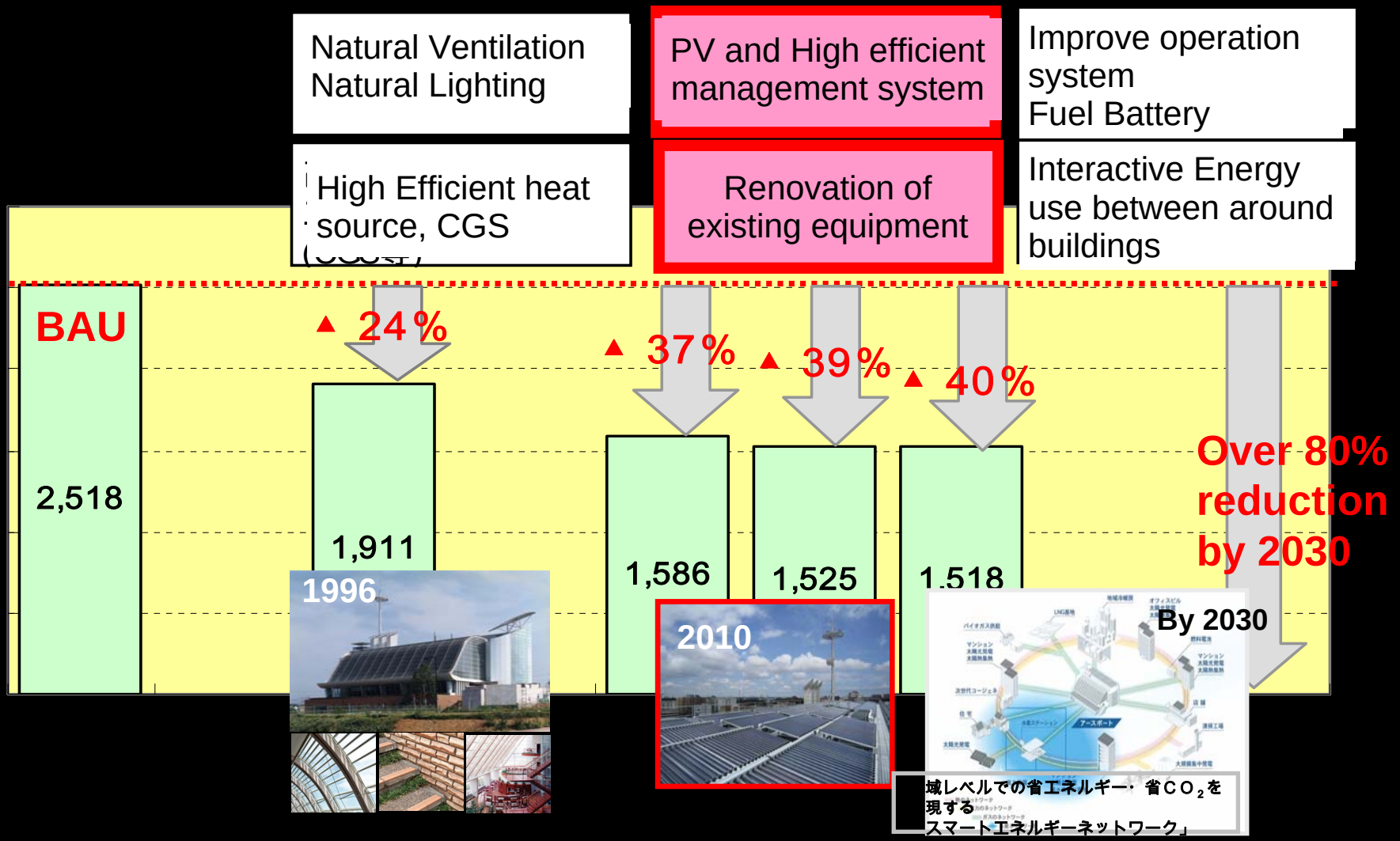
Prism Glass

北

南

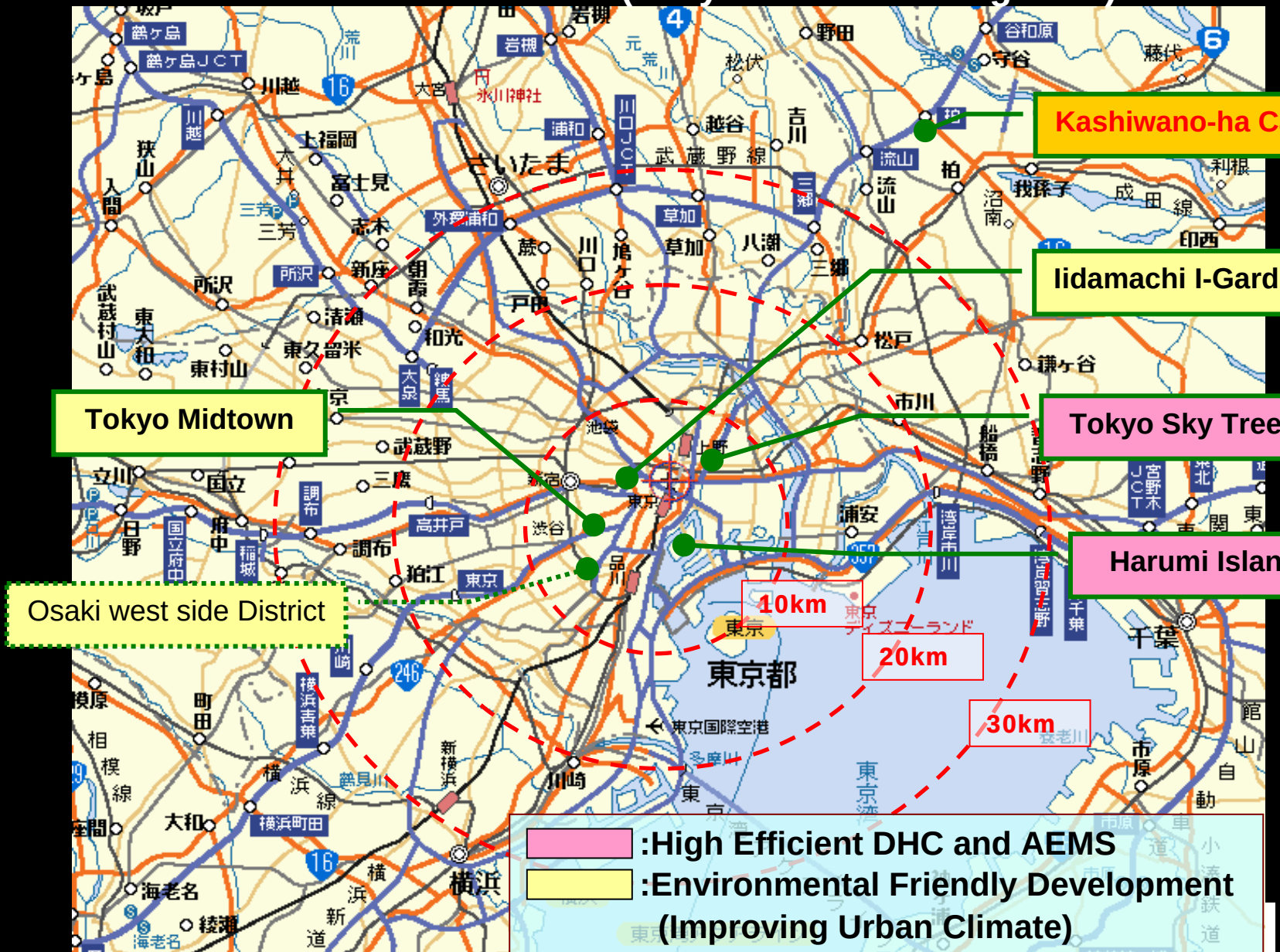
Tokyo Gas Earth Port Building as Zero Energy Building

Continuous challenge for achieving ZEB

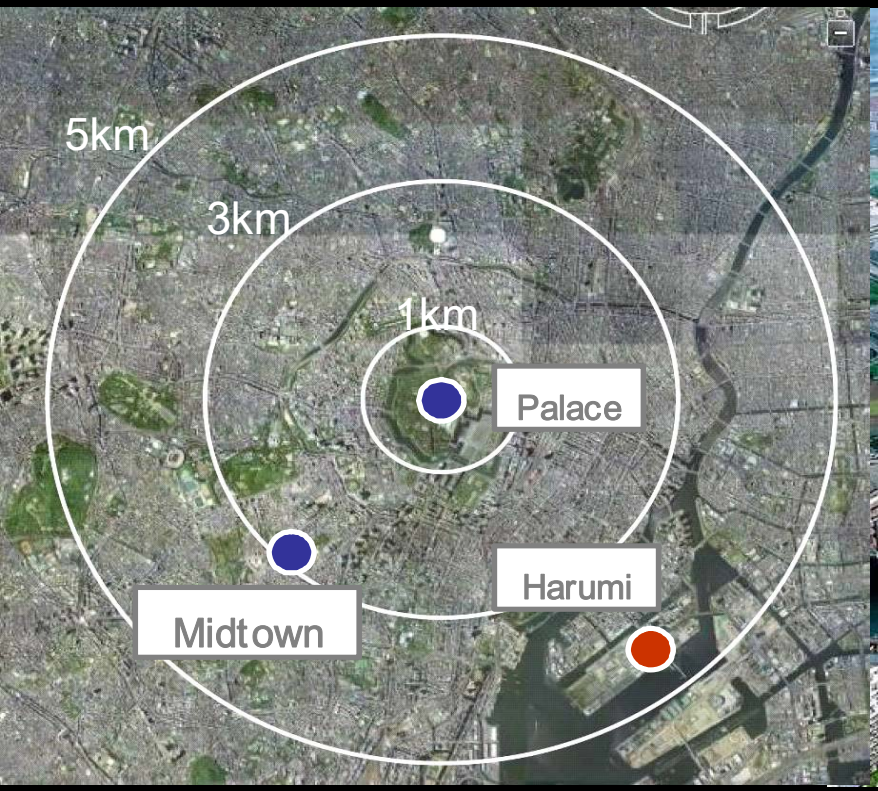


Smart City Challenge

Location of NS Group's Projects (Tokyo & Surrounding Area)



Harumi Triton Square for High efficient DHC



物流ゾーンの法定再開発事業
複合開発　事務所、住宅、商業
竣工　　：2001
延床面積：435,600㎡

Subsidized Redevelopment of an industrial area
Complex of Office, Residential and Retail
Completed　: 2001
BUA　　: 435,600SQM

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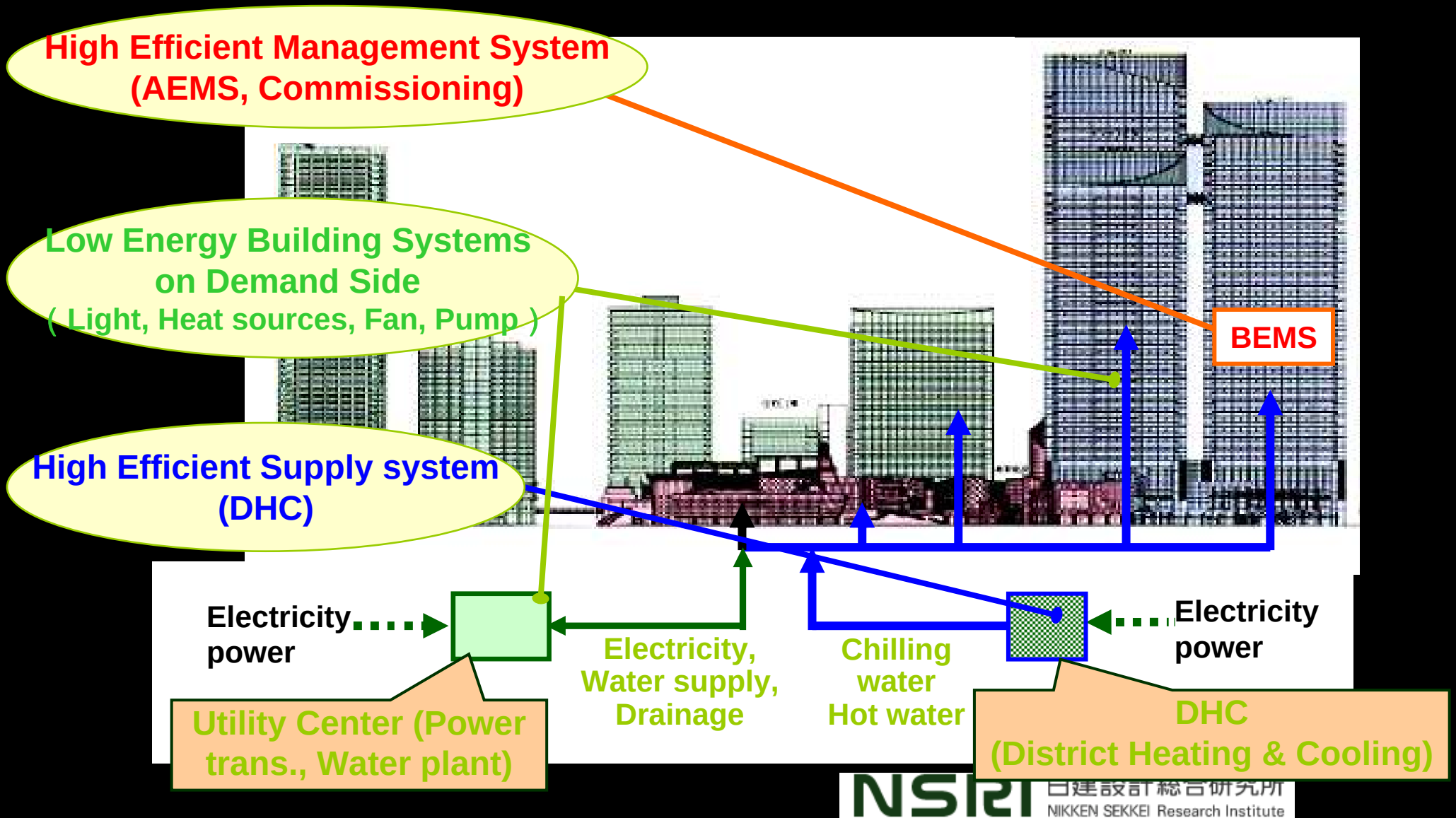
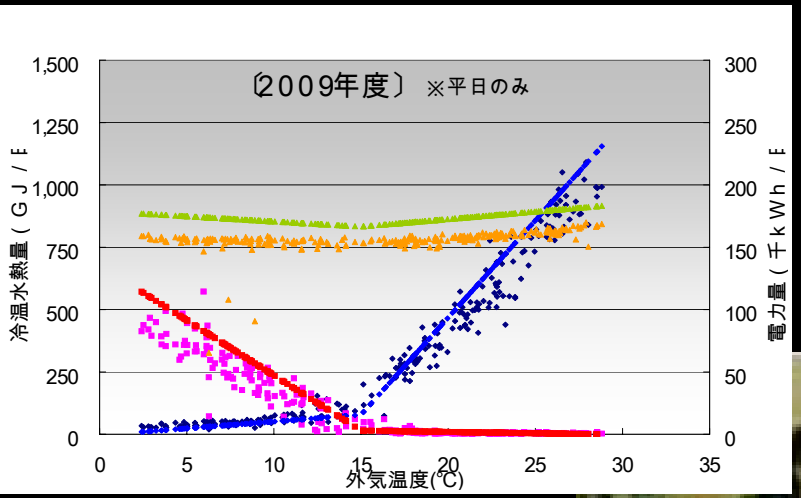
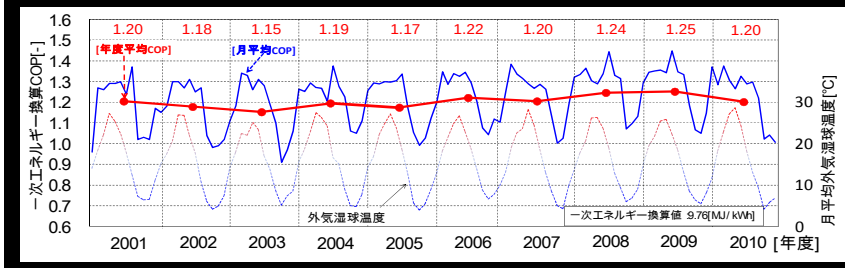
The first comprehensive Area Energy Management on both demand side (buildings) and supply side (DHC)

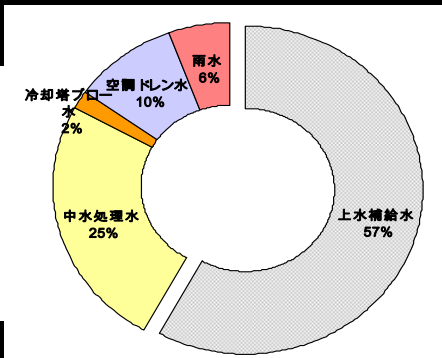


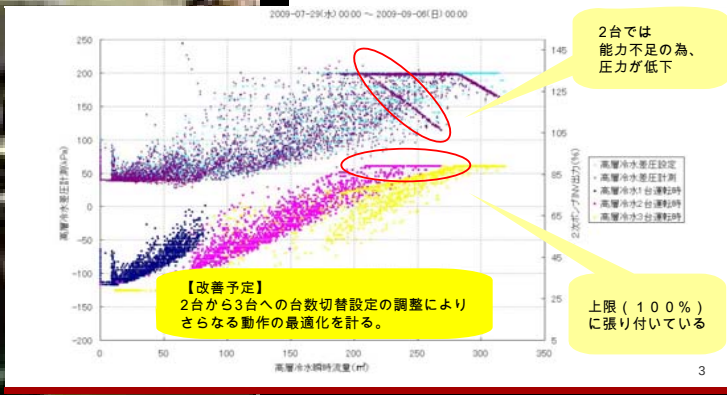
4. Smart Building and Smart City　Smart City

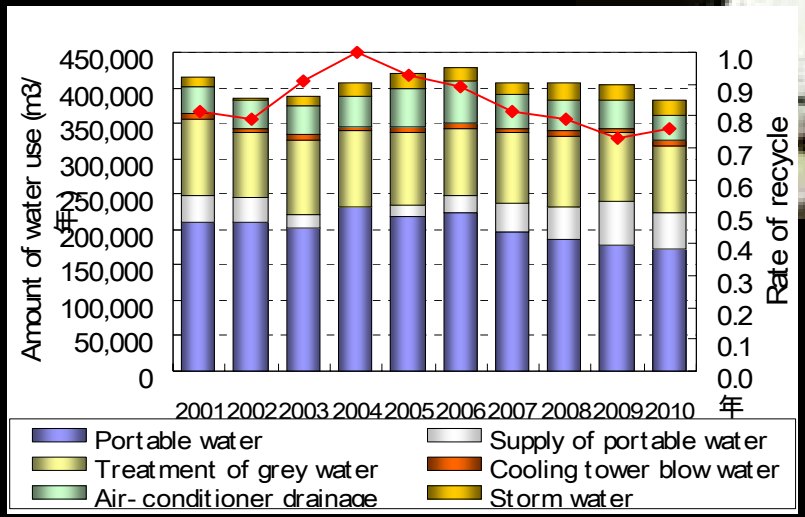
Reduce energy, water, and wastes by analyzing the “Big data” from “Smart meter” for more than ten years





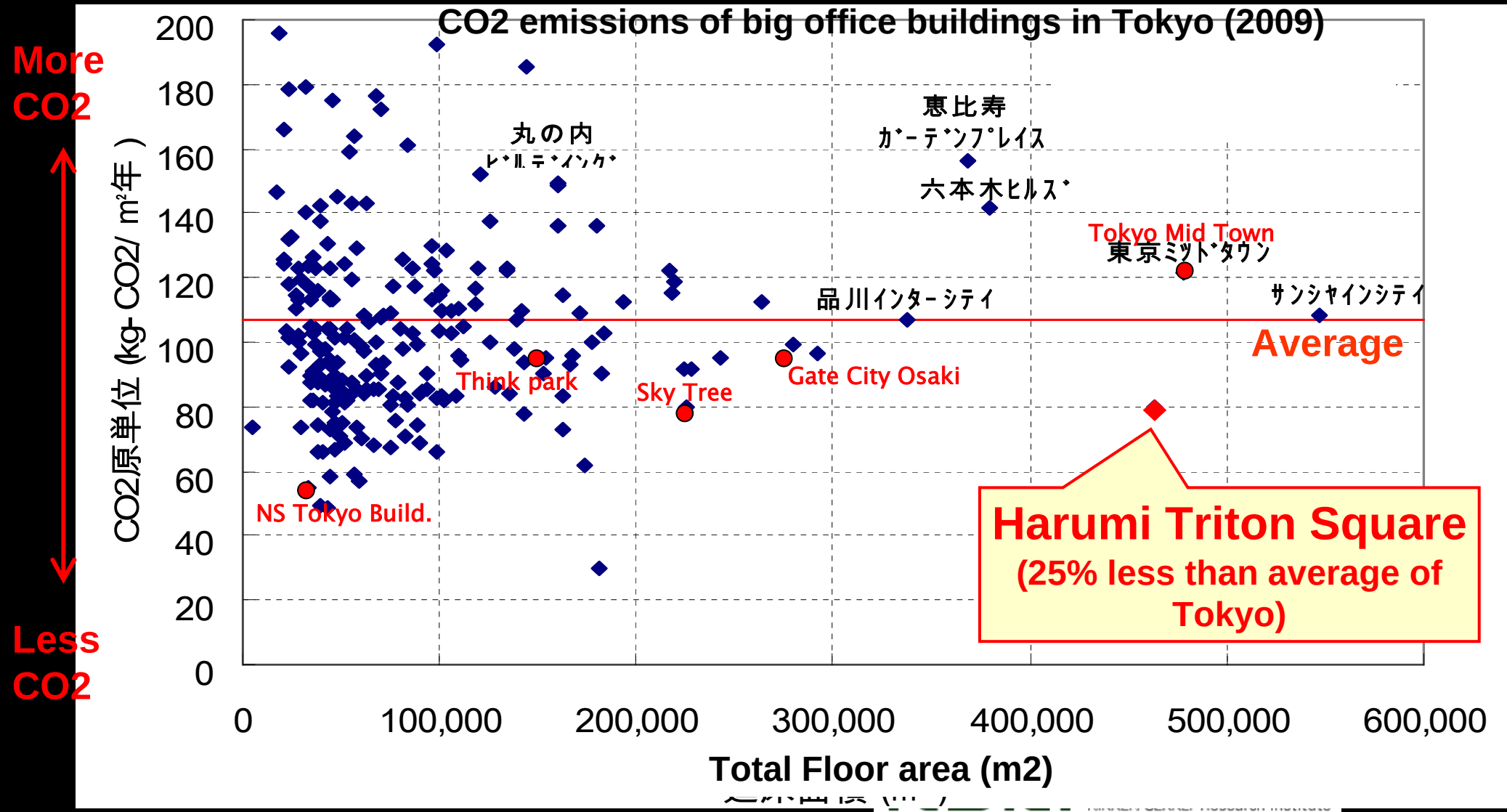




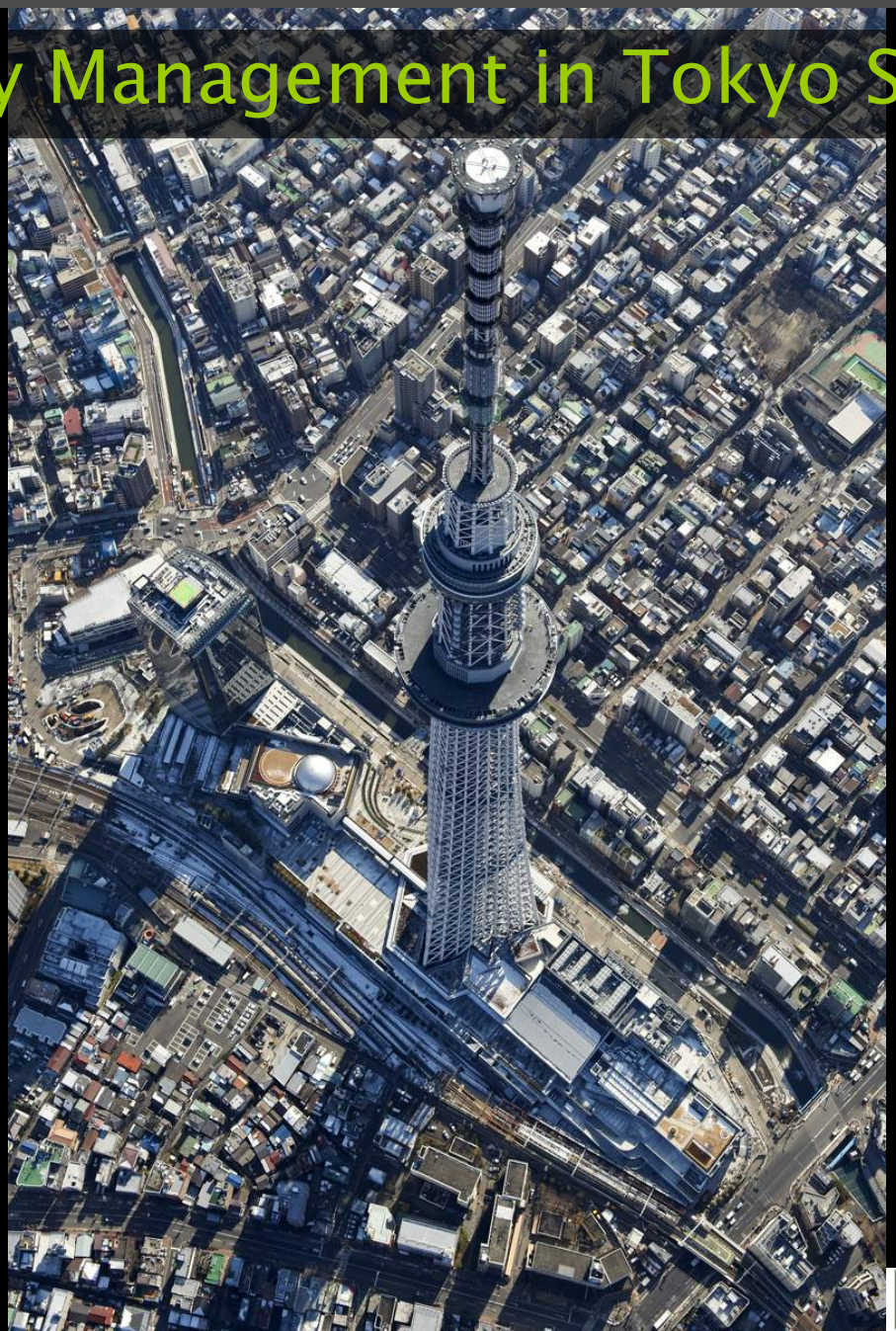


Publishing Environmental Reports for 10 years

Top-class Energy Saving Performance in Tokyo



Energy Management in Tokyo Sky Tree



Completed : 2012
Site area ：36,844.4㎡
Total floor area : 229,782.9m²

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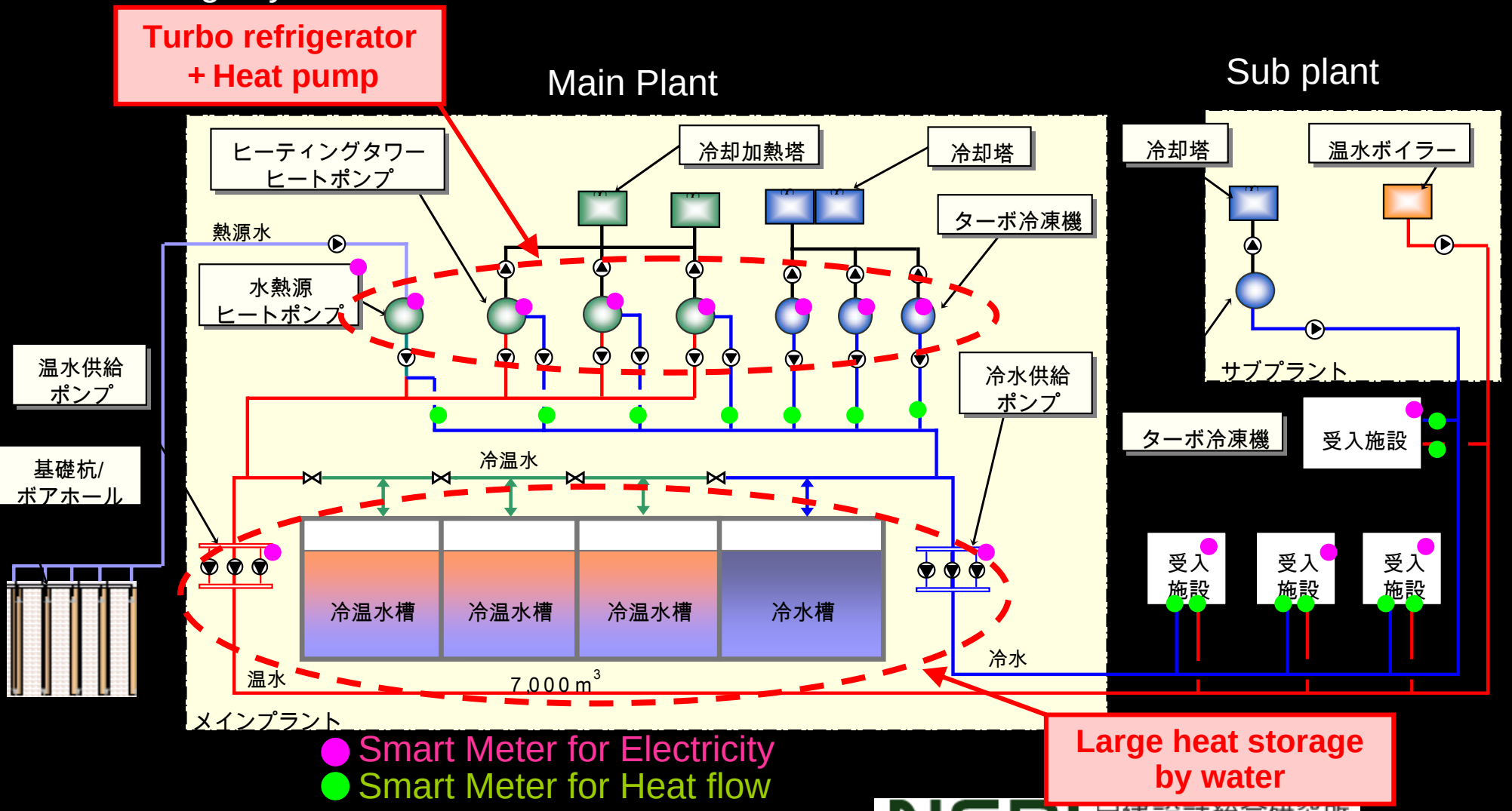
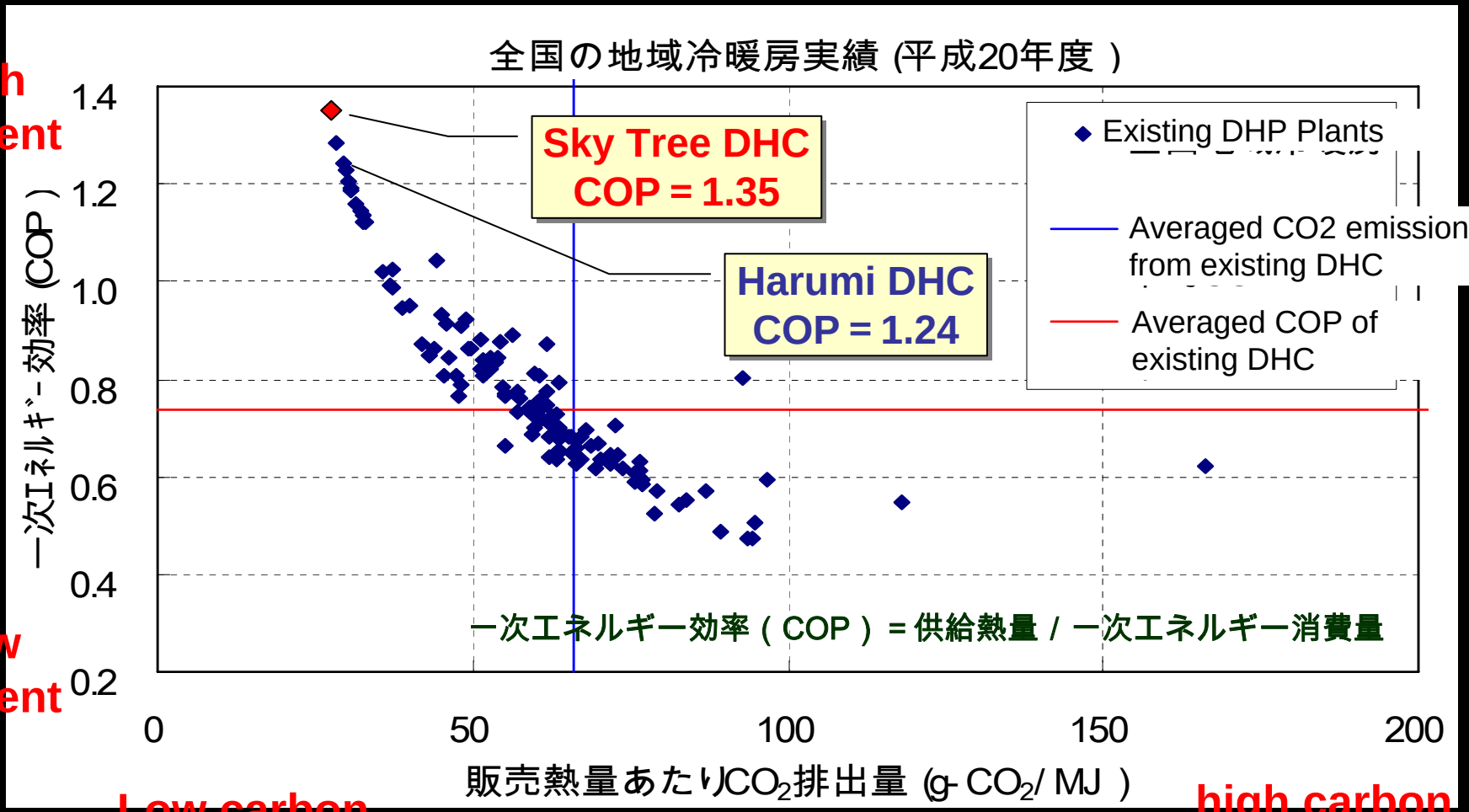
Energy Management in Tokyo Sky Tree

Achieving advanced and high efficient DHC with Turbo refregerator, heat pump and Mega-scale heat heat strage system



Energy Management in Tokyo Sky Tree

Top Revel Performance of DHC in Japan !



High efficient

Low efficient

Low carbon emission

high carbon emission

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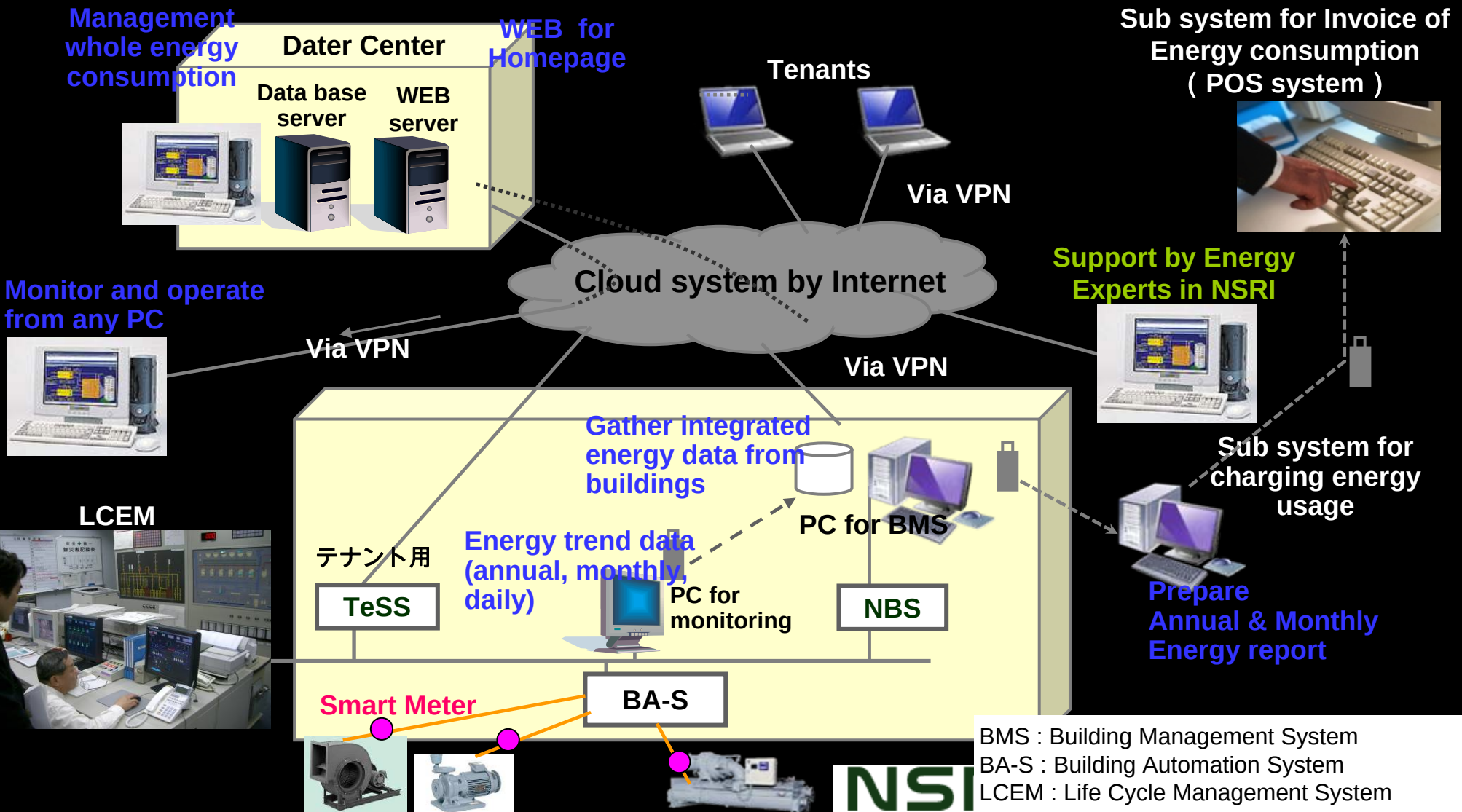
Energy Management in Tokyo Sky Tree

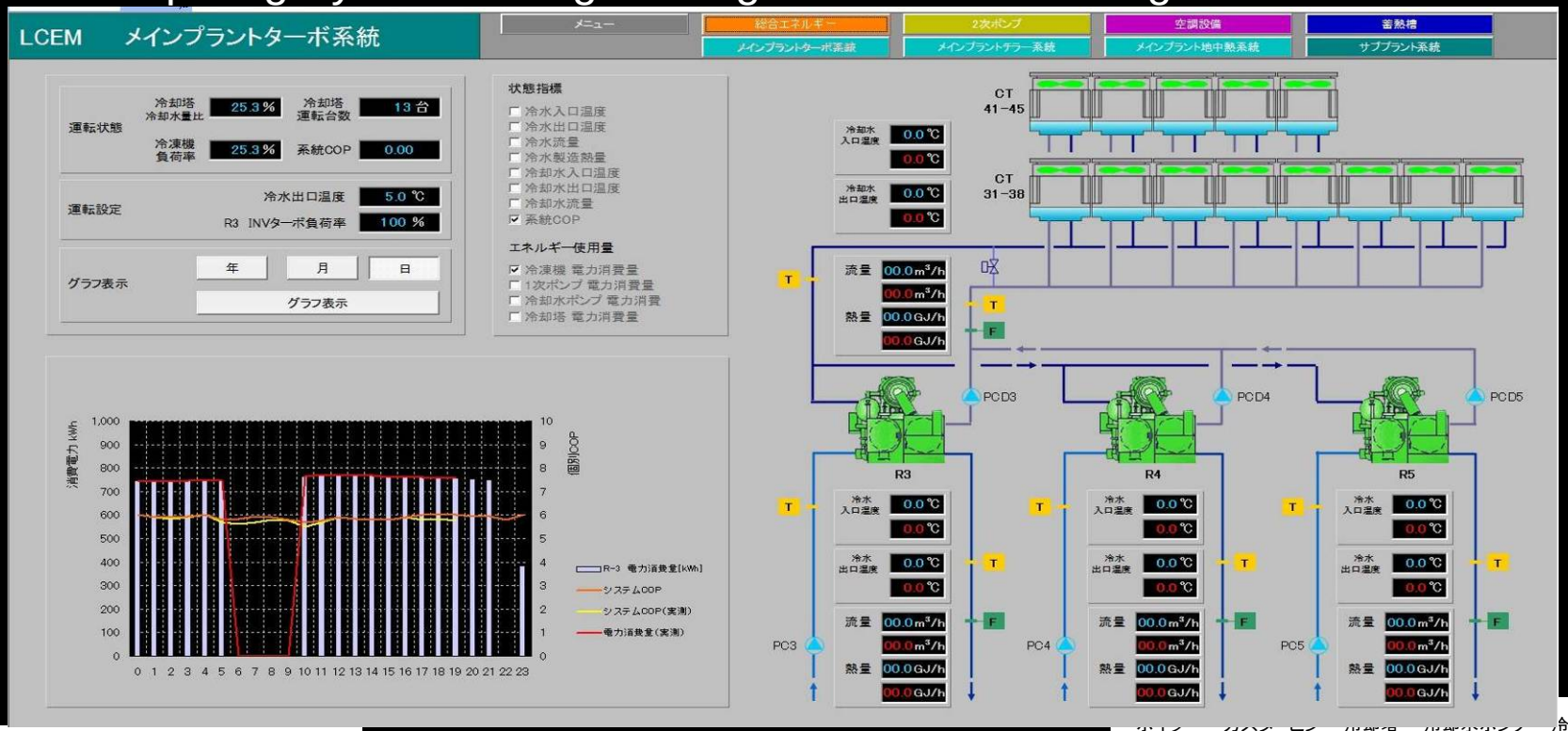
Compose Area Energy Management System as Cloud-type network with data interaction system by Internet

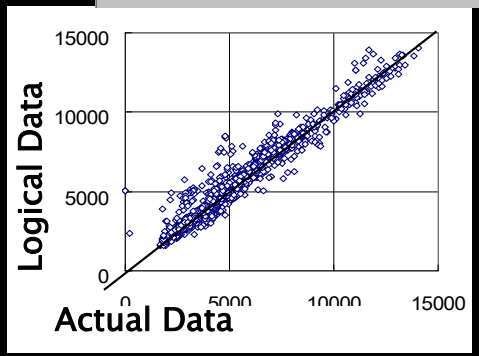


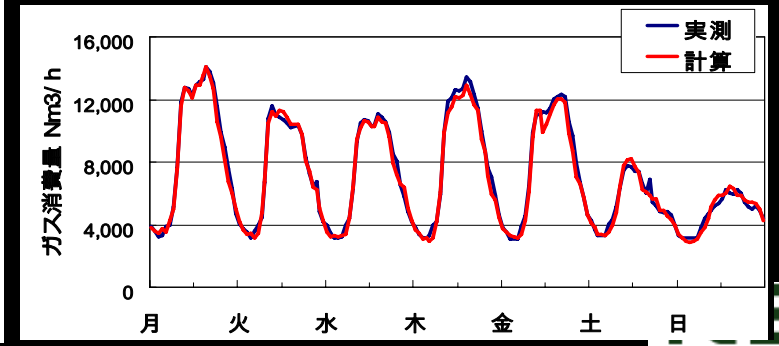
BMS : Building Management System
BA-S : Building Automation System
LCEM : Life Cycle Management System

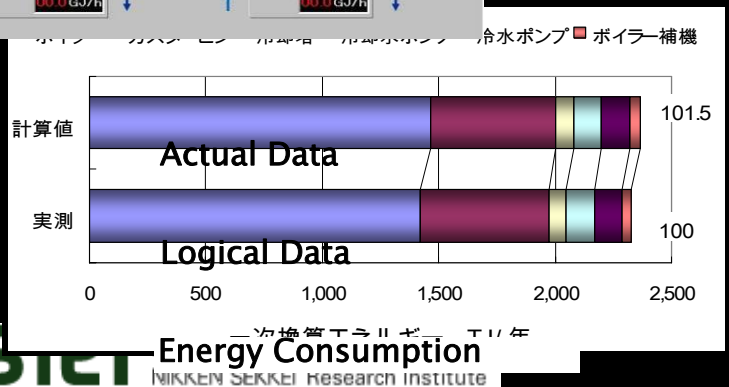
Energy Management in Tokyo Sky Tree

Advanced Energy Management System that can compare Theoretical and Actual Data by “Crowd Computing System” with gathering detailed data through Smart Meter



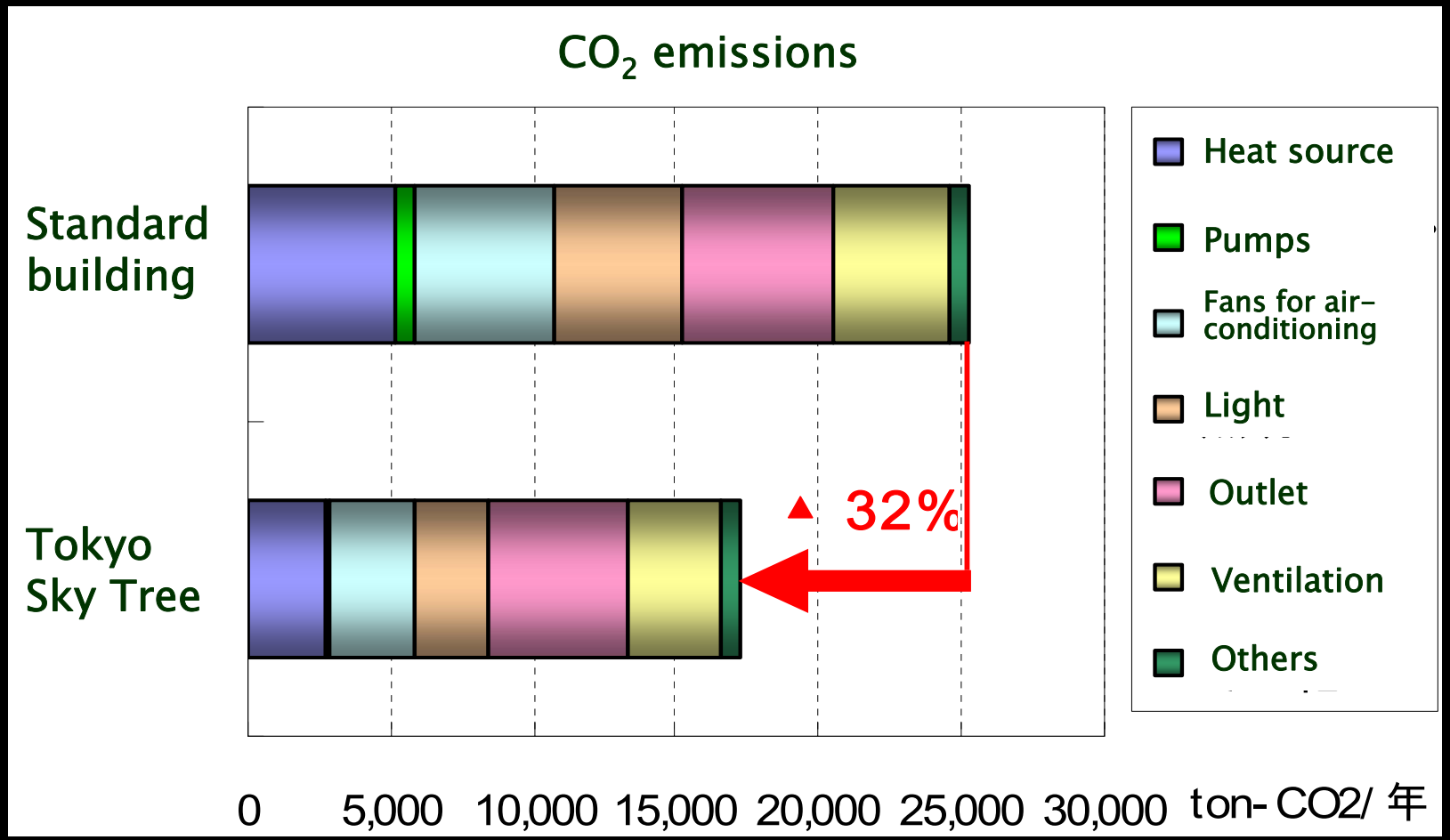






Energy Management in Tokyo Sky Tree

32% CO2 reduction compared with standard building.



Estimated CO2 footprint reduction

I-Garden Air , Tokyo, Japan

- Location: Chiyoda ward, Tokyo, Japan
  Redevelopment of JR yard
- Completed: 2003
- Site area: 41,000m2
- Total floor area: 244,004m2
- Planned population: Residence 249 rooms,
  Hotel 220 rooms, Employees 8,200

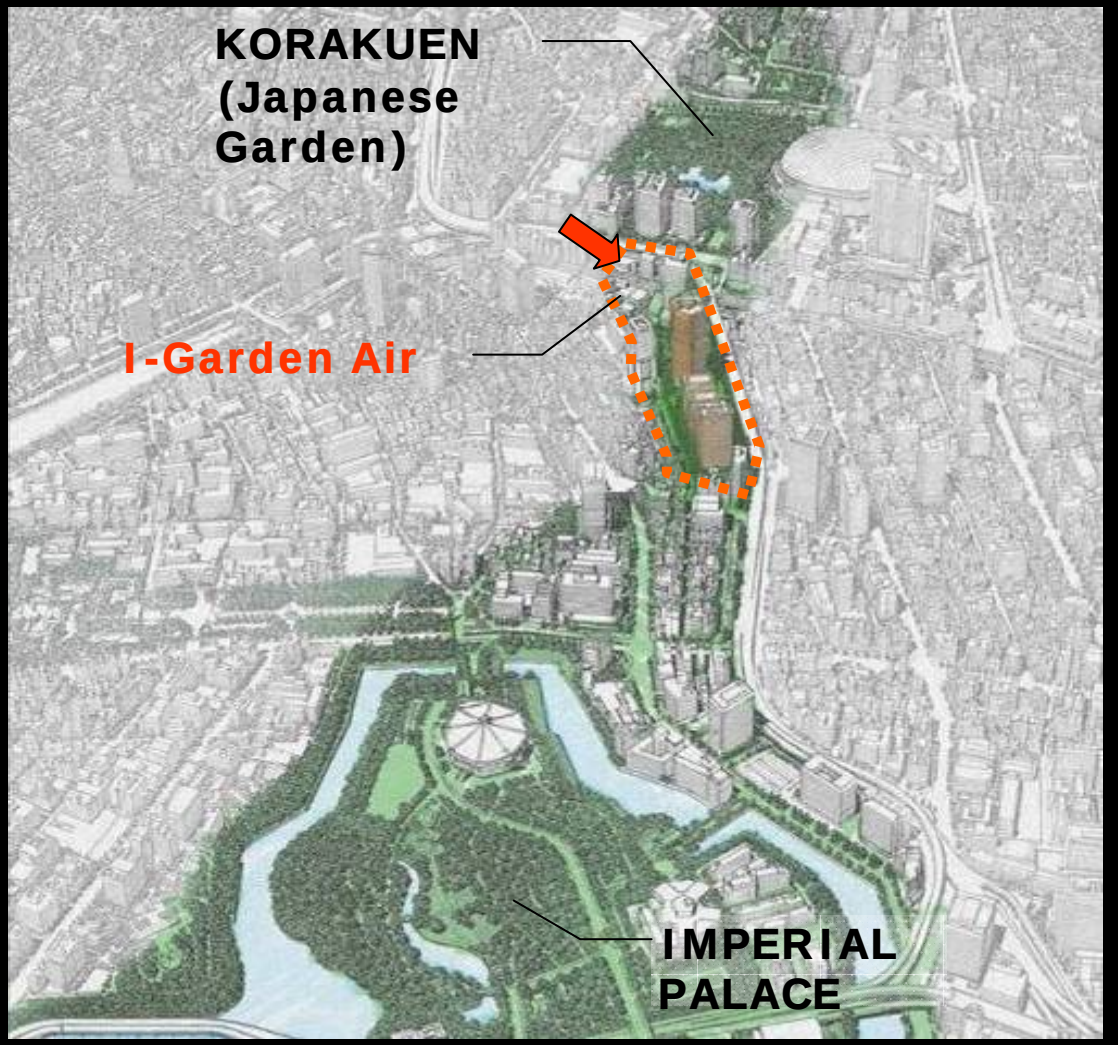
I-Garden Air , Tokyo, Japan

Key Concept for Cool Urban Development

The key concepts was to make the new greenery of the development into an axis linking the green masses of the nearby Imperial Palace and Korakuen.

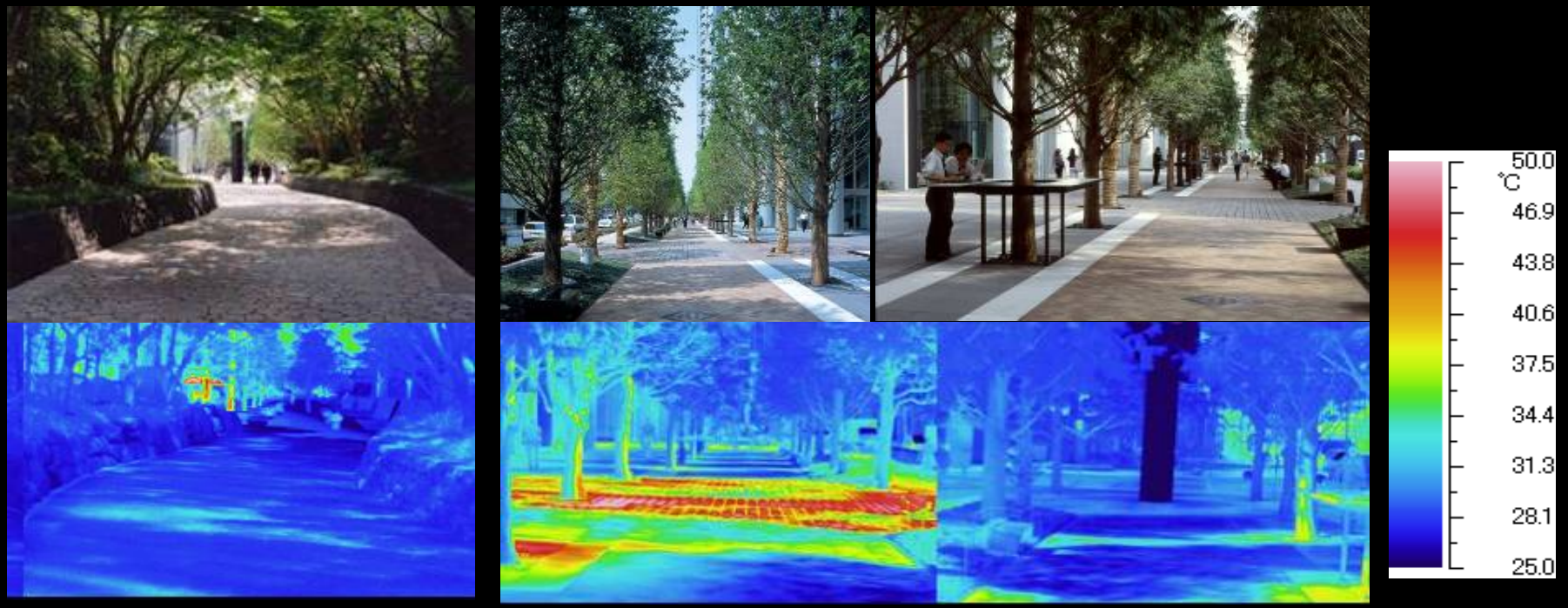
The streets have a unified setback to the building walls, creating a tree-lined green corridor that extends for 300m.

Thermal environment on the site has been improved and helps to modify Urban climate in Tokyo

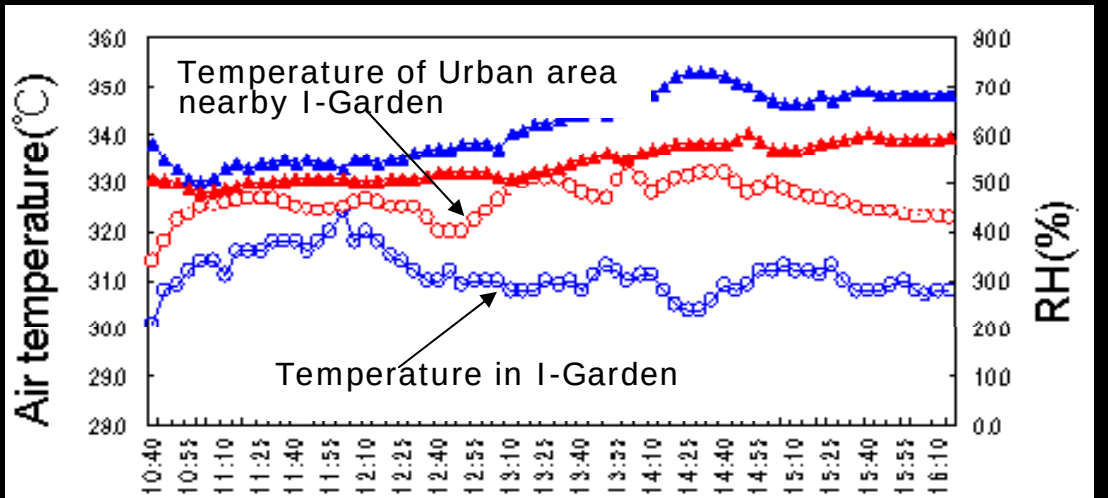


I-Garden Air , Tokyo, Japan

Assessment Results of Thermal Environment



The surface temperature of concrete pavement under sunlight rises to 50 degree, while the paved area that is covered with tall trees is at least 10 degree lower. And Air temperature is 1 – 2 degree lower.



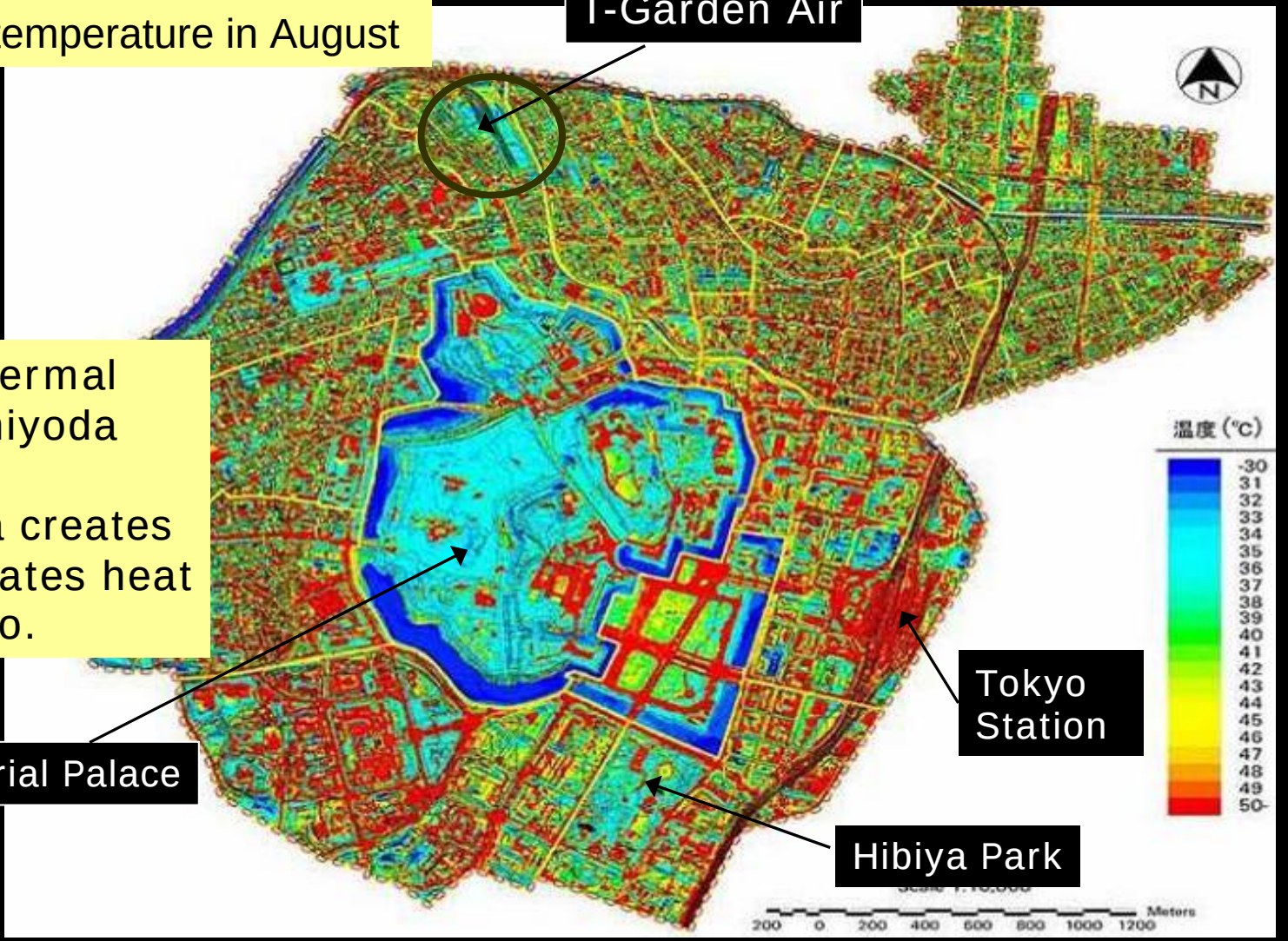
I-Garden Air , Tokyo, Japan

Mitigating heat island effect by Green Corridor

Distribution of surface temperature in August

This figure shows thermal Image in Tokyo's Chiyoda Ward by MSS data.

"I-garden Air" area creates cool spots and mitigates heat island effect in Tokyo.



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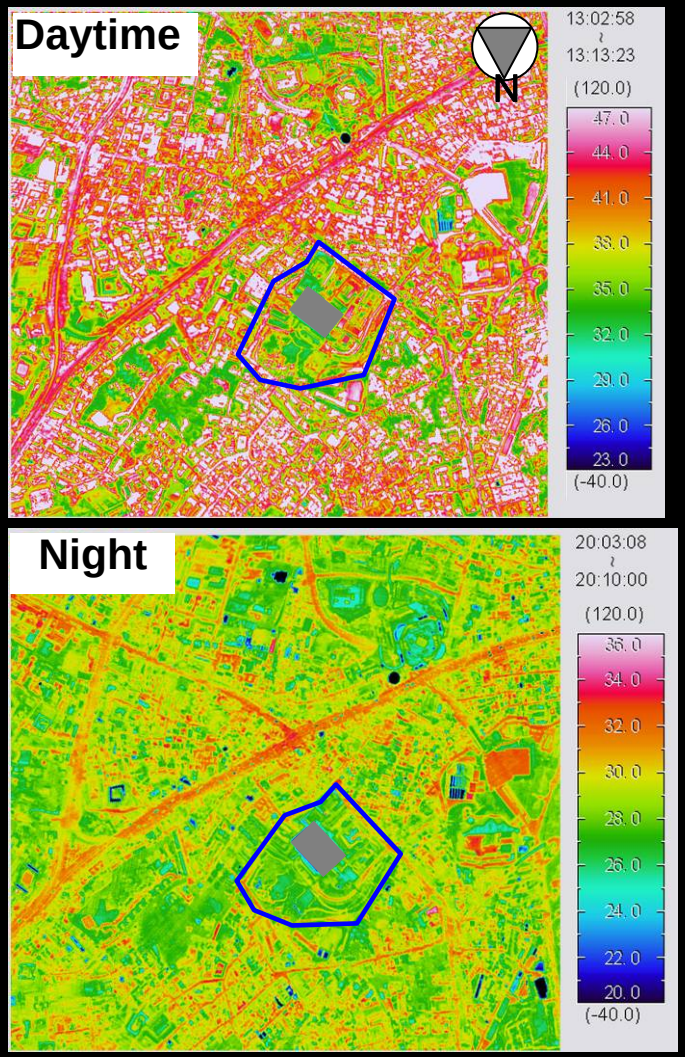
Tokyo Midtown

Complex & Compact type is so effective to save building energy!

Completed : 2007
Site area : 68,891.㎡
Total floor area : 563,800m²

Tokyo Midtown



Surface temperature on 7th, August, 2007

High efficient DHC and Greenery contributes to mitigate Heat Island phenomena

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Kashiwa-no-ha Smart City

Implementing the first Comprehensive Smart City in Japan

Mitsui Fudosan Co., Ltd.
Nikken Sekkei
Nikken Sekkei Research Institute

Kashiwa-no-ha means
Daimyo Oak Leaf

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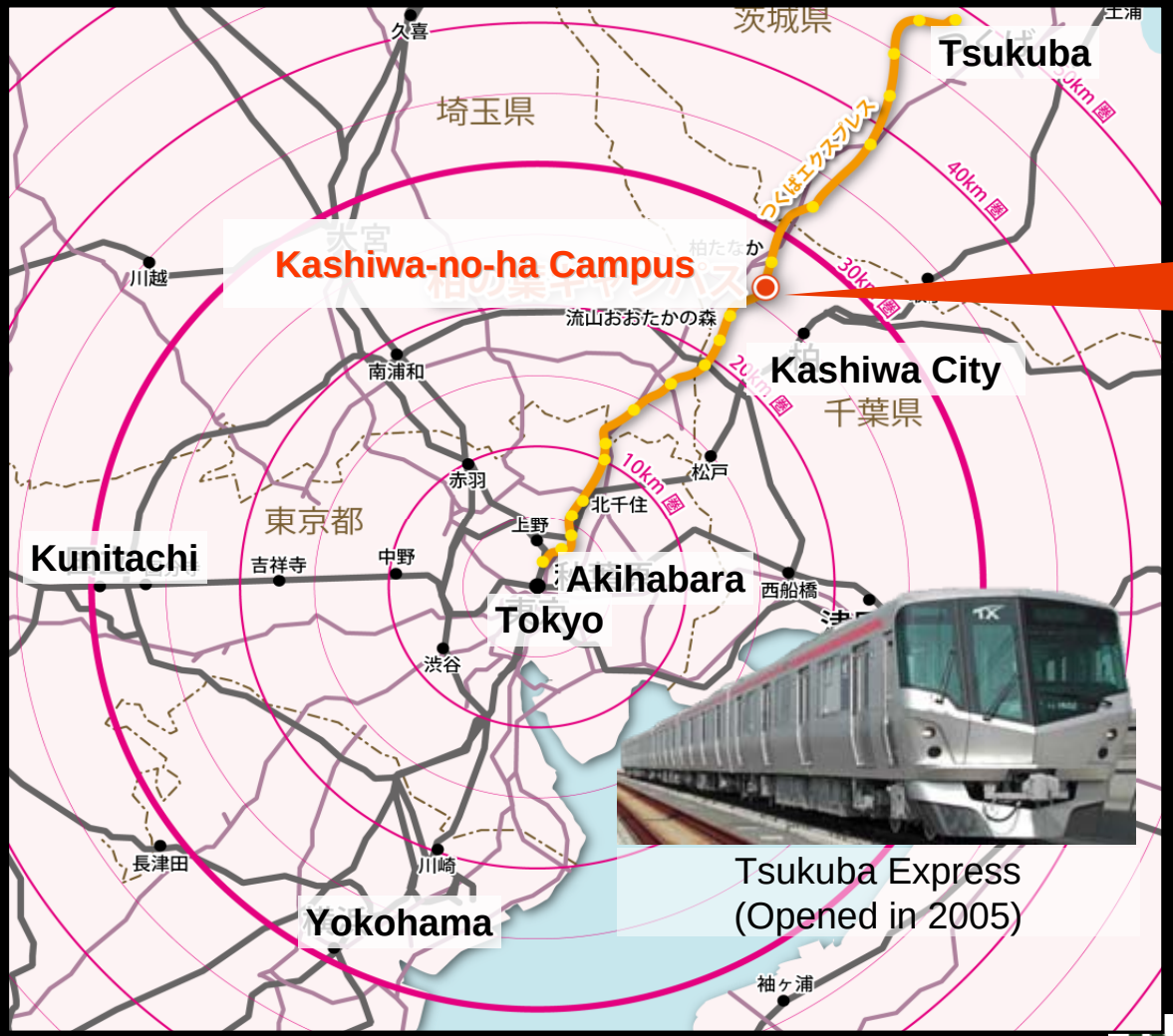
Kashiwa-no-ha Campus in Perspective

- 25 kilometers from central Tokyo, midway between Akihabara and Tsukuba
- 30 minutes from central Tokyo by Tsukuba Express



Tsukuba Express
(Opened in 2005)

Kashiwa-no-ha Campus

A new 2,730,000m2(273ha) town with a projected population of 26,000

Designing New town future

- Utilizing cutting-edge technology
- Many stakeholder could join figuring new town at any stage.

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Surrounded by Leading Research Institutions and Nature

Research Institutions

University of Tokyo
Graduate School of Frontier Sciences

University of Tokyo
Kavli Institute for the Physics and Mathematics of the Universe

Chiba University
Center for Environment, Health and Feld Sciences

Chiba University
Center for Preventive Medical Science

Nature

Konbukuro Pond
Nature Study Park

Kashiwa-no-ha Park

Rental vegetable gardens

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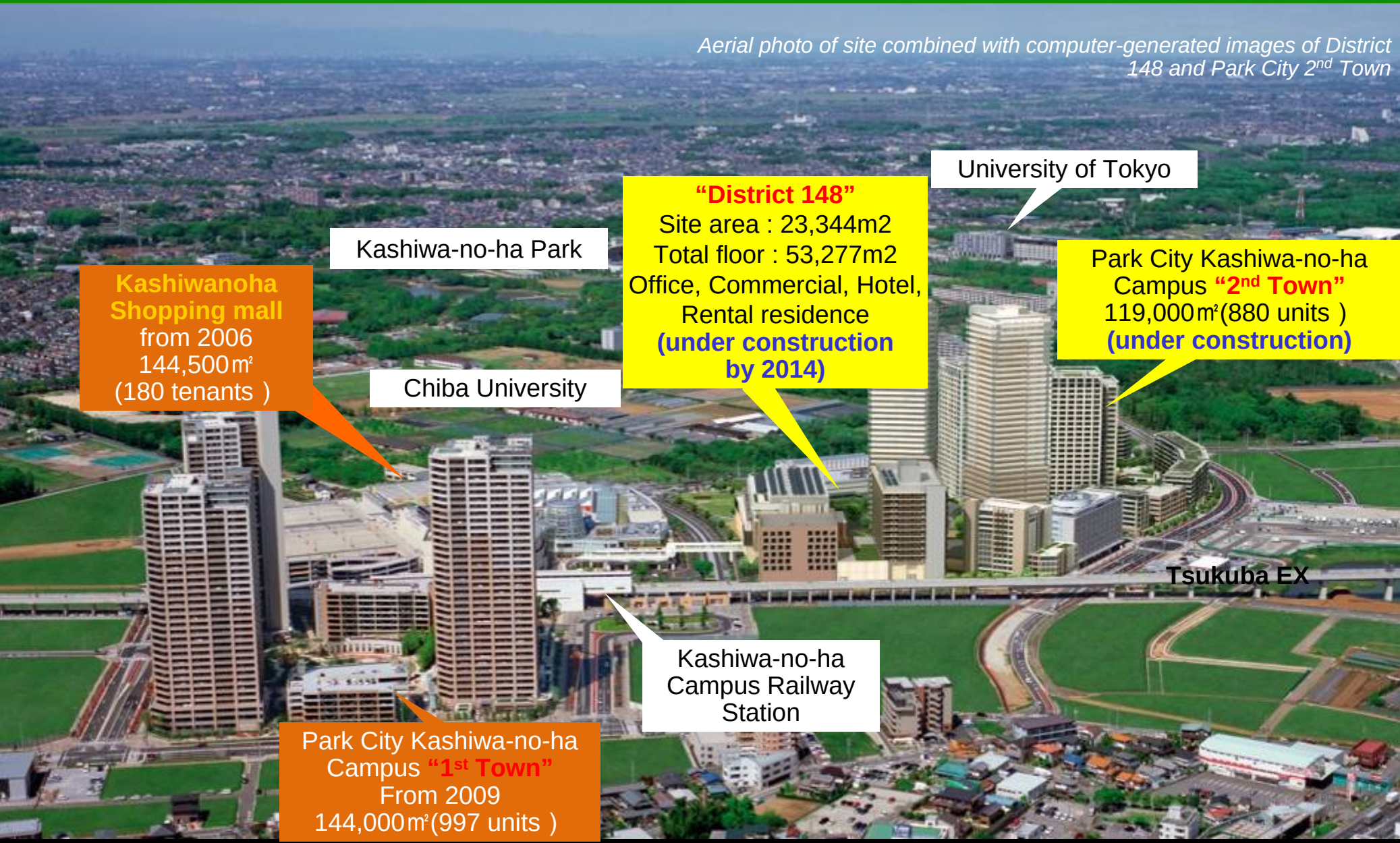
Development around Kashiwa-no-ha Campus Station



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Kashiwa-no-ha Smart City by 2020

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Kashiwa-no-ha Campus Development Concept

Smart City Solutions from social issues

Social Issues

- Global environment
  Resources and energy
- Swiftly aging society
  Physician shortages and soaring medical costs
- Social maturation
  Economic recession

Solution Models

- **Environmental-friendly City**
- **Challenge for Health and Longevity**
- **Business model for New Industry Creation**

Public-Private-Academia partnerships × **Advanced knowledge & Technology**

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Kashiwa-no-ha: A model for resolving global issues

Environmental-friendly City

- Centralizing regional energy management
- Saving, creating, and storing energy
- Encouraging sustainable localization in food and energy
- Low-carbon urban transportation
- Maintaining lifelines during disasters

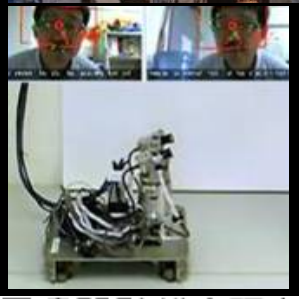
City of Health and Longevity

- Engaging in regional collaboration for disease prevention and preventive care
- Ensuring full social participation of the elderly population
- Using information and communication technology for inter-generational interaction

City of New Industry Creation

- Supporting local start-ups that utilize cutting-edge Japanese technology
- Fostering new industries that can provide a solid foundation for a green economy
- Creating a world-leading community of innovative start-ups

Safe, secure, and sustainable Smart City



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Environmental friendly + Technology + Community

Connecting people

Community participation

Connecting technologies

Cutting-edge environmental technology

Connecting green

Environment-friendly urban planning

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Paradigm shift of Smart City concept after the 3.11 Touhoku Earthquake

Environmental-friendly City

Before the 3.11 Touhoku Earthquake

Low carbon oriented Smart City
(Energy saving Energy generation)
Harmonize Environment× Advanced technology× Community

After the 3.11 Touhoku Earthquake

Topic on Measures

- **Electricity power storage in area**
- **Electric power interchange** in area
- **Reinforcement Building infrastructure**

Topics on Operation

- **Town risk management**
- **BCP・ LCP**
- **Smart service business**

Optimum usage of Area energy

Establish Sustainable Community

Low carbon + DCP oriented Smart city from Japan
Harmonize Environment× Advanced technology× Community and Area energy network
× Life (Business) continuity× Smart service

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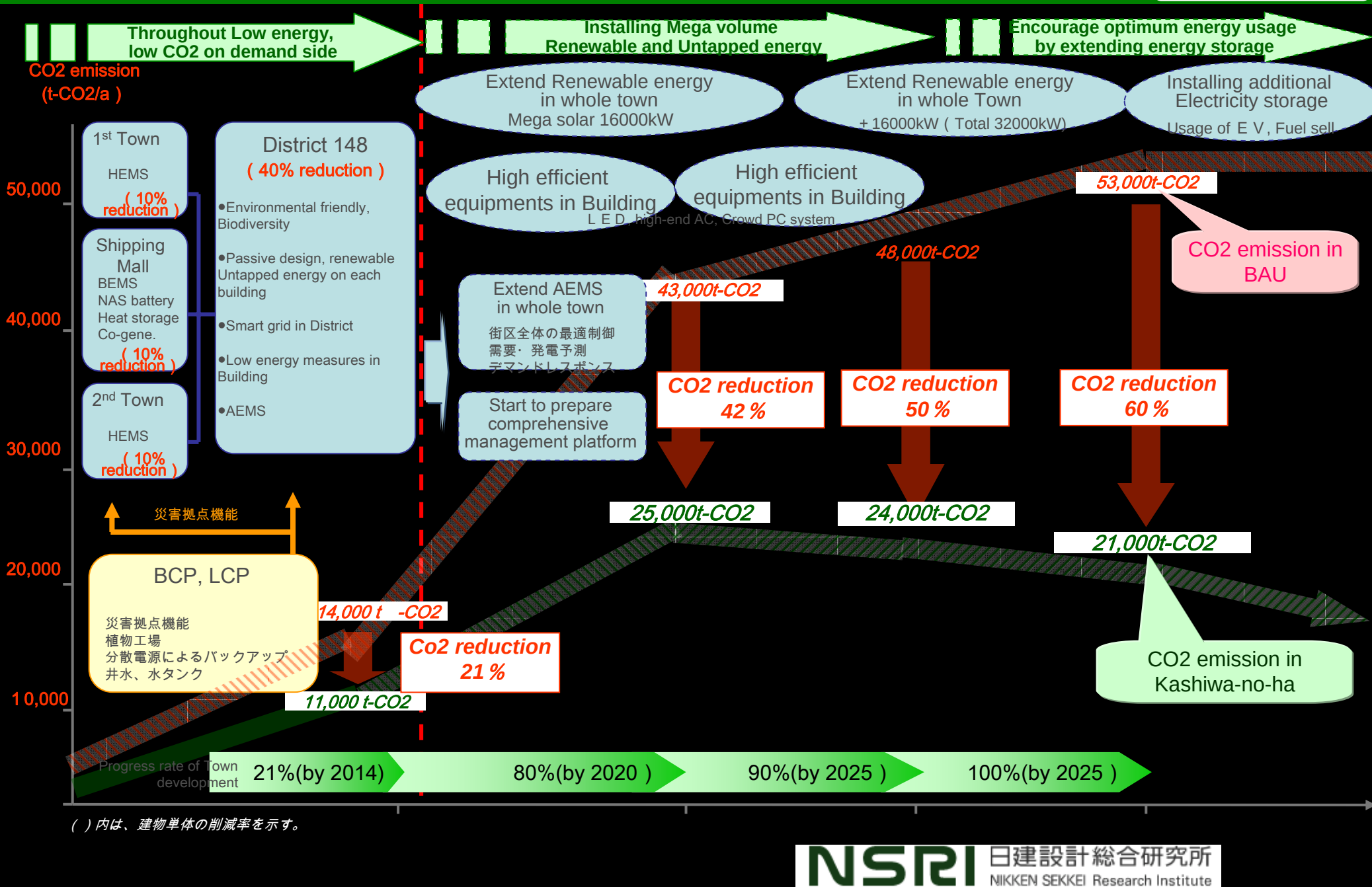
Mid-term & Long-term CO2 reduction target of Kashiwa-no-ha

Environmental-friendly City



( ) 内は、建物単体の削減率を示す。

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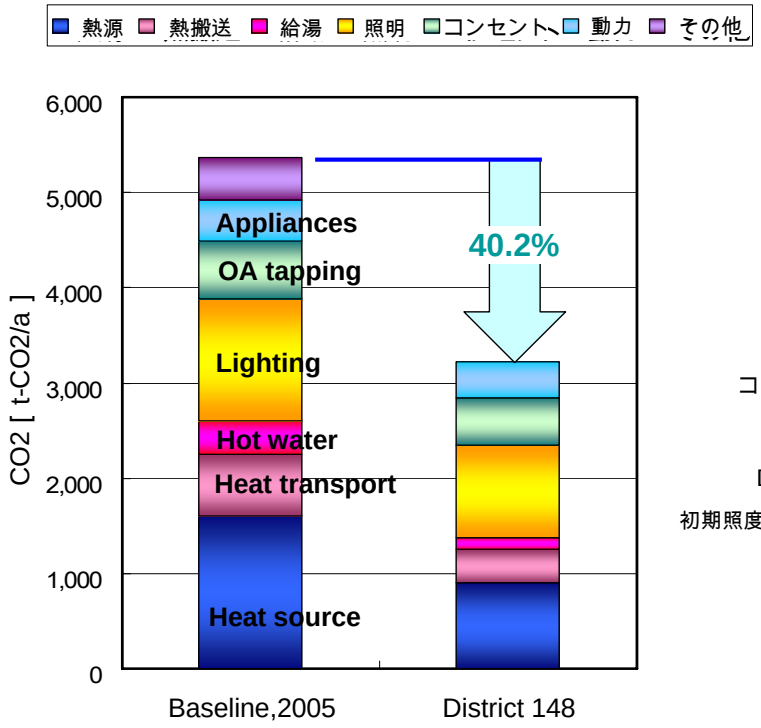
CO2 Reduction measure and effects of Buildings in District 148

Environmental-friendly City

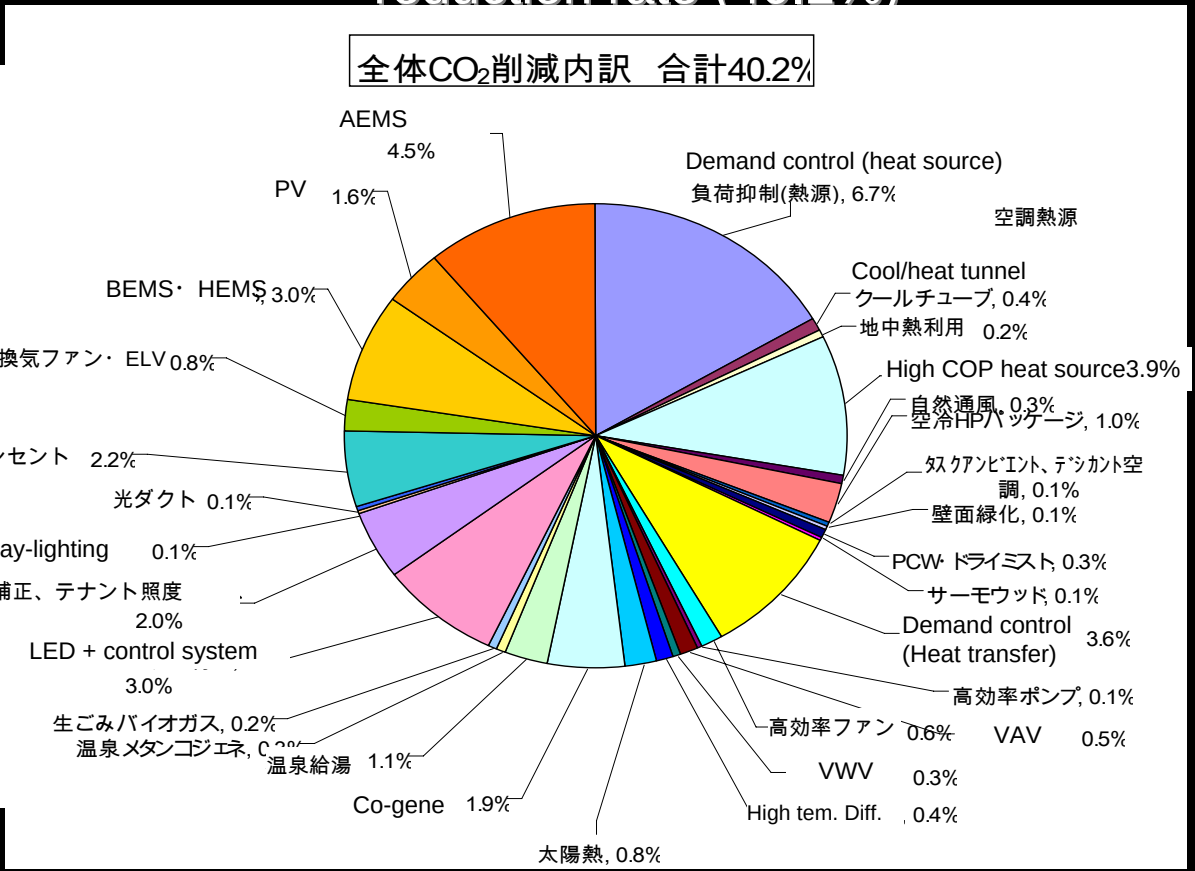
- **Aiming over 40% CO2 reduction in District 148**

Estimation of CO2 Reduction effect

(Baseline : Average CO2 emission of office building, Tokyo, 2005)



Breakdown effect of CO2 reduction rate (40.2%)



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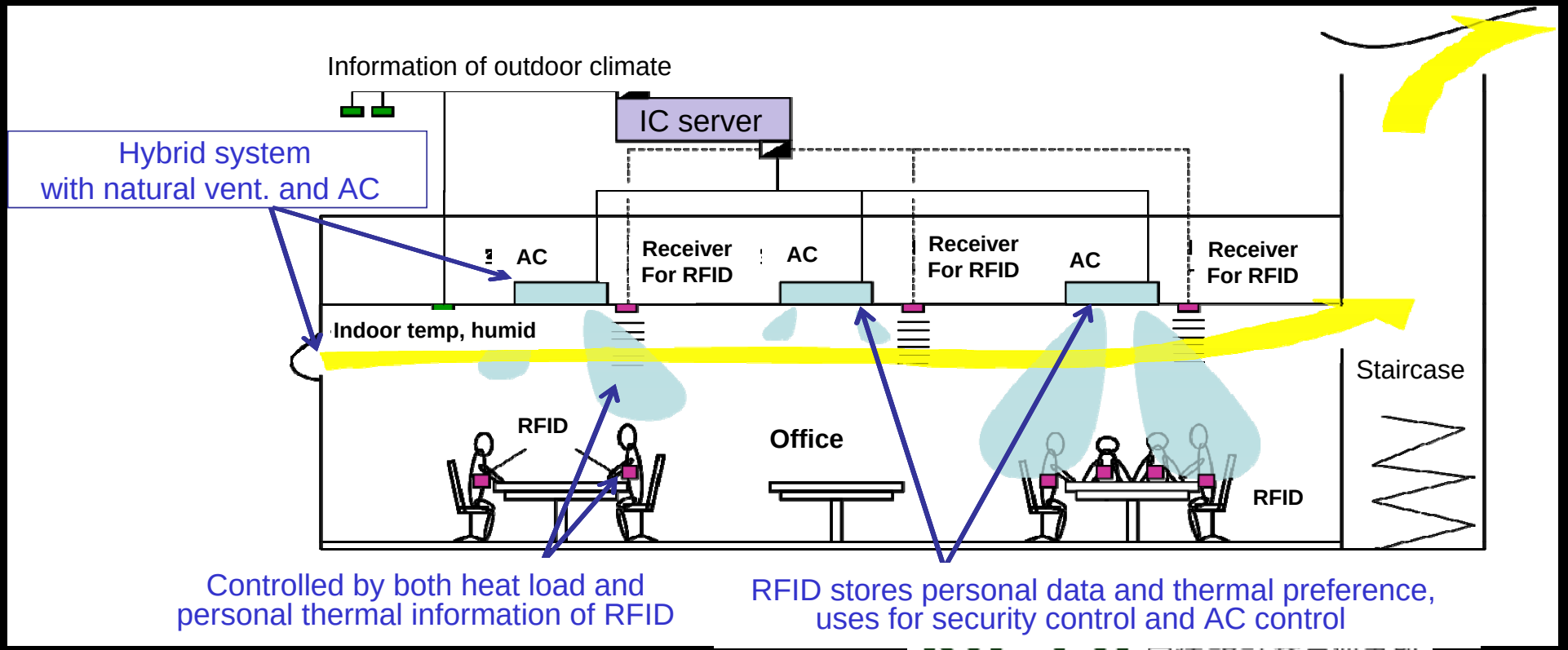
Low carbon measures on Demand side (Low carbon building)

~Re-design of Traditional environmental control methodology with advanced technology~

Environmental-friendly City

Hybrid Air Conditioning System with natural ventilation and high efficient AC in high temperature and humid climate in Japan, Asia

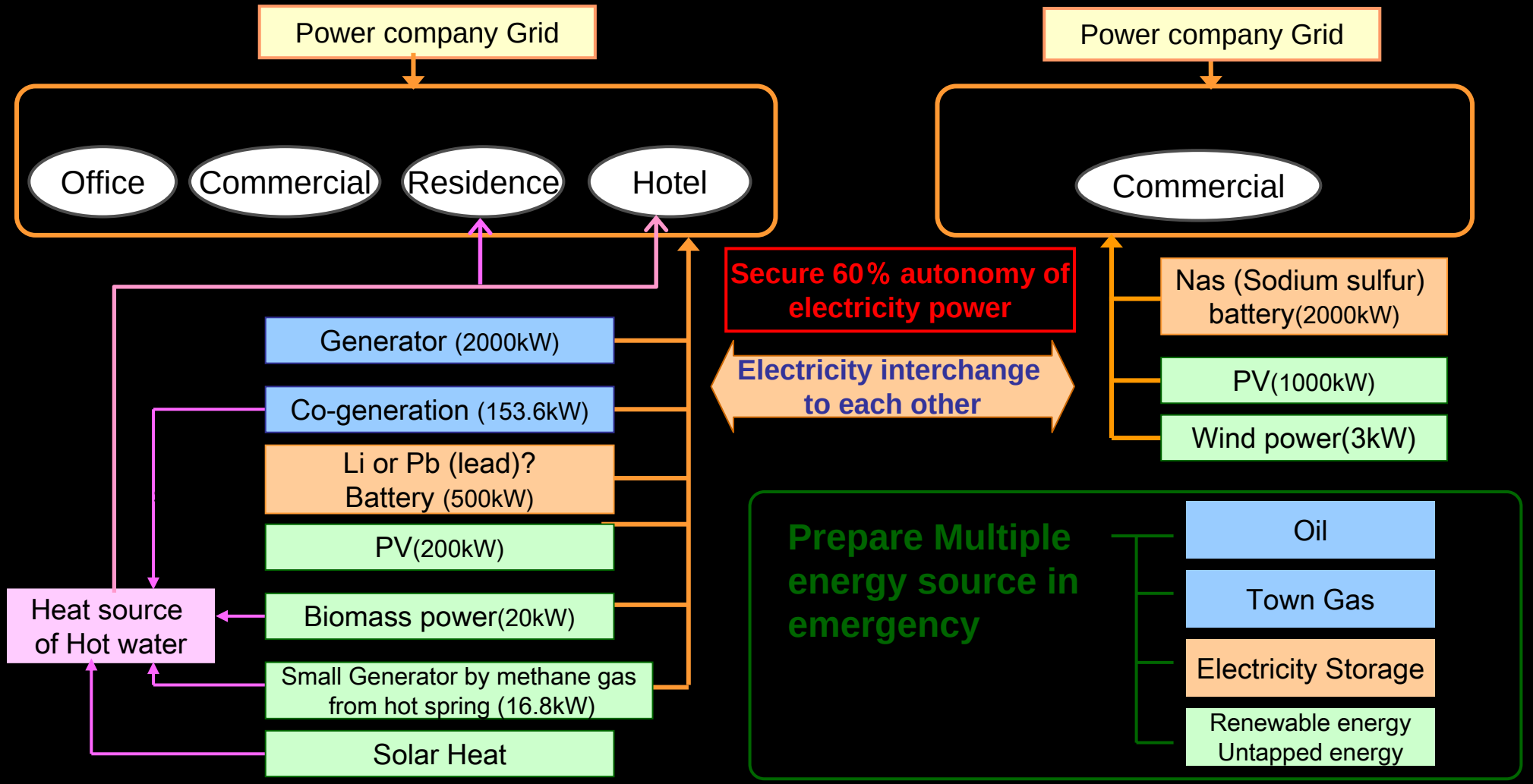
- **Task/Ambient AC system realizes minimum energy consumption by natural ventilation and RFID human sensor.**
- **Desiccant AC controls latent heat by using heat exhaust from Co-gene.**
- **Automatic control by dynamic heat load prediction system with ICT**



Electricity power Interchange ~ Prepare "Dual grid" with Power company's grid and secure autonomy ~

Environmental-friendly City

Secure autonomy of energy network system by using multiple energy ; Renewable energy, Untapped energy, Town Gas, Power and Electricity storage with power company's grid



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Develop First Full-Fledged Smart Grid in Japan

Environmental-friendly City

HEMS:
Home energy management system

BEMS:
Building energy management system

Power company transmission network

Private emergency transmission lines

Information and communications network

- Japan's first full-fledged smart grid for power interchange across districts for different types of facilities
- Installing a private transmission network to swiftly materialize a smart city without burdening power companies

Kashiwa-no-ha leading the world in smart city development

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Low carbon operation with overall stakeholder ~Area Energy Management covering whole area ~

Environmental-friendly City

- Monitoring detailed energy consumption trend, informs stakeholder and encourages low carbon operation.
- Controls the energy balance between demand side and supply side, encourages total electricity consumption in this area.

【User interface】

Control Panel

Digital signage

（Tenant of commerce）

エネルギーの見える化
節電ナビゲーション

AEMS

Integrated Network (Open network)

エネルギー使用情報

HEMS

Residence

Hotel

エネルギー使用情報

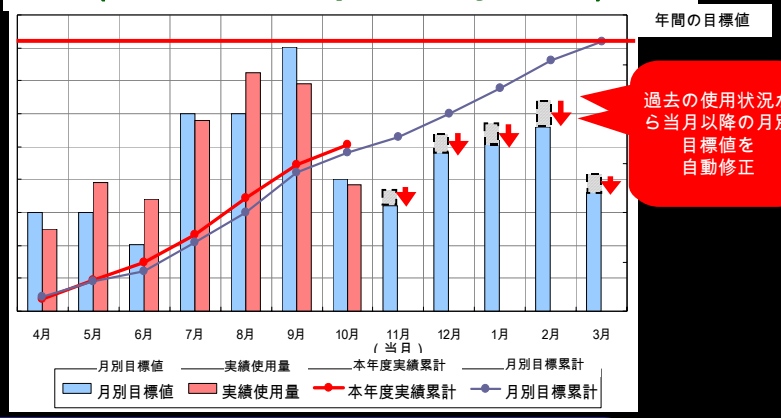
BEMS

Office

Commercial

【District 148】

Navigation system for saving electricity consumption （Demand-response system）



エネルギー使用情報

Residence

【1st Town】

エネルギー使用情報

Residence

【2nd Town】

エネルギー使用情報

Commercial

【shopping mall】

Propose Brand-new Eco-life style as for BCP & LCP

~ Image of setting low energy life style as basic version ~

Environmental-friendly City

Low Energy Life style for Business continuity planning and life continuity planning

1 days | 2 days | 3days

Normal

▲15% Energy reduction

Eco-life style
(Continue 85% Energy consumption)

100% Supply

Implemented by Low energy building, BMS, and Low energy life style

Pre-planned power outage
(When the Power company restricts power supply)

Eco-life style (Continue 85% Energy consumption)

wer ou

Keep 50% energy consumption

Period of Planned power outage

Eco-life style (Continue 85% Energy consumption)

85%

Supply from Smart grid

Keep 50%* reduction of energy

*Based on normal style as 100%

Disaster
Earthquake, Power outage, etc

Eco-life style (Continue 85% Energy consumption)

wer ou

20% Electricity supply allowance to secure safety and minimum lyfe in this area

Period of Planned power outage

Supply from Smart Grid

Supply 20%* for minimum electricity requirement in disaster, and secure safety

*Based on normal style as 100%

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Advanced Urban Transit Systems

Environmental-friendly City

Kashiwa ITS Promotion Council

- Established in Feb 2010 after the Japan Cabinet Office chose Kashiwa City as the fourth model city for intelligent transport system demonstration experiments
- More than 50 groups from the public and private sectors and academia are jointly developing advanced vehicles and systems
- Progress with experiments at Kashiwa-no-ha will be announced at ITS World Congress in Tokyo in 2013

Multi Transport Sharing

- Sharing electric cars, electric motorcycles and bicycles for short local trips
- Users rent and return by swiping IC cards over scanners
- One-way rentals permissible
- 40% CO_2 reduction as of June 2011

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Locally Producing and Consuming Food

Environmental-friendly City

Chiba University Plant Factory

- Japan's largest plant factory research hub
- Hydroponically produces pesticide-free tomatoes and lettuces
- 60 companies participating in competitive yield and production cost experiment

Oak Village Kashiwa-no-ha

- New Japanese-style agri-tourism facility combining organic farming and entertainment
- Created by KCJ Group and launched in April 2012
- Providing farming experience, wedding and dining facilities, and a market

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Establishing Total Healthcare Stations

City of Health and Longevity

Increasing number of active seniors wishing to engage in local activities

Local people with preventive healthcare expertise

Greatening nationwide shortage of physicians

Building a community encouraging a healthy active lifestyle for seniors

Employees to support the better health of citizens

Support daily activities

Elderly people requiring support and nursing care

Rehabilitation at home or centers, oral care, and nutritional information

Comprehensive rehabilitation advice for health maintenance

Preventive education and cultivation of supporters

Total Healthcare Station

- **Rehabilitation personnel**
- **Nurses**
- **Dental hygienists**
- **Nutritionists**

Collaboration

Regional medical institutions

Collaborate with active senior citizens to provide assistance for citizens' health
⇒ Increase preventive healthcare locally

Liaise with physicians and dentists for a holistic healthcare approach covering from illness prevention to health promotion

Collaborate with University of Tokyo and Chiba University initiatives

University of Tokyo Institute of Gerontology
Fostering employment of healthy seniors

Chiba University Center for Preventive Medical Science
Harnessing patient health records towards pursuing a new public health concept

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Annex

Trend of Sustainable Development in JAPAN

NSG engages from Green Building to Green Urban Infrastructure

1980 1990 2000 2010 2015

Smart Energy Network, Smart Community Technology

Community Energy Management (CEMS)

CEMS

Area Energy Management (AEMS)

EMS

Building Energy Management (BMS,HEMS)

BEMS

Prevailing in Commercial Buildings

省エネ建築

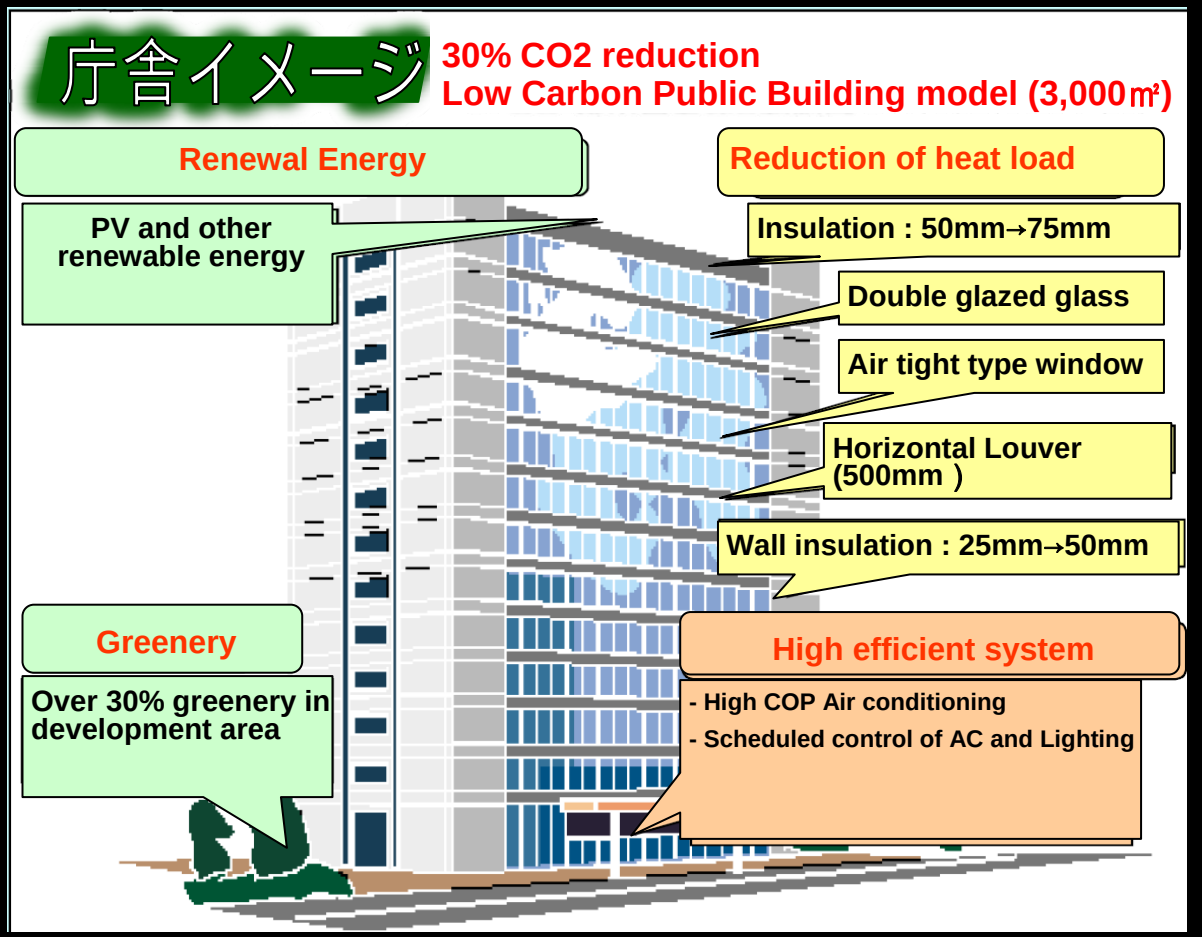
Green Building challenge to ZEB

ZEB: (Nearly) Zero Energy Building

Tokyo Metropolitan City Government

Tokyo City government presents Best Practice model “Tokyo Low Energy 2007”
Aiming best practice of low energy for facilities of Tokyo Metropolitan Government

Required [Over Level 3]
in Manifest System of Building Eco-efficiency

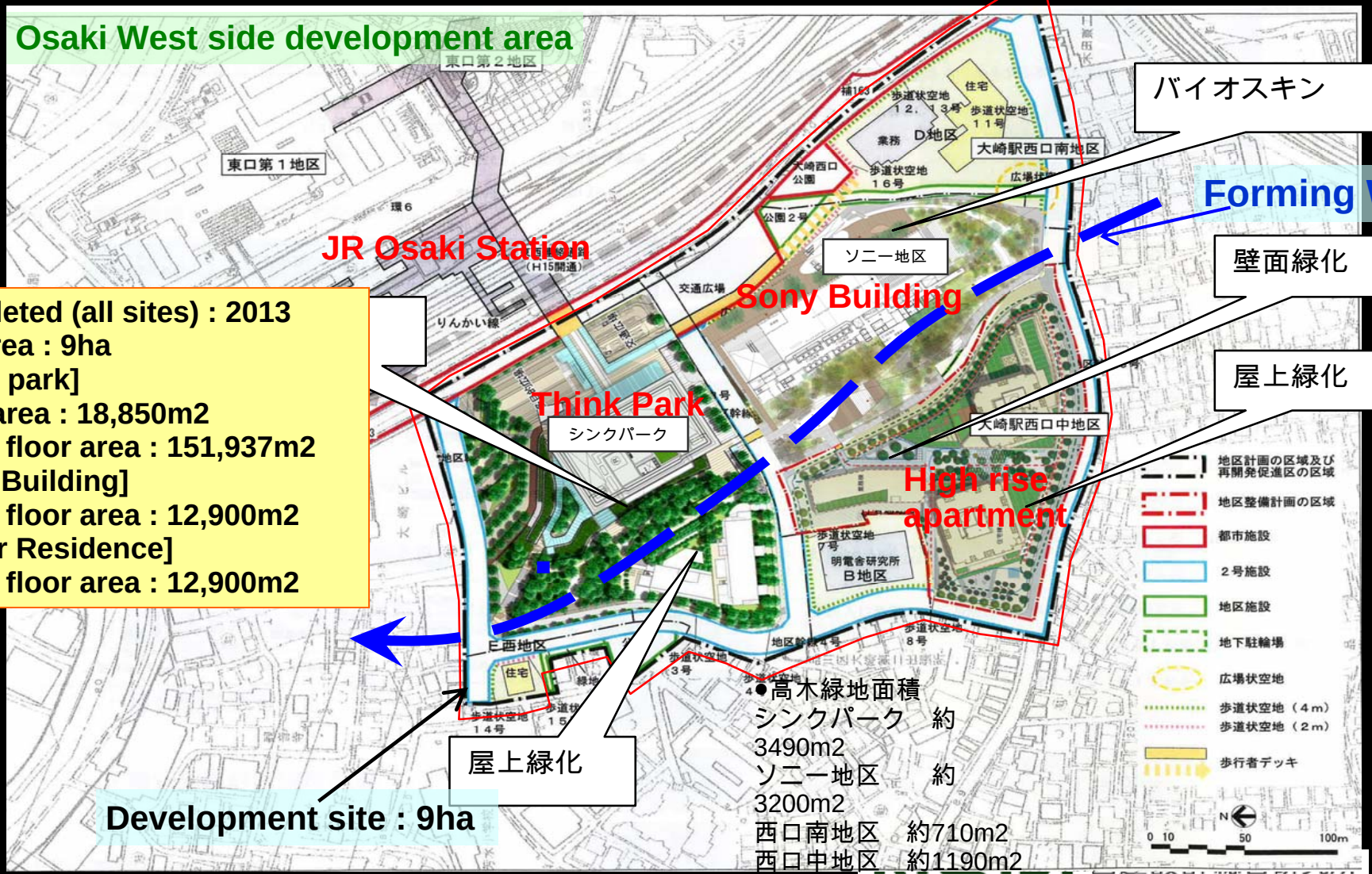


Tokyo Midtown

Contribution to Greenbelt in the mid Tokyo

Osaki West side area development

Development along with Environmental friendly guideline for the area around JR Osaki station

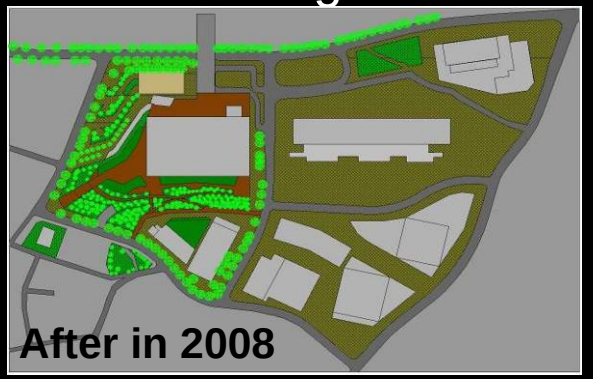


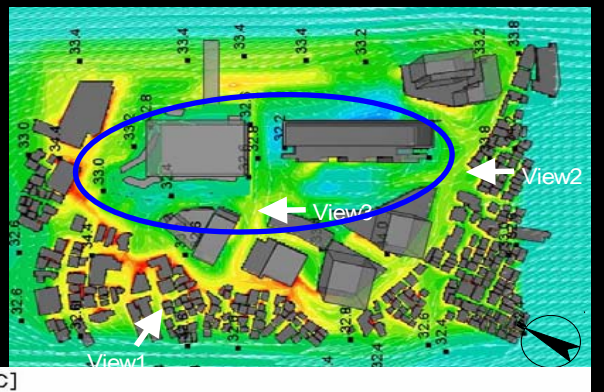
Completed (all sites) : 2013
Site area : 9ha
[Think park]
Site area : 18,850m2
Total floor area : 151,937m2
[Sony Building]
Total floor area : 12,900m2
[Tower Residence]
Total floor area : 12,900m2

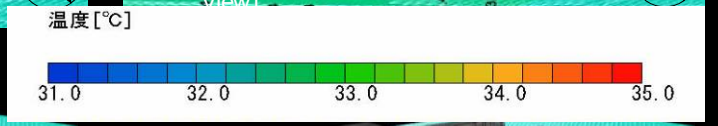
Osaki West side area development

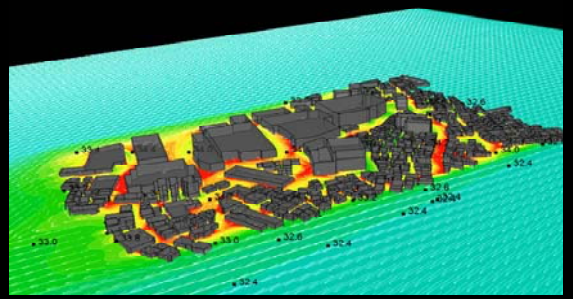
Air temperature distribution at 13:00 PM by Numerical simulation

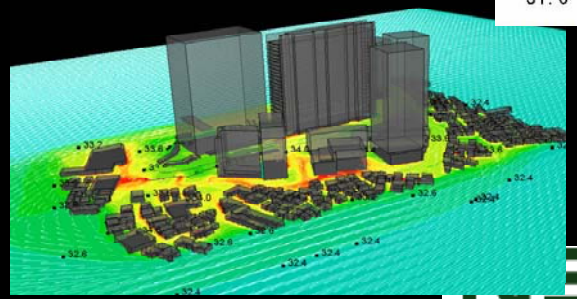
Environmental design not on each building site but in whole area is more effective

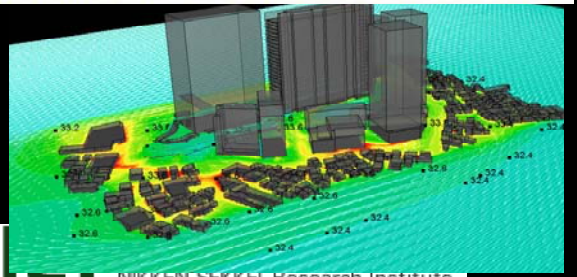












Designation as Comprehensive Special Zone and Future City

Two systems to materialize Japan's New Growth Strategy

Comprehensive Special Zone

Japanese government offering deregulation and tax incentives for advanced regional vitalization initiatives

Future City

Japanese government providing financial assistance for advanced initiatives to tackle environmental and social aging issues through the creation of cities that can be models for the world

December 2011

Kashiwa City received both designations, centering on the Kashiwa-no-ha Campus

The Japanese government is providing comprehensive support to swiftly materialize the world-class **Kashiwa-no-ha Smart City Model**

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TX Entrepreneur Partners (TEP)

City of New Industry Creation

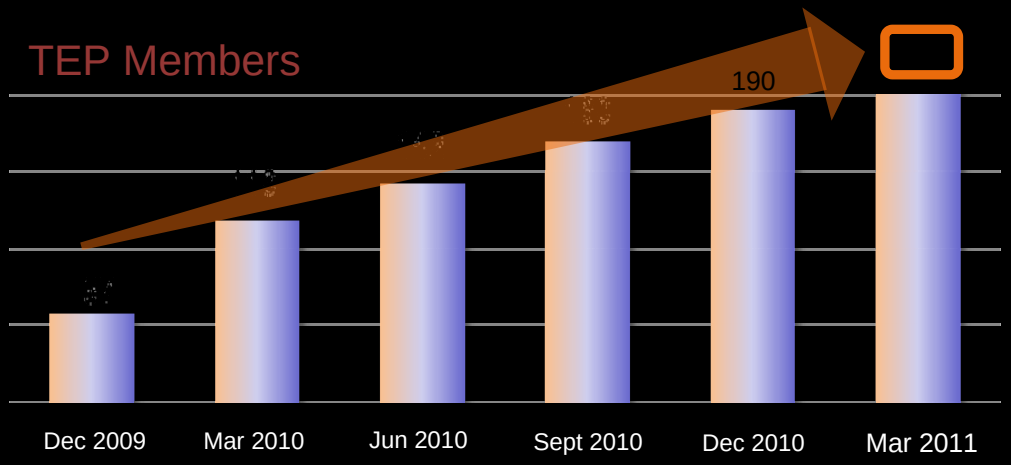
Japan's key challenge in new industry creation:

Cutting-edge Japanese technology often lacks commercialization opportunities

TEP was founded in November 2009 to facilitate community-led venture enterprise development in the area along the Tsukuba Express Line

TEP – A support organization for business start-ups

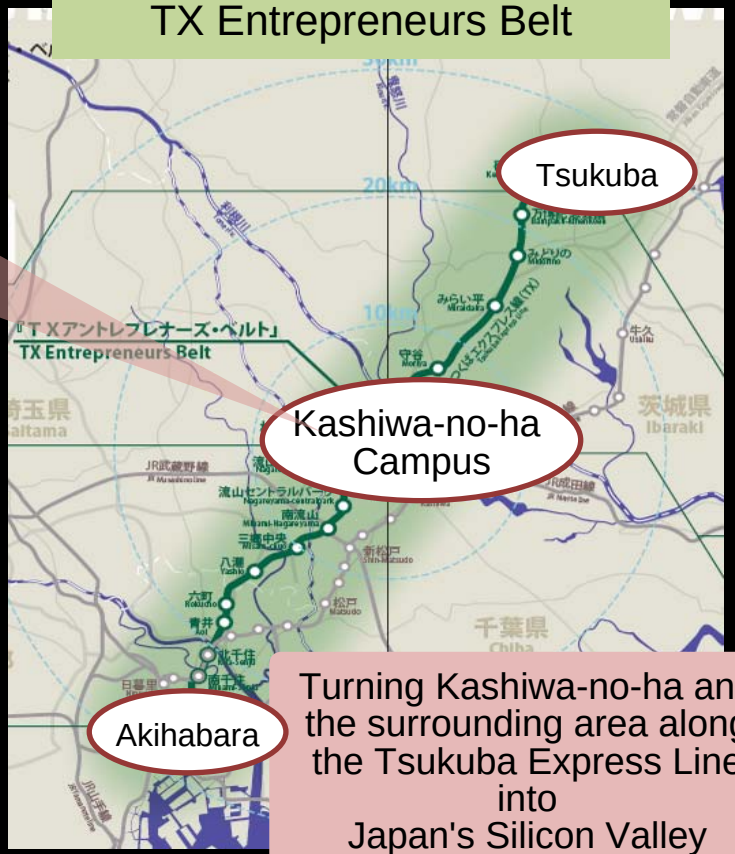
Matching venture with Angel Members providing Support for funding and management



President: **Masaru Murai**

After serving as the 1st president of Compaq Japan , involved in founding of over 10 Japanese and international ventures. Also served as the original chairman of the review committee for Entrepreneur of the Year Japan.

TX Entrepreneurs Belt



Turning Kashiwa-no-ha and the surrounding area along the Tsukuba Express Line into Japan's Silicon Valley

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Part 2

Current Experiences of Advanced Energy Efficiency

by NIKKEN SEKKEI Research Institute

29, 30, May, 2013

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planners | architects | engineers

Contents

1. Guideline of Green Building in Japan
2. Training Program & Technical Support
3. Energy Efficiency Technologies in Buildings in Japan
4. Smart Building and Smart City in Japan
5. Case studies by Simulation Tool for Building Energy Consumption

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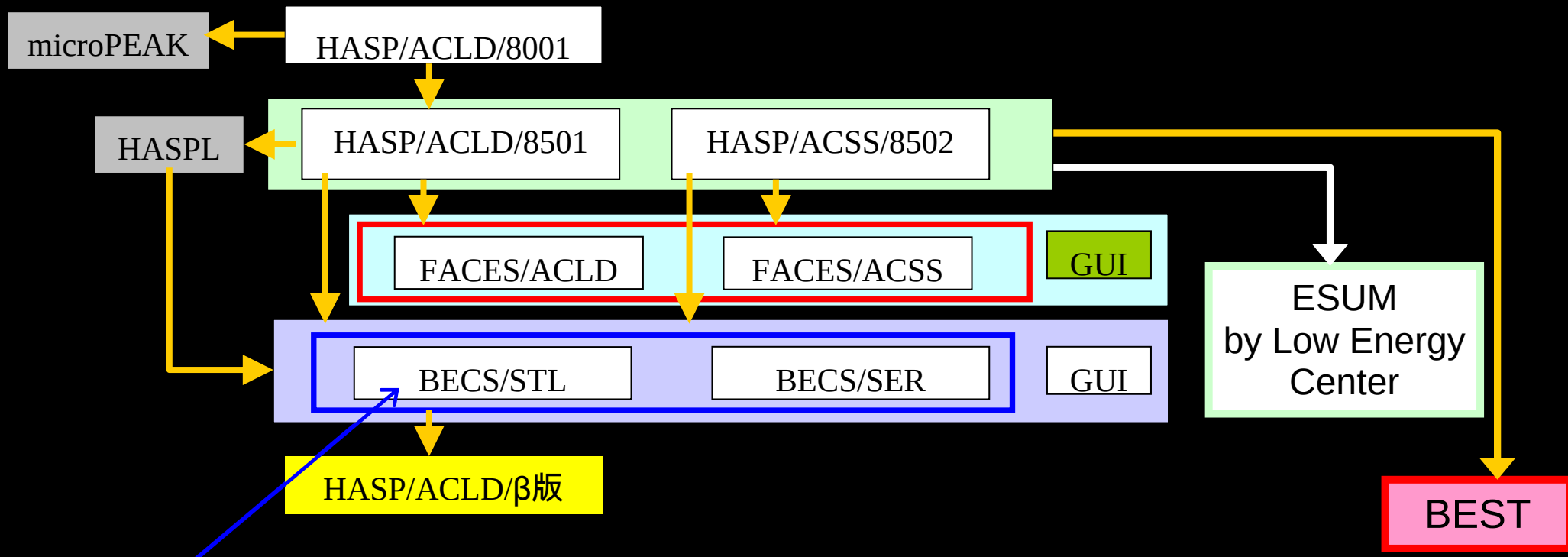
5. Case Studies by Simulation tool for Energy Consumption

1) Background of developing Simulation tool in Japan

Building Energy prediction tool has started its developing just from HASP over 30 years. But HASP is so complex and difficult to operate.

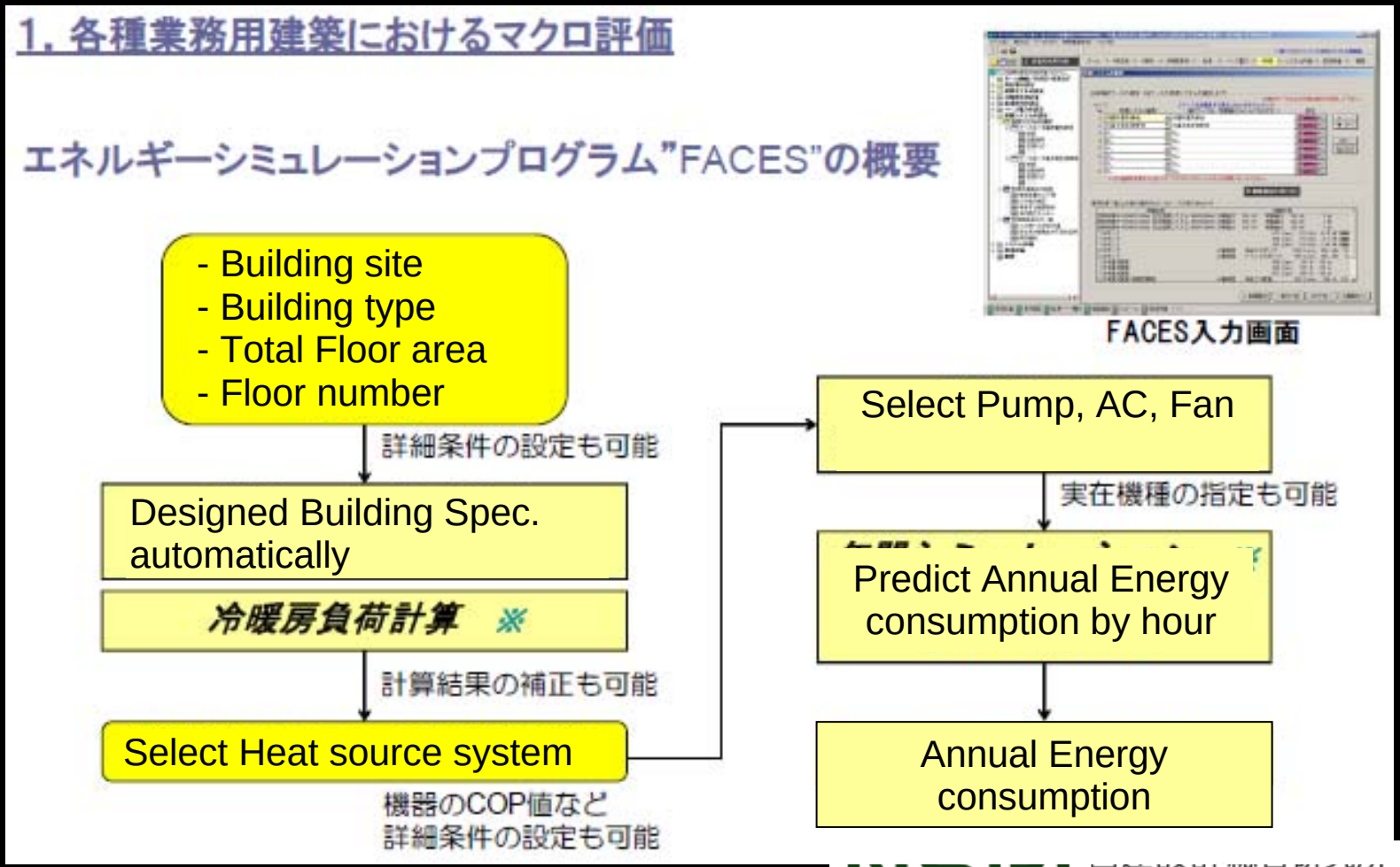
In this reason, recently improved and re-developed simple and convenient tools like as BECS, FACES, and BEST.



*BECS is used to calculate CEC/AC for preparing the manifest of National energy saving law

2) FASES for Annual Building Energy Consumption

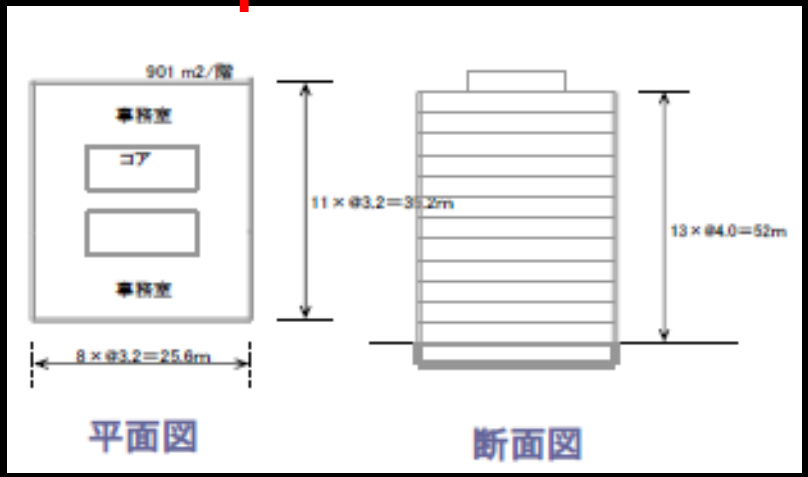
FASES has been developed based on HASP by Joint development team (over 10 company like Electricity companies, General constructors, Architectural firms, JAMBEE). Nikken Sekkei joins the development team.



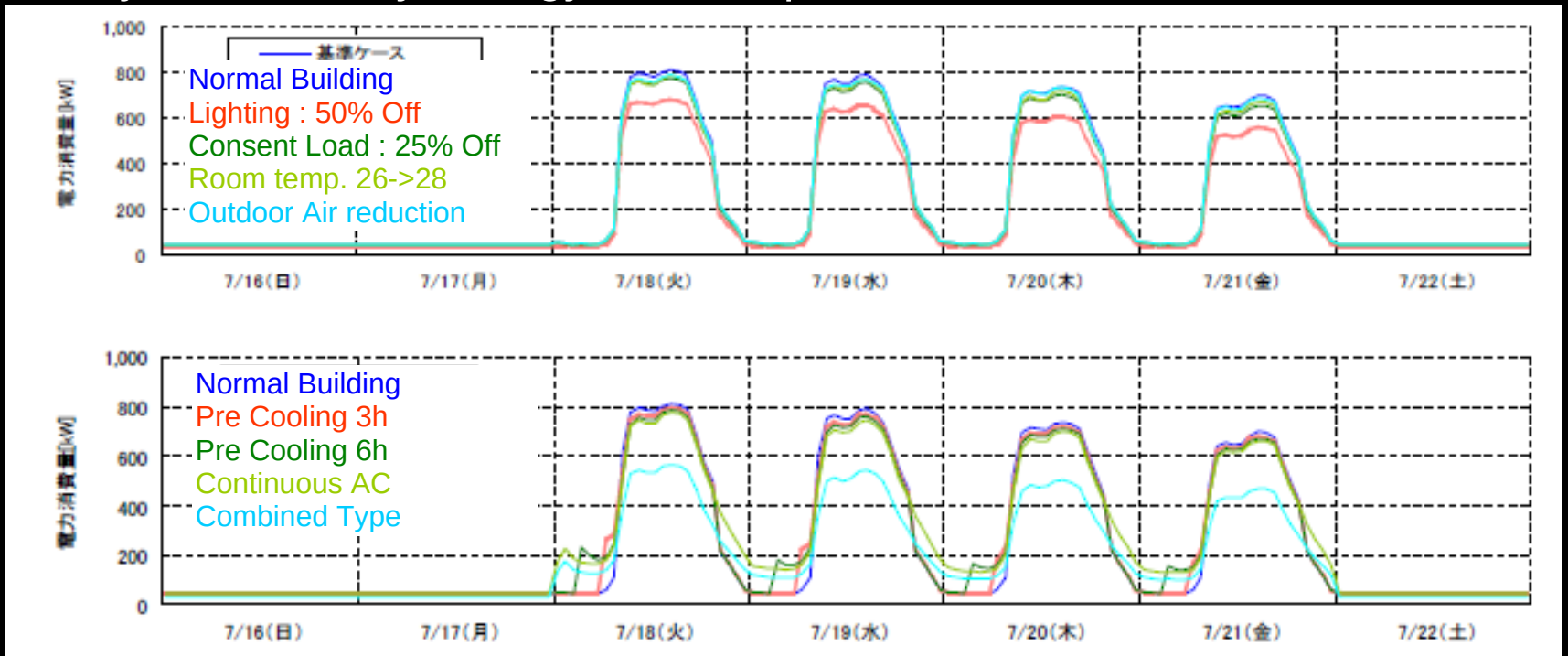
5. Case Studies by Simulation tool for Energy Consumption

2) FASES for Annual Building Energy Consumption

- OFFICE Building
- Total Floor : 11700m2
- 13 Floors
- HP Chiller, AC, FCU
- Roof : RC130mm, Insulation 50mm
  Wall : RC150mm, Insulation 25mm
  Glass : Float glass(6mm)



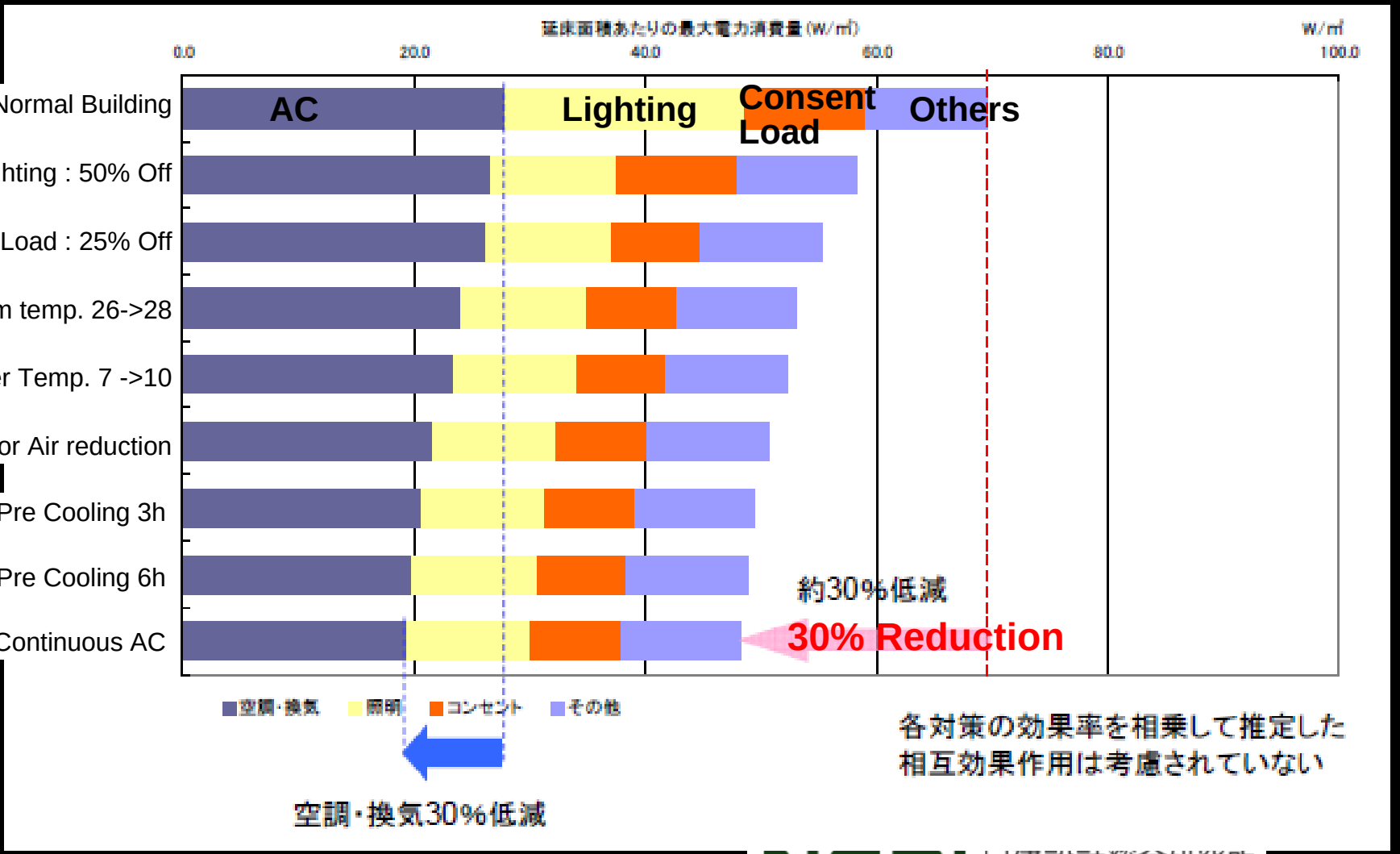
Case Study of Electricity Energy Consumption



5. Case Studies by Simulation tool for Energy Consumption

2) FASES for Annual Building Energy Consumption

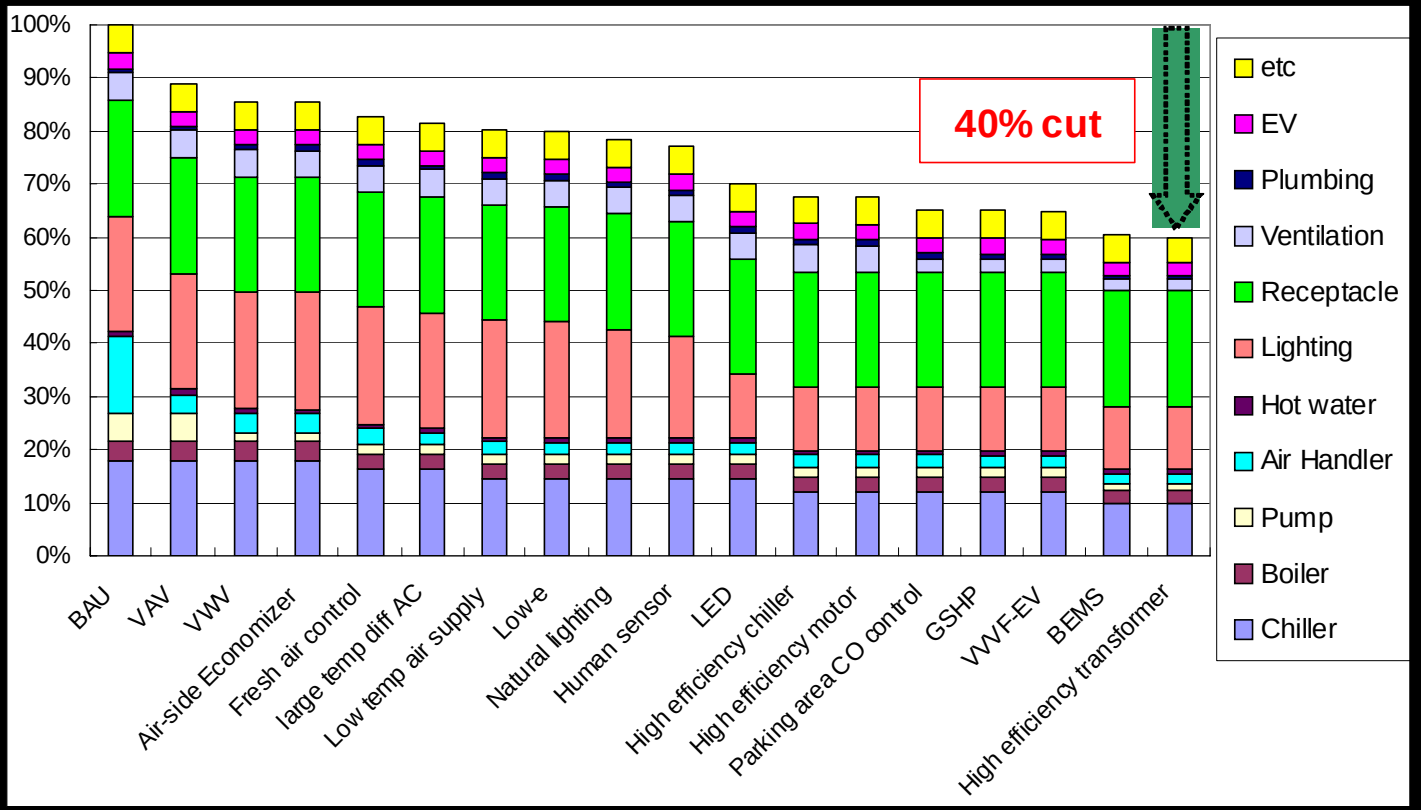
Maximum Electricity Energy Consumption (W/m2)

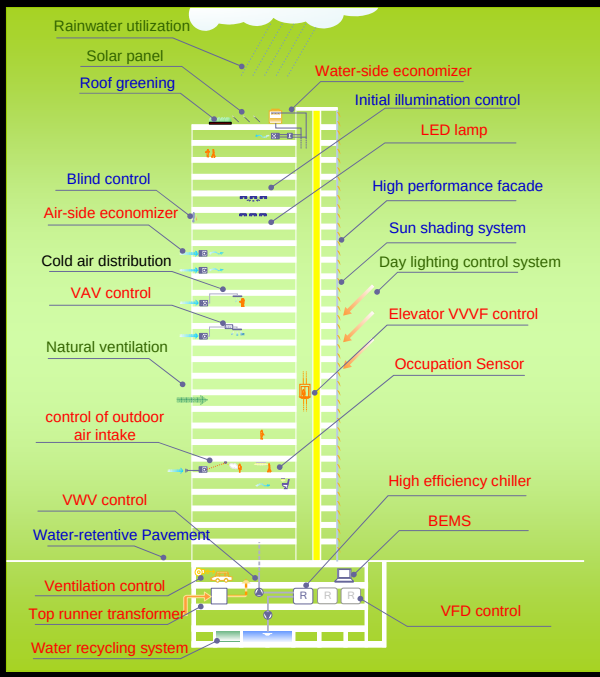


5. Case Studies by Simulation tool for Energy Consumption

FASES for Annual Building Energy consumption

CO2 reduction effects of Low carbon measures of Model Office Building in Yujiapu APEC LCMT Project





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5. Case Studies by Simulation tool for Energy Consumption

BEST for Annual Building Energy consumption

BEST (Building Energy Simulation Tool) is comprehensive energy simulation tool that can predict annual energy consumption trend as follows:

1) Heat source system (CGS, Heat storage system, PV)
2) AC (CAV, VAV, THX, etc)
3) Ventilation
4) Lighting
5) Consent load (Outlet tapping)
6) Hot water supply
7) Others ; Elevator, etc

BEST has been developed since 2005 by BEST Consortium (MLIT, Academies, Private companies).

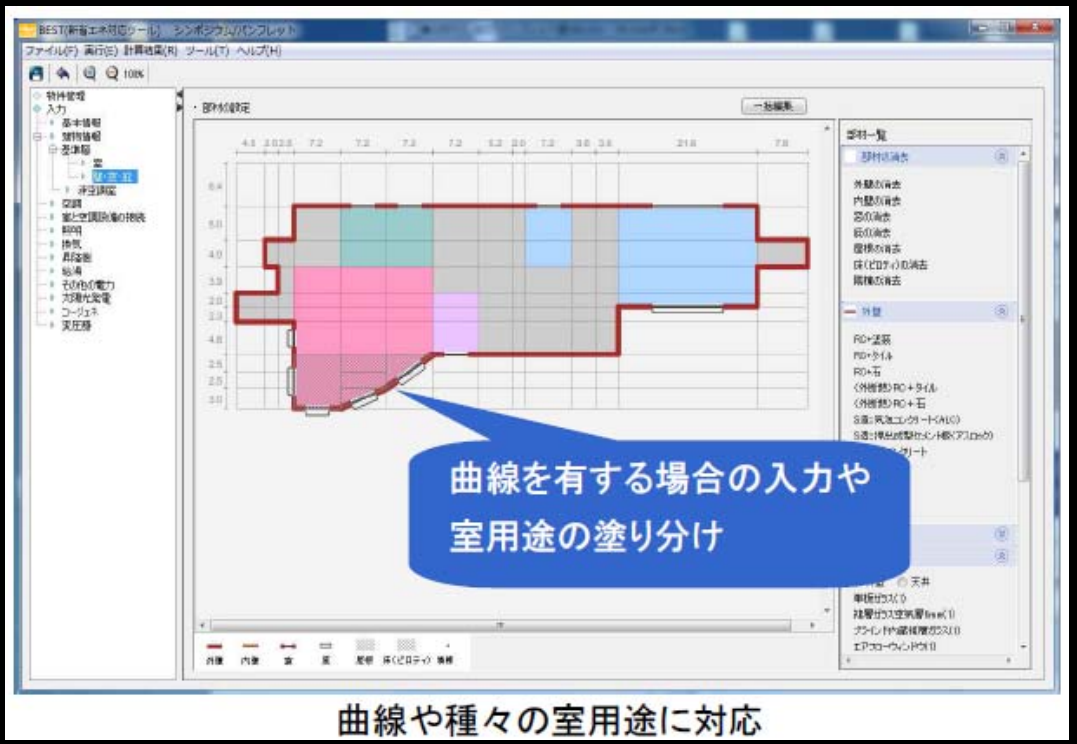
Nikken Sekkei also joined and developed main engine.

5. Case Studies by Simulation tool for Energy Consumption

BEST for Annual Building Energy consumption

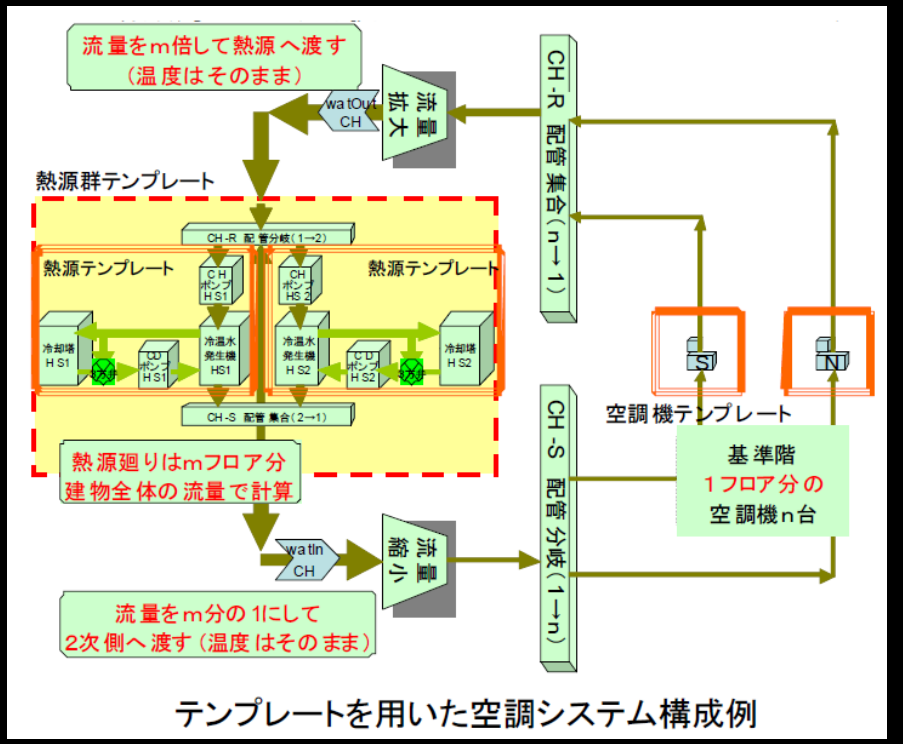
Example of Operation Window

Input the basic plan as calculation condition



曲線や種々の室用途に対応

Heat source system by Template inputting method

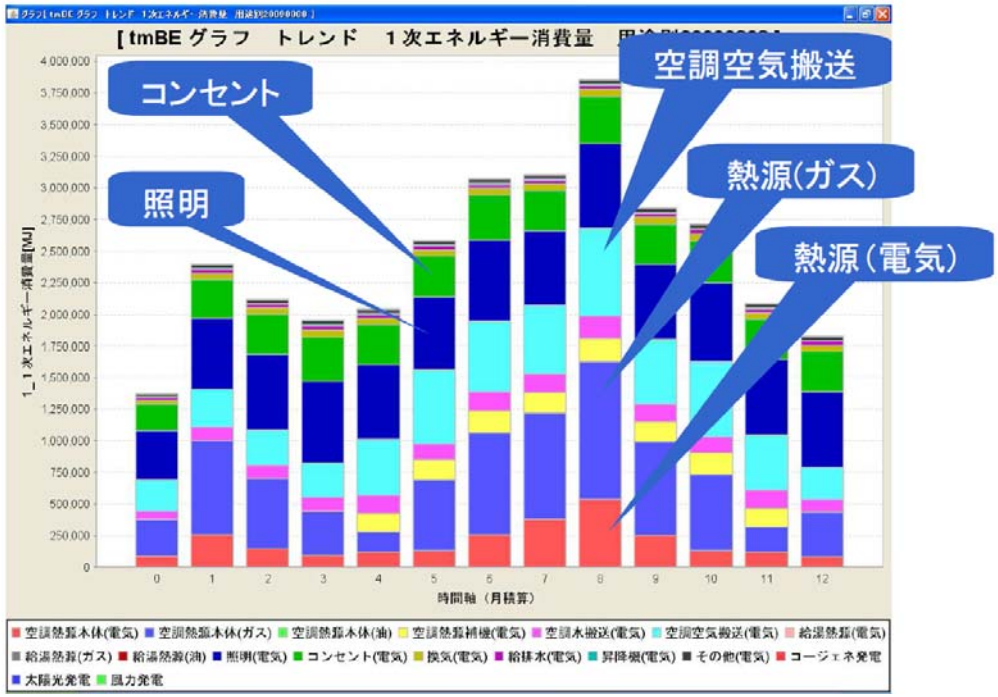


テンプレートを用いた空調システム構成例

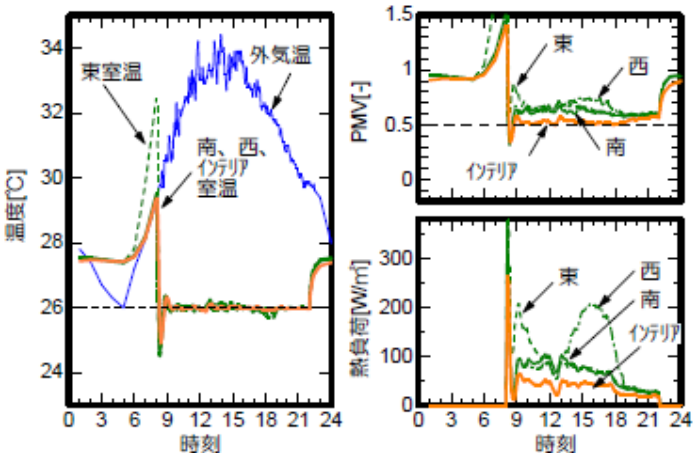
5. Case Studies by Simulation tool for Energy Consumption

BEST for Annual Building Energy consumption

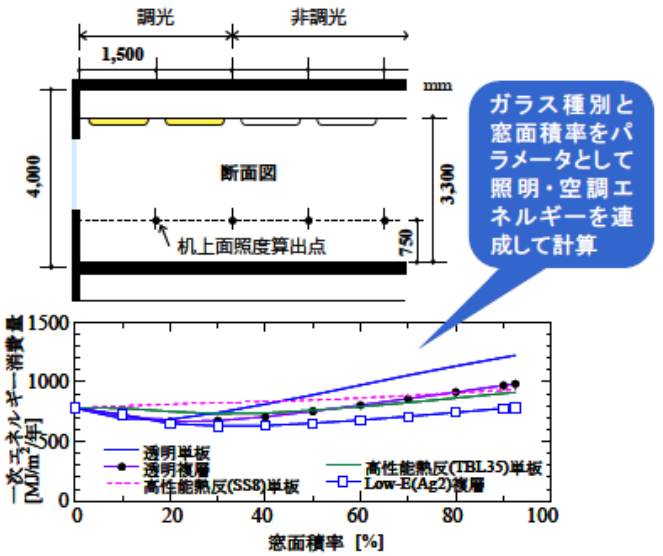
Case Study of Building energy consumption in many point of view



Annual Building Energy Consumption



The Thermal efficient of Glass



Combined analysis of Day Lighting and AC

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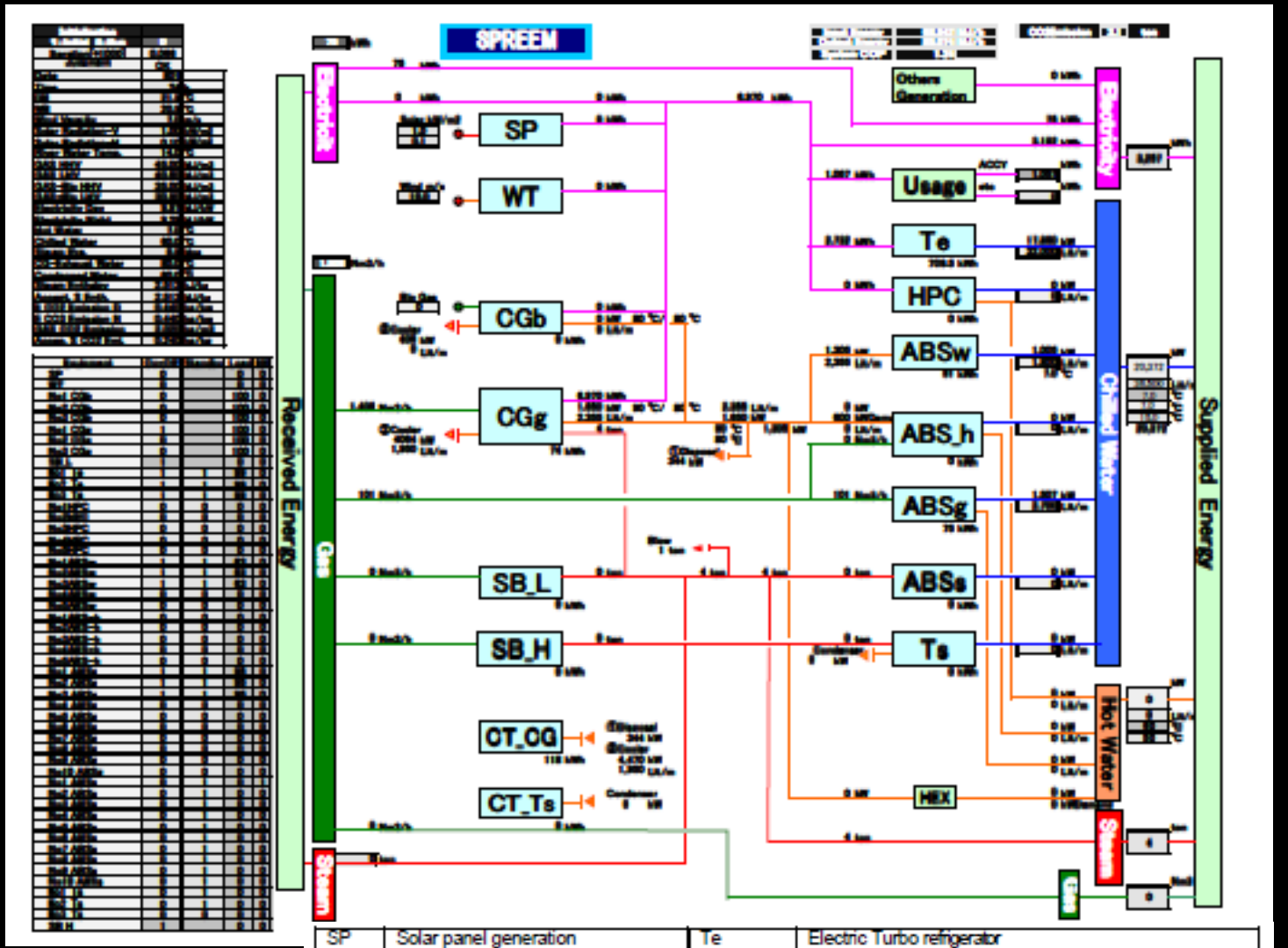
5. Case Studies by Simulation tool for Energy Consumption

SPREEM for area energy consumption developed NSG

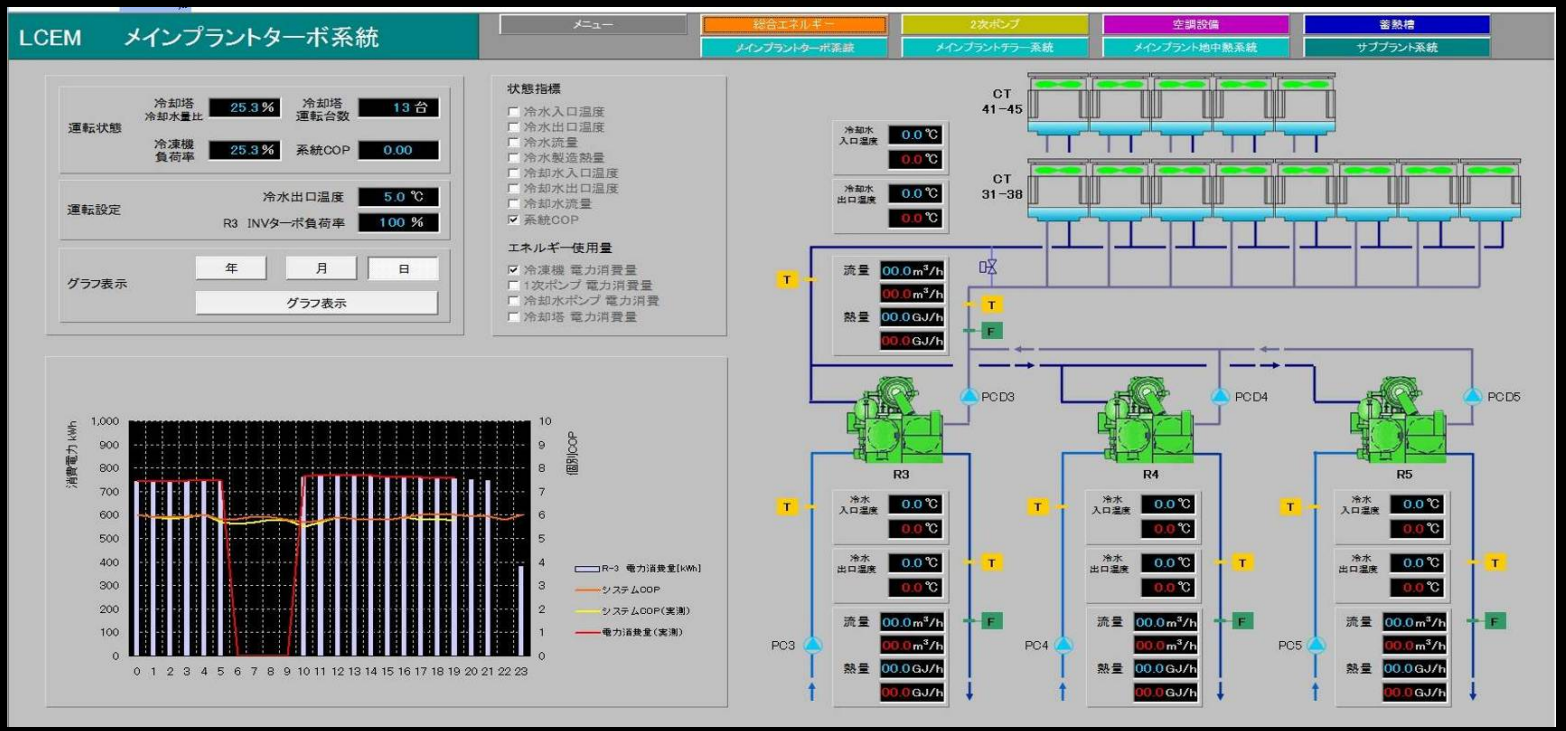


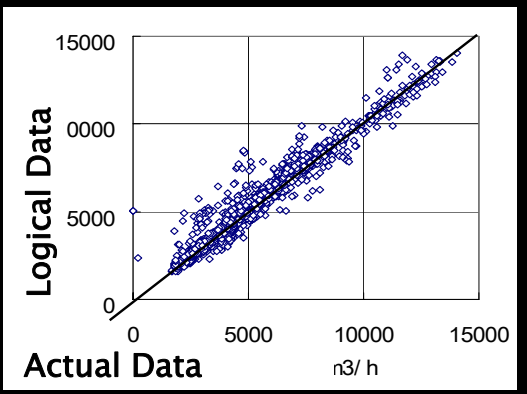
SPREEM :
Simulation Program for Regional Energy and Environmental Management

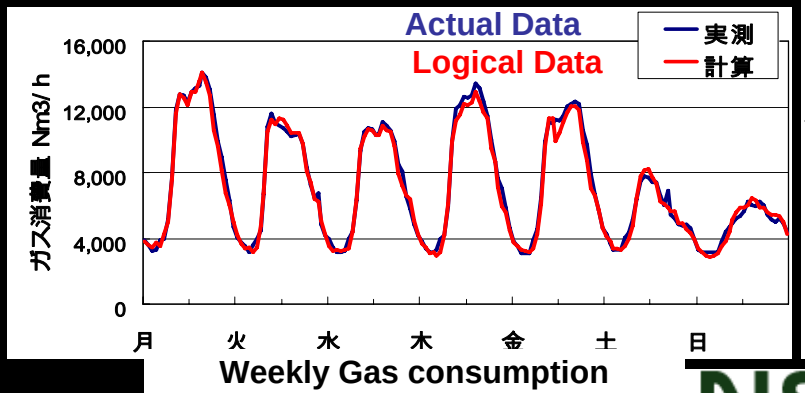
SP	Solar panel generation	Te	Electric Turbo refrigerator
WT	Wind turbine generation	HPC	Water source heat pump chiller unit
CGb	Engine generators by bio gas	ABSw	Hot water absorption water cooler and warmer machine
CGg	Engine generators by gas	ABS_h	Heat recovery absorption water cooler and warmer machine
SB_L	Steam boiler 800kpa	ABSg	Gas absorption water cooler and warmer machine
SB_H	Steam boiler 4000kpa	ABSs	Steam driven absorption refrigerating machine
		Ts	Steam turbine driven turbo refrigerator

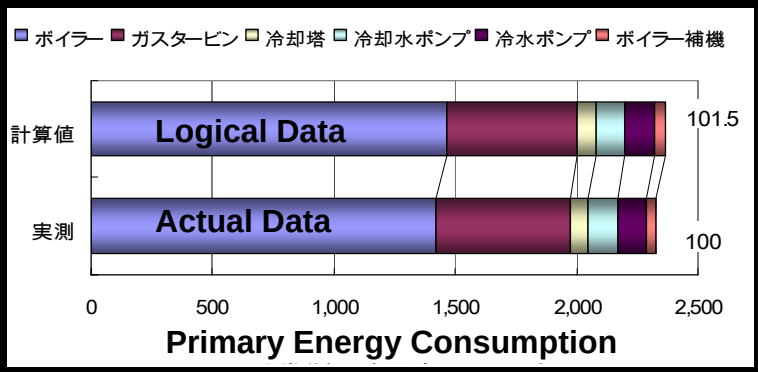
5. Case Studies by Simulation tool for Energy Consumption

Example of Appling SPREEM for Energy Management in Tokyo Sky Tree









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Annex

5. Case Studies by Simulation tool for Energy Consumption

	ACSS/8502	BECS/SER	FACES/ACSS
熱負荷計算からの与条件	連続空調負荷 WF の補正項	除去熱量	除去熱量
出力情報	エネルギー消費量 実現される室の温湿度	エネルギー消費量 CEC/AC、未処理負荷	エネルギー消費量
過負荷の扱い	反復法で熱平衡・流量平衡を求める	未処理負荷の繰り越し	未処理負荷の単純集計
計算時間間隔	1時間毎	1時間毎	1時間毎

5. Case Studies by Simulation tool for Energy Consumption

Example of Official Energy Simulation Tool

DOE-2 (USA)	DOE主体に開発された建物のエネルギーシミュレーションプログラムで、建物空調負荷，空調システムの挙動状態とそれに伴うエネルギー消費量，ランニングコスト解析が可能である。システム仕様や制御手法等は、使用者の技術レベル、目的に応じて設定でき、空調システム設計に対する各種感度解析が可能であるため、実務設計，研究･開発等の幅広い分野で活用されている。
Energy Plus (USA)	米国のUniversity of Illinois、カリフォルニア大学及びLBNLにより開発され、米国エネルギー省から配布されている。モジュール方式が採用され、建物外皮、ゾーン計算や各種空調機器等の計算モジュールは、米国陸軍建設研究所開発のBLAST、米国エネルギー省開発のDOE-2から受け継いだものである。
DeST (china)	Tsinghua University建築学院建築技術科学学科DeSTグループにより、1990年代初期から開発されてきた空調システムのシミュレーションプログラムである。空調エンジニアを支援するために開発され、建物の熱性能最適化等にも利用されている。ユーザーは、中国で約1000人以上あり、実際の空調システム設計や省エネルギープロジェクトに利用されている。
TRNSYS (USA)	Solar Energy Laboratory, Univ. of Wisconsin-Madisonにおいて開発されたもので、各種太陽熱利用システムの検討のために開発されたシミュレーションツールであったが，現在では多種多様なモデルが追加され，空調及びエネルギーシステム全般の解析に広く活用されている。特徴コンポーネント単位でモデル化されたモジュール方式構造にある。
HVACSIM+ (USA) (Japan)	1984年にUnited States Department of Commerce (旧NBS；国家標準局)より空調システム及びそれと関連するもの動的な関係を詳細にシミュレートするために開発されたもので、秒単位の機器挙動、室内環境シミュレーション等が可能な動的システムシミュレーションプログラムである。日本版は有志により維持管理されている。モジュール方式の採用など、TRNSYSの特徴を引き継いだプログラム構造となっている。

5. Case Studies by Simulation tool for Energy Consumption

Example of Official Energy Simulation Tool

HASP / ACSS (JAPAN)	空気調和・衛生工学会で開発された動的熱負荷計算プログラムHASP/ACLDの計算結果をもとに空調システムシミュレーションを行うプログラムで、1985年に(社)建築設備技術者協会で開発された。空調システムの年間エネルギー消費量の予測を主目的とするプログラムであるが、実現される室内の温度、湿度の状態及び除去熱量、空調機・熱源機器などの運転動作も求めることができる。
LCEM (JAPAN)	2006年から国土交通省がリリースしている空調用システムシミュレーションツール。汎用表計算ソフトを用いたオブジェクト化セルズ法という解法を用いたシステムシミュレーションツールで、ライフサイクルの各段階で共通して利用できるよう開発されている。オブジェクトは機器単位で構成されており、機器特性、製品版の協定版得あ作成建築設備設計の利用目的に応じて各版を使い分けることが想定されている。
BEST (JAPAN)	2006年からJSBCより頒布されている建物全体のエネルギー消費量を算定するエネルギー保有ラベルである機器特性版、製品版の協定版得あ作成建築設備設計の利用目的に応じて各版を使い分けることが想定されている。
FACES (JAPAN)	電力会社にて開発されたHASP/ACSSをベースとした動的熱負荷＋システムシミュレーションプログラムで、現在もメンテナンスが継続されている。最小限の建物情報で計算が可能であるため、初期の企画段階から比較的簡易に空調エネルギー消費量計算を行うことができる。
ESUM (JAPAN)	建物のエネルギー原単位管理ツールとして（財）省エネルギーセンターより無料配布されているHASP/ACSSをベースとしたエネルギーシミュレーションプログラムである。入力インターフェースがよく整備されており、比較的簡易に建物の空調用エネルギー消費量計算が可能である。

Building Energy Simulation Models

Background

In Thailand, the Energy Conservation Promotion Act (ECP Act) which was promulgated in 1992 and was fully implemented in 1997 has made architectural design professionals become interested in energy efficient design strategies to help conserve energy use in buildings. The law requires that every designated building conduct energy audit and set up plans to improve energy efficiency. Building energy performance such as overall thermal transfer value (OTTV), roof thermal transfer value (RTTV), lighting power density (LPD) and equipment performances were checked against allowance values set by the law. In educational field, energy conservation design principles for buildings in the tropic were first introduced to architectural students in 1994. Only tropical design principles related to sun and rain protections and natural ventilation were taught before that time.

To facilitate energy code compliance, a basic tool that can calculate overall thermal transfer value (OTTV) and roof thermal transfer value (RTTV) was provided from the Department of Alternative Energy Development and Efficiency (DEDE). This early tool requires user inputs in command-line format. Two other tools with more user-friendly features were later developed by Siam Fiberglass Co., Ltd.(SFG) and Chulalongkorn University. OTTV and RTTV calculations use simple mathematics except for the shading coefficient of shading systems part that need computer program to calculate the total effect of shading shapes and locations on building fenestrations resulting from different sun angles in one year. After the new building energy code 2009 has been promulgated, DEDE provides a new building energy simulation model (BESM) tool, BEC, now version 1.0.5. for evaluating building energy efficient measures in accordance with the new energy code requirements. The new building energy code divides designated buildings into 3 types according to their daily operation hours, provides credits for the use of solar energy and daylighting, adds requirements for hot water systems ,and introduces a new option of whole building energy compliance.

Complying with new building energy code could save building energy use 10%-20% annually (Chirarattananon, Chaiwiwatworakul et al. 2010). However, energy conservation effort for commercial buildings in Thailand has been considered to have achieved limited success. Over the past 15 years of ongoing energy efficiency program, commercial building stakeholders are aware of energy conservation opportunities in their buildings. However, only simple and low cost measures have usually been implemented. In building design phase where energy efficient strategies could be effectively incorporated into the building, energy simulation tools could be used to investigate energy efficient design options and support decision making in selecting suitable strategies.

Building Energy Simulation Models (BESM)

The performance of a building is a result of complex processes. A better building design can reduce energy use by 30% compared to a conventional building design, while still provide an equal or better environment for its occupants. Barriers to achieve this goal is usually not technology constraints, but poor data to make informed decisions (Clarke 2001). Building simulation tools are created to help provide real world replication and predict how buildings and systems will perform once they are constructed and implemented, thus providing information for decision making. Building energy performance prediction tools are a series of complex mathematical models that address the dynamic interaction of building and system performances with building geometry, plan, components, system choices, climate conditions and occupant use patterns.

❖ **Annex II :** Assessment of Building Energy Simulation Model **(Activity 1.3.1a)**

In early days, simple single-zone buildings used degree-hour or degree-day based calculations to predict energy used. These methods are based on steady heat flow concept and only applicable with residential and small commercial buildings. With the available of computers, simulation program with transient heat calculation methods has then been introduced to predict energy used in more complex buildings. The first program developed by the Automated Procedures for Engineering Consultants, Inc. (APEC) was the Heating and Cooling Peak Load Calculation (HCC) program (APEC 1967), which was used for calculating hourly peak and annual heating-cooling loads for heating, ventilating, and air-conditioning (HVAC) systems in buildings. The APEC members were later formed into the ASHRAE Task Group on Energy Requirements (TGER), and then developed the procedures for simulating the dynamic heat transfer through building envelopes, procedures for calculating psychrometric properties, and the algorithms for simulating the primary and secondary HVAC system components for determining heating and cooling loads for computerizing energy calculations (ASHRAE 1975).

The need for BESM is primarily driven by building energy law and standard in 1990s and sustainable building rating systems in 2000s which usually rely on ASHRAE Standard 90.1 Appendix G – Performance Rating Method, that buildings desire to elevate their performances beyond ASHRAE standard code have to use energy simulation software to calculate their energy performance compared with base case buildings. ASHRAE 90.1 listed eight criteria as requirements for acceptable BESM. These models must be able to handle 10 or more thermal zones, generate hourly data for 8,760 hours/year, account for thermal mass effects, model part load performance curve, model capacity and efficiency correction curve for mechanical heating and cooling, model air-side economizers with integrated control, and accommodate hourly variation in occupancy, lighting power, equipment power, thermostat set points, and HVAC system operation defined separately for each zone (American Society of Heating Refrigerating and Air-Conditioning Engineers Inc. 2007). ASHRAE 90.1 appendix G Performance Rating Method section G2.2.4 also states that the simulation tool must be tested in accordance to ASHRAE standard 140 by the software provider. Example of programs listed in the standard are DOE-2, BLAST, and EnergyPlus. Qualified software for calculating U.S. commercial building tax deductions are Autodesk Green Building Studio, DesignBuilder, DOE-2.2, EnergyGauge, EnergyPlus, EnergyPro, EnerSim, eQUEST, Hourly Analysis Program (HAP), IES, Tas, TRACE700, and TRNSys (U.S. Department of Energy 2013). In additional to this list, Leadership in Energy & Environmental Design (LEED) rating system indicates some qualified tools for their rating systems which are DOE-2, eQUEST, Visual DOE, EnergyPlus, EnergyPro, HAP, TRACE700 ,and IES.

Green Building XML schema, developed by Green Building Studio, Inc. with funding provided by the California Energy Commission PIER Program and Pacific Gas and Electric, is an open schema to facilitate the transfer of building properties from building information modeling (BIM) programs to building energy analysis tools. The first version of Green Building XML schema or gbXML was released in 2000 (gbXML.org 2013). An examples of tools that use gbXML is Autodesk's Green Building Studio, a web-based energy modeling tool that uses a gbXML format and runs a DOE-2.2 engine. Conceptual Energy Analysis and Project Vasari, also offered by Autodesk, are the first BIM tools to directly export to DOE-2 and EnergyPlus.

In Thailand, BESM have been used in academics both to equip students with simulation skill and in building technology research in the past 20 years. In practice, buildings that use BESM in design phase are very rare. Few design firms have their own in-house energy simulators. BEC is one of the models being used widely because of the building code requirement that apply to some building groups. Apart from BEC, other BESM being used in academic or energy consultant firm mostly depends on programs that

simulator has encounter when in their own higher education period and the software prices. Examples of BESM used in Thailand are VisualDOE, eQUEST, TRNSYS, Tas, Ecotect, EnergyPlus, and Ener-Win. Details of each model (Crawley, Hand et al. 2008) including BEC are as follows:

1. **BEC V1.0.5** http://www.2e-building.com/detail.php?id=14

BEC is an OTTV-based energy estimation model for commercial buildings in Thailand (Chirarattananon and Taveekun 2004) provided from DEDE. Parametric results used in BEC to estimate building energy use were derived using DOE-2.1E and then validated with metered energy used collected by DEDE from designated buildings in the country. BEC provides database for building envelope materials and building systems. It can calculate building energy use according to building envelope systems, lighting density, air-conditioning system size and efficiency, other building equipments and the total building energy use in accordance with Thailand building energy code.

2. VisualDOE 4.0 http://www.archenergy.com/products/visualdoe

VisualDOE is a window interface of DOE2.1E simulation engine. The U.S. DOE consistently supported development of the DOE program until the mid-1990s. VisualDOE takes care of writing the input file, running the simulation and extracting the results from the output file. No experience with DOE2.1E is necessary, but advanced users have the flexibility to modify the input files directly and still run the simulations from within VisualDOE. VisualDOE covers all major building systems including lighting, daylighting, HVAC, water heating, and the building envelope. Among the wide range of simulation results are electricity and gas consumption, electric demand, and utility cost. Through the graphical interface, users construct a model of the building's geometry using standard block shapes, using a built-in drawing tool, or importing DXF files. Building systems are defined through a point-and-click interface. A library of constructions, fenestrations, systems and operating schedules is included, and the user can add custom elements. VisualDOE is especially useful for studies of envelope and HVAC design alternatives. Up to 99 alternatives can be defined for a single project. Summary reports and graphs may be printed directly from the program. Hourly results are available for detailed analysis.

3. eQUEST 3.64, August 2010, http://www.doe2.com/equest/

eQUEST® is a whole-building energy analysis software that uses the latest version of DOE-2 as a simulation engine. The DOE-2 building energy simulation and cost calculation program was initially released by the Lawrence Berkeley National Laboratory (LBNL) in 1978. The program has been updated continuously by LBNL in collaboration with James J. Hirsch and Associates, mostly under funding from the U.S. DOE until version 2.1E in 2003. Since then, James J. Hirsch and Associates has been continuing the development of DOE-2; the latest version is DOE-2.2. In DOE-2, the transient heat transfer calculation methods are used to simulate the dynamic heat transfer through building envelopes. From the literature, results from DOE-2 simulations were shown to vary from 10% to 26% from measured data (Haberl and Cho 2004). eQUEST was tested in accordance to ANSI/ASHRAE Standard 140-2007 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs, and it is qualified for use to evaluate building energy performance for government subsidy programs and building rating systems (U.S. Department of Energy 2013). It also meets all requirements for energy simulation software indicated in ASHRAE 90.1 Appendix G Performance Rating Method's guidelines for acceptable energy simulation software mentioned in section **Error! Reference source not found.**. eQUEST® is available for free from http://doe2.com/eQUEST/. Within eQUEST® graphic user interface, DOE-2.2 performs an hourly simulation of input buildings for 8,760 hours or one full year. It calculates hourly cooling load, heating load, and other energy loads

such as lighting, domestic hot water, or other equipment. Users can model their buildings using "Building Creation Wizard" which quickly generates detailed building input files from simple building envelope and systems input.

4. TRNSYS 17.1, June 2012 **http://www.trnsys.com/**

Developed and released in 1975 by Sandy Klein as part of his PhD thesis, the TRaNsient SYstems Simulation Program (TRNSYS) is a simulation program with a modular structure that implements a component-based approach. TRNSYS components may be as simple as a pump or pipe, or as complex as a multi-zone building model. The components are configured and assembled using a fully integrated visual interface known as the TRNSYS Simulation Studio, while building input data is entered through a dedicated visual interface (TRNBuild). The simulation engine then solves the system of algebraic and differential equations that represent the whole energy system. In building simulations, all HVAC-system components are solved simultaneously with the building envelope thermal balance and the air network at each time step. In addition to a detailed multizone building model, the TRNSYS library includes components for solar thermal and photovoltaic systems, low energy buildings and HVAC systems, renewable energy systems, cogeneration, fuel cells, etc. The modular nature of TRNSYS facilitates the addition of new mathematical models to the program. New components can be developed in any programming language and modules implemented using other software (e.g. Matlab/Simulink, Excel/VBA, and EES) can also be directly embedded in a simulation. TRNSYS can generate redistributable applications that allow non-expert users to run simulations and parametric studies.

5. Tas 9.2.1.5 http://www.edsl.net

Tas is a suite of software products, which simulate the dynamic thermal performance of buildings and their systems. The main module is Tas Building Designer, which performs dynamic building simulation with integrated natural and forced airflow. It has a 3D graphics-based geometry input that includes a CAD link. Tas can import gbXML, INP and IDF files from 3rd party program Tas Systems is a HVAC systems/controls simulator, which may be directly coupled with the building simulator. It performs automatic airflow and plant sizing and total energy demand. The third module, Tas Ambiens, is a robust and simple to use 2D CFD package which produces a cross section of micro climate variation in a space. Tas combines dynamic thermal simulation of the building structure with natural ventilation calculations, which include advanced control functions on aperture opening and the ability to simulate complex mixed mode systems. The software has heating and cooling plant sizing procedures, which include optimum start. Tas has 20 years of commercial use in the UK and around the world.

6. **EnergyPlus** Version 8.0, April 2005 www.energyplus.gov

EnergyPlus is a modular, structured code based on the most popular features and capabilities of BLAST and DOE-2.1E developed by NREL. It is a simulation engine with input and output of text files. Loads calculated (by a heat balance engine) at a user-specified time step (15-min default) are passed to the building systems simulation module at the same time step. The EnergyPlus building systems simulation module, with a variable time step, calculates heating and cooling system and plant and electrical system response. This integrated solution provides more accurate space temperature prediction crucial for system and plant sizing, occupant comfort and occupant health calculations. Integrated simulation also allows users to evaluate realistic system controls, moisture adsorption and desorption in building elements, radiant heating and cooling systems, and interzone air flow. Many graphical user interfaces for EnergyPlus are available or under development, including Simergy, CYPE CAD MEP, DesignBuilder, EFEN, AECOsim Energy Simulator, Hevacomp, MC4 Suite, SMART ENERGY, EPlusInterface, COMFEN, Solar Shoe Box, and N++.

NREL is also developing OpenStudio which is an open source program to facilitate community development, extension, and private sector adoption. OpenStudio includes graphical applications which have the updated SketchUp Plug-in, the stand alone OpenStudio application, the ParametricAnalysisTool, RunManager, and ResultsViewer. The SketchUp Plug-in is an extension to the popular 3D modeling tool that adds OpenStudio context to the SketchUp program. The Plug-in allows users to quickly create geometry and assign space attributes using the built-in functionality of SketchUp including existing drawing tools, integration with Google Earth, Building Maker, and Photo Match. The OpenStudio application is a graphical energy-modeling tool. It includes visualization and editing of schedules, editing of loads constructions and materials, a drag and drop interface to apply resources to spaces and zones, a visual HVAC and service water heating design tool, and high level results visualization. Radiance can also be integrated into the simulation workflow. This is accomplished by using an annual Radiance simulation to measure daylighting, and then creating an electric lighting usage schedule for EnergyPlus. OpenStudio also gives the modeler integrated access to data from the Building Component Library. The ParametricAnalysisTool lets users modify a baseline OpenStudio model using OpenStudio measures to produce design alternatives. OpenStudio measures are specially formatted Ruby scripts and accompanying files for modifying energy models in OpenStudio or EnergyPlus format. RunManager facilitates queuing and running simultaneous EnergyPlus simulations, and ResultsViewer enables browsing, plotting, and comparing EnergyPlus output time series data.

7. **Ener-Win** Version EC, June 2005 members.cox.net/enerwin

Ener-Win, originally developed at Texas A&M University, simulates hourly energy consumption in buildings, including annual and monthly energy consumption, peak demand charges, peak heating and cooling loads, solar heating fraction through glazing, daylighting contribution, and a life-cycle cost analysis. Design data, tabulated by zones, also show duct sizes and electric power requirements. The Ener-Win software is composed of several modules— an interface module, a weather data retrieval module, a sketching module, and an energy simulation module. The interface module includes a rudimentary building-sketching interface. Ener-Win requires only three basic inputs: (1) the building type, (2) the building's location, and (3) the building's geometrical data.

BESM Validation Methods

Typical building energy simulation program contains hundreds of variables and parameters. The number of possible cases that can be simulated by varying each of these parameters in combination is astronomical and cannot practically be fully tested. For this reason the NREL validation methodology required three different kinds of tests:

- Empirical Validation—in which calculated results from a program, subroutine, or algorithm are compared to monitored data from a real building, test cell, or laboratory experiment.
- Analytical Verification—in which outputs from a program, subroutine, or algorithm are compared to results from a known analytical solution or generally accepted numerical method for isolated heat transfer mechanisms under very simple and highly defined boundary conditions
- Comparative Testing—in which a program is compared to itself, or to other programs that may be considered better validated or more detailed and, presumably, more physically correct.

❖ **Annex II :** Assessment of Building Energy Simulation Model **(Activity 1.3.1a)**

The Department of Energy (DOE), through the National Renewable Energy Laboratory (NREL), worked with the International Energy Agency Solar Cooling and Heating Programme Implementing Agreement (IEA SHC) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to develop standard methods of test for building energy analysis computer software. The Building Energy Simulation Tests (BESTEST) were developed under IEA SHC Tasks 8,12 and 22 (Task 12 was a collaborative effort with the IEA Buildings and Community Systems Programme). ASHRAE recently published ANSI/ASHRAE Standard 140 now version 2007 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs, which parallels many of tests in the first IEA SHC BESTEST (Judkoff and Neymark 2006).

Table 1 Summary Comparison of BESM Features

Features	BEC	VisualDOE	eQUEST	TRNSYS	Tas	EnergyPlus	Ener-win
Developer	Department of Alternative Energy Development and Efficiency (DEDE), Thailand	Architectural Energy Corporation	James J. Hirsch & Associates.	Thermal Energy System Specialist	EDSL Ltd	U.S. Department of Energy	Degelman Engineering Group. Inc.
Simulation Engine	BEC	DOE2.1E	DOE2.2	TRNSYS	Tas	EnergyPlus	Ener-win
Public/Proprietary	Public	Proprietary	Public	Proprietary	Proprietary	Public	Proprietary
Cost	Free	$980+ tax	Free	$4500	n/a	Free	$249
Hours	-	8760	8760	8760	8760	8760	8760
Audience	n/a	1000+	10,000+ downloaded annually	500+	n/a	85000+ downloaded since 2001	n/a
Programming language	n/a	Visual Basic and Visual C++	Interface: C++, DOE-2.2: FORTRAN	FORTRAN	FORTRAN, C++	FORTRAN 2003	Visual Basic and FORTRAN
Source code available	✓	-	-	-	-	✓	-
Expertise required	Basic experience with Windows and basic knowledge with building systems	Basic experience with Windows and basic knowledge with building systems	Small with wizard mode, engineering background is helpful in detailed mode	Small with standard package, FORTRAN knowledge with additional components	Moderate, qualified architects and engineers	Moderate/ Engineering background is helpful	Window, thermal properties and energy concept

Features	BEC	VisualDOE	eQUEST	TRNSYS	Tas	EnergyPlus	Ener-win
Support GBxml	-	-	-	-	✓	Depend on GUI	-
Qualified for U.S.Building Tax simulation	-	✓	✓	✓	✓	✓	-
ASHRAE-140 Validation	-	✓	✓	✓	✓	✓	-
Pros	• Easy to use compared to other BESMs	• A DOE-2.1E tool • Dramatically reduces the time necessary to build a DOE-2 model • Displays a 3-D model to help verify accuracy • Implements DOE-2's daylighting calculations • imports CADD data to define thermal zones • Allows input in SI or IP units • For advanced users, allows editing of equipment performance	• Evaluates whole-building performance throughout the entire design process through Its wizards (schematic, design development, and energy efficiency measure) Fast • Fast execute speed • Available free of charge online • Displays a 3-D model to help verify accuracy	• Extremely flexible for modeling a variety of energy systems in different levels of complexity due to its modular approach. • Supplied source code and extensive documentation • Includes a graphical interface to drag-and-drop components for creating input files (Simulation Studio), a utility for easily	• Excellent responsive and accurate tool for concept development • Fast and robust tool with comprehensive capabilities for all types of energy modeling • Customization and refinement of input data and highly customizable control of apertures, plant and systems.	• Accurate, detailed simulation capabilities through complex modeling capabilities. • Available free of charge online • Input is geared to the 'object' model way of thinking. • Successful interfacing using IFC standard architectural model available for obtaining geometry from CAD programs.	• Graphic sketch input interface • Hourly weather data generator with 1500-city worldwide database. • Can run in compacted weather data mode for quick testing of alternative design strategies. • Generous use of defaults for materials, windows, profiles, costs, lights, etc.

Features	BEC	VisualDOE	eQUEST	TRNSYS	Tas	EnergyPlus	Ener-win
		curves. • Allows simple management of up to 99 design alternatives. • The interface is designed to be able to incorporate other energy simulation engines like EnergyPlus. • A live update program via the internet. • Responsive technical support is provided. • Periodic training sessions are available.		creating a building input file (TRNBuild), and a program for building TRNSYS-based applications for distribution to non-users (TRNEdit). • Web-based library of additional components • Frequent downloadable updates also interfaces with various other simulation packages such as COMIS, CONTAM, EES, Excel, FLUENT, GenOpt and MATLAB.		• Weather data for more than 1250 locations worldwide • Includes time steps of less than one hour, modular systems and plant integrated with heat balance-based zone simulation, multizone air flow, thermal comfort, water use, natural ventilation, and photovoltaic systems • Can calculate life cycle costing	

Features	BEC	VisualDOE	eQUEST	TRNSYS	Tas	EnergyPlus	Ener-win
Cons	• Only 1 building type could be specified • Limited number of shading elements(10) • Time consuming in building envelope area calculation • In developing stage, therefore, some bugs can be found.	• Expensive • Had limitations in accurately calculating the heat balance between multiple zones, especially for nighttime air-conditioning cases. • Not appropriate for use in radiant cooling, heating applications or passive solar due to the lack of surface heat balance calculations	• I-P units only • Ground-coupling and infiltration/natural ventilation models are simplified and limited. • Daylighting can be applied only to convex space. • Had limitations in calculating the heat balance between multiple zones, especially for nighttime air-conditioning cases. • Not appropriate for use in radiant cooling, heating applications or passive solar.	• No assumptions about the building or system are made (although default information is provided) so the user must have detailed information about the building and system and enter this information into the TRNSYS interface.	• Not intended for detailed services layout design	• Stand along program without a 'user'-friendly graphical interface.	• Not intended for detailed services layout design.

n/a = no data available at the time of report.

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Project : Promoting Energy Efficiency in Commercial Buildings (PEECB)
Master Plan (4 Years) : Work Plan and Progress

Item	Details of Activiites/Sub-Activities	Works Portion (%)	Status	Y2013				Y2014				Y2015				Y2016				Y2017			
				% Work Progress																			
				Q1	Q2/1	Q2/2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	% of Payment - Planning by Quarter				5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5			
	% of Payment - Accumulation				5	10	15	20	30	40	50	60	65	70	75	80	85	90	95		100			
	Actual - By Quarter																							
	Total Actual																							
PM	**Project Management**	**16.91%**																						
			Plan		4.06	0.68																		
			Actual		4.06	0.68																		
	PM-A) Project Meeting & Workshop & Seminar																							
	A.1) Project Team Meeting (UNDP & DEDE & BMC (Consultant))	2.54%	Plan		5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5			
			Actual		5	5																		
	A.2) Inception Workshop	1.69%	Plan		100																			
			Actual		100																			
	A.3) Meeting with International Expert (Japanese)	3.38%	Plan		5	5	5	5	15	30	30	5												
			Actual		5	5																		
	A.4) Project Public Seminar	1.69%	Plan		5	5				35				20				20			15			
			Actual		5	5																		
	A.5) Stakeholders Meeting	0.85%	Plan		5	5				35				20				20			15			
			Actual		5	5																		
	PM-B) TOR for DEDE to select the competence consultant for Component 2 & 3																							
	B.1) TOR Development	0.85%	Plan		100																			
			Actual		100																			
	B.2) Bidding Process	0.34%	Plan		100																			
			Actual		100																			
	B.3) Proposal Evaluation	0.34%	Plan		100																			
			Actual		100																			
	PM-C) Project Board & Project Management Unit & Working Group																							
	C.1) Preparation of project document and invitation document	0.17%	Plan		100																			
			Actual		100																			
	C.2) Set up coordination	0.85%	Plan		5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5			
			Actual		5	5																		
	C.3) Organize the meeting	0.85%	Plan		5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5			
			Actual		5	5																		
	PM-D) Project Administration																							
	D.1) General organization and administration	2.54%	Plan		5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5			
			Actual		5	5																		
	D2.) Report Preparation	0.85%	Plan		5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5			
			Actual		5	5																		
	Sub-Total PM	**16.91%**																						
C1	**COMPONENT 1 : Awareness Enhancement on Building EE Technologies and Practices**	**63.28%**																						
			Plan		0.91	5.02	8.10																	
			Actual		0.91	5.37																		
	1.1 Establish Commercial Building EE Information Center (CBEEC)																							
	1.1.1 Activity 1.1.1 Establishment of the Commercial Building EE Information Center (CBEEC)																							
	1.1.1 a Conduct of Situation Analysis	3.16%	Plan		5	5	5	5	80															
			Actual		5	10																		
	1.1.1 b Design and Development of the CBEEC	1.90%	Plan		1	1	2	2	94															
			Actual		1	1																		
	1.1.1 C Administration and Maintenance of the CBEEC	6.33%	Plan		5	5	5	5	5	10	10	10	10	5	10	10	2	2	2		4			
			Actual		5	5																		
	1.1.1 d Collaboration on Database of the CBEEC	1.90%	Plan			1	1	1	5	10	10	10	5	5	20	12	2	2	2	5	9			
			Actual			1																		
	1.2 A system of information exchange and dissemination on EE technologies and practices for commercial building stakeholders																							
	1.2.1 Activity 1.2.1 Promoting CBEEC as the information portal for the Commercial Bldg. Sector in Thailand																							
	1.2.1 a Design effective promotional scheme	1.27%	Plan		1	1	50	48																
			Actual		1	1																		
	1.2.2 Activity 1.2.2 Implementation of Awareness Raising Campaigns																							
	1.2.2 a Review of Profiles and Level of Awareness of Target Audience	1.27%	Plan		1	1	50	48																
			Actual		1	1																		
	1.2.2 b Compilation and Production of Marketing and Promotional Tools and Materials	1.90%	Plan		1	1	50	48																
			Actual		1	1																		
	1.2.2 c Design and Implementation of Awareness Campaigns	1.90%	Plan			5	5	5	10	10	10	10	5	5	5	5	5	5	5	5	5			
			Actual			5																		
	1.2.3 Activity 1.2.3 Implementation of Information Disclosure Program for Commercial Bldg. Energy Consumption																							
	1.2.3 a Design Information Disclosure (ID) program & publication materials (link with C2.2)	1.27%	Plan						5	5	5	5	10	5	5	10	10	10	10	10	10			
			Actual																					
	1.3 Development and Promoted Energy Use Simulation Models for Commercial Building Design																							
	1.3.1 Activity 1.3.1 Assessment of the Utilization of Building Energy Simulation Models (BESM) in Thailand																							
	1.3.1 a Assessment of the two (2) most popular simulation models	3.16%	Plan		10	40	40	10																
			Actual		10	40																		
	1.3.2 Activity 1.3.2 Development of a Customized BESM for Commercial Buildings in Thailand																							
	1.3.2 a Selection and Modification of BESM	6.33%	Plan					20	20	20	20	20												
			Actual																					
	1.3.2 b Preparation of Promotional and Training Program	1.90%	Plan									50	50											
			Actual																					
	1.3.3 Activity 1.3.3 Implementation of Sustainable Promotional and Training Program on EE Commercial Building Design																							
	1.3.3 a Conduct the BESM training courses	1.90%	Plan											10	20	30	15	25						
			Actual																					
	1.4 Completed training courses on EE technologies and practices, and financial arrangement for commercial buildings																							
	1.4.1 Activity 1.4.1 Capacity Building Need Assessment for Commercial Building Stakeholder																							
	1.4.1 a Scoping Study on the Training Program	3.16%	Plan		1	50	45	4																
			Actual		1	54																		
	1.4.1 b Identification of Training Activities for Stakeholders	1.27%	Plan		1	40	49	10																
			Actual		1	40																		
	1.4.1 c Development of the Overall Training Program	1.27%	Plan		1	40	49	10																
			Actual		1	45																		
	1.4.2 Activity 1.4.2 Design and Implementation of Training Courses on EE Technologies and Practices, and Financial Arrangement for Commercial Buildings																							
	1.4.2 a Design of Technical Training Courses	1.27%	Plan					5	40	55														
			Actual																					
	1.4.2 b Design and Preparation of Training Materials	1.90%	Plan							25	50	25												
			Actual																					
	1.4.2 c Conduct of Training Program	1.27%	Plan							10	10	10	10	10	10	10	20	10						
			Actual																					
	1.4.2 d Certification and Quality Assurance Mechanism	1.27%	Plan							10	10	10	10	10	10	10	20	10						
			Actual																					
	1.4.2 e Training Program Monitoring and Evaluation	1.27%	Plan							10	10	10	5	5	10	10	20	10	10					
			Actual																					
	1.4.2 f Sustainable Follow-up Capacity Development Program Design	1.27%	Plan							10	10	10	5	5	10	10	20	10	10					
			Actual																					
	1.5 Completed training courses on financial assessment of EE application projects in commercial buildings																							
	1.5 Activity 1.5 Completed Training Courses on Financial Assessment of EE Application Projects in Commercial Buildings																							
	1.5 a Design of Non-Technical Training Courses	1.27%	Plan			5	5	5	80	5														
			Actual			5																		

Project : Promoting Energy Efficiency in Commercial Buildings (PEECB)
Master Plan (4 Years) : Work Plan and Progress

						Y2013				Y2014				Y2015				Y2016				Y2017
		% of Payment - Planning by Quarter				5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5
		% of Payment - Accumulation				5	10	15	20	30	40	50	60	65	70	75	80	85	90	95		100
		Actual - By Quarter																				
		Total Actual																				
Item	**Details of Activiites/Sub-Activities**																					
	1.5 b	Design and Preparation of Training Materials	1.90%	Plan					50	50												
				Actual																		
	1.5 c	Conduct of Training Program	1.27%	Plan							10	10	10	10	20	20	10	10				
				Actual																		
	1.5 d	Training Program Monitoring and Evaluation	1.27%	Plan							5	10	5	10	10	20	10	10	20			
				Actual																		
	1.5 e	Sustainable Follow-up Capacity Development Program Design	0.63%	Plan							5	10	5	10	10	20	10	10	20			
				Actual																		
		Additional Activity : Design and Conduct the Capacity Building - Train the Trainer for DEDE's staff																				
	1	Design and develop the Train the Trainer curriculum for DEDE's staffs	1.27%	Plan			15	80	5													
				Actual			15															
	2	Develop and Preparation of Training Materials	1.90%	Plan			5	5	90													
				Actual			5															
	3	Conduct of Training Program	1.27%	Plan					100													
				Actual																		
	1.6	**Established business linkages between supplier of EE technologies, building owners, banks and building practitioners**																				
	1.6	**Activity 1.6 Established Business Linkages Between Suppliers of EE Technologies, Building Owners, Banks, and Building Practitioners**																				
	1.6 a	Framework Study of Commercial Building Business in Thailand	3.16%	Plan			5	5	5	85												
				Actual			5															
	1.6 b	Establish Business Linkages	1.27%	Plan						5	5	5	5	10	10	10	10	5	5	10	10	10
				Actual																		
		Sub-Total Component 1	**63.28%**																			
C2	**COMPONENT 2 : EE Building Policy Frameworks**		**6.86%**																			
				Plan		0.0	0.14	0.17														
				Actual		0.0	0.14															
	2.1	**Updated and More Effective Policy Measures on Energy Efficiency in Commercial Buildings**																				
	2.1.1	**Evaluation and recommendation of effective approaches and incentives for inclusion of building EE technologies and practices in the design and operation of various types of commercial buidlings**																				
	2.1.1.1	Evaluation of Best EE Options for Commercial Buildings		Plan																		
				Actual																		
	2.1.1.2	Modification of Existing and Development of New EE Policy Instruments for Commercial Buildings		Plan																		
				Actual																		
	2.1.1.3	Seeking Approval on New and Modified Policy from Policymakers		Plan																		
				Actual																		
	2.1.2	**Strengthening implementation effectiveness of the new Building Energy Code**																				
	2.1.2.1	Integration of the BEC Requirements with the EIA Approval Process		Plan																		
				Actual																		
	2.1.2.2	Establishment of the BEC Self-Learning Course for Building		Plan																		
				Actual																		
	2.1.2.3	Maintain Ongoing Dialogues with Municipalities and LAOs		Plan																		
				Actual																		
	2.1.2.4	Strengthening the Inter-Ministerial Coordination Process		Plan																		
				Actual																		
	2.1.3	**Assessment of DEDE's building energy labeling scheme and preparation of recommentations for strengthening implementation in buildings**																				
	2.1.3.1	Review of Available Information on Buildings Energy Labeling and Green Building Scheme		Plan																		
				Actual																		
	2.1.3.2	Assessment and Recommendation of Collaboration between the DEDE's Building Energy Label and Other Rating Sche		Plan																		
				Actual																		
	2.2	**Revised and Up-to-date Data and Information to Facilitate Policy Implementation of Commercial Building EE**																				
	2.2.1	**Activity 2.2.1 Compilation and Update of Energy Performance Database for Building Construction Materials and Electrical Equipement for Commercial Buildings**																				
	2.2.1 a	Data Review of BESM Software	0.69%	Plan			5	10	15	70												
				Actual			5															
	2.2.1 b	Compile and Update of Energy Performance Database	0.69%	Plan						5	15	30	30	20								
				Actual																		
	2.2.2	**Activity 2.2.2 Review and Update of DEDE's SEC Studies and Compilation of Building Stock Data**																				
	2.2.2 a	Review the Existing Specific Energy Consumption Index (SEC)	1.37%	Plan			5	5	5	30	55											
				Actual			5															
	2.2.2 b	Update the SEC for Commercial Building Sector in Thailand	2.06%	Plan						5	15	20	25	35								
				Actual																		
	2.2.3	**Activity 2.2.3 Review and Assessment of DEDE's M&V Scheme and Development of an Improved M&V Protocol for Commercial Building EE Projects**																				
	2.2.3 a	Review Existing M&V Scheme for Completed Projects in Thailand	0.69%	Plan			5	5	5	25	60											
				Actual			5															
	2.2.3 b	Develop recommended M&V Scheme for Commercial Bldgs EE Project in Thailand	1.37%	Plan						20	20	60										
				Actual																		
	2.3	**Approved and Implemented New and Improved Financing Models for Commercial Buildings**																				
	2.3.1	**Development of new and improved financing models for EE commercial building investments**		Plan																		
				Actual																		
	2.3.2	**Approval and implementation of new fiscal policies to promote EE building design for new existing buildings**																				
	2.3.2.1	Conclusion of New Fiscal Policies to Promote EE building Design for New and Existing Buildings		Plan																		
				Actual																		
	2.3.2.2	Organization and Conduct of EE Building Fiscal Policy Workshop		Plan																		
				Actual																		
	2.3.2.3	Conduct of Targeted Policy Coordination Meetings		Plan																		
				Actual																		
	2.3.2.4	Approval and Implementation of new fiscal policies for EE building Projects		Plan																		
				Actual																		
	2.4	**Approved energy efficiency promotion action plan (short and long term) to supplement DEDE Activities**																				
	2.4	Preparation of draft energy efficiency promotion Action Plan (Short and long term) to supplement DEDE activities		Plan																		
				Actual																		
		Sub-Total Component 2	**6.86%**																			
C3	**COMPONENT 3 : EE Building Technologies and Applications Demonstration**		**12.95%**																			
				Plan		0.0	0.0	0.0														
				Actual		0.0	0.0															
	3.1	**Improved confidence in the feasibility, performance, energy, environmental and economic benefits of EE technologies and practices in commercial buildings**																				
	3.1.1	**Installed and operational demonstration projects in selected buildings**																				
	3.1.1.1	**Conduct of comprehensive feasibility studies and determination of implementation requirement, costing and engineering studies/design of selected demonstration projects**																				
	3.1.1.1a	conduct of Comprehensive Feasibility Studies of Demonstration Projects		Plan																		
				Actual																		
	3.1.1.1b	Determination of PEECB Implementation Requirements for Demonstration Projects		Plan																		
				Actual																		
	3.1.1.1c	Establishment of Baseline Data for the Demonstration Project Sites		Plan																		
				Actual																		
	3.1.1.1d	Finalized Design of Demonstration Projects		Plan																		
				Actual																		
	3.2	**Improved local technical and managerial capacity to design, manage and maintain EE technologies and practices**																				
	3.2.1	**Documentation on the results of the demonstration projects and available EE technologies in the markets and dissemination of demo project results**																				
	3.2.1.1	**Activity 3.2.1.1 Documentation of Results of the Demonstration Projects**																				
	3.2.1.1 a	Collect Data and Information of Demonstration Projects	0.65%	Plan						10	10	25	25	30								
				Actual																		

Project : Promoting Energy Efficiency in Commercial Buildings (PEECB)
Master Plan (4 Years) : Work Plan and Progress

Item	Details of Activiites/Sub-Activities			Y2013				Y2014				Y2015				Y2016				Y2017
	% of Payment - Planning by Quarter			5	5	5	5	10	10	10	10	5	5	5	5	5	5	5		5
	% of Payment - Accumulation			5	10	15	20	30	40	50	60	65	70	75	80	85	90	95		100
	Actual - By Quarter																			
	Total Actual																			
	3.2.1.1	Documentation of Results of the Demonstration Projects	1.30%	Plan					5	5	5	5	5	5	5	20	20	20	5	
				Actual																
	3.2.1.2	**Activity 3.2.1.2 Documentation of Information on the Availability and Quality of EE Technologies and Practices**																		
		Applied in Thailand and Other Countries																		
	3.2.1.2 a	Review the Existing Demonstration Projects and Case Studies in Other Countries	0.65%	Plan				10	10	25	25	30								
				Actual																
	3.2.1.2 b	Documentation of Information on the Availability & Quality of EE Technologies and Practices Applied in Th	2.59%	Plan					5	10	10	10	10	10	10	10	10	10	5	
				Actual																
	3.2.1.3	**Activity 3.2.1.3 Dissemination of Successful Case Studies on Demo Projects**																		
	3.2.1.3 a	Dissemination of Successful Case Studies on Demo Projects	3.89%	Plan										10	15	20	20	20	15	
				Actual																
	3.2.2	**Completed training courses for personnel attached to the demo projects**																		
	3.2.2.1	**Activity 3.2.2.1 Design and Conduct of Training Courses for Demo Building Personnel**																		
	3.2.2.1 a	Design the Training Course Outline on Demo Projects & DEDE's Capacity Building	2.59%	Plan								50	50							
				Actual																
	3.2.2.1 b	Conduct the training Courses on Demo Projects	1.30%	Plan										25	25	25	25			
				Actual																
	3.3	**Replication of demonstration projects within the commercial building sector**																		
	3.3.1	**Completed project documents/recommendations for EE project replication in the commercial building sector**																		
	3.3.1.1	Preparation of project documents/recommendations for project replication in hotels, hospitals, office buildings and shopping malls		Plan																
				Actual																
		Sub-Total Component 3	**12.95%**																	
					Q2/1	Q2/2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
	Total (Sub Total PM+Sub Total Component 1 + 2 + 3) : For Contract 1 Only		**100%**	%Plan	5.0	5.8	8.8	8.8	14.3	9.9	7.9	6.9	5.9	4.1	4.0	4.5	4.1	4.3	2.8	1.2	1.5
				% Actual	5.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
				Accumulation %Plan	5.0	10.8	19.6	28.4	42.8	52.7	60.6	67.6	73.5	77.5	81.6	86.1	90.2	94.4	97.2	98.5	100.0
				Accumulation %Actual	5.0	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1

Note: responsible by the consultant of contract-2