

Survey of Energy Use, etc. in School Facilities in the Super Eco School
Demonstration Program
— Report on a Fundamental Study of School Facility Environments —
(2012 Summary)



September 2013

Working Group on a Fundamental Study of School Facility Environments
Educational Facilities Research Center,
National Institute for Educational Policy Research



Introduction

As the reduction of GHG emissions has become a global challenge, we need efforts to reduce environmental burden also in school facilities. Because school facilities are a space for learning and living where children who will bear the next generation spend more than half of the day, it is necessary to promote environmental measures both for securement of appropriate classroom environment and for energy/resource conservation.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Education, Culture, Sports, Science and Technology (MLIT) together compiled a report titled "Toward Zero Energy School Buildings" (Committee for Study of Measures to Promote Zero Energy Buildings [ZEB] in schools) in May 2012. The report organizes approaches to make annual energy consumption practically zero by combining technologies for energy conservation through the reduction of energy consumption in school facilities and energy creation through photovoltaic generation and other means.

In order to promote efforts toward zero energy school buildings, MEXT started Super Eco School Demonstration Program in fiscal 2012 to support the process from basic planning, basic and detailed designs to renovation work aiming to turn existing school buildings into ZEB. Three schools were selected as model schools, with which to disseminate the results of the project across the country.

The Educational Facilities Research Center of the National Institute for Educational Policy Research implemented "Fundamental Study of School Facility Environments (Project leader: Hiromi Komine, Professor at Faculty of Engineering, Department of Architecture and Civil Engineering, Chiba Institute of Technology)" to continuously survey the building specifications, operations, energy consumption and other aspects before and after renovation, accumulate data and analyze their correlation, and thereby contribute to measures for school facility development in the future.

We expect that this report will be used for environment-focused renovation of existing school facilities to ensure a proper classroom environment and further advance energy- and resource-saving means in schools.

September 2013

Outline of the study

○ Conditions survey of energy use in school facilities

1) Schools surveyed

- (i) Yabuki Municipal Yabuki Elementary School, Fukushima Prefecture
- (ii) Kyoto Municipal Kinkaku Elementary School, Kyoto
- (iii) Ikoma Municipal Shikanodai Junior High School, Nara

2) Survey contents

- (i) Survey of thermal environment of school facilities
(Gathering continuous data on temperature, humidity, illuminance and other parameters of school facilities to survey their thermal environment, etc.)
- (ii) Survey of school facilities operation (questionnaire survey)
(Survey of operation status to ascertain the conditions of school buildings, gymnasium, kitchen, base power, etc.)
- (iii) Collection of metered results by energy type (electricity, water, gas, kerosene, etc.)
(Collecting data on energy use in school buildings, gymnasiums, kitchens, base power, etc. and ascertaining their use by installing electricity and gas measurement instruments)

3) Analysis

- (i) Grasping and sorting out of the equipment used in the school facilities by energy type
- (ii) Survey and analysis of the impact of school facility operation on energy consumption
- (iii) Sorting out of studies useful for renovation planning based on the energy consumption and thermal environment of the school
- (iv) Comparison of actual data with FAST (Ver.2)

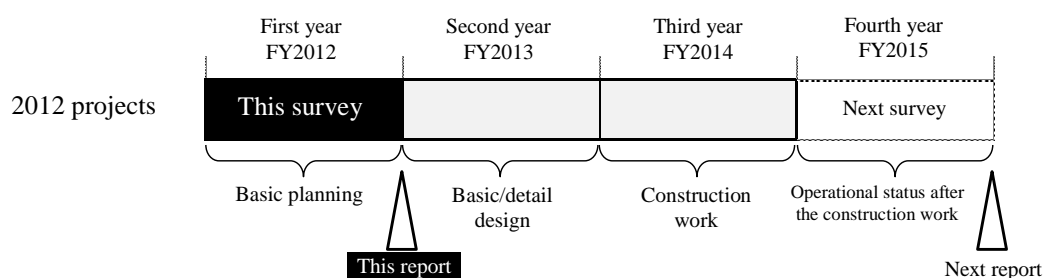
4) Overall schedule

Before the renovation

Ascertaining current energy use (this survey)

After the renovation

Verifying the effects of renovation and operation through a survey and analysis under the same conditions with those before the renovation (planned for the next survey)



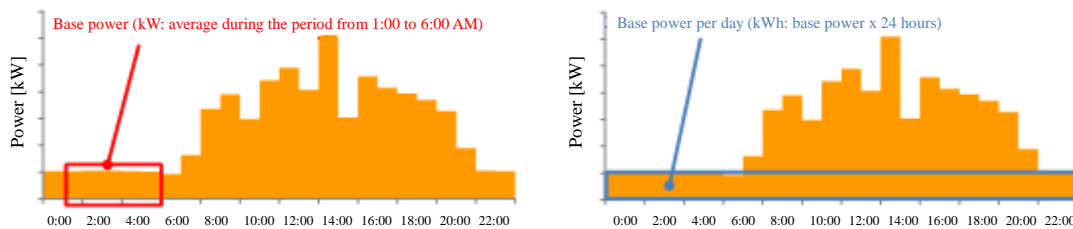
○Essential Features of the report

Measures for enhancement of comfort and energy conservation in environment-focused renovation of school facilities were studied and the following results were obtained.

1) Need for measures to reduce base power

Until this point it was believed that the main areas of energy consumption in schools are lighting, heating, cooling and operation. However, a detailed energy survey conducted in this study found that base power* accounts for a significant ratio (20 to a little over 30 %) of the primary energy consumption of a school.

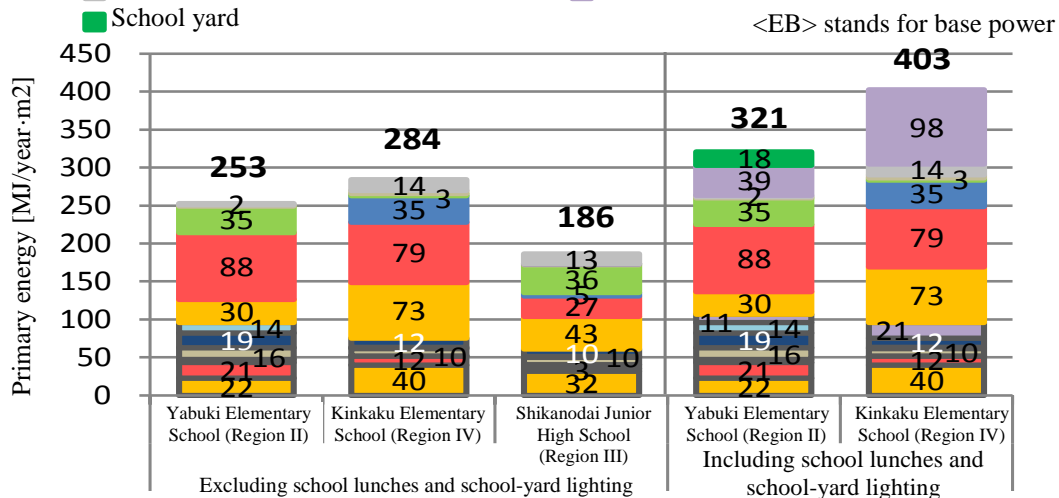
*Base power: power consumed during hours when the school is not open (e.g. at night)



2) Study method of Environment-focused Renovation

The three schools that were studied this time were different in a variety of aspects including the shape of their school buildings, scale, location (climate and natural features), air-conditioning method, educational consideration, and operation. They also have different levels of annual energy consumption. This made it clear that, when considering environment-focused renovation with a view to zero energy building, we need diverse perspectives based on a proper grasp of energy consumption, thermal environment, operation situation, and other conditions of each school.

- Lighting, outlets (mainly outlets) <EB>
- Gymnasium <EB>
- Lift pump <EB>
- Heater for freezing prevention <EB>
- Lighting, outlets (mainly lighting)
- Cooling (only GHP)
- Other (mainly transformer)
- Unknown
- School yard
- Air conditioning <EB>
- Other (mainly transformer) <EB>
- Filter pump <EB>
- School lunch <EB>
- Heating
- Gymnasium
- Lift pump
- School lunch



Annual primary energy consumption per floor area

Reference: average annual energy consumption of schools in the respective regions
 Average of elementary schools : Region II : 389MJ/year·m²; Region IV : 267 MJ/year·m²
 Average of junior high schools : Region III : 347MJ/year·m²

3) Results of the report (recommendations of means toward zero energy buildings by purpose)

(i) Reduction in base power energy

Air-conditioners: Introduce high-efficiency equipment and turn off equipment's main power when not in use

Electric appliances: introduce a mechanism to turn off power at night and holidays.

Equipment always at work: introduce LED and other high-efficiency equipment for illuminated exit signs and others

(ii) Reduction in lighting energy

It is necessary to make appropriate rules, including turning off of lights on sunny days when necessary illuminance is provided by sunlight in addition to daylight utilization and introduction of high-efficiency equipment

(iii) Reduction in air-conditioning energy

It is necessary to set up air-conditioning zones, introduce doors to establish air-conditioning zones and make appropriate rules in addition to the improvement of heat-insulation and air-tightness of the building.

(iv) Planning with operational consideration

It is difficult to achieve the goals of energy saving and environmental improvement by just developing buildings for this purpose. It is also necessary to develop operation manuals to enable proper use and transfer of control at the time of personnel change.

(v) Selection of proper transformers

It is necessary to understand the power capacity use of the school and select transformers with consideration of load factor and efficiency.

4) Examples of the use of the report

The study results of the Institute are used for basic plans of the Super Eco School Demonstration Program formulated by the respective local governments.

Basic plans of the three schools (initiatives)		Yabuki ES	Kinkaku ES	Shikanodai JHS	Proposed in the Report on
Energy saving	Heat insulation of exterior walls and rooftops	○	○	○	P36,59,81,109
	Improvement of heat-insulation and air-tightness of windows	○	○	○	P36,59,81
	Securing of ventilation (night purge)	○	○	○	P83-85
	Air-conditioning zones	○			P32-33,36,109
	Introduction of high-efficiency lighting equipment, etc.	○		○	P27,72,81,108-109
	Introduction of light shelf		○		P59
	Introduction of high-efficiency air-conditioners, etc.			○	P108
	Introduction of water-saving toilets	○		○	-
	Energy saving through operation	○	○	○	P36,59,81,106-110
Energy (information) visualization	○	○	○	P111	

*Initiatives other than energy conservation

Yabuki Elementary School: (1) Energy creation: photovoltaic power generation; (2) Energy storage: storage battery; (3) Other: wooden interior, solar heat utilization

Kinkaku Elementary School: (1) Energy creation: photovoltaic power generation, wind-power generation; (2) Other: wooden interior, rainwater/river water utilization, bench warmed by fermentation heat of fallen leaves, dry mist

Shikanodai Junior-high School: (1) Energy creation: photovoltaic power generation, wind-power generation, foot-operated power generation; (2) Other: rainwater/river water utilization

The report is compiled based on the survey and analysis conducted by the Institute in the 2012 Super Eco School Demonstration Program and can be used as reference for surveys of thermal environment and others that will be carried out by local governments in the projects to be implemented from fiscal 2013 onward. The survey slips at the back of the report are those used for the survey. We recommend their use for ascertaining operational status and illuminance.