

Survey of Energy Use, etc. in School Facilities in the Super Eco School
Demonstration Program
— Report on a Fundamental Study of School Facility Environments —
(2013 Summary)



September 2014



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 design to renovation work aiming to turn existing school buildings into zero energy buildings (ZEB). As model schools with which to disseminate the results of the project across the country, three schools were selected in fiscal 2012 and two schools (reconstruction for one of them) in fiscal 2013. .

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 performance and specifications, operations, energy consumption and other aspects of the equipment installed 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 2014

Outline of the study

○ Conditions survey of energy use in school facilities

1) Schools surveyed

Shizukuishi Municipal Shizukuishi Junior-high School, Iwate

2) Survey contents

(i) Survey of weather conditions, regional characteristics, etc.

(Wind conditions, amount of solar radiation and other conditions of the area where the school is located)

(ii) Survey of thermal environment of school facilities

(Gathering long-term measurement data on temperature, humidity, illuminance and other parameters of school facilities to survey their daily thermal environment, etc.)

* The above survey was conducted in the Super Eco School Demonstration Program.

(iii) Survey of school facilities operation (questionnaire survey)

(Survey of operation status to ascertain the conditions of school buildings, gymnasium, kitchen, base power, etc.)

(iv) 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 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) Verification of consistency between the simulation results of FAST (Ver.2) and measurement data

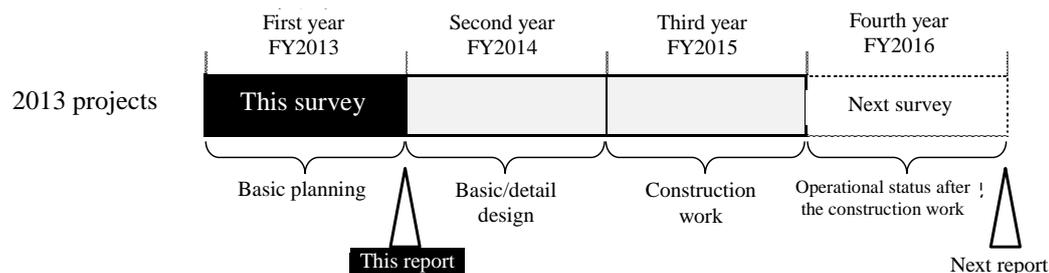
4) Overall schedule

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.

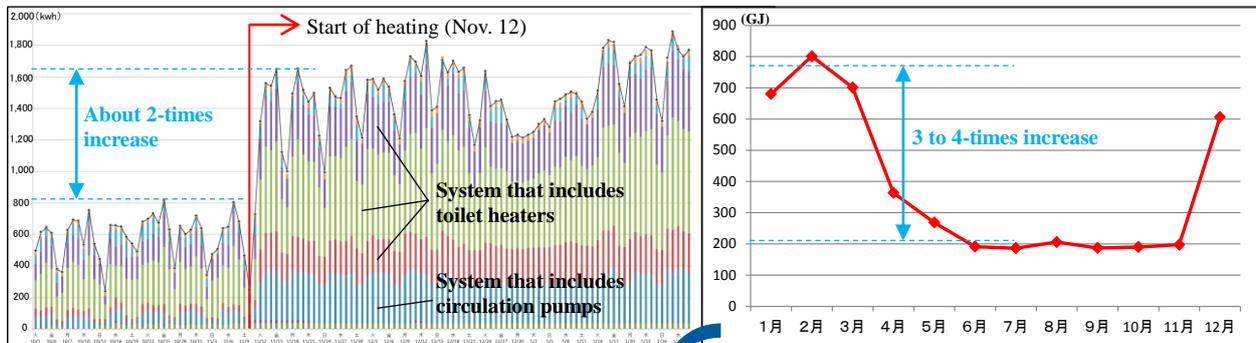
1) Proposal of energy-saving measures for winter heating

As Shizukuishi Town, Iwate Prefecture, belongs to Region 3 of the Energy Conservation Standards (Region II of the old standards), the school consumes a significant amount of energy for winter heating (central heating using vacuum water heaters). A detailed energy survey and operation survey conducted within the study provided wide-ranging knowledge for environment-focused renovation with a view to zero energy building.

(i) Actual conditions of energy use

The peak of energy use at Shizukuishi Junior-high School is in winter. Power consumption during the heating period is about twice that of intermediate seasons, and converted primary energy consumption in winter is three to four times as much as that in summer. The main factors for the increase include the increase in base power due to continuous operation of hot water circulation pumps and electric heaters for toilets and consumption of fuel oil A for vacuum water heaters.

We carried out a detailed energy survey and operation survey and found out that it is possible to reduce heating fuel use, base power, etc. by employing the following means:



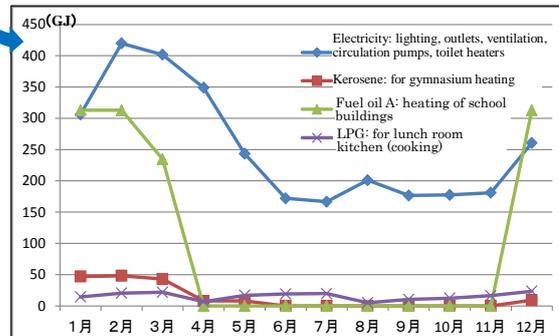
Changes in power consumption

Break down

Converted primary energy consumption by month (total)

(ii) Reduction in heating fuel use

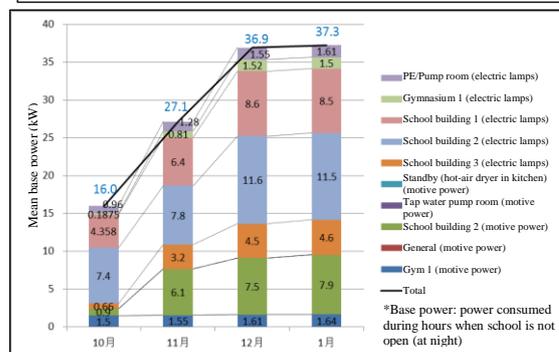
- With the decline in the number of children/students, there are redundant classrooms, etc. It is possible to reduce the use of fuel oil A through efficient heating by concentrating the use of rooms to one area when they are used simultaneously, by establishing air-conditioning zones in corridors and stair cases, for example.
- Two vacuum water heaters are operated alternately on a one-day rotation in order to decrease the risk of failure, but this increases the heat load of the heat source equipment. Changing the alternate operation to a one-week rotation will improve the operating efficiency of the heaters.



Converted primary energy consumption by month (by type)

(iii) Reduction in base power

- Hot water circulating pumps are constantly operated in order to prevent freezing due to a decline in the anti-freeze concentration caused by a leak from hot water piping and the supply of tap water, but repairing hot water piping will eliminate the need for constant operation for freeze proofing.
- Toilet heating is aimed at freeze proofing for piping. Improvement of heat insulation of windows and walls will enable lower temperature setting or reduced operation time.



Monthly mean base power

Mean base power in December: $36.9\text{kw} \times 24\text{h} = 885.6\text{kwh}$
 Power consumption in December (weekday): 1,603kwh
 Base power accounts for 55.2% of power consumption of one day in December (weekday)

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

(i) Reduction in heating energy

Proposal in (ii) of 1)

(ii) Reduction in base power

Proposal in (iii) of 1)

(iii) Reduction in lighting energy

Daylight utilization including light shelves; introduction of high-efficiency equipment; introduction of top lights in the gymnasium

(iv) Measures to counter summer heat

Introduction of wind pressure damper for automatic opening/closing and natural ventilation through night purge

(v) 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.

(vi) Introduction of appropriate demand-monitoring devices

Management of power use in the school to control maximum power

(vii) Use of well water

Use of flowing well for watering and flushing toilets

3) Examples of the use of the report

The following proposals for environment-focused renovation made in the report were adopted in the Basic Plan for the Shizukuishi Junior-high School Super Eco School Demonstration Program formulated by Shizukuishi Town.

Basic plan of Shizukuishi JHS (energy-saving initiatives)	Proposed in the report on	Basic plan of Shizukuishi JHS (energy-saving initiatives)	Proposed in the report on
(1) Visualization of environmental energy	P73	(6) Establishment of heating zones	P64
(2) Concentration of classroom use	P73	(7) Introduction of demand monitoring	P64
(3) Installation of valves in hot water pipes of the existing vacuum water heaters	P64	(8) Introduction of LED lights	P64
(4) Improvement of heat-insulation and air-tightness of exterior walls, ceilings, roofs, floors and openings	P64	(9) Replacement of old vacuum water heaters	P63
(5) Installation of light shelves	P64	(10) Introduction of top lights	P64

Initiatives other than energy conservation

(1) Energy creation: photovoltaic power generation, solar heat utilization, cooling with stored snow, sunroom on balcony

(2) Energy storage: storage battery

(3) Other: wooden interior, rainwater storage pit, snow storage basin

The report is compiled based on the survey and analysis conducted by the Institute in the 2013 Super Eco School Demonstration Program and can be used as reference by local governments and others considering environment-focused renovation of school facilities. The survey slips at the back of the report are those used for the survey. We recommend their use for grasping operational status and illuminance.