Promoting Environment-focused Renovations of School Buildings

Results of a Simulation of Environmental Measures in Model Plans

Report on a Fundamental Study of School Facility Environments (Overview*)

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

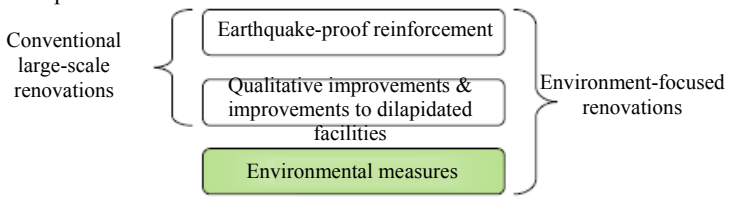
*The full version of this report is available at the following URL:
http://www.nier.go.jp/shisetsu/pdf/e-modelplan.pdf

Introduction

Hitherto, the renovation of school buildings has involved work such as earthquake-proof reinforcement work, repairs to dilapidated equipment and aging parts of the interior and exterior, and alterations to the room layout to adapt to new uses. By adding environmental measures to these, such as insulating the building, shading it from sunlight and updating equipment to energy-conserving models, it is possible to improve the learning environment for pupils, as well as conserving energy. Accordingly, the Working Group on a Fundamental Study of School Facility Environments (Project Leader: Hiromi Komine, Professor, Department of Architecture and Civil Engineering, Chiba Institute of Technology) carried out a study of the design of renovations that take the environment into consideration, and presented renovations that incorporated environmental measures such as those mentioned above, as well as conventional large-scale renovations, in the form of model plans for environment-focused renovations.

Basic Approaches of the Model Plans

i) Plans are based on the premise of renovations of existing school buildings.
ii) Environmental measures are implemented in conjunction with conventional renovations focused on earthquake-proof reinforcement, qualitative improvements and improvements to dilapidated facilities.



iii) Environmental measures that will bring about significant reductions in energy consumption are implemented, based on the particular characteristics of energy consumption in schools. For example, plans are formulated that take into consideration the energy consumption structure of schools, such as reducing the energy used for ordinary lighting.
iv) Consideration is given to measures that take into consideration the climate and siting conditions of the area where the school is located, such as measures to deal with summer heat in urban areas and reducing the heating burden in colder areas.
v) An appropriate learning environment is secured in the classrooms throughout the year. In particular, consideration is given to improvements in the thermal environment.
vi) Improvements in building function are sought through plans that incorporate such aspects as insulation of the building, shading from sunlight and the utilization of natural wind, in order to reduce the environmental burden.
vii) Energy-conserving equipment is introduced, such as lighting, heating and cooling equipment.
viii) The plans also seek to ensure that the cost of renovations is appropriate for those establishing schools.

The Regions on Which the Model Plans for Environment -focused Renovations Focus and the Types of Plan

The two regions targeted by the model plans were selected from among Regions I – VI in the Energy Conservation Standards, based on their regional characteristics.

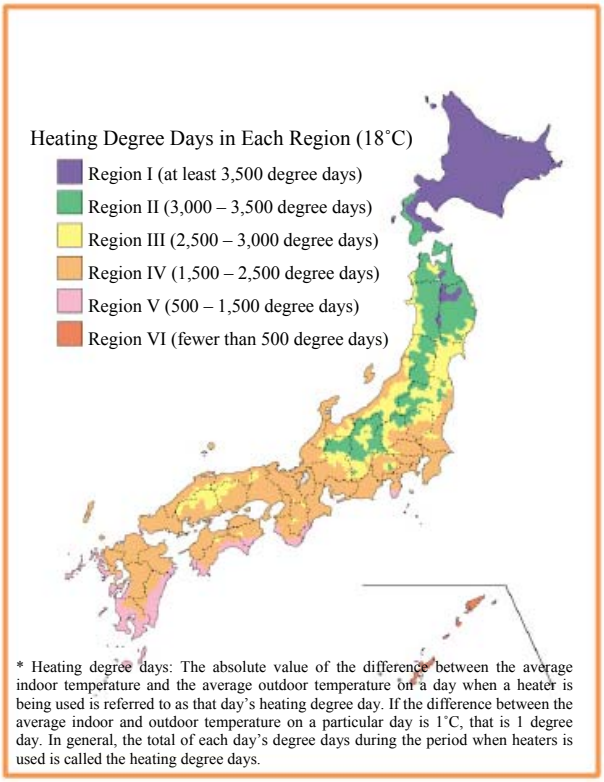
Plan A1 and Plan A2, Focusing on Region IV

Envisaged as models for the region with the largest number of schools

Plan B, Focusing on Region II

Envisaged as a model for colder regions.

○ The results of the verifications demonstrate that, by implementing three main pillars in an integrated fashion, namely improving the building performance through insulation and shading from sunlight, introducing high-efficiency lighting, cooling and heating equipment, and enforcing appropriate running and management, there is sufficient possibility of resolving the problem of heat and cold in the classroom, while simultaneously reducing CO2 emissions.



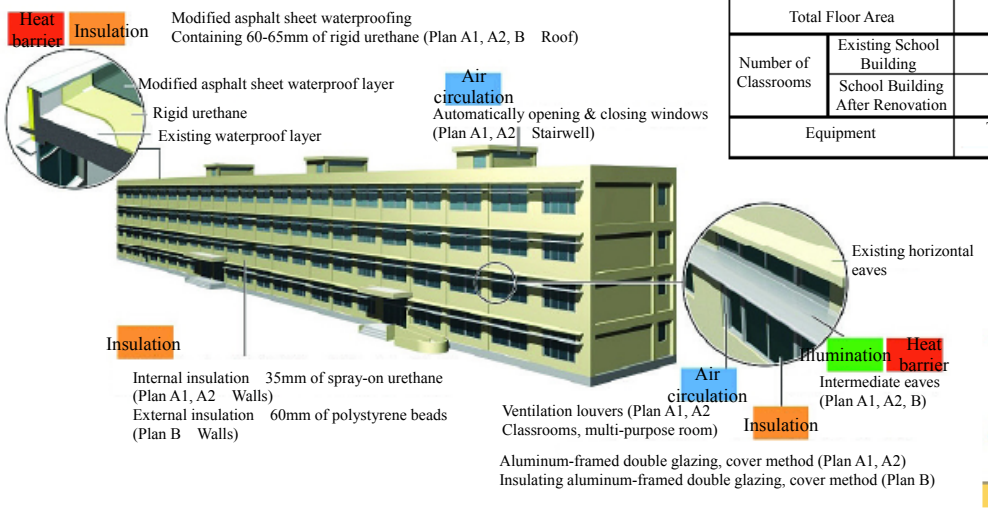
* Heating degree days: The absolute value of the difference between the average indoor temperature and the average outdoor temperature on a day when a heater is being used is referred to as that day's heating degree day. If the difference between the average indoor and outdoor temperature on a particular day is 1˚C, that is 1 degree day. In general, the total of each day's degree days during the period when heaters is used is called the heating degree days.

Regional Classification Under Energy Conservation Standards
Source: Japan Center for Climate Change Actions
Homepage: http://www.jccca.org

Points Common to All Model Plans

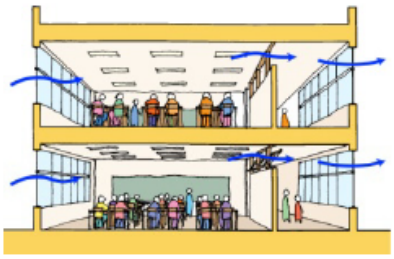
Plan Overview

View of the Outside of the Planned School Building



Outline of the Existing School Building Model

Type		Elementary School (35 years are envisaged to have passed since construction)
Structure & Number of Floors		Reinforced concrete (RC) structure with 4 storeys
Total Floor Area		About 5,100m^2
Number of Classrooms	Existing School Building	26 ordinary classrooms, special needs education class, special classrooms
	School Building After Renovation	12 ordinary classrooms, special needs education class, special classrooms
Equipment		The heating & cooling equipment was updated 20 years after the building was constructed



Main Conditions for the Simulations

- Calculations of CO_2 emissions were limited to the school building itself, so CO_2 emissions resulting from the use of the gymnasium and swimming pool were excluded.
- CO_2 emissions resulting from the cooking of school meals and community open days, where there is a big difference between schools in terms of the running of facilities and their methods of use, were excluded.
- During long holidays, the school, including the management rooms, was treated as being on holiday.
- The heater operation period was specified as 1 November – 31 March. Of this period, the winter holidays, weekends and national holidays were excluded.

The operation period was specified as the times when people are in the room in question, when the room temperature falls below the set temperature for heating (18˚C in the classrooms and 23˚C in the management rooms).

- The cooler operation period was specified as 1 June – 30 September. Of this period, the summer holidays, weekends and national holidays were excluded. The operation period was specified as the times when people are in the room in question, when the room temperature rises above the set temperature for cooling (28˚C).
- Corridor lighting was not used at all in sections where there are windows, while lighting in the toilets was assumed to be for a total of two hours per day.

In utilizing these model plans, it is necessary to bear in mind the following points:

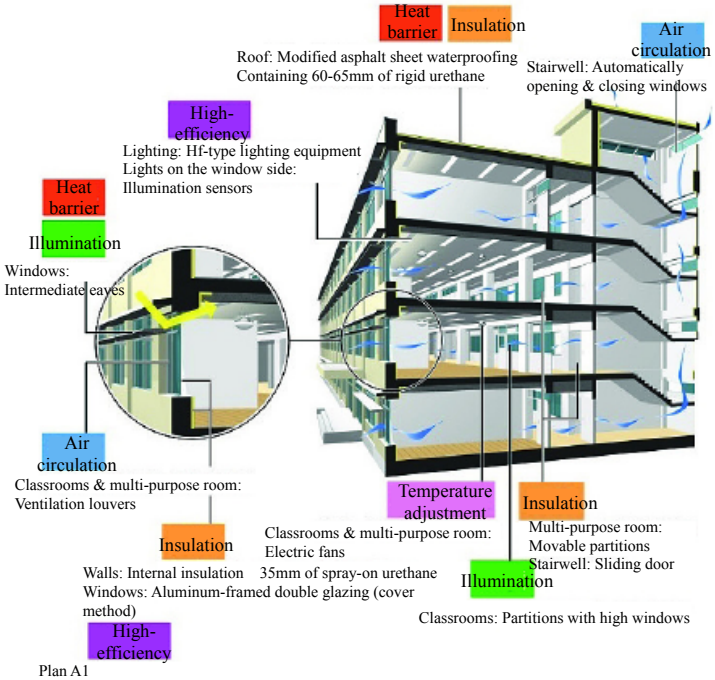
- When contemplating environment-focused renovations, it is necessary to take into consideration siting conditions and the climate in the area where the school is located and confirm the conditions based on the actual situation of the individual school.
- In order to grasp the actual energy consumption and CO_2 emissions of the school as a whole, it is necessary to base calculations on the actual usage situation of facilities and the operation of facilities and equipment.
- From the perspective of combining energy conservation with securing a good learning environment, if implementing a facilities plan that enables coolers to be operated in classrooms, as in these model plans, it is important to consider the operating conditions of the air conditioning equipment, such as the period of operation, the length of time for which it will be used each day, and the temperature at which it will be set, as well as considering the running costs.
- Solar photovoltaic power generation is presented as an option in these model plans for environment-focused renovations. If 10,000kWh of the annual electricity consumption of the school is covered using solar photovoltaic power generation, one can expect a reduction of approximately 4.2t* in CO_2 emissions annually

  * In order to calculate the CO_2 equivalent, this report uses the figure0.418kg-CO_2/kWh, which is based on the *Ministerial Ordinance on the Calculation of Greenhouse Gas Emissions Resulting From Business Activities by Specified Emitters* (2006, Ministry of Economy, Trade and Industry and Ministry of the Environment Ordinance No.3).
- In designing environment-focused renovations, there will be times when simulations will be required when conducting in-depth deliberations of the effects of the renovations, so it is necessary to consider the costs of such simulations as a separate design cost.

Model Plans A1 and A2 (Region IV)

*Apart from the fact that it involves the use of heat pump air conditioners as a cooling and heating method and the installation of coolers in ordinary classrooms as well, Plan A2 is the same as Plan A1.

Plan Overview



Plan A1
Staffroom & special classrooms: [Heaters, coolers] High-efficiency HP air conditioners (2008 level)
Classrooms & multi-purpose room: [Heaters] FF-type oil heaters [Coolers]: None
Plan A2
Staffroom & special classrooms: [Heaters, coolers] High-efficiency HP air conditioners (2008 level)
Classrooms & multi-purpose room:
[Heaters, coolers] High-efficiency HP air conditioners (2008 level)

Water conservation
Hand-washing: Foam water taps
Toilets: Devices that imitate the sound of toilets being flushed
Urinals: Automatic flushes

Table of Environment-focused Renovations

	Target area	Plan A (Region IV)	
		Before Renovation	Environment-focused Renovation
(1) Insulation	External walls (inside the room)	–	Internal insulation Spray-on type: 35mm (rigid urethane)
	Windows	Aluminium sashes, float plate glass	All windows conveted to double glazing with aluminum sashes (cover method)
	Roof	–	Modified asphalt sheet waterproofing (with 60mm of rigid urethane)
	Air conditioning zones (stairwell, foyer, etc.)	Permanently open fire doors	Installing doors that can be opened and closed
	Partitioning (between multi-purpose space and corridors)	–	Installing movable partitions
(2) Shading from sunshine	External walls	Existing horizontal eaves (W500)	Installing eaves midway across the windows (W600)
(3) Temperature adjustment	Internal walls and ceilings (ordinary classrooms and multi-purpose space)	–	Electric fans (4 in each room)
(4) Illumination	External walls	–	Installing eaves midway across the windows (W600)
	Partitioning (between ordinary classrooms and corridor)	–	Steel partitions (with high windows, H: 1700mm)
(5) Utilizing natural wind	Partitioning (between ordinary classrooms and corridor)	–	Steel partitions (with high windows, H: 1700mm)
	Windows (ordinary classrooms, multi-purpose space)	–	Ventilation louvers
	Windows (stairwells, corridors)	–	Installing windows that open and close automatically (Swindow)
(6) Efficient use of energy & water conservation	Lighting (ordinary classrooms, multi-purpose space)	FL-type lighting equipment (40W×16)	HF-type lighting equipment (with illumination sensors near the windows)
	Lighting (toilets, stairs)	FL-type lighting equipment (20W×2)	FL-type lighting equipment (with motion sensors)
	Heating & cooling facilities (staff room, special classrooms)	Heating: HP air conditioner Cooling: HP air conditioner (1995 equivalent)	Heating: HP air conditioner Cooling: HP air conditioner (2008 high-efficiency model)
	Heating & cooling facilities (ordinary classrooms, multi-purpose space)	Heating: FF-style oil heaters Cooling: None	(A1) Heating: FF-style oil heaters Cooling: None (A2) Heating: HP air conditioner Cooling: HP air conditioner (2008 high-efficiency model)
	Sinks	Running taps	Foam water taps
	Toilets	The toilets have no devices that imitate the sound of toilets being flushed, urinals are the flush valve type	Toilets are equipped with devices imitating the sound of toilets being flushed, urinals are equipped with an automatic flush

Results of Simulations

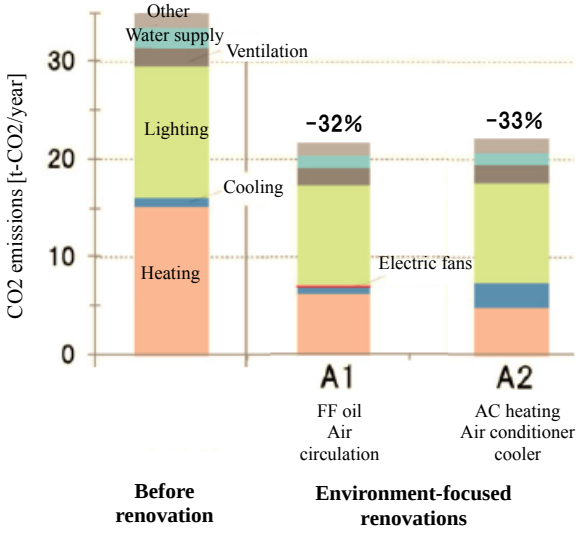
(1) Reduction in CO2 Emissions

Annual CO2 Emissions

If environment-focused renovations of school buildings are carried out, annual CO2 emissions are reduced by approximately 32% (9t) under Plan A1 and approximately 33% (9t) under Plan A2, compared with the situation before renovations.

CO2 Emissions Resulting From Cooler Use

If environment-focused renovations are carried out and coolers are used, with the temperature set at 28˚C, out of consideration for the running time, there is an increase of approximately 1.0t, equivalent to approximately 8% of the CO2 emissions of the school building as a whole. On the other hand, as a result of the introduction of high-efficiency air conditioning equipment and improved insulation capacity, there is a significant CO2 emission reduction effect resulting from the reduction in the energy used for heating in winter, so CO2 emissions over the course of the year decrease by approximately 33%, compared with the situation before renovations.



Annual CO2 Emissions (Region IV)

Annual CO2 Emissions Resulting From Heater and Cooler Use

By improving the insulation capacity of the building in conjunction with improvements to the efficiency of heating and cooling equipment, annual CO2 emissions resulting from heater and cooler use are reduced by approximately 46% (5t) under Plan A1, and by approximately 48% (5t) under Plan A2, compared with the situation before renovations.

Annual CO2 Emissions Resulting From Lighting

By updating lighting equipment to high-efficiency models and introducing illumination sensors and motion sensors, annual CO2 emissions resulting from lighting are reduced by approximately 23% (3t) compared with the situation before renovations.

Annual CO2 Emissions Resulting From Water Use

By updating decrepit facilities and installing water-conserving toilets and foam water taps for hand-washing, annual CO2 emissions resulting from water use are reduced by approximately 46% (1t) compared with the situation before renovations.

CO2 Emissions [t-CO2/year]
(Region IV)

	Before Renovation	Environment-focused Renovations A1 (FF heating + air circulation)		Environment-focused Renovations A2 (AC heating + air circulation)	
Heating	15.0	5.2	(△46)	3.6	(△48)
Cooling	0.9	0.5		1.9	
Electric Fans	0.0	0.1		0.0	
Lighting	13.4	8.6	(△23)	8.6	(△23)
Ventilation	1.8	1.4		1.4	
Water Supply	2.4	1.3	(△46)	1.3	(△46)
Other	1.5	1.1		1.1	
Total	35	18.0	(△32)	18.0	(△33)

*Figures in parentheses represent the percentage share of the reduction in CO2 emissions compared with the situation before renovations.

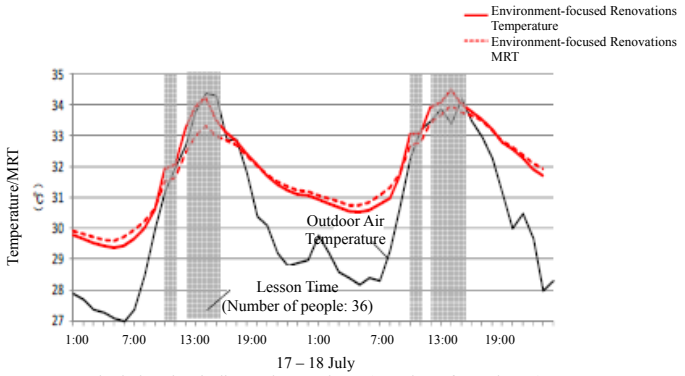
(2) Improvements in the Classroom Environment

Room Temperature in Summer

In summer, there are days when the room temperature in the classroom exceeds 30˚C, even if the rooms are shaded from sunlight and air circulation is encouraged. Consequently, it is necessary to take measures such as reducing sensory temperature by promoting convection flows using fans, or introducing coolers (as in Plan A2).

Room Temperature in Winter

If environment-focused renovations are carried out and the insulation capacity of the building is improved, the sensory temperature is about 2 - 3˚C higher than in the case of conventional renovations, even if the heater is set at the same temperature. Moreover, there is a smaller decrease in the room temperature and wall surface temperature of the classroom after the heaters are switched off, so the room temperature and wall surface temperature of the classroom can be kept above 10˚C at night in winter.
As a result, the load when the heater starts up the next morning is reduced, meaning that the classroom heats up faster, even when the same heating equipment is used.



Shaded region indicates lesson times (Number of people: 36)

Changes Over Time in the Summer Temperature and MRT (Plan A1, Region IV)

* MRT is the abbreviation for mean radiant temperature (also known as mean peripheral wall temperature), and expresses the surface temperature of the surfaces of which a room consists (walls, floor, ceiling and windows) as an average weighting for the area of the room.

Light Environment

As well as having a sun shading effect, intermediate eaves installed on the windows also function as a light shelf, so improvements in the light environment in the classroom can be expected.

(3) Initial Costs of Environment-focused Renovations

Estimated Construction Costs (per m2, excluding tax)

The unit cost of environment-focused renovations implemented in conjunction with earthquake-proof reinforcement, qualitative improvements and improvements to dilapidated facilities is around ¥120,000 – 123,000/m2; the increase in unit cost attributable to adopting environmental measures is around ¥33,000 – 36,000/m2. After securing the requisite sources of funding, a large-scale renovation project that takes environmental measures into consideration can also be carried out effectively in conjunction with renovation or improvement projects focused on the existing school building, particularly earthquake-proofing work.

Estimated Construction Costs Per Unit of Floor Area (Excluding Tax)
(¥/m2)

Type of Work	Main Content	Conventional Renovations	Environment-focused Renovations A1 (FF oil heating + air circulation)	Environment-focused Renovations A2 (Coolers used in classrooms)
Construction costs	Demolition work Renovation work (Updating the interior and exterior of the building and the joinery) Earthquake-proof reinforcement	63,200	95,700	95,700
Mechanical equipment work	Hygiene equipment work (Replacing toilets, etc.) Water supply & drainage work Heating & cooling equipment work Ventilation equipment work	20,500	20,700	21,900
Electrical equipment work	Lighting equipment work Ancillary work Power supply work	3,300	3,700	4,900
Total		87,000	120,100	122,500

Model Plan B (Region II)

Plan Overview

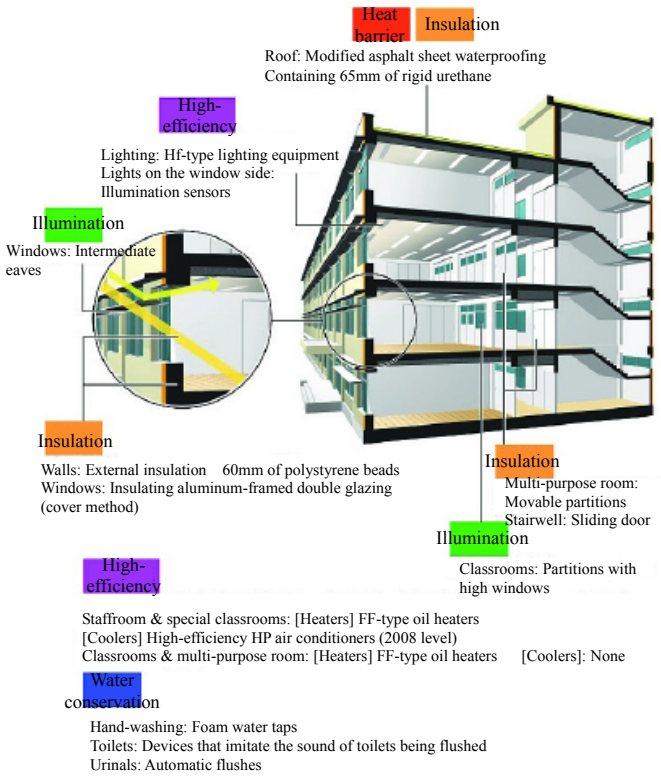


Table of Environment-focused Renovations

	Target area	Plan B (Region II)	
		Before Renovation	Environment-focused Renovation
(1) Insulation	External walls (inside the room)	—	External insulation 60mm (polystyrene beads)
	Windows	Aluminium sashes, float plate glass	All windows conveted to double glazing with aluminum sashes (cover method, insulating frames)
	Roof	—	Modified asphalt sheet waterproofing (with 65mm of rigid urethane)
	Air conditioning zones (stairwell, foyer, etc.)	Permanently open fire doors	Installing doors that can be opened and closed
	Partitioning (between multi-purpose space and corridors)	—	Installing movable partitions
(2) Shading from sunshine	External walls	Existing horizontal eaves (W500)	Installing eaves midway across the windows (W600)
(3) Temperature adjustment	Internal walls and ceilings (ordinary classrooms and multi-purpose space)	—	Electric fans (4 in each room)
(4) Illumination	External walls	—	Installing eaves midway across the windows (W600)
	Partitioning (between ordinary classrooms and corridor)	—	Steel partitions (with high windows, H: 1700mm)
(5) Utilizing natural wind	Partitioning (between ordinary classrooms and corridor)	—	Steel partitions (with high windows, H: 1700mm)
	Windows (ordinary classrooms, multi-purpose space)	—	None
	Windows (stairwells, corridors)	—	None
(6) Efficient us	Lighting (ordinary classrooms, multi-purpose space)	FL-type lighting equipment (40W×16)	HF-type lighting equipment (with illumination sensors near the windows)
	Lighting (toilets, stairs)	FL-type lighting equipment (20W×2)	FL-type lighting equipment (with motion sensors)
	Heating & cooling facilities (staff room, special classrooms)	Heating: HP air conditioner Cooling: HP air conditioner (1995 equivalent)	Heating: HP air conditioner Cooling: HP air conditioner (2008 high-efficiency model)
	Heating & cooling facilities (ordinary classrooms, multi-purpose space)	Heating: FF-style oil heaters Cooling: None	Heating: FF-style oil heaters Cooling: None
	Sinks	Running taps	Foam water taps
	Toilets	The toilets have no devices that imitate the sound of toilets being flushed, urinals are the flush valve type	Toilets are equipped with devices imitating the sound of toilets being flushed, urinals are equipped with an automatic flush

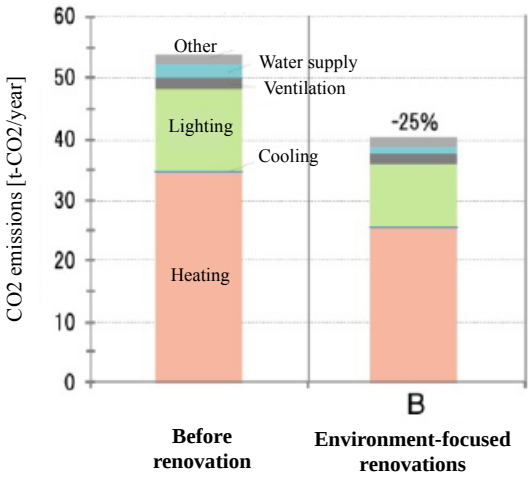
Results of Simulations

(1) Reduction in CO2 Emissions

Annual CO2 Emissions

If environment-focused renovations of school buildings are carried out, annual CO_2 emissions are reduced by approximately 25% (13t), compared with the situation before renovations.

In Region II, which is a colder region, the share of energy use attributable to heating in winter is greater than in Region IV, so by installing high-efficiency heating and cooling equipment, insulating the roof, walls and apertures, and establishing heated zones, energy use resulting from heating will decrease, leading to a reduction in CO_2 emissions.



Annual CO2 Emissions (Region IV)

CO_2 Emissions Resulting From Cooler Use

By improving the insulation capacity of the building in conjunction with improvements to the efficiency of heating and cooling equipment, annual CO_2 emissions resulting from heater and cooler use are reduced by approximately 26% (9t) compared with the situation before renovations.

Annual CO_2 Emissions Resulting From Lighting

By updating lighting equipment to high-efficiency models and introducing illumination sensors and motion sensors, annual CO_2 emissions resulting from lighting are reduced by approximately 23% (3t) compared with the situation before renovations.

Annual CO_2 Emissions Resulting From Water Use

By updating decrepit facilities and installing water-conserving toilets and foam water taps for hand-washing, annual CO_2 emissions resulting from water use are reduced by approximately 46% (1t) compared with the situation before renovations.

CO_2 Emissions [t-CO_2/year]
(Region II)

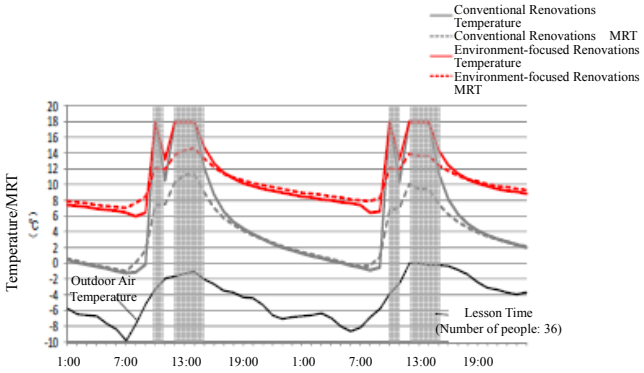
	Before Renovation	Environment-focused Renovations B	
Heating	33.1	24.4	(△26)
Cooling	0.1	0.1	
Electric Fans	0.0	0.0	
Lighting	12.5	9.6	(△23)
Ventilation	1.5	1.5	
Water Supply	2.4	1.3	(△46)
Other	1.2	1.3	
Total	51.0	38.0	(△25)

*Figures in parentheses represent the percentage share of the reduction in CO_2 emissions compared with the situation before renovations.

(2) Improvements in the Classroom Environment

Room Temperature in Winter

If environment-focused renovations are carried out and the insulation capacity of the building is improved, the sensory temperature is about 2 - 3˚C higher than in the case of conventional renovations, even if the heater is set at the same temperature. Moreover, there is a smaller decrease in the room temperature and wall surface temperature of the classroom after the heaters are switched off, so the room temperature and wall surface temperature of the classroom can be kept above 6˚C at night in winter.
As a result, the load when the heater starts up the next morning is reduced, meaning that the classroom heats up faster, even when the same heating equipment is used.



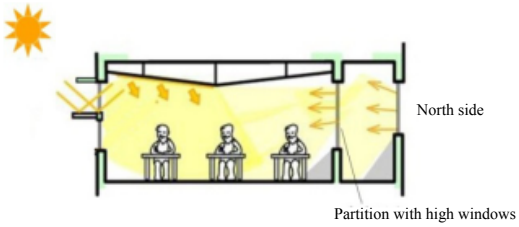
30 – 31 January
Shaded region indicates lesson times (Number of people: 36)

Changes Over Time in the Summer Temperature and MRT (Plan B, Region II)

* MRT is the abbreviation for mean radiant temperature (also known as mean peripheral wall temperature), and expresses the surface temperature of the surfaces of which a room consists (walls, floor, ceiling and windows) as an average weighting for the area of the room.

Light Environment

As well as having a sun shading effect, intermediate eaves installed on the windows also function as a light shelf, so improvements in the light environment in the classroom can be expected.



(3) Initial Costs of Environment-focused Renovations

Estimated Construction Costs (per m^2, excluding tax)

The unit cost of environment-focused renovations implemented in conjunction with earthquake-proof reinforcement, qualitative improvements and improvements to dilapidated facilities is around ¥136,000/m^2; the increase in unit cost attributable to adopting environmental measures is around ¥49,000/m^2. After securing the requisite sources of funding, a large-scale renovation project that takes environmental measures into consideration can also be carried out effectively in conjunction with renovation or improvement projects focused on the existing school building, particularly earthquake-proofing work.
*In the case of Plan B, insulating aluminum-framed double glazing is used on windows and external insulation is used on external walls, so the cost of renovation work is more expensive than in the case of Plan A.

Estimated Construction Costs Per Unit of Floor Area (Excluding Tax)
(¥/m2)

Type of Work	Main Content	Conventional Renovations	Environment-focused Renovations B (FF oil heating + air circulation)
Construction costs	Demolition work Renovation work (Updating the interior and exterior of the building and the joinery) Earthquake-proof reinforcement	63,200	109,300
Mechanical equipment work	Hygiene equipment work (Replacing toilets, etc.) Water supply & drainage work Heating & cooling equipment work Ventilation equipment work	20,500	23,200
Electrical equipment work	Lighting equipment work Ancillary work Power supply work	3,300	3,700
Total		87,000	136,200

Environment-focused Renovation Model Plan Specifications and Effects

The table below shows the list of work conducted in each model plan for environment-focused renovations and the energy conservation effect and environmental improvement effect of the work carried out, as well as the effects that measures to deal with dilapidation aimed to achieve.

○ denotes the effect aimed for in the renovation specifications

Renovation Item			Target Area	Specification	Applicable Plan	Energy Conservation Effect				Environment Improvement Effect						Anti-dilapidation Measures
						Heating	Cooling	Lighting	Water	Thermal Environment		Light Environment			Sound Environment	
										Winter	Summer	Winter	Middle	Summer		
External Walls	1	Waterproofing	Roof	Modified asphalt sheet waterproofing	Common											○
	2	Insulation	Roof (external insulation)	60mm rigid urethane	A1,A2	○	○			○	○					○
				65mm rigid urethane	B	○	○			○	○					○
			Roof (internal insulation)	35mm spray-on rigid urethane	A1,A2	○				○						
			Roof (external insulation)	60mm polystyrene beads	B	○				○						
	3	Windows	Classrooms	Aluminum window frames with ventilation louvers Double glazing (cover method)	A1,A2	○				○						○
				Insulating aluminum window frames Double glazing (cover method)	B	○				○						○
			Special classrooms, management rooms, corridors	Aluminum window frames Double glazing (cover method)	A1,A2	○				○						○
				Insulating aluminum window frames Double glazing (cover method)	B	○				○						○
	4	Ventilation windows	Stairwell	Automatically opening & closing windows	A1,A2						○					
				None	B						○					
	5	Eaves	Windows	Horizontal eaves above the windows (W500) (existing) + horizontal eaves midway down the windows (W600)	Common		○				○		○	○		
Internal Partitions	6	Stairwell partition doors	Stairwell, foyer, etc.	Installation of doors that can be opened & closed	A1,A2	○	○			○	○					○
					B	○				○	○					○
	7	Partitions	Ordinary classrooms - corridor	Steel partitions with high windows (Windows H: 1700mm)	A1,A2	○	○			○	○	○	○	○		○
					B	○				○	○	○	○	○		○
			Ordinary classrooms - multi-purpose space Multi-purpose space - corridor	Movable partitions	A1,A2	○	○			○	○					○
					B	○				○	○					○
Interior Finish	8	Internal walls	Ordinary classrooms, multi-purpose space	Emulsion paint (white)	Common			○				○	○	○		○
	9	Floors	Ordinary classrooms, multi-purpose space	Flooring boards (cushioned)	Common										○	○
	10	Ceilings	Ordinary classrooms, multi-purpose space	Decorative rock wool acoustic boards	Common										○	○
Hygiene Facilities	11	Hand basins	Taps	Foam water taps	Common				○							
	12	Toilets	Toilets	Switch to water-conserving toilets	Common				○							○
	13	Sensor installation	Toilets & urinals	Devices that imitate the sound of the toilet flush, automatically flushing urinals	Common				○							
Heating & Cooling Facilities	14	Heaters & coolers (air conditioners)	Special classrooms, management rooms	Switch to high-efficiency air conditioners (equivalent to 2008 standard)	A1,A2	○	○			○	○					○
				Switch to high-efficiency air conditioners - cooler only (equivalent to 2008 standard)	B		○			○	○					○
	15	Heaters (FF oil heaters)	Ordinary classrooms, multi-purpose space (in Plan B, special classrooms & management rooms are also included)	Updating equipment	A1,B					○						○
				Installation of new high-efficiency air conditioners (equivalent to 2008 standard)	A2	○				○						○
	16	Coolers (air conditioners)	Ordinary classrooms, multi-purpose space	-	A1,B											
				Installation of new high-efficiency air conditioners (equivalent to 2008 standard)	A2						○					
	17	Electric fans	Ordinary classrooms, multi-purpose space	4 units installed in each classroom	Common						○					
Electric Lighting Facilities	18	Electric lighting	Ordinary classrooms, multi-purpose space	Switch to Hf-type lighting equipment (Hfl32W x 16 units)	Common			○								○
	19	Sensor installation	Ordinary classrooms, multi-purpose space	Lighting sensors installed on the window side of the classroom	Common			○								
			Toilets, stairwell	Installation of motion sensors	Common			○								

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