Learning through the Use of Earth-friendly Energy

Guidebook on the Use of New Energy at School Facilities

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Minister's Secretariat
Ministry of Education, Culture, Sports, Science and Technology (MEXT)

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With the cooperation of
Ministry of Economy, Trade and Industry
and
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Japan

INTRODUCTION

Global warming is a concern common to all countries. Of all the world's issues that require full-scale efforts, it is one of the most significant. The Kyoto Protocol's first commitment period started in 2008, and various measures have been taken by many countries so that they may attain their goals of reducing greenhouse gas (GHG) emissions. Japan aims at a 6% reduction in emissions in the five years ending in 2012, as compared to the 1990 emissions level. Because the Government of Japan announced the mid-term target of a 25% reduction in GHG emissions from the 1990 level by 2020, it is vital to strengthen efforts toward building a low-carbon society.

In July 2009, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) prepared a guidebook titled *Learning through the Use of Solar Power: Guidebook on the Introduction of Solar Photovoltaic Power Generation* in collaboration with the Educational Facilities Research Center of the National Institute for Educational Policy Research. On the basis of the guidebook, this booklet, *Learning through the Use of Earth Friendly Energy*, was prepared in order to provide concise information required by school authorities regarding solar heat utilization, wind power generation and New Energy other than photovoltaic power.

New Energy is derived from various sources, including sunlight, solar heat, wind power and biomass. Whatever the source, New Energy is renewable and does not emit carbon dioxide when it is used. Other than photovoltaic power, New Energy has been utilized at very few schools, and more varieties of New Energy are expected to be used at many schools as part of efforts to reduce GHG emissions.

School is a part of life for children, who will forge our future world. They learn at school, and their experiences there affect their growth and development in many ways. Introducing New Energy to schools will make school facilities places that provide environmental education to children. Everything they learn and experience at such facilities will greatly enhance their environmental awareness.

Schools are among the public facilities with which the public is most familiar, being established in all corners of the country. It is expected that environmental measures will be promoted at the regional level when environmental measures are taken at school.

The information in this guidebook was carefully selected to satisfy the needs of school authorities. It includes examples of New Energy utilized in environmental education, the effects of such utilization, the processes of installing facilities necessary for the use of New Energy, points to be checked in designing and building such facilities, and the maintenance of the facilities. Cases of application are also shown, according to the type of New Energy. It is hoped that this guidebook will be fully utilized by school authorities who wish to use New Energy at their schools.

March 2010

Learning through the Use of Earth-friendly Energy
— Guidebook on the Use of New Energy at School Facilities

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1. The Usefulness and Effects of Application of New Energy at School Facilities

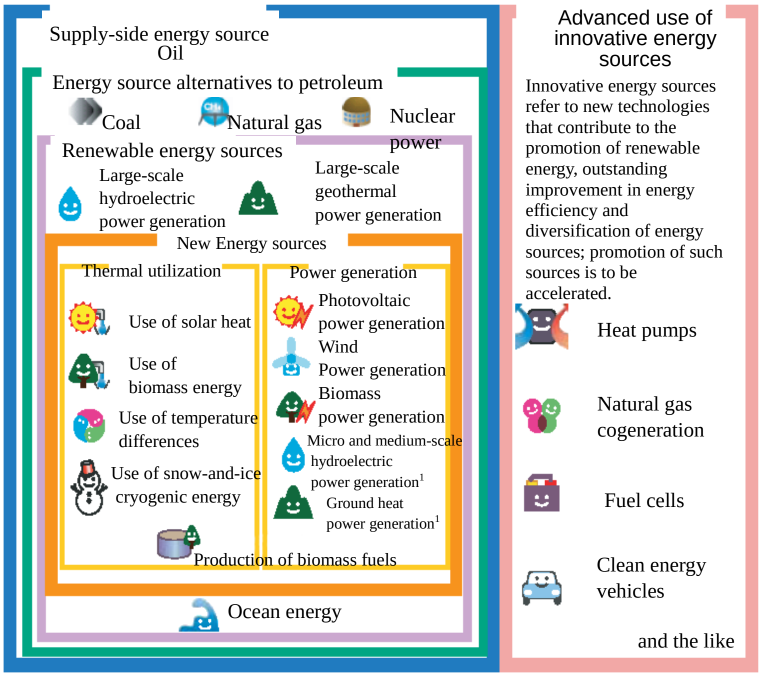
New Energy is defined as domestically produceable energy that contributes to the diversification of energy sources. It has excellent ecological features that address global warming, since it reduces emissions of carbon dioxide.
In addition, installation of New Energy systems at school buildings enhances students' awareness of energy. They learn that New Energy can be utilized for air-conditioning, power generation and so forth, and they become directly aware of the blessings of solar, wind, ground heat and other energy sources.

(1) What is New Energy?

Definition of New Energy

The Act on the Promotion of New Energy Usage defines New Energy as shown at right.
Among renewable energy sources, the introduction of New Energy sources such as solar radiation and wind power, in particular, is to be promoted.
- Fuel cells are not included in the definition of New Energy, but this guideline addresses them, as they are effective in reducing carbon dioxide emissions at school buildings.

For details on photovoltaic power generation, please refer to *Learning through the Use of Solar Power - Guidebook on the Introduction of Solar Photovoltaic Power Generation* published in July 2009.



[1]The only ground heat power generation system that is categorized as a New Energy source is the binary cycle power system; the only hydroelectric power generation systems that are categorized as New Energy sources are those that use waste hydraulic recourses and have an output of 1,000 kW or less. Source: NEDO

New Energy Uses

Type of New Energy		Method of using the New Energy source	Reference
	Solar heat	Solar heat is accumulated by rooftop collectors and the like for use in water heating and air-conditioning.	p.6
	Micro wind power generation (Windmills)	"Wind power" rotates windmills, which consequently generate power by transferring the rotating force to the generator.	p.8
	Ground heat	Ground heat energy is used for air-conditioning with heat exchangers or heat pumps, or for ventilation by transferring indoors the air that is warmed or cooled at shallow depths underground.	p.10
	Biomass energy (pellet stoves)	Wood pellets made of waste wood or thinned lumber are utilized for heating.	p.12
	Snow-and-ice cryogenic energy	Cryogenic energy derived from snow or ice is used for air-conditioning.	p.14
	Micro hydroelectric power generation	Power is generated by water flow or small head of water channels, small streams and the like.	p.15
	Fuel cells	The hydrogen-oxygen chemical reaction directly converts hydrogen and oxygen into an electric current.	p.16

New Energy Sources: Features and Issues

Representative New Energy sources include insolation, solar heat, wind and biomass energy, all of which are renewable and produce no carbon dioxide emissions at use. Use of New Energy sources helps to reduce national dependency on imported oil and to diversify energy sources in order to secure the national energy supply.
However, since the initial costs remain high, incentives aiming to further technical development and cost reductions are required for widespread use of these energies. In addition, the energy output fluctuates in the case of energy sources that are susceptible to meteorological influences.
Since the efficiency and other features of a New Energy source depend on the location of each school, it is necessary to understand the local conditions for the selection of the optimal alternative; for instance, daylight hours and insolation for solar heat, wind conditions* for wind power or underground temperature for ground heat.

*This refers to wind situations and characteristics, specifically, the characteristics of mean and instantaneous wind velocities, and the frequencies of wind directions and velocities.

(2) Environmental education

Observation of the implemented New Energy sources, for firsthand understanding

Installation of New Energy systems provides examples for observation, so that students can understand in a real sense that solar radiation, wind power, ground heat, snow-and-ice cryogenic heat and other energy sources can be applied to power generation, air-conditioning and so forth.

By observing windmills and solar panels, one becomes more aware that wind power and solar radiation generate power. (Izumino Elementary School, Kanazawa City, Ishikawa Pref.)

The movement of tape strips in the ground heat air-conditioning duct is displayed for indoor observation of air flow. A panel exhibition outlining the system was created for visitors. (Shizusato Nanohaha Kindergarten, Takashima City, Shiga Pref.)

Solar heat energy can be felt by placing a hand over the warm airflow when the duct for air warmed by rooftop equipment is partly opened. (Source: *The Egg of the Earth*)

The coolness of snow stored in the cryogenic cooling system in the summer is experienced. An experiment on vegetable storage. (Yasuzuka Elementary School, Joetsu City, Niigata Pref.)

Left: A session for experiencing the heat emitted by a pellet stove. Students learn that thinned lumber and scrap wood can be processed into easy-to-use forms of fuel, such as pellets. (Mikata Junior High School, Wakasa Town, Fukui Pref.; Center: Observation of micro hydroelectric power generation by water wheels enhances comprehension of the kinetic energy of water flow. (Hata Water Wheels, Hata Town, Nagano Pref.)

Utilization of display panels for understanding the mechanisms whereby natural energy sources can be used efficiently

Explanations on display panels aim to present the mechanisms of power, from its generation to its use, and the instantaneous power output, which facilitates extensive study of New Energy use.

This panel displays the instantaneous wind velocity and wind power output. The comparison between generated power and the power consumed by cafeteria lighting helps one understand the scale of the generated power.

An example display of a solar heating system. The solar water heating system can be understood instantly. (Daiichi Elementary School, Yamagata City, Yamagata Pref.)

1. The Usefulness and Effects of Application of New Energy at School Facilities

Visualizing the movements of equipment driven by the generated power, to increase awareness of the relations between natural conditions and power output

The use of power generated by New Energy sources may be limited to those devices whose operations are visible, such as in pumping systems of fish tanks or biotopes that are accessible to students. Because their operations are visible they can serve as teaching resources in environmental education to promote firsthand understanding of the relationship between natural conditions (wind conditions, water flow and the like) and the power output.

The wind power is employed to drive a fountain pump. The fountain spouts vigorously when the wind is strong and stops spouting when the wind weakens. The device demonstrates that the power generation capacity relies on the wind. (Noichi Elementary School, Konan City, Kochi Pref.)

Teaching materials and simulation models of the New Energy systems are prepared, to enhance comprehension of the mechanisms.

The development of teaching materials and simulation models that work on the same principles as the actual systems enables students to learn the mechanisms of New Energy systems and to deepen their understanding.

For instance, they can experience power generation by applying wind to miniature wind power generation appliances, and by using solar thermal energy to heat bottled water.

Studying the principles of solar heat collection and efficiency differences by using water in bottles of different colors (Takaki Elementary School, Fukuoka City, Fukuoka Pref.)

Learning the mechanism of fuel cells with a small model (Idogaya Elementary School, Yokohama City, Kanagawa Pref.)

Learning the mechanism of wind power generation with a small model. (Idogaya Elementary School, Yokohama City, Kanagawa Pref.)

1. The Usefulness and Effects of Application of New Energy at School Facilities

Research presentations and workshops interactively deepen comprehension on New Energy sources.

The installation of New Energy systems in accessible locations increases the opportunities for students to proactively study energy issues. In addition, research presentations and workshops facilitate further learning on the benefits of New Energy and the significance of measures to address global warming.

Students discuss global warming and energy issues. (Mikata Junior High School, Wakasa Town, Fukui Pref.)

Presentations summarizing discussions about energy issues (Idogaya Elementary School, Yokohama City, Kanagawa Pref.)

Collaborations with experts, including those from NPO's, enrich understanding by the local community.

Using websites and presentations to provide parents and local residents with information on installation situations and applications to environmental education contributes to activities by the whole community. Environmental seminars with guest experts from NPOs and so forth raise awareness of New Energy not only among the students but among the entire community.

Learning the mechanism of wind power generation at a lecture by a visiting expert (Idogaya Elementary School, Yokohama City, Kanagawa Pref.)

Students listen attentively to explanations by the head janitor of the snow cryogenic cooling system. (Yasuzuka Elementary School, Joetsu City, Niigata Pref.)

Items to be considered in using New Energy systems as teaching resources

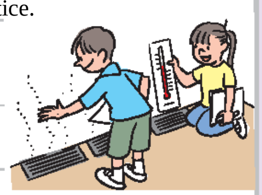
■Equipment observation sites should be spacious, safe and suitable to the methods and content of the learning activities.
■In the case of rooftop equipment observations, sufficient safety must be secured, for instance by installing guard nets or fences that prevent falls from edges or skylights.
■During maintenance of rooftop equipment, access to the rooftop should be properly restricted. Moreover, stairs and other maintenance installations should be managed such as to prevent students from using them.
■Primarily, the main unit, the mounts and other parts of solar thermal collectors should be carefully designed and constructed to prevent student injuries. Subsequently, precautions and other instructions should be provided to the students.
■Students are instructed to treasure New Energy systems installed at school facilities as long-lasting learning resources.

(References) p. 3, *Learning through the Use of Solar Power - Guidebook on the Introduction of Solar Photovoltaic Power Generation*

◆TOPICS◆ References for use in classes designed to promote students' proactive learning about New Energy

Since environmental education aims to nurture human resources that will contribute to sustainable community development, the Ministry of the Environment has drafted booklets* that extract major items related to environmental education from the national Courses of Study, and that sort the items by field and developmental phase (elementary school lower, middle and upper grades; junior high school); these booklets have been used for environmental education at schools. The following excerpts from the booklets concern the New Energy-related items "resources and energy," and "mechanism and effects of global warming."

		Resources and energy	Mechanism and effects of global warming
		Raise awareness that mineral resources and fossil fuels are limited. Have students grasp the development and use status of New Energy, such as photovoltaic and wind power. Enable determination and implementation of less resource-intensive lifestyles.	Help students to understand that excessive dependence on fossil fuels in manufacturing and lifestyles has been altering the atmospheric composition, and therefore, causing global warming. Enable students to determine what we can do in our daily lives to control global warming; put it into practice.
Elementary school lower grades			
Elementary School Middle grades	Social Studies	● Waste management and recycling ● Securing potable water, electric power and gas	
	Science	● Movements of wind and rubber ● Properties of light ● Electrical pathways ● Functions of electric power	● Features of air and water ● Metals, water, air and temperature
Elementary school upper grades	Science	● Functions of electric current ● Utilization of electric power	● Mechanism of combustion
Junior high school	Social Studies	● Geographical features of Japan from a global perspective (resources and energy, industries) ● Issues of Japan and the global society (global environment, resources and energy issues)	● Modern Japan and the world ● Issues of Japan and the global society (for a better society)
	Science	● Electric current ● Electric current and magnetic fields ● Aqueous solutions and ions ● Energy ● Development of science and technology	● Changes of state ● Chemical changes ● Meteorological changes ● Organisms and the environment
	Crafts and Home Economics	● Technologies applied in daily life and industry ● Mechanism and maintenance inspections of energy converters, design and fabrication of products employing energy conversion techniques	



*Environmental Education to be Applied in Classrooms: *Guidelines Understandable at a Glance by Grade and Subject* (Ministry of the Environment: http//www.env.go.jp/policy/nerai/) (in Japanese)
Environmental education from a comprehensive standpoint can be exercised when combined with agendas other than those excerpted.
Furthermore, as a portal site for environmental education and learning useful at schools, homes, and workplaces, the Eco Learning Library (Ministry of the Environment: http://www.eeel.go.jp) has been established. (in Japanese)

(3) Achieving reductions in carbon dioxide emissions

Use of solar heat

When solar heat is utilized only for water heating, the mean collected thermal energy, energy saved and carbon dioxide emissions reduced are estimated as follows (in comparison with liquefied petroleum gas, city gas and kerosene). Please note that the area of the heat collector of the equipment affects the amount of carbon dioxide emissions reduction, and other factors.

Solar heating equipment	Area of heat collector	Annual collected thermal energy	Annual energy saved, Cost savings, Carbon dioxide emissions reductions		
			LP gas	City gas	Kerosene
Solar water heating system	6 m^2	13.06 mil. kJ (3.12 mil. kcal)	273.9 kg 59,628 yen 822 kg carbon dioxide	305.5 m^3 33,879 yen 675 kg carbon dioxide	374.6 L 29,196 yen 933 kg carbon dioxide

- Annual collected thermal energy: annual nationwide mean insolation [inclination: 30˚]: 5.44 mil. kJ/m^2/year (1.3 mil. kcal/m^2/year), heat collection efficiency: 40%
- Combustion efficiency of fuels: 95%
- The annual heat collection capacity per 6 m^2 of heat collector is approx. equivalent to the average annual energy consumption for water heating per household. (Approx. 3 mil. kcal/household/year (Approx.12.59 mil. kJ/household/year)): EDMC Handbook of Energy and Economic Statistics in Japan, 2006) (Source for annual thermal energy collected by the solar water heating system: Solar System Development Association)

Use of micro wind power generation

In installing wind power generation equipment at school facilities, the annual power output, energy saved and carbon dioxide emissions reduced are estimated as follows. It should be remembered that the power output fluctuates depending on wind properties and local environments. It also varies by the manufacturer and the type of windmill.

System capacity	Annual power output	Annual cost savings	Carbon dioxide emissions reduction
2 kW	1,340 kWh	16,294 yen	569.5 kg carbon dioxide

- The annual mean wind velocity of the area is 4 m/s (measured at the installation site).
- The power output is the calculated annual mean value based on the measured values obtained by a manufacturer of micro wind power generation equipment (3-bladed propeller type).
- Annual power output capacity of a windmill for 2 kW is equivalent to approximately 32% of the annual total energy consumption of a typical household (4,209 kWh/household/year, from a survey conducted in 2005 by the Energy Conservation Center, Japan).

Use of biomass energy (pellet stoves)

In the case of heating with a wood pellet stove, the mean fuel costs per 100 kg of pellets, the heat output and the carbon dioxide emissions reductions are estimated as follows (calculated on the assumption that the heating fuels that were replaced were liquefied petroleum gas, kerosene, and electricity). Use of a pellet stove requires expenses for pellet fuel.

Fuel costs	Heat output	Equivalent energy, equivalent costs, and carbon dioxide emissions reduction for replacing each type of fuel		
		LP Gas	Kerosene	Electricity
4,500 yen (excluding transportation costs)	1.89 mil. kJ (0.45 kcal)	37.5 kg 8,163 yen 113 kg carbon dioxide	51.2 L 3,990 yen 127 kg carbon dioxide	522.2 kWh 6,349 yen 222 kg carbon dioxide

- The heat output per 100 kg of pellets is equivalent to approximately l5% of the average annual energy consumption for heating per household. (Approx. 2.92 mil. kcal/household/year (approx. 12.28 kJ/household/year): *EDMC Handbook of Energy and Economic Statistics in Japan, 2006*) (Source of pellet fuel costs and heat output: Wood Pellet Promotion Conference)

The coefficients employed for the above calculations

■Heat outputs of each fuel are: 50.2×10^3 kJ/kg for LP gas, 45×10^3 kJ/m^3 for city gas, 36.7×10^3 kJ/L for kerosene, and 3.6 kJ/kWh for electricity. (Figures for LP gas and kerosene are cited from the data in *Calculation and Reporting Guidelines for Greenhouse Gas Emissions* (Ministry of the Environment), and that for city gas is the value published by Tokyo Gas Co., Ltd.)

■The prices of each fuel are 217.7 yen/kg for LP gas, 110.9 yen/m^3 for city gas, 77.94 yen/L for kerosene, and 12.16 yen/kWh for electricity. (Figures for LP gas and kerosene are excerpted from the data published by the Oil Information Center, that for city gas is from Tokyo Gas Co., Ltd. and that for electricity is from Tokyo Electric Power Co. (as of January 2010).)

■The carbon dioxide emission coefficients for each fuel are 3.0 kg carbon dioxide/kg for LP gas, 2.21 kg carbon dioxide/m^3 for city gas, 2.49 kg carbon dioxide/L for kerosene and 0.425 kg carbon dioxide/kWh for electricity. (Figures for LP gas and kerosene are from the data in *Calculation and Reporting Guidelines for Greenhouse Gas Emissions* (Ministry of the Environment), the figure for city gas is the value published by Tokyo Gas Co., Ltd, and that for electricity is from Tokyo Electric Power Co.)

2. Installation and Use of New Energy Sources

This section outlines the systems of typical new energy sources that are expected to be adapted by schools, and items to be considered for the introduction of such systems.

(1) Use of solar heat

Solar heat is generally used in systems that provide hot water or heating, and for systems that combine hot water supply and heating or hot water supply and heating/cooling. An absorption refrigerator is needed in the case of a cooling system.

Air, water and anti-freezing fluid are generally used as the heat transfer media, and these are conveyed by either the natural circulation that results from the density gradient of such media or by forced circulation with pumps. Below, typical systems that have been introduced into schools are shown.

(a) System outline

Radiant air floor heating system

Use for environmental education:	The installation of devices that allow the heat to be felt and the effects to be visualized (e.g.: the chance to feel hot air, the use of display panels)
Applicability to conventional buildings by:	The installation of pitched double-roofs and of air ducts (When the roof is re-built, it is necessary to confirm the structural safety of the building.)

Ambient air taken from the eaves is heated by solar radiation in a glass heat collector built on the roof, and then that air is used for heating. The warmed air is blown through the underfloor below the rooms, which heats the floor and the air in the rooms while providing ventilation. During the daytime, the heat of the warmed air is stored in the concrete thermal mass built under the floor. In the evening the heat is naturally released to moderate the drop in air temperature.

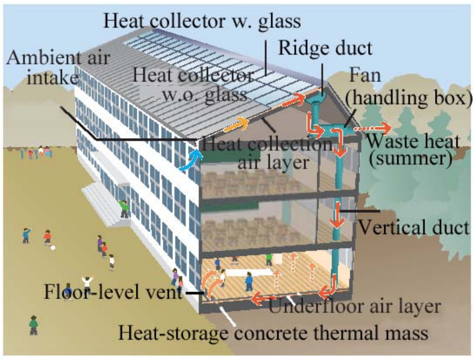


Fig.1 Schematic of radiant air floor heating system for classrooms (winter operation)

Futaba Elementary School (Kamaishi, Iwate Pref.) w. heat collector area of 551 m^2

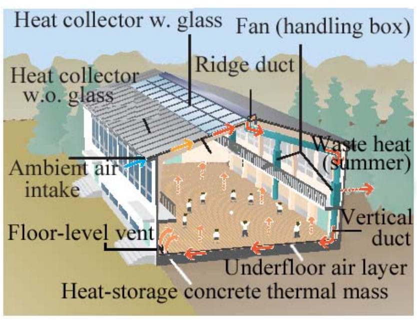


Fig.2 Schematic of radiant air floor heating system for gym (winter operation)

Daishichi Kyoda Elementally School (Arakawa Ward, Metropolitan Tokyo) w. heat collector area of 63.5 m^2

View of the inside of the roof from the gym. Air is piped to the underfloor through the blue ducts.

"Water-use" hot water supply system

Use for environmental education:	The installation of devices that allow the effects to be visualized (e.g.: the use of display panels)
Applicability to conventional buildings by:	Confirmation of the structural stability of the building against roof load, and securing of space for installing the device

The system supplies hot water warmed by the solar heat collectors installed on the roof. Solar-warmed water is first stored in the thermal storage tank. Then, the water temperature is adjusted by an auxiliary heat source in order for hot water to be supplied.

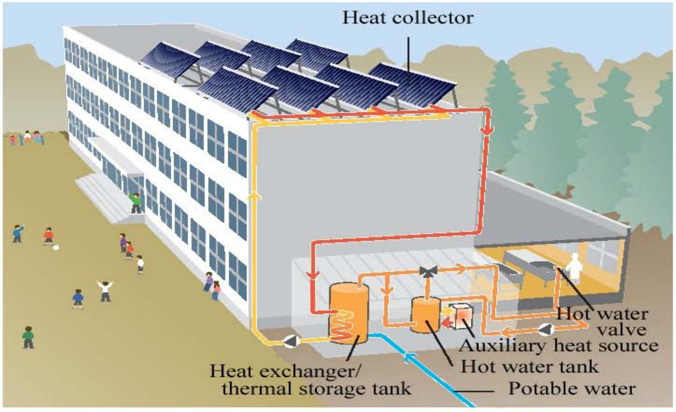


Fig.3 Schematic of "water-use" hot water supply system

Kowa Elementary School (Nerima Ward, Metropolitan Tokyo) w. a heat collector area of 96 m^2

(b) Major devices

1) and 2) below are commonly used for radiant air floor heating systems and "water-use" hot water supply systems, while 3) below is exclusively used for "water-use" hot water supply systems.

1) Heat collector

This collects heat from solar radiation and conducts the heat to a heat transfer medium, such as water or air. There are roughly two types: "water-use*" heat collectors (flat panels or vacuum tubes) and "air-use" heat collectors.

*When the warmed water is used for hot water supply, measures against the bacteria that cause legionellosis are needed. Although the vacuum tubes efficiently collect heat and it is possible to raise the water temperature to 60ºC or higher, the flat panels are not able to raise the water temperature high enough; thus, the warmed water needs to be heated in a boiler. Such additional heating makes the water safer in terms of legionellosis, but it lowers the proportion of heat derived from solar radiation.

2) Thermal mass

This stores solar heat collected by solar heat collectors, and releases it when needed.
Generally used are building thermal mass, in which floors and walls are used as the thermal mass, and "water thermal mass," in which water in a thermal storage tank (hot water tank) is used to store heat.

3) Auxiliary heat source

This is a heating device that raises the water temperature when weather conditions make solar heat insufficient. Boilers are generally used, one example of which is a gas-fired boiler.

(c) Items to be considered in designing and planning

■ common to air use and water use ■ exclusive to "water use"

Designing work is primarily contracted out to an architectural office. The following items are the main ones to be considered in the introduction of a solar heating system. School establishers should understand the items so that they can request that the architects include them in their analyses.

- ■When a heat collector is installed on the roof of an existing school building, the structural stability of the building should be confirmed. (Refer to p. 12 of *Learning through the Use of Solar Power - Guidebook on the Introduction of Solar Photovoltaic Power Generation*).
- ■The heat collectors should be set at the optimal gradient for maximum heat collection. Footholds and areas for maintenance should also be integrated into the design.
- ■The azimuth of the heat collector should be within 30° from the south.
- ■ The distances between the heat collectors and the hot water tank (thermal storage tank), and between the hot water tank and the hot water valve/radiator should be as small as possible, to minimize energy loss.
- ■ In cold regions where water freezes in winter, it is necessary to drain the water in the pipes.
- ■ Because the surface of the vacuum tubes is glass, thorough safety measures should be taken.

(2) Micro wind power generation (windmills)

The energy generated by wind increases in proportion to the area of blades that receive wind power. This makes it possible to produce wind turbines of various blade sizes and rated outputs, from small to large. Also, various shapes of blade are available. The blade shape best suited to the local wind conditions should be chosen. Currently, horizontal-axis turbine blades installed with propeller-type rotors are mainly used. In addition, vertical-axis wind turbines that can operate regardless of wind direction are also available.

Typical systems that have been introduced into schools are shown below.

(a) System outline

Micro wind power generation (independent type)

Use for environmental education:	The installation of devices that allow the wind to be felt and the effects to be visualized (e.g.: observation of wind turbines, use of display panels)
Applicability to conventional buildings by:	Securing spaces for wind turbine and electric equipment installation

Wind turbines are installed on the rooftop of the school building or in the schoolyard. Wind causes the wind turbines to rotate. The kinetic energy of turbine rotation is converted into electric power by means of a power generator. The generated electricity can be stored in batteries or inverters and then supplied to the pumps of water tanks for growing aquatic and other organisms and to power lighting and so on.

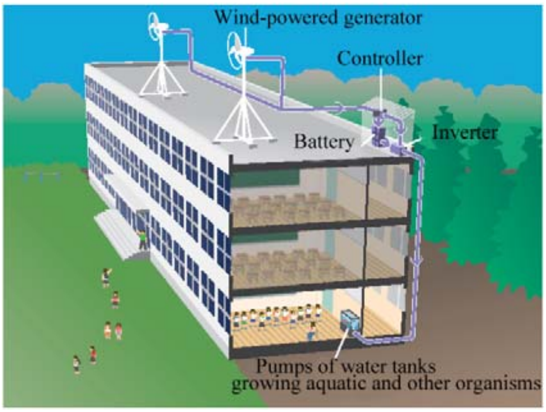


Fig.4 Schematic of micro wind power generation (independent type*)

* Independent types of wind power generators require batteries to make up for the shortfall in power output for the rated consumption of load devices.

Kowa Elementary School (Nerima Ward, Metropolitan Tokyo) w. 3 wind turbine units (rated output: 300 W)

A completely independent system that stores power generated by the wind turbine and by the photovoltaic panels and supplies it to the lighting devices at night. Batteries and inverters are installed inside the tower.

Gifu Elementary School (Gifu, Gifu Pref.): Rated outputs of 1,000 W (wind power) and 60 W (photovoltaic)

Kanamachi Elementally School (Katsushika Ward, Metropolitan Tokyo): Rated outputs of 450 W (wind power) and 150 W (photovoltaic)

(b) Major devices

1) Wind power generator

This consists of wind blades that receive wind energy, gears to transmit blade rotation to the turbine and a power generator that converts the kinetic energy of the rotating turbine into electric energy.

2) Controller

This device automatically controls the rotation speed of the blades to prevent them from rotating faster than their rated rotation speed during strong winds, including gusts.

3) Inverter

This device converts direct current (DC) to alternating current (AC). When direct current is generated by a wind power generation system, it needs to be converted to alternating current to avoid a drop in voltage during transmission.

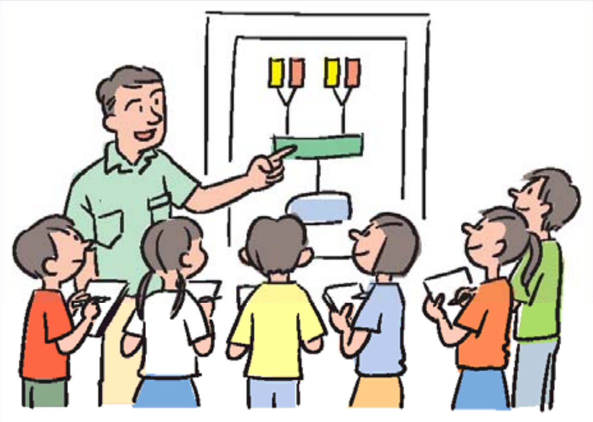
(c) Items to be considered in designing and planning

Designing work is primarily contracted out to an architectural office. The following items are the main ones to be considered in the introduction of micro wind power generation. School establishers should understand the items so that they can request that architects include them in their analyses.

- As of March 2010, there were no regulation criteria by which to assess the performance of windmills for micro wind power generation. The system that can perform best under the site conditions should be determined by studying durability, the method of controlling the system when excessively strong winds blow and other relevant items.
- Rooftop installation of micro wind power generation systems requires confirmation of building structural safety against the various loads posed by the system as well as confirmation of the levels of vibration caused by the system.
- Micro wind power generation systems are highly useful for environmental education. The methods of educational use should be integrated into the design plan such as to secure opportunities for students to safely observe the system.
- The rotating wind blades should be installed higher than students can raise their hands.
- Because winds are stronger at higher places than at lower places, the higher the elevation of the system installed, the higher its efficiency. Find locations within the school premises that are advantageous in terms of power generation efficiency as well as of observation opportunities.
- The wind turbine should be located where the winds are the least obstructed.

◆TOPICS◆ Communication between teachers and students facilitated through environmental education (an example from the City of Ichikawa, Chiba Prefecture)

The City of Ichikawa has been implementing an environmental education program that the city developed on the basis of facilities for utilizing new energy installed in schools. This education program, prepared in 2005, is the result of close cooperation among the board of education, environment-related municipal departments and agencies, and school teachers. The education program was intended to fulfill the city's aim of enhancing environmental awareness among children while satisfying educational needs at school. After completing the program, each pupil writes a letter describing his or her impressions, and the letters are sent by the school to the city. This program is very meaningful to the city officials supporting environmental education, because they can see the effectiveness of the program in changing pupils' ways of thinking about the environment.



(1) Environmental education program: "Catch the wind!"

This program was developed for fourth-graders at schools with wind power/ photovoltaic hybrid power generation facilities. A city official playing the role of "Kaze-tarou" (Wind boy) visits each school to provide the program that is described below.

[Introduction]

1. Each pupil fills a transparent plastic bag with wind, holds the bag tight at the top with one hand and squeezes the bag with the other to feel the air that is expelled from the small opening at the top.
2. Students are shown a miniature windmill and are told how a windmill works.

[Main part of the program]

3. Students shown a photo of the facilities installed in the schoolyard are asked what the facilities power.
4. Students are asked questions about energy.
5. Students are given an explanation about the cause-and-effect relationship between energy and global warming.
6. Students are shown some examples of windmills in the Netherlands and of large power generation facilities in Hokkaido.
7. Students are given an assignment to write about what they can do for the earth.

[Concluding activity]

8. At the end of the program, the miniature windmill is operated.
9. At a later date, Kaze-tarou writes to the students to share his candid feelings about the program that he participated in with them.

(2) Response from the school

After the program at each school, students write about their impressions of the program and summarize what they've learned in the program in a school paper, or homeroom teachers summarize their pupils' views and impressions of the program. These outputs are very valuable for the city officials in charge of environmental education. The candid views and opinions of pupils, in particular, affect the development of environmental education in the city, and the feedback from students help the providers of environmental education to learn many things.

After the program, some students reported the following:

○"After listening to what Kaze-tarou said today, I thought I should be more careful about our environment. I'll tell this to my family, who I'll ask to work together for energy savings."

○"We were able to run a toy car for only a short distance, even though it took a whole hour to charge it, so I understood how important it is to generate power. I won't leave the lights on anymore."

○"I learned that Japan emits a lot of exhaust gasses (greenhouse gasses). It is actually the fourth largest emitter in the world. I want to help to reduce CO_2 emissions."

(3) Ground heat

There are two major systems for ground heat use: 1) a ventilation system which uses a cool/heat trench, in which air cooled or heated by the trench installed in the building foundation is used for ventilation; and 2) a ground source heat pump system, which provides heat for air-conditioning (cooling/heating) and for hot water. The heat is taken from a heat pump system whose heat source is water from a ground heat exchange well whose water temperature is cooler than the ambient air in summer and warmer than the ambient air in winter. Because ground source heat pump systems release the exhaust heat from building air-conditioning deep underground, the systems help to ease the heat island phenomenon.

Typical systems that have been introduced into schools are shown below.

(a) System outline

Ventilation system which uses a cool/heat trench

Use for environmental education:	The installation of devices that allow coolness/heat to be felt and the effects to be visualized. (e.g.: the chance to feel cold/hot air, the use of display panels)
Applicability to conventional buildings by:	Underground trench or pit (or double floor) installed in an existing building.

The temperature of the cool/heat trench has almost no fluctuation, thanks to the ground heat. Air passed through the trench/pit at low speed is cooled/heated there and then blown into the rooms. The rooms are ventilated with air that is cooler than the ambient air in summer and warmer than the ambient air in winter.

The system can be effectively used in combination with other cooling/heating systems. Use of the air in trenches for air-conditioning reduces the ambient air load.

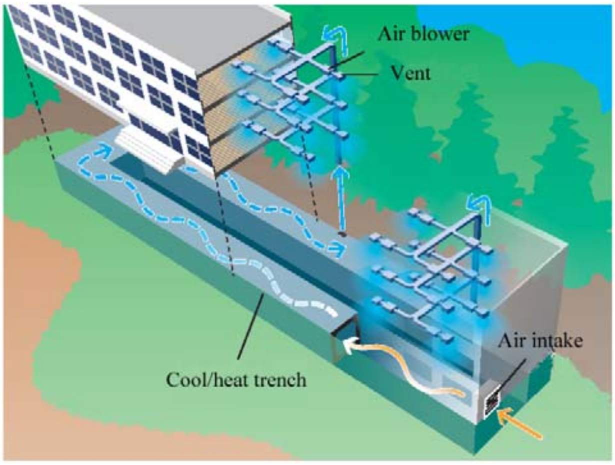
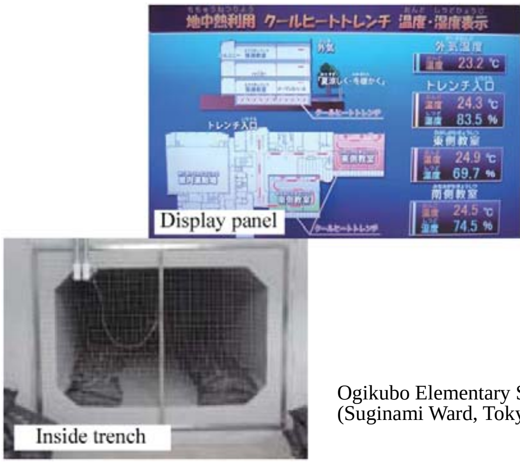


Fig.5 Schematic of a ventilation system which uses a cool/heat trench (summer operation)



Ogikubo Elementary School (Suginami Ward, Tokyo)

(b) Major devices

1) Cool/heat trench

Heat conducted from the ground keeps the temperature of the trench nearly uniform. During the time that the air flows at very low speed through the trench for a considerably long distance, the air is cooled or warmed.

2) Air blower

This blows the air in the cool/heat trench into the rooms.

(c) Items to be considered in designing and planning

Designing work is primarily contracted out to an architectural office. The following items are the main ones to be considered in the introduction of a ventilation system which uses a cool/heat trench. School establishers should understand the items so that they can request that architects include them in their analyses.

- Good methods of hygiene control for the air in the trench should be integrated into the design, because the air in the trench is directly supplied to the rooms. Such hygiene control methods include groundwater proofing, the drainage of condensation water and the installation of sterilization lamps to prevent mold and the like from growing.
- Confirmation is needed that the ventilation capacity of the system meets the total air volume of the rooms for which the system is used.

(a) System outline

Ground source heat pump system (water-type)

Use for environmental education:	The effects to be visualized (e.g.: the use of display panels)
Applicability to conventional buildings by:	Availability of land area where boreholes can be made for the wells

A heat-carrying medium, such as water, is circulated through a resinous U-pipe ground heat exchanger (or heat exchange well) that is 50 to 100 m deep. Because the temperature deep underground is stable throughout the year, the water circulating in the exchanger maintains almost the same temperature regardless of the season. The heat pump unit installed at ground level further raises/lowers the water temperature. The cooled/heated water is circulated through fan coil units for cooling/heating the building and heated water is also used for hot water supply.

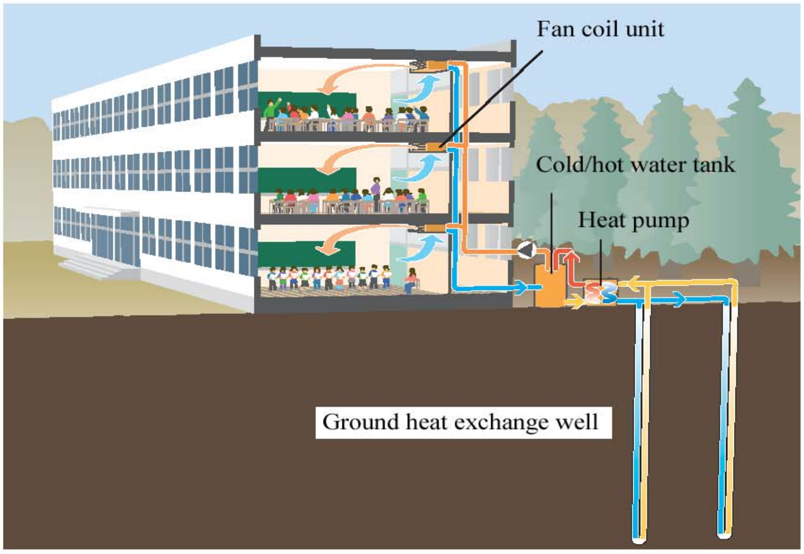
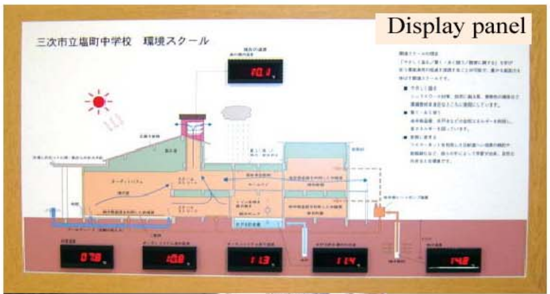


Fig.6 Schematic of ground source heat pump system



Shiomachi Junior High School (Miyoshi, Hiroshima Pref.)
(21 wells of 90 m in depth)

(b) Major devices

1) U-pipe ground heat exchanger

This is a pipe through which a heat-carrying medium, such as anti-freeze, is circulated to collect heat from the ground or to release exhaust heat from the heat pump into the ground.

2) Heat pump

This device transfers heat: It absorbs heat when the heat-carrying medium evaporates and emits heat when the heat-carrying medium condenses. The water that circulates inside the building is cooled/heated by a heat pump in which the heat exchangers conduct the cold/heat of the heat-carrying medium into the circulating water.

3) Cold/hot water tank

The water cooled/warmed by the heat pump is stored in a tank for cooling/heating the building.

4) Fan coil unit

This device circulates indoor air by blowing it with a fan, and it vents cooled/heated air.

(c) Items to be considered in designing and planning

Designing work is primarily contracted out to an architectural office. The following items are the main ones to be considered in the introduction of a ground source heat pump system. School establishers should understand the items so that they can request that architects include them in their analyses.

- Identify the land area where boreholes for the pipes of the heat exchanger can be installed.
- Decide the number and depth of the ground heat exchanger wells in light of the required cooling/heating capacity for air conditioning.
- Keep the distances between the ground heat exchangers and the heat pump to a minimum, for the efficient use of ground heat.

(4) Use of biomass energy (pellet stoves)

Biomass energy is derived from organic matter, i.e., matter from organisms, such as the cellular tissues of plants and animals and animal excreta. The use of plant-derived biomass energy is gaining attention, because it is considered carbon-neutral energy. Carbon emissions from biomass are viewed as part of the natural carbon cycle, in which the carbon is found in different molecules but carbon dioxide absorption and emission are in balance. Therefore carbon emissions from biomass are not regarded as adding to atmospheric concentrations of carbon dioxide.

(a) System outline

Pellet stoves

Use for environmental education:	The opportunity to experience the use of the stove and the effects to be visualized (e.g.: the chance to observe the stove in use, including input of fuel and cleaning of ash; and to feel the warmth from the stove)
Applicability to conventional buildings by:	Installation of air supply/exhaust stovepipes on the wall or chimney in the existing building

The fuel of pellet stoves is called pellets, which are bar-shaped particles created by compressing woodchips (from timber and branches) and tree bark and leaves. The stoves have two chambers: one for pellet storage and the other for combustion. A small amount of stored pellets is consecutively feed into the combustion chamber. This requires that the pellet stove use electricity. Most pellet stoves use electricity, which also enables automatic ignition at the press of a switch. The ease of use of pellet stoves is quite close to that of coal-fired stoves and kerosene heaters. The combustion efficiency is around 85-90%.

Carbon-neutral process of using pellet stoves

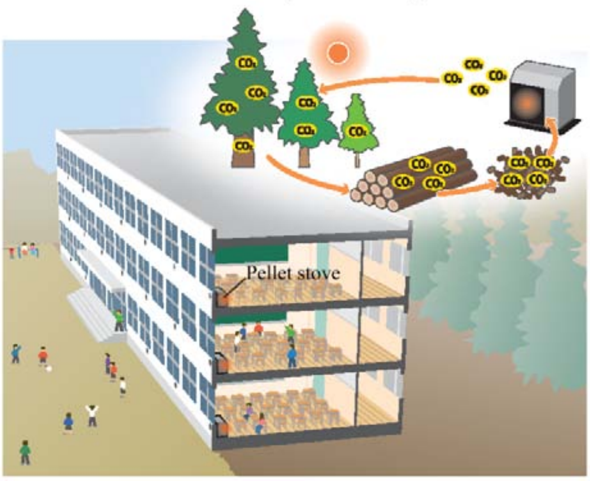


Fig.7 Pellet stoves using biomass energy

Mikata Junior High School (Wakasa, Fukui Pref.)
(FF stove* w. heating capacity of 12.8 kW)
*A forced draft balanced flue (FF) stove uses forced ventilation in a closed system. It achieves higher combustion efficiency than a chimney stove.

Because pellets are a combustible fuel, they need relatively large, fire-free storage.

Kaminaka Junior High School (Wakasa, Fukui Pref.)
(Chimney stove* w. heating capacity of 13.1 kW)
*A chimney stove naturally vents exhaust gas via a pipe. Its heating capacity is less than that of an FF stove.

(b) Major devices

1) Pellet stove

There are two types of pellet stove: a radiative heat type, which heats a room by raising the temperature of the stove itself, and a convection type, which blows out hot air.

<How to use the stoves>

- It's easy to turn them on/off. Just press the "On/Off" button.
- Temperature control and pellet supply are also automatic.
- It's easy to clean out the ash. You need to clean only the receiving plate. With increases in the use of these pellets, pellet stoves have made great strides in functionality and ease of use.

2) Pellets

These represent an effective use of unused scrap wood and wood residue from wood mills, including lumber remnants, tree bark and sawmill residue. Some wood pellets are identified by the species and part of the material trees. These are classified as "whole-tree cedar," for example

<Types of pellets>

Whole-tree pellets: Made from the whole tree, including the bark. The bark makes the pellets brown.

White pellets: Made from the whole tree, but without the bark. The color is whiter than other types, as the name suggests.

Bark pellets: Made of tree bark. The color is dark brown.

(c) Items to be considered in designing and planning

Designing work is primarily contracted out to an architectural office. The following items are the main ones to be considered in the introduction of a pellet stove. School establishers should understand the items so that they can request that architects include them in their analyses.

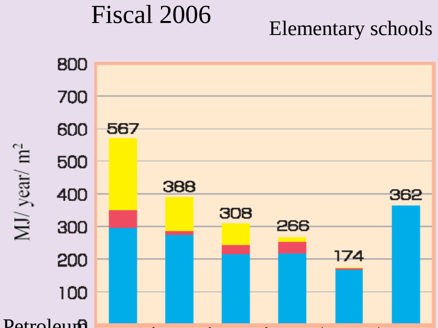
- ■A pellet stove needs to be equipped with either a chimney or ducts on the wall behind for forced ventilation. The compatibility of the chimneys and ducts that are installed in the building should be clarified.
- ■Because it is a combustion device, the safety of students should be secured by examining the activities that might be conducted in the room and determining stove installation locations accordingly.
- ■The storage location of the fuel pellets needs to be determined in light of the fuel supply route to each stove and the combustible nature of the fuel.
- ■The time taken to warm the room after the pellet stove is turned on is longer than for stoves using other fuel, such as kerosene. The installation locations of pellet stoves should be carefully considered, so as to avoid installation in rooms where on/off operation is frequent.

◆TOPICS◆ The state of energy consumption at school facilities

The National Institute for Educational Policy Research conducted a questionnaire survey in fiscal 2007 regarding energy consumption at schools nationwide. The results are shown below. It is shown that colder regions tend to use more energy than other regions, except those with the very hottest weather. Most of the energy consumed at school is in the form of electricity.

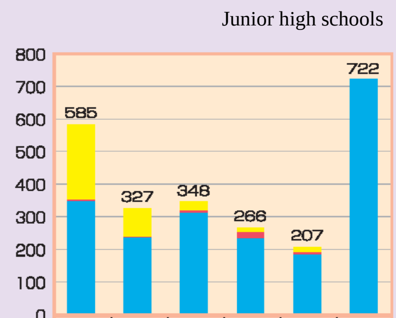
School facilities are among the facilities that are required to reduce CO_2 emissions. In light of this, it is critical to actively introduce into schools facilities that use New Energy, according to the current state of energy consumption at each school and in view of the optimum New Energy suitable to each specific region.

Fiscal 2006



	I	II	III	IV	V	VI
Petroleum	219	103	65	16	3	0
Oil	55	12	28	35	4	0
Electricity	294	274	215	216	167	362

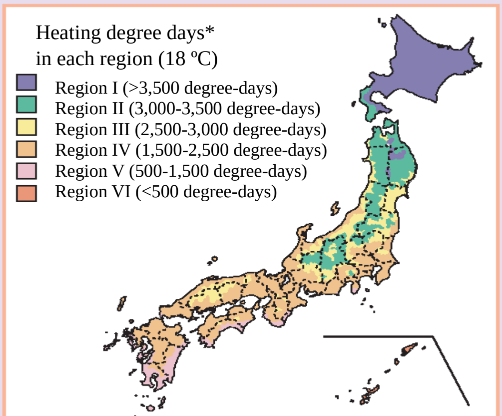
Data on 511 schools nationwide



	I	II	III	IV	V	VI
Petroleum	234	89	30	16	18	0
Oil	4	2	7	18	5	0
Electricity	347	235	310	233	184	722

Data on 211 schools nationwide

Primary energy consumption per floor area at elementary/junior high schools (MJ/year/m^2)
Regions I-VI: Areas classified by "heating degree days" shown on the right-hand map



*Heating degree days: A "heating degree day" is the absolute value of the difference between the average indoor temperature and the average outdoor temperature on a day when buildings needed to be heated. When the difference between the average indoor and outdoor temperatures on a day is 1 ºC, the heating degree day value is 1. In general, heating degree day refers to the total of heating degree days in a period when heating is needed.
Source: Japan Center for Climate Change Actions (http://www.jccca.org/)

(5) Other New Energy sources

In addition to the energy sources that have been introduced, the following New Energy sources could be introduced to school facilities. The suitability of a system using the New Energy source to the region and to the school should be carefully analyzed before the introduction of such an energy source.

(5-1) Use of snow-and-ice cryogenic energy

Snow-and-ice cryogenic energy systems store naturally frozen snow and ice until summer, when they're used as cryogenic energy sources. The cool air or snow/ice meltwater is used for air-conditioning.
Storage of snow/ice is necessary for the system. Typical systems that have been introduced into schools are shown below.

(a) System outline

Snow-cooling system (using snow meltwater)

Use for environmental education:	The installation of devices that allow the cold to be felt
Applicability to conventional buildings by:	Securing spaces for snow storage

In the snow-cooling system (using snow meltwater), stored snow is melted by adding water, and the snow meltwater is circulated by pumps through a heat exchanger where water for air-conditioning is cooled. Another fan coil unit exchanges heat between the cold water and the room air for air-conditioning.
In general, the snow meltwater that is warmed at the heat exchanger between the snow meltwater and the circulating water is re-used for melting stored snow and cycled as snow meltwater.

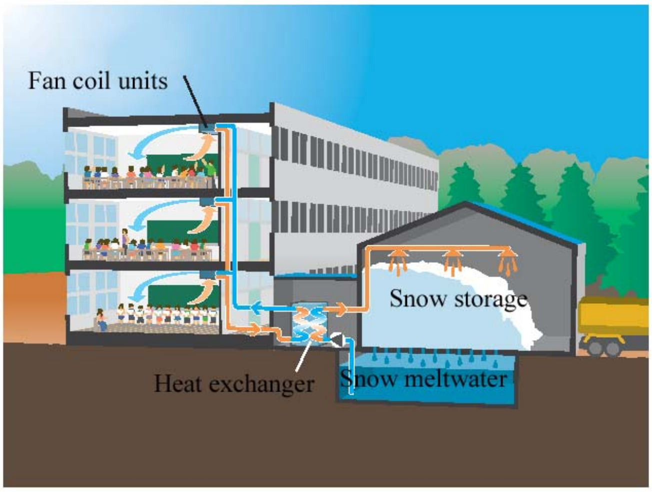


Fig.8 Schematic of snow-cooling system

Dumped snow

Yasuzuka Junior High School (Joestu, Niigata Pref.) w. snow storage capacity of 660 t.

(b) Major devices

1) Snow storage
Snow removed from roads by heavy machinery is kept in storage until needed.

2) Heat exchanger
In this device, cryogenic energy from cold snow meltwater is conducted to a medium used for room air-conditioning.

3) Fan coil units
This device consists of a blower and a heat exchanger, in which heat is exchanged between cold water and room air, and the cooled air is blown into rooms.

(5-2) Micro hydroelectric power generation

Micro hydroelectric power generation relies on water flow or small height differences in a river. As long as the flow can be maintained, electric power can be generated. The generated power is proportional to the head and the volume of water. Types of micro hydraulic power generation systems include one with overshot water turbines, one with submersible propeller turbines and one with undershot water turbines. Overshot water turbines are used when the head pressure is in the midrange; submersible turbines, with submerged propellers, and undershot water turbines are used when the head pressure is low. Typical systems that have been introduced into schools are shown below.

(a) System outline

Micro hydroelectric power generation

Use for environmental education:	The installation of devices that allow the water flow to be felt and the effects to be visualized (e.g.: observation of water turbines, use of display panels)
Applicability to conventional buildings by:	The availability of streams or waterways and space for the power generation system.

Electric power can be generated by installing undershot water turbines or overshot water turbines in streams or waterways with sufficient water flow or head. The kinetic energy of flowing water or the potential energy of the head drives these turbines, converting the energy into electric power at the generator. The generated power can be supplied to external lamps at the school site or applied to other uses.

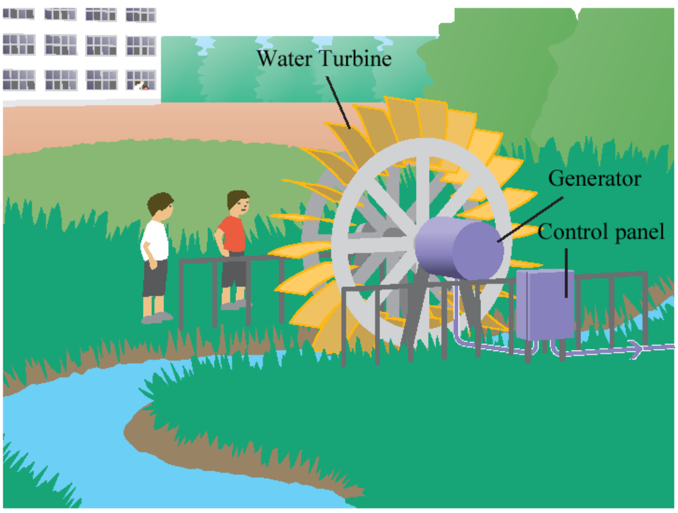
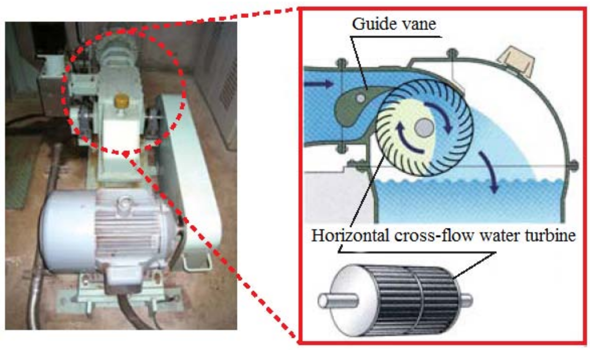


Fig.9 Schematic of micro hydroelectric power generation using an undershot water turbine

Hata Water Turbine (Hata, Nagano Pref.)
(Undershot water turbine: rated output of 0.8 kW)



Oooka Elementary School/ Oooka Junior High School (Nagano, Nagano Pref.)
(Inside the overshot water turbine: rated output of 6.7 kW)

(b) Major devices

1) Water turbine
The blades that receive the energy exerted by flowing water or by the impact of falling water

2) Generator
A device that generates power by converting the kinetic or potential energy of water, which rotates a turbine, into electric energy

Notes:
1. No application to the Ministry of Economy, Trade and Industry is needed for permission to install a micro hydroelectric power generation system when the system has an output of less than 10 kW and a voltage of less than 600 V, which is the typical scale of generator for a school.
2. When a river or the like is used from which water is drawn for the first time, an application for permission under the River Act is needed. Please consult the relevant section of the municipality or the river administrator.

(5-3) Fuel cells*

*Fuel cells are not regarded as New Energy sources.

Power is generated at a fuel cell unit that is installed on the premises, so there's not the power loss one sees in power transmission from the power plant to the site. Heat generated during power generation is used for water heating. All this makes fuel cells a highly energy efficient form of power generation.

For a given quantity of electricity and heat generated, fuel cells emit much less carbon dioxide than conventional energy sources do. In addition, fuel cell operation does not make noise or produce hazardous exhaust gases. Thus they're an eco-friendly power generation system. Below we show typical systems that have been introduced into schools.

(a) System outline

Power generation and hot water supply by fuel cells

Use for environmental education:	Effects to be visualized (e.g.: the use of display panels)
Applicability to conventional buildings by:	Availability of space in the building where fuel cell units can be installed

Fuel cells use a reformer to extract hydrogen from city gas, LP gas or kerosene. Then, using the oxygen in ambient air, a chemical reaction opposite to that of water electrolysis generates an electric current. An inverter converts this current to alternating current, which is supplied to room lighting and air conditioning via the distribution panel.
A heat collector gathers the heat generated when the fuel cells generate electricity to heat water. The warmed water is stored in a tank for hot water supply.

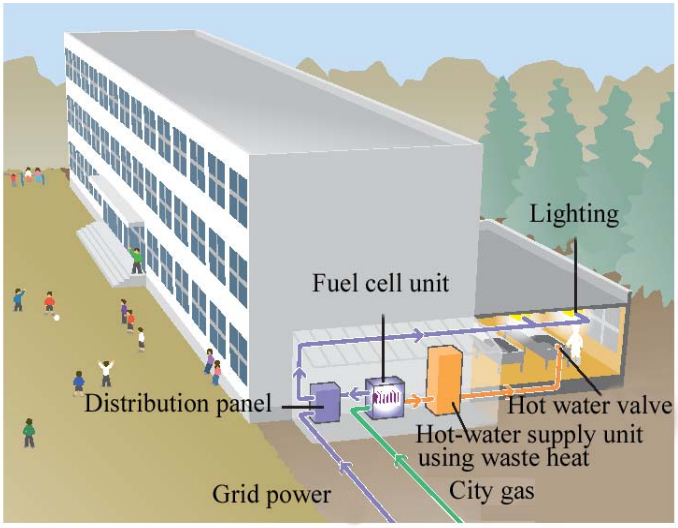
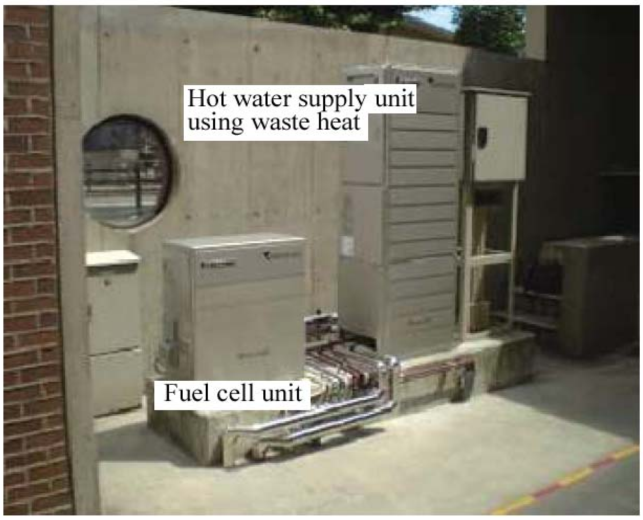


Fig.10 Schematic of a fuel cell system used at a school



Onoden Elementary School, Musashino City, Metropolitan Tokyo (Rated output: 1 kW)

(b) Major devices

1) Fuel cell unit

Reformer: Reforms city gas, LP gas or kerosene to obtain hydrogen.
Fuel cell: Reformed hydrogen and ambient-air oxygen are electrochemically reacted to form water, with negatively charged electrons creating an electrical current.
Inverter: Converts direct current to alternating current.

2) Hot-water supply unit using waste heat

Waste heat collector: Collects heat from the reformer and fuel cell body to heat water.
Hot water tank: Stores hot water and supplies it as needed.

3. Introduction to the Operation and Maintenance of New Energy Systems at School Facilities

When examining the feasibility of introducing New Energy systems to school facilities, it is highly recommended that procedures for their introduction be understood and that the schedule be followed. When applicability to conventional buildings is under review, careful consideration must be given to the construction schedule and the service life of the buildings, in order to determine whether the systems can operate for the long term.

Introduction procedures (flow)

Common procedures for introducing New Energy systems to school buildings are presented here. The deliberations are to be conducted along with consultations with the designing agent, the manufacturer and others before the project is adopted. The potential uses for environmental education should also be fully discussed.
It may also be the case that the installations are expected to serve as part of the municipality's action plan to counteract global warming or as part of the plan for introduction of New Energy systems.

Item	Deliberations and determination of the project	Implementation design	Installation works	Service commencement and usage for environmental education	Operation and maintenance
Implementer	School authority (The items in blue font below need to be discussed with the designing agent, the manufacturer and other parties.)	Designing agent	Construction agent	School	Manufacturer, expert agent, other parties
Description	·Awareness of advantages and effects of the installations ·Selection of a school for installation ·Budgeting (confirmation of subsidies programs) ·Confirmation of the outline of the installation schedule ·Surveys on natural conditions, such as insolation and wind ·Technical precautions in application to environmental education ·Visualization and hands-on experience of the installation effects ·Cost ·Installation sites, and the scale ·Systems and installations, etc.	·System designing and drawing formulation ·Construction planning ·Operation and maintenance planning	·Construction works · Adjustment through trial operation	·Inauguration of operations ·Usage for environmental education	·Regular inspections

Note: Confirmation on procedures required by municipal ordinances and the River Act is also required.

Relation between the New Energy systems and the local features

New Energy system	Relevant local features	Suitable local features	Remarks
Use of solar heat	Daylight hours, amount of insolation	Long daylight hours, high insolation	*Monthly Mean Solar Radiation Data throughout Japan* (NEDO) http://nedo.go.jp/library/index.html
Micro wind power generation	Wind conditions	A certain level of wind velocity maintained on a year-round basis	*Local Area Wind Energy Map* (NEDO) http://app2.infoc.nedo.go.jp/nedo/ index.html
Use of ground heat	Disparities between underground and atmospheric temperatures	Large disparities between underground and atmospheric temperatures	At approx. 5 m under the ground, an almost fixed temperature range is sustained, although it may be affected by the local annual mean temperature.
Use of biomass energy (pellet stoves)	Availability of pellets	Relatively ready availability of pellets	*Pellet Retailers Map* (Wood Pellet Promotion Conference) http://www.woodpellet.jp/wppc/ shop_list.asp
Use of snow-and-ice cryogenic energy	Amount of snowfall	Constant snowfall in winter	Annual Maximum Snow Depth (Mean values, 1971 – 2000; Japan Meteorological Agency) http://www.data.jma.go.jp/obd/stats/ data/mdrr/atlas/snow/snow_13.pdf
Micro hydroelectric power generation	Flow rate (head)	Existence of nearby rivers and water channels, high flow rate (high head)	N/A
Fuel cells	N/A	N/A	Suitable for facilities requiring constant hot water supply

Operation and maintenance work, and maintenance inspections

Operation and maintenance of New Energy systems is, in principle, to be regularly conducted by the contracted manufacturer or specialist. The school personnel and the authority carry out daily operational tasks, such as visual inspections and cleanups around the equipments. The service life of equipment is generally considered to be 10 to 30 years, depending on the duration of operation. Batteries for wind power generation usually require replacement every 3 - 6 years*.

*Source: Surveys on figures published by manufacturers

Installations at school facilities

(1) Solar heat, the energy source of the solar heat radiant air floor heating system, is also used for heating the swimming pool.

Outline of the system and the school

Adatara Elementary School, Nihonmatsu City, Fukushima Prefecture

- No. of classes (scale of the school): 5 classes
- Major devices (capacity, etc.): Solar heat radiant air floor heating system (area of heat collector: 934.5 m^2)
- Use of devices: For heating classroom buildings (area: 2,579 m^2) and swimming pool (area: 2,122 m^2)
- FY of installation: FY2004
- Total cost of solar heating equipment: Approx. 19 mil. yen

A panoramic view of the school, which uses solar thermal energy

Features

♦Systems installed

The solar heat radiant air floor heating system was introduced to classroom buildings and the gym. Furthermore, the air warmed by solar heat is transferred to a space under the water tank for the indoor swimming pool, which is on the floor below the gym. This makes the pool water warmer than the tap water.

♦Use for environmental education

Efforts are being made to enable students to naturally sense the blessings of the sun through physical contact with the system and to appreciate the importance of living in harmony with nature.

♦Evaluation

Before renovations, the wooden buildings experienced temperature disparities (uneven temperature distribution) in versus out of the classrooms, because stove heating was used in classrooms. After the system was introduced, no disparities in temperatures have been observed between classrooms and corridors, and the even thermal distribution has been providing comfortable air conditions.

A swimming pool that uses solar heat energy

(2) A gym installed with the solar heat radiant air floor heating system through eco-renovations

Outline of the system and the school

No.7 Haketa Elementary School, Arakawa Ward, Metropolitan Tokyo

- No. of classes (scale of the school): 12 classes
- Major devices (capacity, etc.): Solar heat radiant air floor heating system (area of heat collector: 63.5 m^2)
- Use of devices: For heating the gym (area: 530 m^2)
- FY of installation: FY2007
- Total cost of solar heat equipment: Approx. 16 mil. yen

The upper part of the gym, equipped with air ducts to carry the solar heated air under the floor

Features

♦Systems installed

Decrepit classroom buildings and the gym underwent environment-oriented renovations, under the framework of the School Eco-Renovation and Environmental Education Program of the Ministry of the Environment. A solar heat radiant air floor heating system and solar water heating were adopted in the gym. Toward reducing the construction costs, insulation work was implemented on existing roof claddings, upon which roof-mounting solar thermal collectors were installed.

♦Use for environmental education

Since the environment-oriented renovations were carried out while students were using the buildings, they could observe the details and progress of the renovations. The renovation operations themselves served as effective resources for environmental education during and after the renovations.

♦Evaluation

The gym is open to the community, and local residents other than students have also expressed satisfaction with the warm air conditions after renovations, in contrast to the frigid winter-time environments before the improvements.

The temperatures in attic, in the building and of the ambient air are displayed. This simple display can be used for teaching observation techniques.

(3) 24-hour ventilation with the ground-source air conditioning system

Kamaishi Junior High School, Kamaishi City, Iwate Prefecture

Outline of the system and the school

- No. of classes (scale of the school): 15 classes
- Major devices (capacity, etc.): Ground-source air-conditioning system (air volume: Approx. 10,000 m^3/h, ventilation rate: 0.7 times/h)
- Use of devices: For heating and air conditioning the classroom buildings (area: 6,392 m^2) and gym (area: 1,556 m^2)
- FY of installation: FY2006

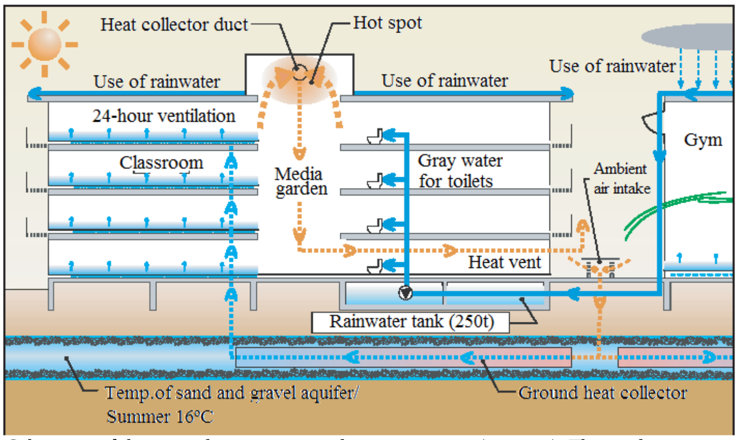

Corridors warmed by ground heat.


Intake ducts for heat recovery at the top of the building

Features

♦Systems installed

Based on the concept of creating a school whose agenda includes harmony with the environment, 24-hour ventilation by the ground-source air conditioning system, and rainfall utilization, have been put into practice. The 24-hour ventilation uses the ground heat from the sand-gravel aquifer whose temperature is stable year around. In summer, ambient air whose temperature is higher than the ground temperature is cooled by the ground; in winter, the opposite takes place. This reduces the heating/cooling loads. In winter, a heat storage heater that uses midnight power is applied in addition to the ground-source air conditioning system.



Schematic of the ground-source air-conditioning system (summer). The sand and gravel aquifer is about 3 m under the ground

♦Use for environmental education

The system embodies the school agenda of harmony with nature and other objectives, and has made the school into a community-based educational facility.

♦Evaluation

Fresh air influx after 24-hour heat exchange creates excellent classroom environments, particularly at the beginning of the day.

(4) A ground-source air-conditioning system used as a resource for environmental education

Kiyosato Nanohana Preschool, Takashima City, Shiga Prefecture

Outline of the system and the school

- No. of classes (scale of the school): 10 classes
- Major devices (capacity, etc.):
  Ground-source air-conditioning system (air volume: 300 m^3/h, ventilation rate: Approx. 3 times/h)
- Use of devices: For heating and air conditioning the school building (area: 3,296 m^2)
- FY of installation: FY2005
- Total cost of ground-source air-conditioning equipment: Approx. 43 mil. yen

The ground-source heat ducts at the entrance of the school building are partially transparent, so that the airflow can been seen by the movement of tape strips.

Features

♦Systems installed

The renovations of the old decrepit buildings incorporated a ventilation system using ground heat, photovoltaic power, solar water heating, and other eco-friendly devices, such as light ducts for sunshine lighting and the double layered roof for heat absorption.
For the ground-source air-conditioning system, 44 ground-source heat pipes were installed at a depth of 4.5 m. This system can carry out heat exchange with the cool heat of well water in summer.

♦Use for environmental education

The facilities have been developed in consideration of environmental education. Toward having students feel the benefits of devices by having them see their effects, the school has been making various efforts in environmental education, such as installing transparent ducts, setting up display panels and presenting the properties of light by prismatic projection into the corridors.

♦Evaluation

The students have a very comfortable school life, as no temperature differences are felt when they move between the classrooms and the corridors.

A photovoltaic power generation system has been installed, as have many eco-friendly devices, including the solar water heating system.

The display panel at the entrance outlines the system configuration. This facility features numerous of devices for environmental education.

(5) A snow cooling system whose power is obtained photovoltaically

Yasuzuka Junior High School, Joestu City, Niigata Prefecture

Outline of the system and the school

- No. of classes (scale of the school): 4 classes
- Major devices (capacity, etc.): Snow cooling system (snow storage capacity: 660 t) Photovoltaic power generation: 30 kW)
- Use of devices: For cooling all rooms in the buildings (area: 3,182 m^2)
- FY of installation: FY2003
- Total cost of snow cooling system installation: Approx. 50 mil. yen (Additional information: Total cost of photovoltaic power generation equipments: Approx. 30 mil. yen)

An indoor gym equipped with photovoltaic power generation (left). The snow storage (right)

Features

♦Systems installed

Along with major renovations, photovoltaic power generation and a snow cooling system were jointly applied, with assistance from the NEDO Project for Promoting the Local Introduction of New Energy. The snow cooling system uses the snow that accumulates during winter as cryogenic energy for summertime cooling. The power generated photovoltaically (30 kW) is used to drive snowmelt circulation pumps and the fans.
Snow is delivered to snow storage by the city, and operation and maintenance are collaboratively done by the City of Joetsu and the Snowman Foundation.

Snow delivery into the storage

♦Use for environmental education

Comprehensive energy and environmental education, including that on the snow cooling system, has been provided during individual subject classes and comprehensive learning classes. Collaborations with parents, local residents and experts have been proactively made, which has led to the establishment of a unified community scheme for environmental education.

An outlet for the snow cooling system in the classroom; a ceiling fan coil unit

(6) Micro hydroelectric power generation utilizing a check dam near the school

Ohoka Elementary and Junior High Schools, Nagano City, Nagano Pref.

Outline of the system and the school

- No. of classes (scale of the school): 6 elementary school classes, 3 junior high school classes
- Major devices (capacity, etc.): Micro hydroelectric power generation (rated output: 6.7 kW)
- Use of devices: For power supply to all the of the elementary school buildings (area: 2,133 m^2) and junior high schools (area: 1,953 m^2)
- FY of installation: FY2007
- Total cost of micro hydroelectric power generation equipment: Approx. 20 mil. yen

Micro hydroelectric power generation facility (right) Check dam (left). The system uses the potential energy that derives from the head.

Features

♦Systems installed

Assisted by the NEDO Project for Promoting the Local Introduction of New Energy, a micro hydroelectric power generation system was installed in the existing check dam. After discussions the community decided to supply the power to elementary and junior high schools in Ohoka. The power output accounts for about 16% of the power demand of these schools (FY2008). The surplus power generated during nights and extended holidays is sold to the power company. A particularly significant feature is that the school is offering collaborative assistance to the NEDO program implemented by the city: The environmental department of the city is responsible for facility management, such as maintenance of the generator and electric cables; the school operates and uses the system.

♦Use for environmental education

Micro hydroelectric power generation is a topic in classes of comprehensive learning in the first year of junior high school; the mechanism of power generation mechanism, power output and energy saving effects have been studied, and facility observations have been conducted.

Learning about the power generation mechanism during observation of micro hydroelectric power generation

A turbine and a generator

(7) The nation’s first elementary school to introduce residential fuel cells

Ohnoden Elementary School, Musashino City, Metropolitan Tokyo

Outline of the system and the school

- ●No. of classes (scale of the school): 24 classes
- ●Major devices (capacity, etc.): Fuel cells (rated output: 1kW, hot water tank capacity: 200 L)
- ●Use of devices: For hot water supply to the adjacent school lunch center and the lunchroom of the school; for power supply for lights within the school
- ●FY of installation: FY2005
- ●Total cost of fuel cell systems: Approx. 12 mil. yen

The entire fuel cell system installed at the elementary school

Features

♦Systems installed

When the decrepit school buildings were renovated, photovoltaic power generation and fuel cells were introduced. This is the nation’s first case of a municipality introducing residential fuel cells.
The generated power is used for lighting at the school. A water heating system that uses waste heat supplies hot water to the lunchroom and elsewhere within the school buildings, as well as to the neighboring municipal school lunch center.

♦Use for environmental education

Displays to provide current output and easily understandable explanations on power generation and the mechanism of fuel cells are actively employed in environmental education. In addition, the fuel cell system can be observed freely through the east gate of the elementary school, which is adjacent to explanatory panels on the system mechanism. In this way, efforts to create an environment-oriented school are actively publicized to the community.

The system can be observed through the east gate of the school. The neighboring panels provide clear explanations on the system mechanism and benefits.

(1) Solar heat, the energy source of the solar heat radiant air floor heating system, is also used for heating the swimming pool.

Actions of the municipalities

(1) Along with its proactive introduction, micro wind power generation effectively used for environmental education

Kyoto City, Kyoto Prefecture

Outline

- ●No. of schools: About 180 schools (Approx. 70% of all public elementary and junior high schools)
- ●Major devices (capacity, etc.): Hybrid micro wind power generation (approx. 460 - 1,160 W/school)
- ●Use of devices: Use of the power is limited to prominent locations within the school buildings.
- ●FY of installation: FY2005 - present
- ●Total cost of micro wind power generation (per school): Approx. 0.8 mil. - 3 mil. yen

At Takeda Elementary School, the power produced by wind power generation is used to drive miniature trains arranged near the entrance, for enjoyable learning.

Features

♦Background of actions

In February 2004, the Kyoto Children Environment Forum took place, offering an opportunity for students to present their research on the environment. The agenda was wind power generation, and the presentations addressed core issues, which also impressed the adults, including those from the board of education.
This occasion motivated the City of Kyoto to proactively adopt wind turbines for environmental education.

♦Creative approaches to designing installations

Each school made efforts to visualize the generated power: The power is used to drive mechanisms at prominent places, such as water tank pumps, LCD TVs for announcements, the sensor-activated lighting system and miniature trains displayed at the entrance for fun-filled learning.

♦Use for environmental education

The entire community, particularly the students, is actively practicing environment-related actions, as their awareness of environmental issues has been raised.

On the rooftop of Yotoku Elementary School, explanations on the mechanism of wind power generation are provided to students.

At Yotoku Elementary School, the produced power is applied as pumping energy for the water tanks in Yotoku Aquarium, on the 1st floor.

(2) Efforts to introduce pellet stoves to all elementary and junior high schools

Wakasa Town, Mikata Kaminaka-gun, Fukui Prefecture

Outline

- No. of schools: 11 elementary schools, 3 junior high schools
- Major devices (capacity, etc.): pellet stoves (made from biomass) (heating capacity/stove: approx. 2.3 - 14.0 kW)
- Use of devices: For many installations at lunch rooms, and in some infirmaries, special and regular classrooms, depending on the school.
- FY of installation: FY2005 - FY2008
- Total cost of pellet stoves (per stove): Approx. 0.4 mil. - 0.5 mil. yen

At Mikata Junior High School, all regular classrooms are equipped with a pellet stove.

Features

♦Background of actions

The Wakasa Town government adopted the “biomass town” plan in 2006 and commenced activities aiming for a recycle-oriented society. The entire town is promoting the use of pellet stoves.

In light of this, pellet stoves were introduced at all municipal elementary and junior high schools, since a school, as a public facility, can be used for environmental education and plays an important role in transmitting information to the community.

At Kaminaka Junior High School, pellets are stored under the stairs.

♦Creative approaches to designing installations

Observations of actual equipment and experiences that provide for the physical sensation of heat generated from pellets can contribute to environmental education by themselves, but the refilling of fuel pellets and removal of ashes are also undertaken by students as part of environmental education at many schools.

♦Use for environmental education

Collaboration with the community is active, as seen in the fact that observation programs take place at a pellet plant in Wakasa Town, where students can experience log splitting during pellet processing. Environmental education sessions by experts are also actively offered, which shows the established awareness and framework in the entire community for environmental education.

A pellet stove filled with fuel

(3) An approach to introducing different New Energy systems at all municipal elementary schools in the region

Tajiri Area (former Tajiri Town), Osaki City, Miyagi Prefecture

Outline

- No. of schools: 3 schools (former Tajiri Town)
- Major devices (capacity, etc.):
  - ･Solar water heater (area of heat collector: 1.56 m^2; capacity of hot water tank: 80 L)
  - ･Photovoltaic power generation (3.0 kW)
  - ･Hybrid micro wind power generation (Wind power 27 W X 3; 72 W X 2. Photovoltaic power 110 W)
- FY of installation: FY2004
- Total cost of equipment:
  Micro wind power generation: Approx. 7.6 mil. yen
  Use of solar heat: Approx. 3.9 mil. yen
  Photovoltaic power generation: Approx. 5.3 mil. yen

An installed micro wind power generation device serves as a symbol of the school. (Tajiri Elementary School, Osaki City, Miyagi Pref.)

Features

♦Background of actions

The former Town of Tajiri, which merged into Osaki City in 2006, formulated a regional New Energy vision in February 2004, for the purpose of promoting environmental education, New Energy sources and energy conservation. The vision aims to enhance understanding of New Energy by offering new learning activities at schools that use the New Energy systems installed in the region.

♦Creative approaches to designing installations

The former Tajiri Town government has installed New Energy equipment in every municipal elementary school, in order to raise community awareness.

♦Use for environmental education

A system for enhancing students' spontaneous understanding of New Energy has been formulated, but development of an organization to maintain the system is an issue.

Hot water produced by the solar water heater is used in showers at the swimming pool. (Onuki Elementary School, Osaki City, Miyagi Pref.)

A photovoltaic power generation system was installed on the school rooftop. (Numabe Elementary School, Osaki City, Miyagi Pref.)

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