In order to achieve LEHVE design, it is extremely important to quantitatively and comprehensively determine the effectiveness of individual technologies described above. This chapter provides methods for estimating the energy saving effects and costs that can be utilized for determining the effectiveness of these technologies under such prerequisites as occupant lifestyle, types of housing and local conditions. Please use these as tools for predicting the effectiveness of your design plans.

6

Chapter 6 : Energy Saving Effect Evaluation and its Utilization in Design

6

Chapter 6
Energy Saving Effect Evaluation and its Utilization in Design

6.1 Energy Saving Effect Using Elemental Technologies and Calculation Method

6.1.1 Summary of Energy Saving Effect Using Elemental Technologies

1. Necessity of information on energy saving effect and its quantification

Information on energy reduction effects is extremely important not only for those who practice housing construction but also homeowners and occupants, manufactures who provide technologies in the form of products, parties engaged in the energy business, national and local governments about to implement measures to prevent global warming, and other public agencies when making decisions on various matters. Now that the Kyoto Protocol's commitment period for reducing green house gas emissions has started, neutral yet trustworthy information on energy saving effects is needed since it provides guidelines when determining what the truly effective energy saving measures are and which method of which elemental technology should the limited funds be used for. In addition, we can say that such information has not been made available despite the fact that it has been eagerly demanded by society since the oil crisis of 1973. The lack of trustworthy information on reduction effects means that the reduction of utility costs through energy saving measures, i.e. economic benefits, is not clear. This also means that the acceptable degree of the increase in initial costs that occurs during the energy saving measures has been unclear to this date. The information on the reduction effect listed in this document is not necessarily complete. We are required to continue research that offers a wider range of application with improved precision.

Unlike roads and dams, most of buildings are built by the private sector, as is equipment used for buildings. However, most of the technologies, which are related to energy performance (low carbon performance) and are required for future buildings (including non-residential buildings), can be shared as public technologies by the private sector. Even if the construction of each building is a private activity, technologies used for energy performance can be recognized as public technologies. This also applies to earthquake resistance and fire protection capacity performance, the improvement of which is made compulsory by the Building Standards Act. With regard to the evaluation of elemental technologies related to energy conservation, which can be considered as public technology, it is necessary to implement it under certain rules from now on.

2. Elemental technologies and energy saving effect through their use

Chapter 1 in this document talked about the definition of low energy housing with validated effectiveness and why its design guidelines are necessary, and Chapter 2 described the flow of design method and matters to consider. Chapter 3 onward focused on the 13 elemental technologies for energy conservation (Table 1) and presented estimated values, using reduction rates (%), for how much energy saving effect can be achieved through the use of methods related to each elemental technology. In this chapter, we will describe the details of Step iv. Analyzing design models and verifying their effectiveness (Fig. 1 Design flow of low energy housing with validated effectiveness in Chapter 2 on p.021), which uses quantitative information related to energy saving effect.

Table 1 Elemental technologies discussed in this document

		Field of thermal environment	Field of air environment	Field of light environment	Other
Natural energy application technology	Technology that replaces fuel energy with natural energy such as wind, solar heat, sunlight	Use of solar radiation heat (Solar heat utilization 1) Solar water heating (Solar heat utilization 2)	Use/control of wind	Daylight utilization (Sunlight utilization 1) Photovoltaic power generation (Sunlight utilization 2)	
Heat control technology of building envelopes	Technology that controls heat transfer and maintains an appropriate indoor environment using architectural solutions for building envelopes including insulation and solar shading	Insulated building envelope planning Solar shading method			
Energy-efficient equipment technology	Technology that uses select energy efficient equipment and systems, reduces energy, and increases comfort	Cooling/heating system planning Domestic hot water system planning	Ventilation system planning	Lighting system planning	Introduction of high-efficiency consumer electronics Treatment and efficient use of water and kitchen waste

The reduction rates listed in Chapter 3, 4 and 5 are based on average design details as of 2000 (design details indicated as "level 0" in sections of each elemental technology) as well as on energy consumption that occurs in the lifestyle pattern considered as most typical. The following are the two major reasons for having hardly any opportunities for information related to energy saving effects as presented in this document as presented in this document: a lack of sufficient knowledge on factors that cause a large influence on energy consumption in buildings including houses, and the possibility that energy saving effects vary under different lifestyle pattern conditions. While knowledge has accumulated thanks to the advancement of field studies on energy consumption and lifestyle and the implementation of validation experiments, the disadvantages of avoiding the presentation of energy saving effects, with the latter reason as an excuse, have been increasing seriously. Therefore, the "Design Guidelines for Low Energy Housing with Validated Effectiveness" set given conditions for housing forms and living pattern and put together design methods and elemental technologies, of which effectiveness is expressed by energy consumption reduction rates.

Design methods based on numerical values under such given conditions also have disadvantages. To put it simply, there may be large errors in energy saving effects under conditions other than the given conditions. For example, if the number of family members is different or the hours for being at home are long, it is expected that there will be some difference in the degree of energy consumption and energy saving effects among elemental technologies compared to those for a family of four, a given condition set in this document. However, if asked whether there is such a thing as quantitative information that takes into consideration all design conditions, the answer is "No". While so-called simulation allows us to do a lot of calculation on paper by assuming various cases, it is not easy to accurately reflect the actual performance of specific equipment at this point.

Table 2 shows assumed numerical values based on "average design details as of 2000 and energy consumption that occurs in the lifestyle pattern considered as most typical" mentioned earlier. Total consumption based on primary energy conversion and composition by use are determined according to the results of field studies and validation experiments. In this document, we call these numerical values "reference energy consumption". Reference energy consumption varies depending on regions and heating and cooling system types.

Table 2 Reference energy consumption as of 2000

Use of energy	Zone VI (Naha)		Zone V (Kagoshima)			
			Partial intermittent heating and cooling		Whole-building continuous heating and cooling	
Cooling	10.3 GJ	(15.5%)	5.7 GJ	(8.3%)	27.1 GJ	(27.0%)
Heating	0 GJ	(0.0%)	5.0 GJ	(7.3%)	13.4 GJ	(13.3%)
Ventilation	3.1 GJ	(4.7%)	3.1 GJ	(4.5%)	4.7 GJ	(4.7%)
Domestic hot water	13.8 GJ	(20.7%)	19.2 GJ	(28.0%)	19.2 GJ	(19.1%)
Lighting	13.6 GJ	(20.4%)	11.3 GJ	(16.5%)	11.3 GJ	(11.2%)
Consumer electronics	21.4 GJ	(32.1%)	19.9 GJ	(29.0%)	20.4 GJ	(20.3%)
Cooking	4.4 GJ	(6.6%)	4.4 GJ	(6.4%)	4.4 GJ	(4.4%)
Total	66.6 GJ	(100%)	68.6 GJ	(100%)	100.5 GJ	(100%)

* Reference energy consumption for "ventilation" indicates values in a duct system. As for the values in a through-the-wall system, see Table 3 on p.340 and Table 4 on p.341.

In the meantime, with regard to the energy consumption reduction effect gained through the use of various elemental technologies for energy conservation and related methods, Table 3 and Table 4 show the summary of what was described in Chapter 3, 4 and 5. However, the numerical values indicating energy saving effect in Table 3 and Table 4 are presented in the form of “energy consumption ratio”, which has a simple relationship with reduction rate as shown in the following formula, so that calculation of energy consumption after reduction becomes easier. In addition, as for photovoltaic power generation, instead of using rates, we convert power generation that corresponds to the capacity of solar cells installed in a house into primary energy. Values obtained through this are subtracted from the entire energy consumption of the house.

Energy consumption ratio = (100 – energy consumption reduction rate (%)) × 1/100

Table 3 Energy reduction effect through use of elemental technologies (Zone VI: Naha)

Usage	Reference energy consumption	Elemental technology		Energy consumption ratio (Reference value considered to be 1.0)			
				Level 1	Level 2	Level 3	Level 4
Cooling	11.0GJ	Use and control of wind		0.96	0.91	0.88	
		Solar shading method		0.9	0.8	0.75	0.7
		Cooling system planning		0.9	0.8	0.75	0.65
Ventilation	3.1GJ*1	Ventilation system planning	Duct type[1]	0.7	0.5		
	2.8GJ*2		Through-the-wall[2]	0.8			
Domestic hot water	13.8GJ	Solar water heating		0.9	0.7	0.5	0.3
		Hot water system planning		0.9	0.8	—	0.6
Lighting	13.6GJ	Daylight utilization		0.97～0.98	0.95	0.9	
		Lighting system planning		0.85	0.8	0.7	
Consumer electronics	21.4GJ	Introducing high-efficiency consumer electronics		0.8	0.6		
Other (cooking)	4.4GJ	—					
Total	66.6GJ	—					
	66.3GJ						
Power		Photovoltaic power generation		33.7GJ reduction	45.0GJ reduction		

■Special Comments
- Reference energy consumption and the energy consumption ratio are set according to ventilation system types. The values in the upper cells (1) in the ventilation" and total" sections are for duct systems, and the values in the lower cells (2) are for through-the-wall ventilation systems.
- In regard to energy consumption in other (cooking)", since there are no significant differences among devices, only reference energy consumption is set.
- Power" is indicated in the form of amount of annual primary energy consumption reduction (power generation) that is estimated based on the capacity of solar cells installed. Values in the table above are the estimated values in Naha (See Section 3.3 Photovoltaic Power Generation).
- Section 5.7 Treatment and Efficient Use of Water and Kitchen Waste discussed in Chapter 5 are not included in this table.

Table 4 Energy reduction effect through use of elemental technologies (Zone V: Kagoshima)

Usage	Reference energy consumption	Elemental technology		Energy consumption ratio (Reference value considered to be 1.0) Level 1	Level 2	Level 3	Level 4
Cooling	5.7GJ (27.1GJ)	Use and control of wind		0.95	0.88	0.82	
		Solar shading method	South-facing	0.85	0.7	0.55	
			Southeast/ southwest-facing	0.8	0.75	0.65	
			East/west-facing	0.8	0.75	0.65	
		Heating and cooling system planning (cooling)	Partial intermittent cooling	0.95	0.9 / 0.85	0.8 / 0.75	0.7 / 0.65
			Whole-building continuous cooling	0.75	0.6		
Heating	5.0GJ (13.4GJ)	Insulated building envelope planning	Partial intermittent heating	0.7	0.5	0.45	0.35
			Whole-building continuous heating	0.6	0.5	0.4	0.3
		Use of solar radiation heat (requires insulated building envelope planning of at least Level 3)		0.95	0.9	0.8	0.6
		Heating and cooling system planning (heating)	Partial intermittent heating	0.95	0.9 / 0.85	0.8 / 0.75	0.7
			Whole-building continuous heating	0.8	0.55		
Ventilation	3.1GJ*1 (4.7 GJ)	Ventilation system planning	Duct type[1]	0.7	0.5		
	1.0GJ*2		Through-the-wall[2]	0.8			
Domestic hot water	19.2GJ	Solar water heating		0.9	0.7	0.5	0.3
		Hot water system planning		0.9	0.8	0.7	0.6
Lighting	11.3GJ	Daylight utilization		0.97 ～ 0.98	0.95	0.9	
		Lighting system planning		0.7	0.6	0.5	
Consumer electronics	19.9GJ (20.4GJ)	Introducing high-efficiency consumer electronics		0.8	0.6		
Other (cooking)	4.4GJ	—					
Total	68.6GJ (100.5GJ)	—					
	66.5GJ						

Power		Photovoltaic power generation	32.7GJ reduction	43.6GJ reduction

■Special Comments

- For the reference energy consumption in heating", cooling", ventilation" and consumer electronics", two types of values are listed according to heating and cooling operation systems. The values in the upper cells correspond to the consumption under the partial intermittent heating and cooling system, and the values in brackets in the lower cells correspond to the consumption under the whole-building continuous heating and cooling system.
- For the insulated building envelope planning, energy consumption ratios are set to correspond to heating and cooling operations systems.
- For solar heat utilization aimed at space heating, in order to adopt Level 1 or higher, it is necessary that the level of the insulated building envelope planning is 3 or higher.
- The partial intermittent heating and cooling system in the table above shows values for air conditioners only. For air conditioners for cooling, level 2⁻ (energy consumption ratio: 0.9), level 3⁻ (0.8) and level 4⁻ (0.7) are set. Level 2⁻ (0.9) and level 3⁻ (0.8) are set for air conditioners for heating.
- For ventilation", reference energy consumption and energy consumption ratio are set according to ventilation system types. The values in the upper cells (1) in the ventilation" and total" sections are for duct systems, and the values in the lower cells (2) are for through-the-wall ventilation systems.
- In regard to energy consumption in other (cooking)", since there are no significant differences among devices, only reference energy consumption is set.
- Power" is indicated in the form of amount of annual primary energy consumption reduction (power generation) that is estimated based on the capacity of solar cells installed. Values in the table above are the estimated values in Kagoshima (See Section 3.3 Photovoltaic Power Generation).
- Section 5.7 Treatment and Efficient Use of Water and Kitchen Waste discussed in Chapter 5 are not included in this table.

6.1.2 Given Conditions Related to Determination of Energy Saving Effect

Information on energy saving effect, which is a basis for the method of designing LEHVE, is the result of evaluation implemented under certain given conditions. Such given conditions are set while considering the factors listed in Table 5.

Table 5 Given conditions common to all evaluations

Items		Conditions	
		Zone VI	Zone V
Construction site region		Naha (suburb)	Kagoshima (suburb)
Building site size		430 m² (4,628 ft²)	210 m² (2,260 ft²)
Building conditions	Structure	Reinforced concrete	Post-and-beam construction
	Number of stories	One-storey house	Two-storey house
	Exterior finish	Roof: Concrete with paint finish Exterior wall: Same as above Opening: Aluminum sash	Roof: Metal sheet roofing Exterior wall: Cement siding Opening: Aluminum sash
	Interior finish	Roof/wall: Plaster board with cloth finish Floor: Flooring/partial *tatami* mat finish	Roof/wall: Plasterboard/vinyl clothing Floor: Flooring/partial *tatami* mat finish
Living conditions	Family structure	4 people (husband and wife with two children) Householder: 45-year old (company employee) Wife: 42-year old (full-time homemaker) Daughter: 17-year old (high school student) Son: 15-year old (junior high school student)	Same as left
	Life style	Assume average use of time according to nationwide survey	Same as left
	Indoor set temperature	28°C during summer (while cooling is used)	28°C during summer and 18°C during winter (while cooling and heating is used)
	Heating and cooling usage time slot	See Table 5; Supplementary Fig. 1	Same as left
	Hot water usage amount	Table b and figure in Section 5.4 Domestic Hot Water System Planning on p.273 .	Same as left
	Use of lighting device	See Table 5; Supplementary Table 1	Same as left
	Use of consumer electronics	See Table 5; Supplementary Table 2	Same as left

In addition, most of the evaluations were conducted by using a model house plan established under the given conditions listed above.

The model house plan will be described in the next chapter onward. Two types, a general model (Type A) and a model that pays some consideration to the use of natural energy (Type B), are set up for both Zone VI and Zone V.

Table 5; Supplementary Fig 1　Conditions for heating and cooling usage time slot (Partial intermittent heating and cooling)

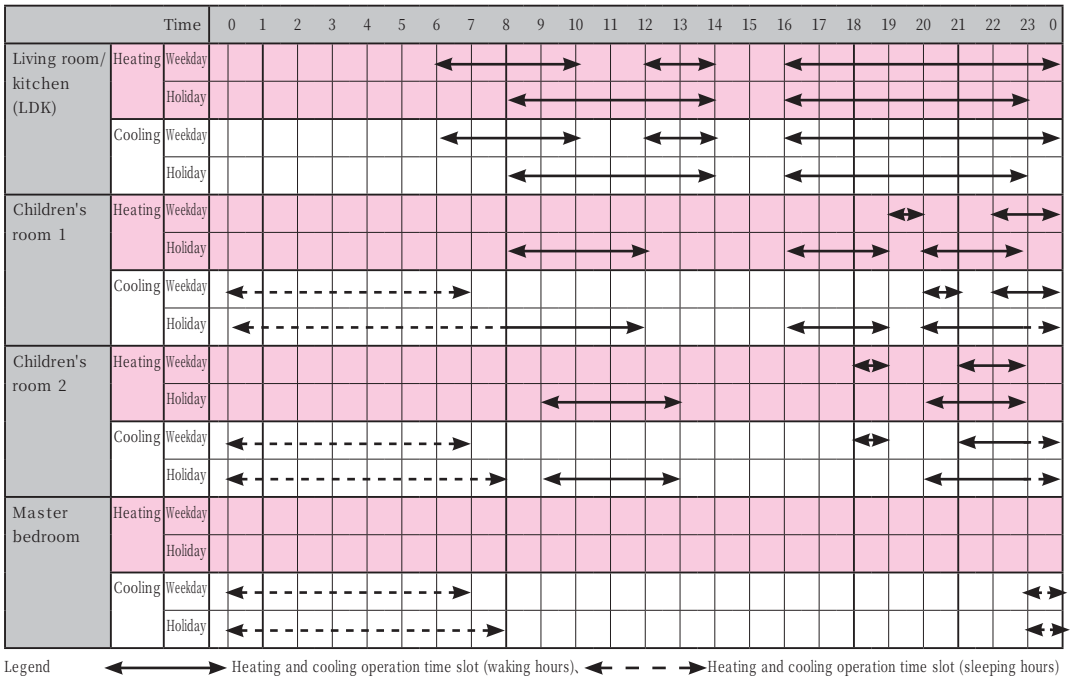


Table 5; Supplementary Table 1　Conditions for use of lighting device (Energy saving method not applied)

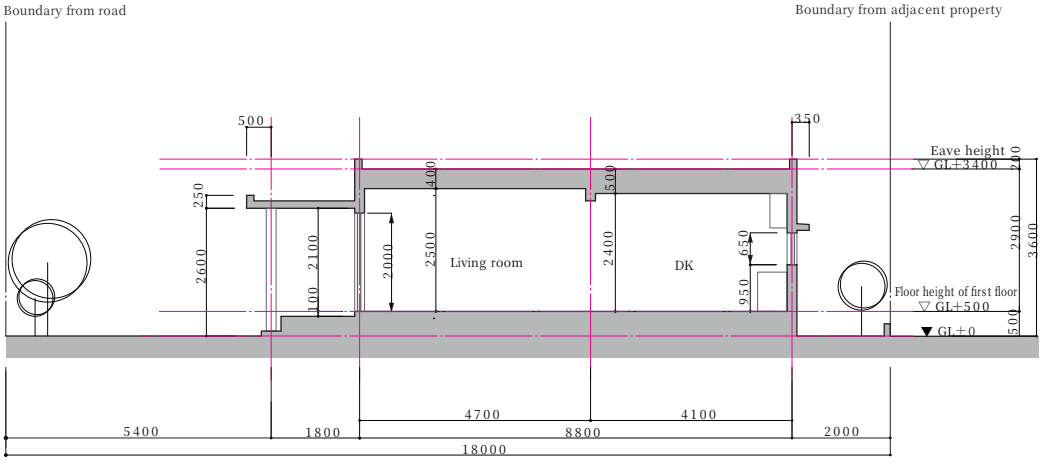
Usage location	Types of devices/lamps		Quantity (unit)	Wattage (W/unit)	Weekday		Holiday (staying home)		Holiday (away from home)	
					Switch-on time (time/day)	Power consumption (kWh/day)	Switch-on time (time/day)	Power consumption (kWh/day)	Switch-on time (time/day)	Power consumption (kWh/day)
Entrance porch	Ceiling	Mini krypton bulb	1	54	2.250	0.122	0.5	0.027	1	0.054
Hallway, corridor	Ceiling	Ring FL	1	27	0.333	0.009	1.25	0.034	0.5	0.014
	Down light	Mini krypton bulb	2	54	7.500	0.810	2	0.216	2.75	0.297
First floor toilet	Down light	Mini krypton bulb	1	54	1.417	0.077	3	0.162	1.5	0.081
Washing room	Ceiling	Ring FL	1	27	2.000	0.054	2.5	0.068	2.75	0.074
	Bracket	Straight FL	1	19	2.500	0.048	1.5	0.029	2.75	0.052
Bathroom	Bracket	Standard light bulb	2	54	0.750	0.081	1.25	0.135	1.25	0.135
Kitchen	Ceiling	Straight FL	1	46	3.000	0.138	2.75	0.127	0.75	0.035
	Under-cabinet light	Straight FL	1	21	2.500	0.053	2.75	0.058	0.75	0.016
Living/ dining room	Ceiling	Ring FL	2	70	10.250	1.435	10.75	1.505	5	0.700
	Pendant	Standard light bulb	1	90	3.500	0.315	2	0.180	0.25	0.023
Japanese-style room	Ceiling	Ring FL	1	74	2.917	0.216	1.25	0.093	3	0.222
	Bracket	Straight FL	1	22	2.917	0.064	1.25	0.028	3	0.066
Master bedroom	Ceiling	Ring FL	1	74	0.667	0.049	1.25	0.093	1	0.074
	Bracket	Mini krypton bulb	1	54	0.500	0.027	1.25	0.068	1	0.054
Children's room 1	Ceiling	Ring FL	1	59	3.250	0.192	7.75	0.457	1.75	0.103
	Desk lamp	Compact FL	1	21	2.750	0.058	5	0.105	1	0.021
Children's room 2	Ceiling	Ring FL	1	59	2.750	0.162	7.25	0.428	2.5	0.148
	Desk lamp	Compact FL	1	21	1.500	0.032	3.25	0.068	0	0.000
Total (kWh/day)						3.94		3.88		2.17

Table 5; Supplementary Table 2
Conditions for use of consumer electronics

Type	Annual operation time (h)	Annual operation time (h)
Refrigerator	8760.0	0.0
29-inch TV	3048.0	5712.0
14-inch TV	505.3	8254.8
Hot water heated toilet seat	8760.0	0.0
MD player	800.3	7959.8
CD radio-cassette recorder	157.8	8602.3
Washing machine	200.5	8559.5
Desk light	896.5	0.0
PC	373.5	0.0
Vacuum	60.8	0.0
Kitchen hood fan	456.5	8303.5
Hair dryer	135.3	0.0
Iron	42.7	0.0
Computer game	505.3	8254.8

◆Zone VI: Model house (Type A)

■Plan view

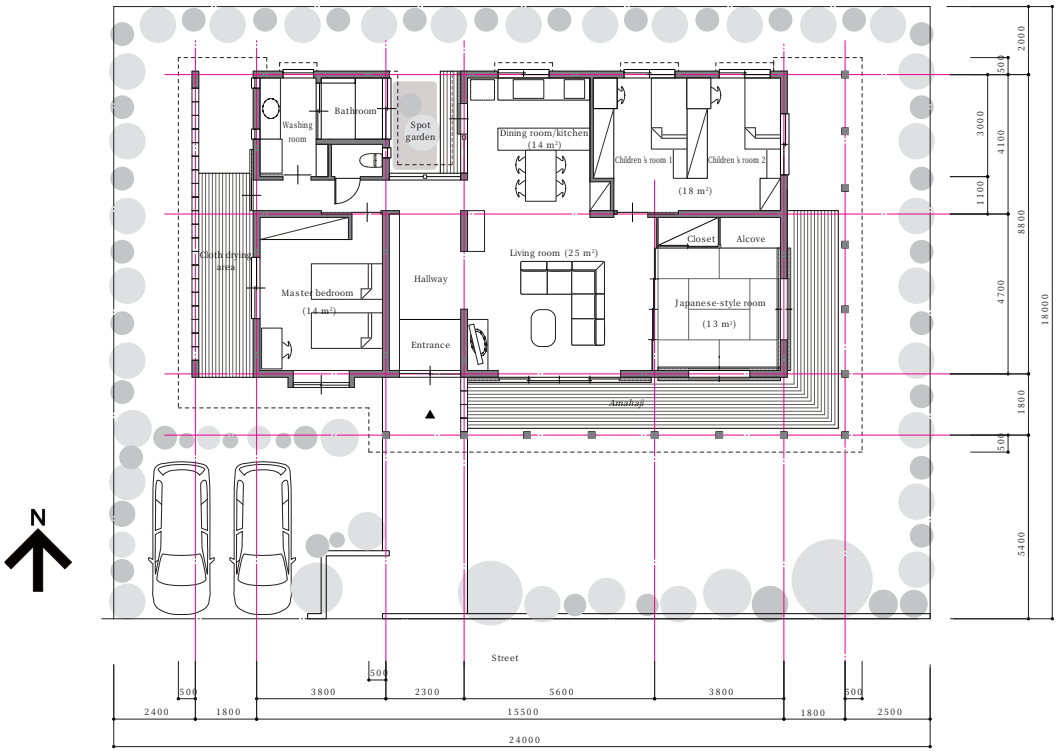


■Cross-section drawing

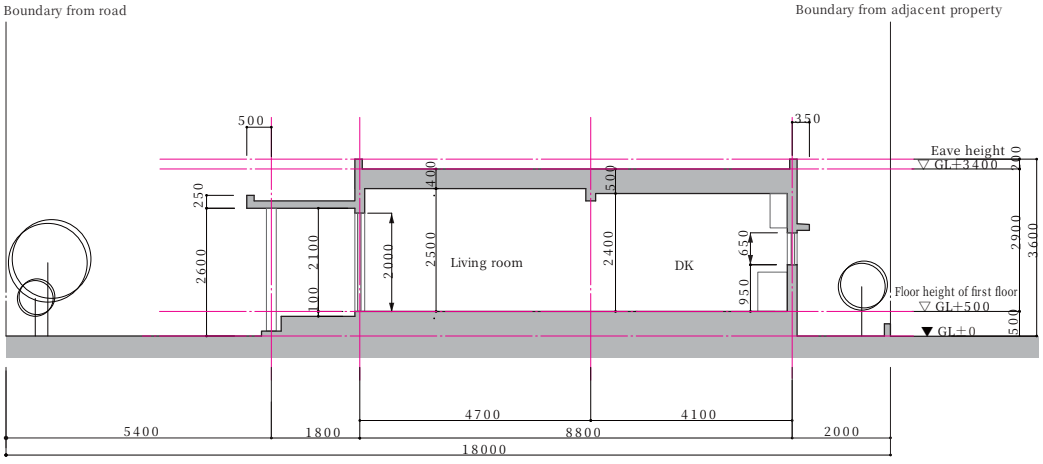
■Design specifications

Structure:	Reinforced concrete
Number of stories:	One-storey house
Site area:	432.0 m² (4,650 ft²)
Building area:	185.5 m² (1,996.7 ft²)
Total floor area:	145.3 m² (1,564 ft²)
Family structure:	Husband and wife with two children

◆Zone VI: Model house (Type B)



■First floor plan view

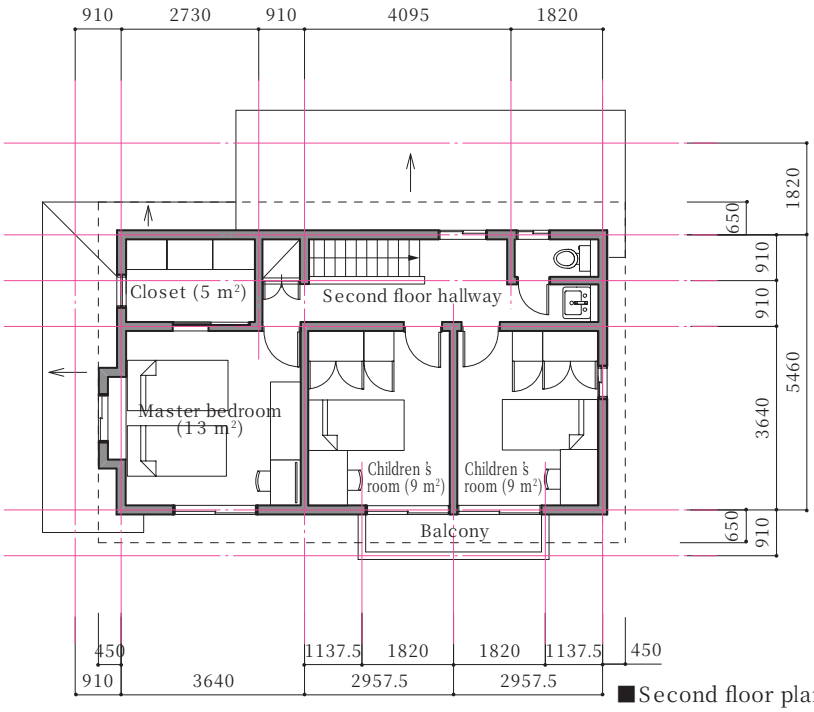


■Cross-section drawing

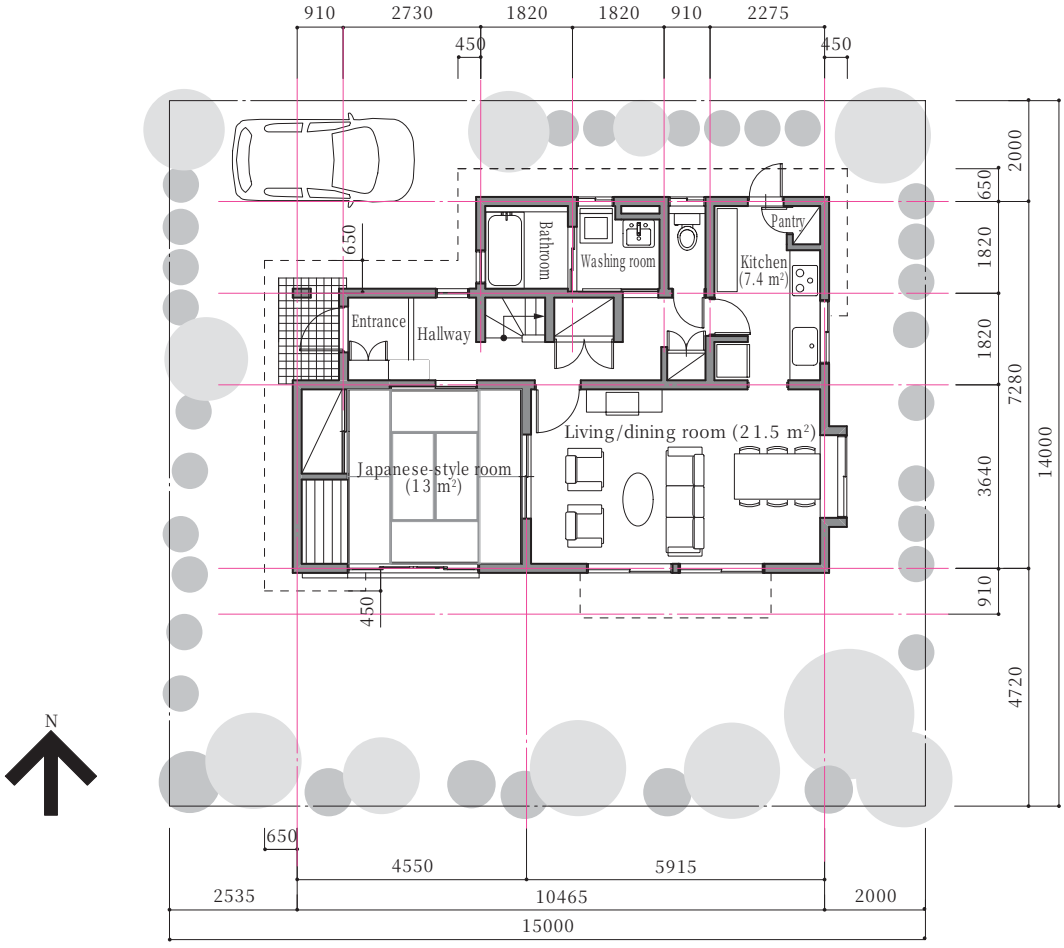
■Design specifications

Structure:	Reinforced concrete
Number of stories:	One-storey house
Site area:	432.0 m² (4,650 ft²)
Building area:	185.5 m² (1,996.7 ft²)
Total floor area:	145.3 m² (1,564 ft²)
Family structure:	Husband and wife with two children

◆Zone V: Model house (Type A)



■Second floor plan vie



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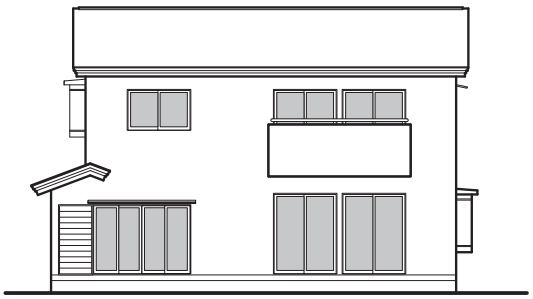
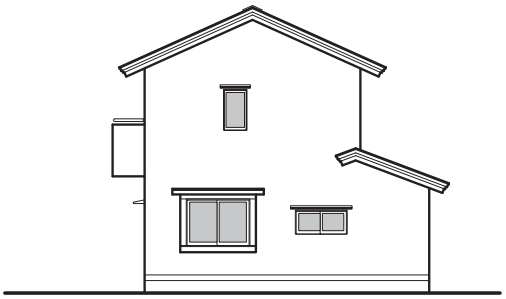
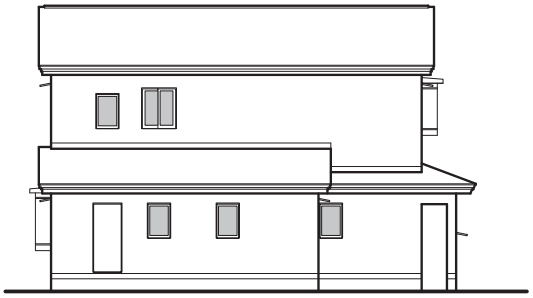
■First floor plan view



■South elevation view

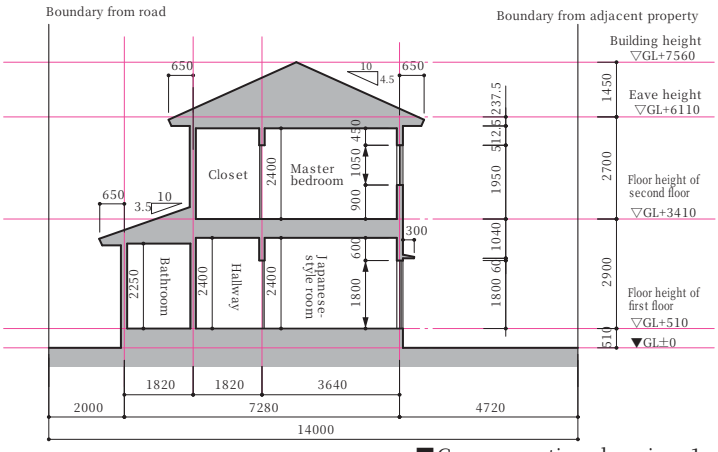


■East elevation view

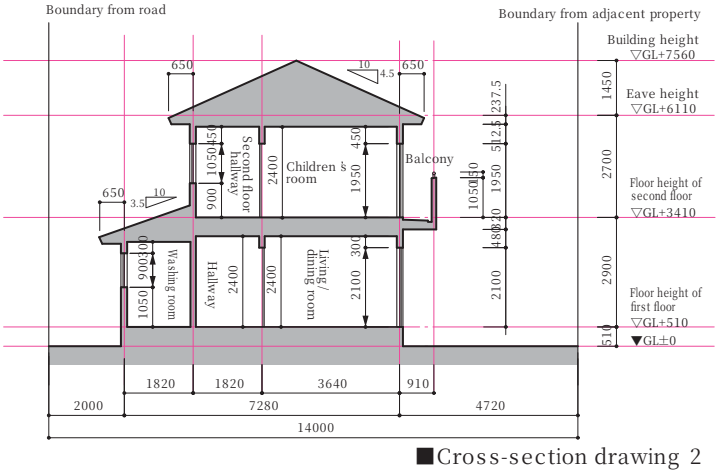


■North elevation view

■West elevation view



■Cross-section drawing 1



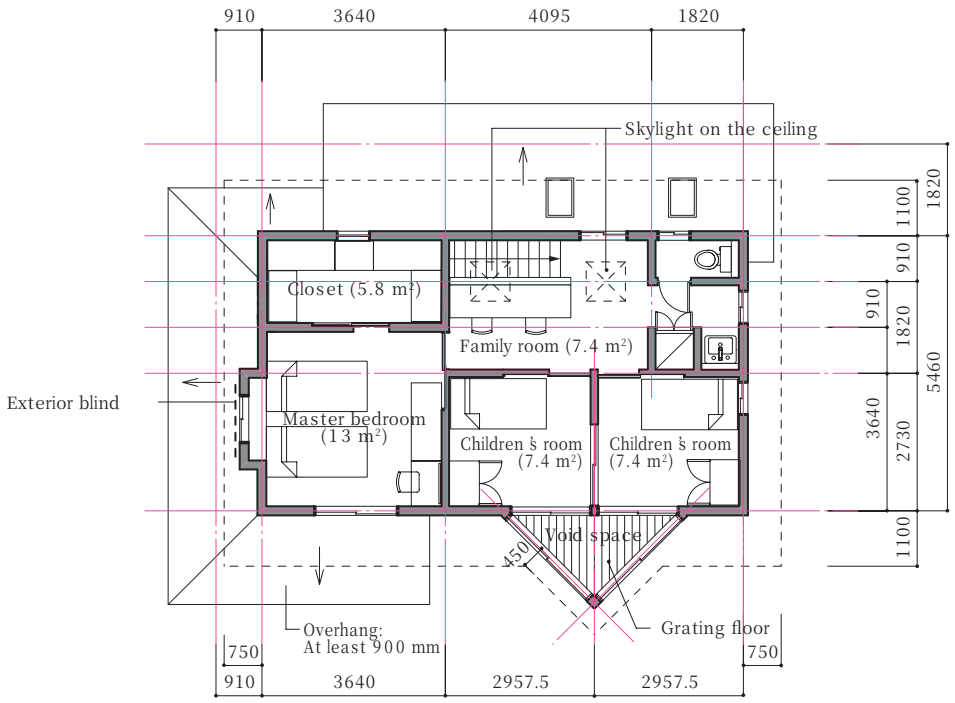
■Cross-section drawing 2

■Design specifications
Structure : Wooden
Number of stories : Two-storey house
Site area : 210.00 m² (2,260.42 ft²)
Building area : 69.56 m² (748.74 ft²)
Total floor area:
-Second floor : 57.14 m² (615.05 ft²)
- First floor : 62.93 m² (677.37 ft²)
- Total : 120.07 m² (1,292.42 ft²)

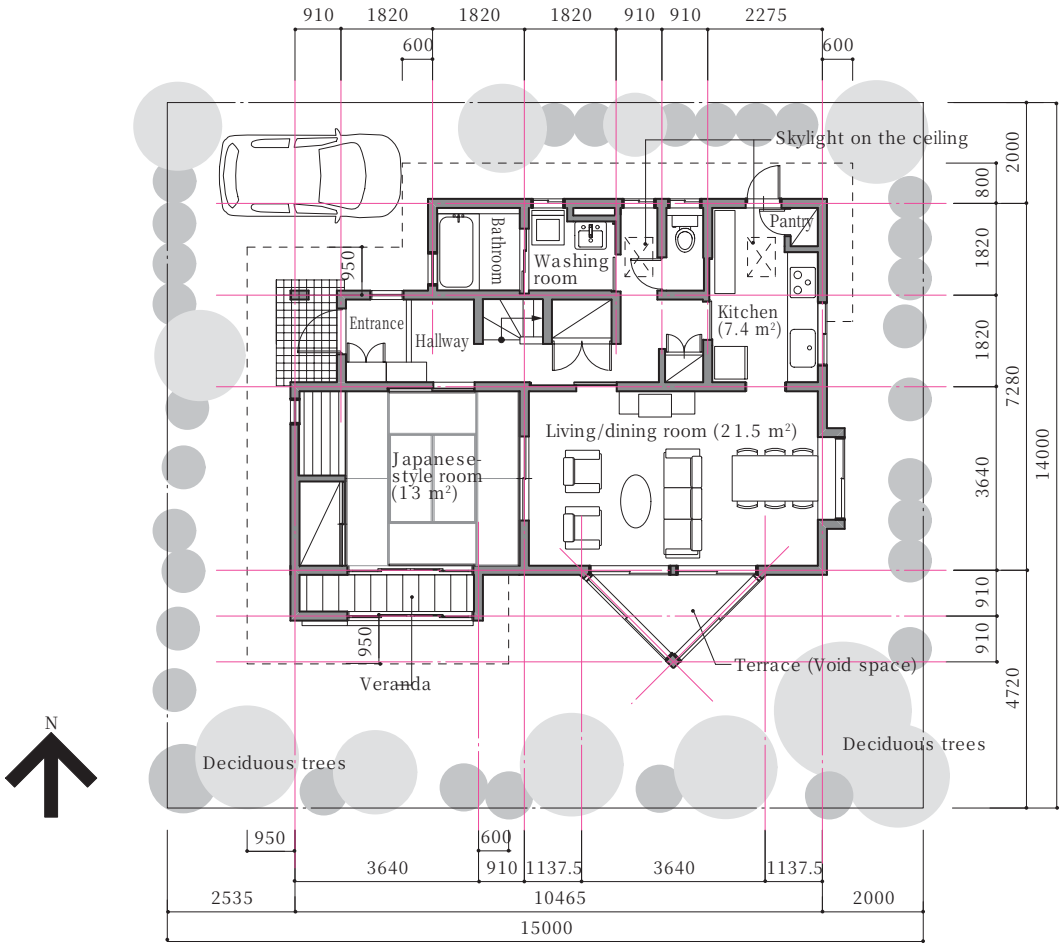
Window area: 27.92 m²
Window area against total area : 23.25%
(Window area does not include entrance and door for shoe area)

Family structure : Husband and wife with two children

◆Zone V: Model house (Type B)



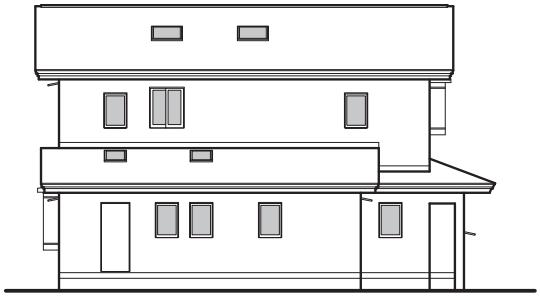
■Second floor plan view



■First floor plan view

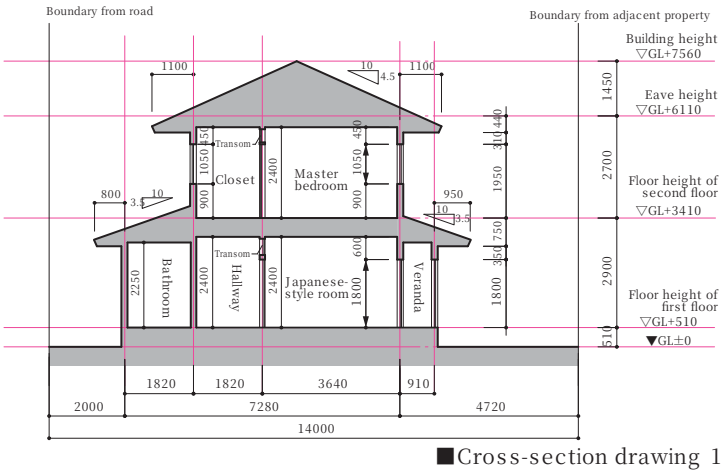
■South elevation view

■East elevation view

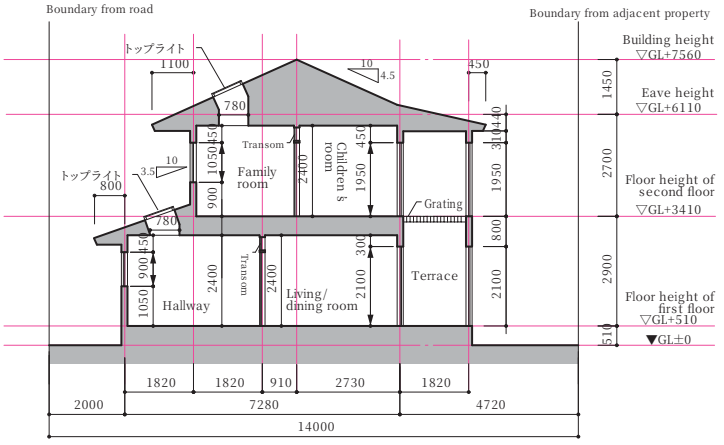


■North elevation view

■West elevation view



■Cross-section drawing 1



■Cross-section drawing 2

■Design specifications
Structure : Wooden
Number of stories : Two-storey house
Site area : 210.00 m² (2,260.42 ft²)
Building area : 77.83 m² (837.76 ft²)
Total floor area :
- Second floor: 57.14 m² (615.05 ft²)
- First floor: 71.21 m² (766.50 ft²)
- Total: 128.35 m² (1,381.55 ft²)

Window area : 29.47 m²
Window area against total area : 22.96%
(Window area does not include skylight, entrance and door for shoe area)

Family structure : Husband and wife with two children

6.1.3 Basis for Calculation Determination of Energy Saving Effect

1. Background that made energy saving effect evaluation difficult

One of the reasons why it was conventionally difficult to obtain numerical values related to the effect of various energy saving methods for buildings is the difficulty in judging the effect of various energy saving methods through field studies. In other words, when comparing energy saving method A applied to one building and method B applied to another building, or when evaluating the effect of energy saving method A by comparing the building using energy saving method A and another building that does not use this method, it is necessary not only that the two buildings enjoy the same weather conditions but also that conditions other than the method are as similar as possible. In addition, while the buildings are required to offer the same way of living, even if the number of family members and family attributes are the same on the surface, it is almost impossible to match the factors that have a strong influence on energy consumption, such as the number of hours being at home, how equipment is used, and the opening and shutting of windows. For these reasons, we have been facing a difficult situation whereby only vague effects can be distinguished when comparisons are made through field studies.

Given this, in the study that serves as the basis of this document, we used a method that mechanically recreates the occupant's life to quantify the energy saving effect. In this method, we assumed one family's living hours, method of using equipment, and method of closing and opening windows and curtains based on statistics and existing field study results. In the test house for the study, equipment was operated and windows were opened and closed mechanically or electronically as if the family lived there. With regard to various types of equipment used in the experiment for quantifying the effect, actual units (products that are actually sold on the market) were the target of evaluation. It is important to evaluate the performance of equipment purchased and used commonly, not that which has been specially prepared for the experiment, by actually using it. The performance of actual units cannot be understood if only a part of the equipment's operation mechanism is evaluated.

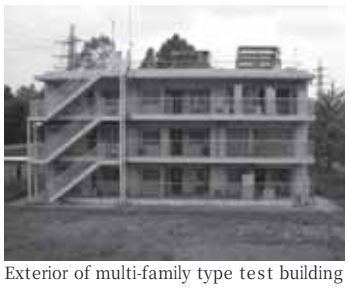
Table 6 Matters to keep in mind when evaluating actual effect of energy saving methods

System devices wherein control method is critical	Electric water heater with natural refrigerant heat pump
System devices wherein operating environment is critical	Heating and cooling system (efficiency varies depending on heating load) Refrigerator (room temperature) Hot water heated toilet seat (room temperature)
System devices wherein performance of auxiliary components (other than devices for core mechanism) is critical	System devices located outside (antifreezing heater) Solar heat system (supportive devices including circulating pump, etc.)

2. Overview of validation experiment methods

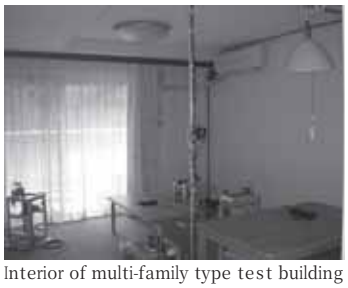
Validation experiments can be divided roughly into the following; comprehensive experiments that recreate the occupant's life and energy consumption phenomena as a whole, and individual experiments where each machine is individually evaluated.

The comprehensive experiments used test buildings like the ones shown in Photo 1 , and the devices shown in Photo 2 were used to operate equipment and open and close windows automatically according to a schedule. In the meantime, individual experiments were implemented when many tests were needed to be conducted under diversified conditions by artificially changing weather conditions. An artificial climate chamber was used. Photo 3 shows the measuring of air conditioner efficiency under various conditions provided by changing the test outside air temperatures inside the artificial climate chamber.



Exterior of multi-family type test building

Exterior of detached house type test building



Interior of multi-family type test building (living room)

Photo 1 Test buildings

Control room (control panel, PC for control)

Internal heat generation/humidification simulator (human body, consumer electronics, etc.)

Group of domestic hot water systems placed in the hallway of multi-family type test building

Photo 2 Test devices

House/equipment inside artificial weather chamber

Measuring of air conditioner load efficiency

Photo 3 Artificial weather climate

3. Use of simulation

Simulation is a method that virtually recreates the behaviours of the target phenomena under discussion on a computer after theoretically clarifying the phenomena. For example, heat that enters and exits through walls and windows is calculated while outside conditions, such as outside air temperature and solar radiation, as well as heat quantity generated inside the building, are taken into consideration. The advantage of doing a simulation on a computer is that it is possible to carry out a forecast evaluation on a huge number of conditions related to a phenomenon (e.g.: several hundred patterns). Simulations enable what cannot be realized by experiments, because they take too long or cost too much. However, the program used for a simulation must offer calculation results with fully verified accuracy, and it is also necessary that a fully experienced person operates the program so that no mistakes occur when entering calculation conditions.

In the creation of this document we used the following simulation programs: three types (SimHeat, SMASH and Passwork) for heat phenomena, one type (VentSim) for ventilation and cross ventilation phenomena, and one type (Inspirer) for light-related phenomena.

6.1.4 Methods of Calculating Energy Consumption, CO_2 Emissions, and Costs

1. Elemental technology evaluation scale

In this document, energy consumption is the main index used to evaluate the effect of elemental technologies and related methods. In this chapter, however, we added two more indices, CO_2 emissions and economic efficiency (cost).

The reason why we consider CO_2 emissions to be important is obviously because CO_2 emissions caused by energy consumption have worsened the state of global warming. As for economic efficiency, every designer worries about it when selecting elemental technologies and methods during the designing process. Trying to spread energy saving technology without considering economic efficiency would be impossible. In regard to design technology that can be used by many designers for a long time, it is desirable that it allows the increase in initial costs to be recovered as soon as possible through the reduction in running costs. In addition, this document offers guidelines regarding the limit for the extent of increase in initial costs (information for main suppliers of elemental technologies and methods) and how much reduction (support) in initial costs through public subsidies is called for (information for national and local governments) in order to recover the money after a period of, say, 15 years.

Supplementary explanation on the three indices is given below.

Glossary: GJ
GJ is pronounced as "gigajoule", and joule (J) is a unit of energy amount. Since giga means one billion, 1 GJ is 1 billion joules.

1) Energy efficiency: Annual energy consumption (primary energy in GJ/year)

- When evaluating energy efficiency, the evaluation of electric power energy uses a conversion factor (9,760 kg/kWh*) provided in energy conservation standards for buildings, i.e. "Criteria for Judgment by Owners Regarding the Rationalization of Energy Use Related to Buildings" (Notification No.1 in 2003 by the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure, Transport and Tourism and Notification No.5 in 2006 by the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure, Transport and Tourism as the latest version). In other words, the evaluation uniformly uses primary energy conversion values.
  * When different conversion factors for night and daytime are used, the values of 9,280 kJ/kWh and 9,970 kJ/kWh can be used for night electricity (receiving electricity supply from 22:00 and 8:00 the next day) and for daytime electricity (receiving electricity supply from 8:00 to 22:00), respectively.
- Primary energy conversion values of processed natural gas, LPG and kerosene are as follows.
  Processed natural gas (13A): 46,046 (kJ/Nm3) ☒ See Table 7 on the next page for Okinawa Gas.
  LPG: 50,200 (kJ/kg)
  Kerosene: 37,000 (kJ/L)

2) Global warming impact: Annual CO_2 emissions (in kg-CO_2/year)

- In order to prevent global warming, the Kyoto Protocol, which requires developed countries to reduce greenhouse gas emissions, came into effect as of February 16, 2005. With regard to greenhouse gas emissions between 2008 and 2012, the Kyoto Protocol obliges developed countries as a whole to achieve 5.2% reductions compared to 1990 levels, with Japan to achieve 6% reductions. If reduction targets are not met, there is likely to be a penalty within a new framework starting 2013. Based on such circumstances, this document positions "CO_2 emissions" as a main axis of evaluating global warming impact from the perspective of preventing global warming.
- The method of calculating CO_2 emissions is based on the "Ordinance Regarding the Calculation of Greenhouse Gas Emissions That Occur During the Business Activities of Specific Producers" (Ordinance No. 3 by the Ministry of Economy, Trade and Industry and the Ministry of the Environment issued on March 29, 2006) which was provided based on the "Order for the Enforcement of the Act on the Promotion of Global Warming Prevention" (Ordinance No. 143 in 1999, Ordinance No. 195 finalized on June 13, 2008)

Table 7 Coefficient for calculating CO_2 emissions

Types of fuel, etc.	Unit	Coefficient
Processed natural gas	Megajoule (MJ; generated heat amount)	Okinawa Gas Nihon Gas (Kagoshima) Shikoku Gas (Kochi City) (13A zone) (5B zone)
Liquefied petroleum gas (LPG)	Kilogram (kg)	3.00 kg-CO_2/ kg
Kerosene	Liter (L)	2.489 kg-CO_2/ L
Electricity	Kilowatt-hour (kWh)	See Table 8

Table 8 Coefficients applied to electric utility companies under which Zone V and Zone VI fall (actual values in 2007)

Electric utility company	Coefficient (kg-CO_2/ KWh) in 2007	Coefficient in 2008	Adjusted Coefficient in 2008
Tokyo Electric Power Company	0.425	0.418	0.322
Chubu Electric Power	0.470	0.455	0.424
Kansai Electric Power Co., Inc	0.366	0.355	0.299
Chugoku Electric Power Co., Inc.	0.677	0.674	0.501
Shikoku Electric Power Co., Inc.	0.392	0.378	0.326
Kyushu Electric Power Co., Inc.	0.387	0.374	0.348
Okinawa Electric Power Company, Incorporated	0.934	0.946	0.946

* The values in the left column are those announced by the Ministry of Environment, except for the values for Chugoku Electric Power Co., Inc. and Okinawa Electric Power Co., Inc., which are announced by themselves. The values in the center and right columns are the newest values announced in December 2009. ("Adjusted Coefficient" is the one reflecting, the amount of the Kyoto Mechanism Credit acquired by electric power companies and transferred to the state.) However, the values in the left column (Coefficient in 2007) are adopted for the calculation of the CO_2 emissions in this guidelines. Refer to the homepage of the Ministry of Environment, if the latest values are necessary, because the coefficients are being revised every year.

established in order to enforce the "Act on the Promotion of Global Warming Prevention". With regard to each fuel and electricity, Table 7 shows coefficients for calculating CO_2 emissions based on their consumption taken from the Ordinance in question. However, as for electricity, the numerical values (Table 8) which were announced by the Ministry of Environment according to the Ordinance Article 10.2 or by electric utility companies shall be used.

- In addition, when calculating CO_2 emissions to be reduced in cases where a certain technology or a designing method is used, coefficients to be used may be different from the ones listed in Table 8. For example, the "Progress of Kyoto Protocol Target Achievement Plan" (July 29, 2008) by the headquarters for promoting the prevention of global warming uses 0.6 kg-CO_2/kWh as a coefficient for calculating the emissions caused by thermal power generation, in a part of calculating the reduction effects.

3) Economic efficiency: Initial cost, annual energy cost (running cost), simple payback time

- The initial costs discussed in this document are roughly estimated values based on regular prices. However, the open prices of equipment are based on market price research results.
- The annual energy cost of domestic hot water is based on the pricing system of electric power companies and gas companies in the regions concerned. The electric bills of other consumer electronics and air conditioners were calculated based on the "new electric power reference price (22 yen excluding tax/ kWh).
- Simple payback time indicates how many years it takes to recover the increase in initial costs through energy cost reduction; it can be calculated based on the following formula.

Simple payback time [years]
= Increase in initial cost [yen] / annual energy cost reduction [yen/year]

6.2 Evaluation of Energy Performance, Global Warming Impact, and Cost through Application of Elemental Technologies

6.2.1 Evaluation Results in Zone VI

1. Energy performance

- The results of evaluating energy performance (annual energy consumption) are shown in Table 9.
- For each elemental technology, the Table shows the results of calculating annual energy consumption at each level, energy consumption reduction rates compared to level 0, and applied methods.

Table 9 Energy efficiency evaluation results <Zone VI>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	Cooling system planning		10.3 GJ 0 AC COP3	8.6 GJ ▲16.4% AC COP4	8.2 (7.6) GJ ▲20.5(▲25.9)% AC COP3 + electric fan/ceiling fan (or COP5)	7.0 GJ ▲31.4% AC COP4 + electric fan/ceiling fan	6.4 GJ ▲37.6% AC COP5 + electric fan/ceiling fan
Ventilation	Ventilation system planning	Duct type	3.1 GJ 0 Normal-efficiency fan (AC motor)	2.0 GJ ▲36.3% Normal-efficiency fan (AC motor) Increased duct diameter	1.5 GJ ▲52.9% High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	2.8 GJ 0 Turbofan Outside air terminal: regular hood	2.2 GJ ▲16.6% Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		13.8 GJ 0 Conventional gas water heater (An example other than above) 13.1 GJ ▲5.1% Conventional oil water heater	12.0 GJ ▲13.0% Latent heat recovery gas water heater	11.0GJ ▲20%～	9.7GJ ▲30%～	6.9GJ ▲50%～
				11.8 GJ ▲14.5% Latent heat recovery oil water heater	9.9 GJ ▲28.3% Latent heat recovery gas water heater + piping method/ hot water saving devices		7.7 GJ ▲44.2% Electric water heater with a natural refrigerant heat pump (energy-efficient mode)
					9.8 GJ ▲29.0% Latent heat recovery oil water heater + piping method/ hot water saving devices		6.3 GJ ▲54.3% Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/ hot water saving devices
					8.9 GJ ▲35.5% Electric water heater with a natural refrigerant heat pump (medium boiling mode)		5.2 GJ ▲62.3% Solar water heating (solar water heating: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		13.6 GJ 0 Conventional device + continuous lighting while staying in the room or on/off lighting + one-light-per-room system	11.0 GJ ▲18.8% High-efficiency device + on-off lighting + one-light-per-room system	10.6 GJ ▲22.0% High-efficiency device + lighting adjustment + one-light-per-room system	9.4 GJ ▲30.6% High-efficiency device + lighting adjustment + distributed multiple system (simplified)	
Consumer electronics	High-efficiency consumer electronics		21.4 GJ 0 Conventional consumer electronics (made in 1997)	17.1 GJ ▲20% Energy-efficient products (500 kWh decrease)	12.8 GJ ▲40% Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		4.4 GJ Cooking stove or induction heating (IH) cooking heater (values are according to the results from a survey on cooking stove)				
Overall			66.6 GJ* 0	55.1 GJ - 39.7 GJ ▲17.3% – ▲40.4%			

Note 1: Upper values indicate annual primary energy consumption; lower values indicate energy consumption reduction rate (▲: reduction, +: increase).
Note 2: With regard to domestic hot water, energy saving effects shown in the table (second row onward at level 0 as well as level 1 to 4) were confirmed for the types of machines used for validation experiments.
* When the duct system is used in the ventilation system planning.

2. Global warming impact

- The results of evaluating global warming impact (annual CO^2 emissions) are shown in Table 10.
- For each elemental technology, the Table shows the results of calculating annual CO^2 emissions at each level, CO^2 emissions reduction rates compared to level 0, and applied methods.

Table 10 Global warming impact evaluation results <Zone VI>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	Cooling system planning		983 kg 0 AC COP3	821 kg ▲16.4% AC COP4	781 (728) kg ▲20.5 (▲25.9)% AC COP3 + electric fan/ceiling fan (or COP5)	674 kg ▲31.4% AC COP4 + electric fan/ceiling fan	613 kg ▲37.6% AC COP5 + electric fan/ceiling fan
Ventilation	Ventilation system planning	Duct type	295 kg 0 Normal-efficiency fan (AC motor)	188 kg ▲36.3% Normal-efficiency fan (AC motor) Increased duct diameter	139 kg ▲52.9% High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	265 kg 0 Turbofan Outside air terminal: regular hood	221 kg ▲16.6% Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		713kg (processed natural gas) 0 835 kg (LPG) +17.1% Conventional gas water heater (An example other than above) 893 kg +25.2% Conventional oil water heater	632 kg (processed natural gas) ▲11.4% 737 kg (LPG) ▲3.4% Latent heat recovery gas water heater 809 kg +13.5% Latent heat recovery oil water heater	527 kg ▲26.1% Latent heat recovery gas water heater + piping method/ hot water saving devices 670 kg ▲6.0% Latent heat recovery oil water heater + piping method/ hot water saving devices 895 kg +25.5% Electric water heater with a natural refrigerant heat pump (medium boiling mode)		774 kg +8.6% Electric water heater with a natural refrigerant heat pump (energy-efficient mode) 632 kg ▲11.4% Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/hot water saving devices 278 kg ▲61.0% Solar water heating (solar water heater: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		1,301 kg 0 Conventional device + continuous lighting while staying in the room + one-light-per-room system	1,057 kg ▲17.0% High-efficiency device + on/off lighting + one-light-per-room system	1,016 kg ▲20.3% High-efficiency device + lighting adjustment + one-light-per-room system	903 kg ▲29.1% High-efficiency device + lighting adjustment + distributed multiple system (simplified)	
Consumer electronics	High-efficiency consumer electronics		2,048 kg 0 Conventional consumer electronics (made in 1997)	1,636 kg ▲20% Energy-efficient products (500 kWh decrease)	1,225 kg ▲40% Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		223 kg (processed natural gas) Cooking stove or IH cooking heater				
Overall			5,563 kg* 0	4,734 kg – 3,381 kg ▲14.9% – ▲39.2%			

Note 1: Upper values indicate annual CO_2 emissions (kg-CO_2); lower values indicate CO_2 emissions reduction rate (▲: reduction, +: increase).
Note 2: With regard to domestic hot water, CO2 emissions were calculated based on the energy consumption of the types of machines used for validation experiments by using conversion factors listed in Table 7 and Table 8 on p.346 (value provided by Okinawa Gas was used for the CO2 emission coefficient).
* When the duct system is used in the ventilation system planning.

3. Economic efficiency

1) Initial cos

- The results of evaluating initial costs are shown in Table 11.
- For each elemental technology, the Table shows the results of calculating initial costs needed when methods at each level were applied, changes compared to the initial cost at level 0, and applied methods.

Table 11 Initial cost evaluation results <Zone VI>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	Cooling system planning		417,000 yen 0 AC COP3	461 ,000 yen + 44,000 yen AC COP4	429 (608),000 yen + 12(+191),000 yen AC COP3 + electric fan/ceiling fan (or COP5)	473,000 yen + 56,000 yen AC COP4 + electric fan/ceiling fan	620,000 yen + 203,000 yen AC COP5 + electric fan/ceiling fan
Ventilation	Ventilation system planning	Duct type	276,000 yen 0 Normal-efficiency fan (AC motor)	277,000 yen + 1,000 yen Normal-efficiency fan (AC motor) Increased duct diameter	365,000 yen + 89,000 yen High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	117,000 yen 0 Turbofan Outside air terminal: regular hood	117,000 yen ± 0,000 yen Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		483,000 yen 0 Conventional gas water heater (An example other than above) 528,000 yen + 45,000 yen Conventional oil water heater	544,000 yen + 61,000 yen Latent heat recovery gas water heater 580,000 yen + 97,000 yen Latent heat recovery oil water heater	601,000 yen + 118,000 yen Latent heat recovery gas water heater + piping method/ hot water saving devices 637,000 yen + 154,000 yen Latent heat recovery oil water heater + piping method/ hot water saving devices 916,000 yen + 433,000 yen Electric water heater with a natural refrigerant heat pump (medium boiling mode)		916,000 yen + 433,000 yen Electric water heater with a natural refrigerant heat pump (energy-efficient mode) 973,000 yen + 490,000 yen Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/ hot water saving devices 917,000 yen + 434,000 yen Solar water heating (solar water heater: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		407,000 yen 0 Conventional device + continuous lighting while staying in the room or on/off lighting + one-light-per-room system	543,000 yen + 136,000 yen High-efficiency device + on/off lighting + one-light-per-room system	580,000 yen +173,000 yen High-efficiency device + lighting adjustment + one-light-per-room system	675,000 yen +268,000 yen High-efficiency device + lighting adjustment + distributed multiple system (simplified)	
Consumer electronics	High-efficiency consumer electronics		— Conventional consumer electronics (made in 1997)	— Energy-efficient products (500 kWh decrease)	— Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		— Cooking stove or IH cooking heater				
Electricity	Photovoltaic power generation		0 0 Do not introduce	2,753,000 yen + 2,753,000 yen Approx. 3 kW	3,486,000 yen + 3,486,000 yen Approx. 4 kW		

Note: Upper values indicate initial cost (unit-price-based).
Lower values indicate increase or decrease in initial costs when the initial cost at level 0 is considered 0.

2) Annual energy cost (running cost)

- The results of evaluating annual energy costs are shown in Table 12.
- For each elemental technology, the Table shows the results of calculating annual energy costs needed when methods at each level were applied, changes compared to the energy cost at level 0, and applied methods.

Table 12 Annual energy cost evaluation results <Zone VI>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	Cooling system planning		23,000 yen/year 0 AC COP3	19,000 yen/year − 4,000 yen/year AC COP4	18(17),000 yen/year − 5(−6),000 yen/year AC COP3 + electric fan/ceiling fan (or COP5)	16,000 yen/year − 7,000 yen/year AC COP4 + electric fan/ceiling fan	14,000 yen/year − 9,000 yen AC COP5 + electric fan/ceiling fan
Ventilation	Ventilation system planning	Duct type	7,000 yen/year 0 Normal-efficiency fan (AC motor)	4,000 yen/year − 3,000 yen/year Normal-efficiency fan (AC motor) Increased duct diameter	3,000 yen/year − 4,000 yen/year High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	6,000 yen/year 0 Turbofan Outside air terminal: regular hood	5,000 yen/year −1,000 yen/year Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		82,000 yen/year 0 Conventional gas water heater (An example other than above) 44,000 yen/year − 38,000 yen/year Conventional oil water heater	72,000 yen/year − 10,000 yen/year Latent heat recovery gas water heater 40,000 yen/year − 42,000 yen/year Latent heat recovery oil water heater	62,000 yen/year − 20,000 yen/year Latent heat recovery gas water heater + piping method/ hot water saving devices 33,000 yen/year − 49,000 yen/year Latent heat recovery oil water heater + piping method/ hot water saving devices 9,000 yen/year − 73,000 yen/year Electric water heater with a natural refrigerant heat pump (medium boiling mode)		8,000 yen/year − 74,000 yen/year Electric water heater with a natural refrigerant heat pump (energy-efficient mode) 6,000 yen/year − 76,000 yen/year Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/ hot water saving devices 38,000 yen/year − 44,000 yen/year Solar water heating (solar water heater: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		31,000 yen/year 0 Conventional device + continuous lighting while staying in the room + one-light-per-room system	25,000 yen/year − 6,000 yen/year High-efficiency device + on/off lighting + one-light-per-room system	24,000 yen/year − 7,000 yen/year High-efficiency device + lighting adjustment + one-light-per-room system	21,000 yen/year − 10,000 yen/year High-efficiency device + lighting adjustment + distributed multiple system (simplified)	
Consumer electronics	High-efficiency consumer electronics		48,000 yen/year Conventional consumer electronics (made in 1997)	39,000 yen/year Energy-efficient products (500 kWh decrease)	29,000 yen/year Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		— Cooking stove or IH cooking heater				

Note: Upper values indicate annual energy cost.
Lower values indicate reduction in annual energy costs when the annual energy cost at level 0 is considered 0 (increase: +; decrease: -).

■Conditions for initial cost test calculation (Zone VI)

①Cooling

- Market prices of air conditioners were calculated based on the research results on the websites below (October, 2008).
  (1) img.yamada-denkiweb.com/item/list.php/special/2ct28/tm002/?lorder=1&ltype=1&Current_Page=1
  (2) www.yodobashi.com/enjoy/more/productslist/cat_162_539_9560938/moid_542185/sr_nm/9560884.html
- The number of air conditioners installed for each room and their capacities are as follows (See 3.1 on p.064).
  Living and dining rooms: 5 kW × 1 unit、Master bedroom: 2.8 kW × 1 unit、Children's room: 3.6 kW × 1 unit
- Prices are all special prices listed on websites (including tax).
- With regard to air conditioner installation fees, we checked local consumer electronics stores and used the following prices (basic installation fee only, including tax).
  Capacity 2.8 kW or lower: 15,000 yen per unit, 2.9 kW or higher: 20,000 yen per unit
- As for electric fans, we checked local consumer electronics stores and used the price at 4,000 yen (including tax) per unit.

Table 11 Supplementary Tables: Air conditioner prices and COP that corresponds to solar shading method levels

Supplementary Table 1: Price range (Unit: yen)

Solar shading method levels	6 *tatami* mats (10 m²)	8 *tatami* mats (13 m²)	10 *tatami* mats (16 m²)	14 *tatami* mats (22 m²)
Level 0	144,800			
Level 1	84,100	175,900		
Level 2	89,400	112,300 – 119,200	179,600	221,700
Level 3		79,200		203,600
Level 4		89,400	103,100 – 132,800	147,500

Supplementary Table 2: Air conditioner COP

Solar shading method levels	6 *tatami* mats (10 m²)	8 *tatami* mats (13 m²)	10 *tatami* mats (16 m²)	14 *tatami* mats (22 m²)
Level 0	5.8			
Level 1	5.1	5.5		
Level 2	4.9	5.1 – 5.4	5.4	4.8
Level 3		4.8		4.6
Level 4		5.1	4.6 – 5.3	3.7

The air conditioner prices in Table 11 (Initial cost evaluation results on p.356) were the ones surveyed on the assumption that the air conditioner is required to provide the maximum cooling capacity when the solar shading ability of building envelope is at level 0. Meanwhile, the maximum cooling capacity required becomes lower when the building envelope ' s solar shading ability is improved, making it possible to lower the initial costs since a smaller air conditioner is adequate in this case.

Supplementary Table 1 of Table 11 shows the results of surveyed prices of air conditioners that meet the requirements of the maximum cooling capacity for each room size according to the level of solar shading methods. When the room size is definitely the same, the cost of installing an air conditioner clearly tends to become lower as the solar shading performance improves. For example, in the case of an 8-tatami-mat room, the price is approximately 176,000 yen when the solar shading method is at level 0. However, at level 4, the air conditioner installation cost is reduced almost by half, being approximately 89,000 yen.

Incidentally, Supplementary Table 2 of Table 11 lists the energy efficiency of corresponding types. Although types with a smaller maximum cooling capacity tend to offer lower energy efficiency, they are considered to have few problems from the viewpoint of substantial energy conservation.

②Ventilation

- Regular prices listed in manufacturers' catalogues are used as unit prices, and local labor costs for the region in question are used for other prices (October, 2008).
- As for cut lengths (flexible pipes), converted unit prices for each unit of length were used.
- As for cost per man-hour, labor costs (electrical work) in the region in question are used for each specialist.
- With regard to the man-hours for labor costs, we assumed numbers within the bounds of common sense of equipment installation for a new detached house.
- Expenses regarding expendable supplies and miscellaneous materials, transportation cost and other expenses are not included.
- Prices do not include tax.

③Domestic hot water

- Regular prices listed in manufacturers' catalogues are used as unit prices, and local labor costs for the region in question are used for other prices (October, 2008).
- The range of estimates includes the water heater itself (including necessary items separately sold such as a remote controller and a circulation adaptor), piping around the water heater (water pipes, hot water pipes, gas pipes), piping and devices inside the building (kitchen faucets, bathroom shower faucets).
- As for cut lengths (each pipe), converted unit prices for each unit of length were used.
- As for cost per man-hour, labor costs (plumbing work, electrical work) in the region in question are used for each specialist.
- With regard to the man-hours for labor costs, we assumed numbers within the bounds of common sense of equipment installation for a new detached house.
- Expenses regarding expendable supplies and miscellaneous materials, transportation cost and other expenses are not included.
- Prices do not include tax.

④Lighting

- Regular prices listed in manufacturers' catalogues are used as unit prices (January, 2009).
- As for switches, their prices were calculated based on the cost component percentages listed in the existing "Design Guidelines for Low Energy Housing with Validated Effectiveness" (published in June, 2005).
- As for costs per man-hour, labor costs in the region in question are used for each specialist (October, 2008).
- Expenses regarding expendable supplies and miscellaneous materials, transportation cost and other expenses are not included.
- Prices do not include tax.

⑤Photovoltaic power generation

- The range of estimates includes costs of photovoltaic power generation system components, costs of wiring, processing and system installation, costs of electricity application and inspection, and other expenses. The same temporary scaffolding as that used when constructing the building is assumed to be used for the installation of the system.
- Prices do not include tax.

■Conditions for annual energy cost (running cost) test calculation (Zone VI)

①Processed natural gas cost

- Processed natural gas costs were calculated based on the list of rates provided by Okinawa Gas (http://www.okinawagas.co.jp/). See Table.

  Note 1: Calorific value: 61.954 MJ/Nm3

  Note 2: Rate category B was applied.

  Note 3: Basic rates were proportionally divided according to the composition ratio of each energy use listed in the reference energy consumption in Zone VI (Naha). See Table 2 on p.339.

Table: List of rates provided by Okinawa Gas (Applicable period: Gas rates between April 2008 Unit: Yen (including tax)

Fee classification	Usage per month	Basic rate per month	Reconciliation unit price* per m³	Base unit price per m³
A	Up to 18 m3	796.95	350.2	340.158
B	Up to 19 m3 to 152 m3	1,438.50	314.56	304.521
C	Over 152 m3	8,400.00	268.76	258.72

Note 1: Unit price adjusted based on raw material costs; increase by 10.0464 yen/m2 (unit price adjusted every six months according to changes in raw material costs).
Note 2: Gas rate = basic rate + (quantity consumed × reconciliation unit price).
* Reconciliation unit price = basic unit price + unit price adjusted based on raw material costs (Note 1); unit price used for calculating actual prices

②Kerosene cost

- Kerosene costs were calculated based on the price information provided by the Oil Information Center (http://oil-info.ieej.or.jp/).

* Research results in October 2008 were applied.

Retail price of kerosene at a gas station (Okinawa): 2,264 yen/18 L

③Electricity cost

- Electricity costs for devices other than night heat storage devices were calculated based on the reference unit price of electric charges (22 yen/kWh including tax). Therefore, if there is a need to calculate the precise electricity energy cost, it is necessary to covert reference unit price provided by each electric power company.

* Reference unit price of electric charges: This is used for indicating electric charges specified in the manufacturing business display rules by the Home Electric Appliances Fair Trade Conference (http://www.eftc.or.jp/).

- Electricity costs for night heat storage devices were calculated based on “Ee Life”, a seasonal and hourly rate lighting service offered by the Okinawa Electric Power Company (Table).

  Note 1: Basic rates were proportionally divided according to the composition ratio of each energy use listed in the reference energy consumption in Zone VI (Naha). See Table 2 on p.339.

  Note 2: A power distribution control discount for an electric water heater with a natural refrigerant heat pump (device capacity: 2 kVA) can be applied.

Table: Ee Life unit price table (Electric charges for meter reading in Sep. 2008; unit price adjusted based on fuel costs is 0 yen)

Classification			Unit	Unit price (yen, including tax)
Basic charge	—		1 contract	1,575.00
Electricity charge	Daytime	Summer	1 kWh	38.37
		Other seasons	1 kWh	35.04
	Active hours		1 kWh	26.22
	Nighttime		1 kWh	11.46
Discount for 5-hour rechargeable devices			1 kW	210
Discount for recharge control type/nighttime heat storage type devices			1 kW	157.5
Ee plan discount (discount for all-electric homes)			—	Discount target abount x 10%

Notes:
1. “Summer” is the season between July 1 and September 30; “Other seasons” means the rest of the year.
2. “Daytime” means the period of time between 10:00 and 17:00 on weekdays (from Monday to Saturday).
3. “Living hours” mean the period of time between 7:00 and 10:00 and between 17:00 and 23:00 on weekdays and from 7:00 till 23:00 on holidays specified by the optional provisions.
4. “Nighttime” means the period of time other than “Daytime” and “Living hours”.
5. “Amount subject to discount” is a total of basic rate and electric energy charges.
6. The maximum Ee Plan discount is 3,150 yen per month (including tax) for each contract.
7. “All-electric home” means that electricity provides the heat source for the entire house.

6.2.2 Evaluation Results in Zone V

1. Energy performance

- The results of evaluating energy performance (annual energy consumption) are shown in Table 13.
- For each elemental technology, the Table shows the results of calculating annual energy consumption at each level, energy consumption reduction rates compared to level 0, and applied methods.

Table 13 Energy efficiency evaluation results <Zone V>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	Heating and cooling system planning (Cooling through air conditioner)		5.7 GJ 0 (Living/Dining room and kitchen) Cooling COP3 (Other habitable rooms) Cooling COP3	5.4 GJ ▲5 % (Living/Dining room and kitchen) Cooling COP4 (Other habitable rooms) Cooling COP3	4.8 GJ ▲15 % (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan (Other habitable rooms) Cooling COP3	4.3 GJ ▲25 % (Living/Dining room and kitchen) Cooling COP4 + electric fan/ceiling fan *Appropriate device capacity setting (Other habitable rooms) Cooling COP3	3.7 GJ ▲35 % (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan *Appropriate device capacity setting (Other habitable rooms) Cooling COP3
Heating	Heating and cooling system planning (Heating through air conditioner)		5.0 GJ 0 (Living/Dining room and kitchen) Heating COP4.14 (Master bedroom) Heating COP5.72 (Children ' s room) Heating COP5.65 <Heating level 0>	4.8 GJ ▲5 % (Living/Dining room and kitchen) Heating COP5.20 (Master bedroom) Heating COP5.72 (Children ' s room) Heating COP5.65 <Heating level 1>	4.8 GJ ▲5 % (Living/Dining room and kitchen) Heating COP5.20 (Master bedroom) Heating COP5.72 (Children ' s room) Heating COP5.65 <Heating level 1>	3.5 GJ ▲30 % (Living/Dining room and kitchen) Heating COP6.22 (Master bedroom) Heating COP5.72 (Children ' s room) Heating COP5.65 <Heating level 4>	3.5 GJ ▲30 % (Living/Dining room and kitchen) Heating COP6.22 (Master bedroom) Heating COP5.72 (Children ' s room) Heating COP5.65 <Heating level 4>
Ventilation	Ventilation system planning	Duct type	3.1 GJ 0 Normal-efficiency fan (AC motor)	2.0 GJ ▲36.1% Normal-efficiency fan (AC motor) Increased duct diameter	1.5 GJ ▲52.5% High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	1.0 GJ 0 Turbofan Outside air terminal: regular hood	0.8 GJ ▲17.1% Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		19.2 GJ 0 Conventional gas water heater	16.3 GJ ▲15.1% Latent heat recovery gas water heater	13.5 GJ ▲29.7% Latent heat recovery gas water heater + piping method/hot water saving devices	12.1 GJ ▲37.0% Electric water heater with a natural refrigerant heat pump (energy-efficient mode)	9.9 GJ ▲48.4% Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/hot water saving devices
			(An example other than above) 18.1 GJ ▲5.7% Conventional oil water heater	16.3 GJ ▲15.1% Latent heat recovery oil water heater	13.4 GJ ▲30.2% Latent heat recovery oil water heater + piping method/hot water saving devices		
				15.3 GJ ▲20.3% Electric water heater with a natural refrigerant heat pump (medium boiling mode)			10.0 GJ ▲47.9% Solar water heating (solar water heating: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		11.3 GJ 0 Conventional device + continuous lighting while staying in the room + one-light-per-room system	7.4 GJ ▲34.5% High-efficiency device + on-off lighting + one-light-per-room system	6.1 GJ ▲46.1% High-efficiency device + lighting adjustment + one-light-per-room system	5.8 GJ ▲48.8% High-efficiency device + lighting adjustment + distributed multiple system (simplified/complete)	
Consumer electronics	High-efficiency consumer electronics		19.9 GJ 0 Conventional consumer electronics (made in 1997)	15.9 GJ ▲20% Energy-efficient products (500 kWh decrease)	11.9 GJ ▲40% Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		4.4 GJ Cooking stove or induction heating (IH) cooking heater (values are according to the results from a survey on cooking stove)				
Overall			68.6 GJ* 0	56.3. GJ − 40.7 GJ ▲17.9% − ▲40.7%			

Note 1: Upper values indicate annual primary energy consumption; lower values indicate energy consumption reduction rate (▲: reduction, +: increase).
Note 2: As for heating (heat pump air conditioner), the table shows primary energy consumption determined by the capacity of cooling (air conditioner) devices.
Note 3: With regard to domestic hot water, energy saving effects shown in the table (second row onward at level 0 as well as level 1 to 4) were confirmed for the types of machines used for validation experiments.
* When the duct system is used in the ventilation system planning.

2. Global warming impact

- The results of evaluating global warming impact (annual CO_2 emissions) are shown in Table 14.
- For each elemental technology, the Table shows the results of calculating annual CO_2 emissions at each level, CO_2 emissions reduction rates compared to level 0, and applied methods.

Table 14 Global warming impact evaluation results <Zone V>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	Heating and cooling system planning (Cooling through air conditioner)		226 kg 0 (Living/Dining room and kitchen) Cooling COP3 (Other habitable rooms) Cooling COP3	215 kg ▲5% (Living/Dining room and kitchen) Cooling COP4 (Other habitable rooms) Cooling COP3	192 kg ▲15% (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan (Other habitable rooms) Cooling COP3	170 kg ▲25% (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan *Appropriate device capacity setting (Other habitable rooms) Cooling COP3	147 kg ▲30% (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan *Appropriate device capacity setting (Other habitable rooms) Cooling COP3
Heating	Heating and cooling system planning (Heating through air conditioner)		198 kg 0 (Living/Dining room and kitchen) Heating COP4.14 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 0>	188 kg ▲5 % (Living/Dining room and kitchen) Heating COP5.20 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 1>	188 kg ▲5 % (Living/Dining room and kitchen) Heating COP5.20 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 1>	139 kg ▲30 % (Living/Dining room and kitchen) Heating COP6.22 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 4>	139 kg ▲30 % (Living/Dining room and kitchen) Heating COP6.22 (Master bedroom) Heating COP5.72 (Children ' s room) Heating COP5.65 <Heating level 4>
Ventilation	Ventilation system planning	Duct type	122 kg 0 Normal-efficiency fan (AC motor)	78 kg ▲36.1% Normal-efficiency fan (AC motor) Increased duct diameter	58 kg ▲52.5% High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	41 kg 0 Turbofan Outside air terminal: regular hood	34 kg ▲17.1% Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		966 kg (processed natural gas) 0 1138 kg (LPG) +17.8% Conventional gas water heater (An example other than above) 1211 GJ +25.4% Conventional oil water heater	819 kg (processed natural gas) ▲15.2% 963 kg (LPG) ▲0.3% Latent heat recovery gas water heater 1086 kg +12.4% Latent heat recovery oil water heater 637 kg ▲34.1% Electric water heater with a natural refrigerant heat pump (medium boiling mode)	675 kg (processed natural gas) ▲30.1% Latent heat recovery gas water heater + piping method/hot water saving devices 893 kg ▲7.6% Latent heat recovery oil water heater + piping method/hot water saving devices	503 kg +47.9% Electric water heater with a natural refrigerant heat pump (energy-efficient mode)	411 kg ▲57.5% Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/hot water saving devices 499 kg ▲48.3% Solar water heating (solar water heater: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		448 kg 0 Conventional device + continuous lighting while staying in the room + one-light-per-room system	294 kg ▲34.5% High-efficiency device +on/off lighting + one-light-per-room system	241 kg ▲46.1% High-efficiency device + lighting adjustment + one-light-per-room system	229 kg ▲48.8% High-efficiency device + lighting adjustment + distributed multiple system (simplified/complete)	
Consumer electronics	High-efficiency consumer electronics		789 kg 0 Conventional consumer electronics (made in 1997)	631 kg ▲20% Energy-efficient products (500 kWh decrease)	473 kg ▲40% Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		223 kg (processed natural gas) Cooking stove or IH cooking heater				
Overall			2,972 kg * 0	2,715 kg – 1,680 kg ▲8.6% – ▲43.5%			

Note 1: Upper values indicate annual CO_2 emissions (kg-CO_2); lower values indicate CO_2 emissions reduction rate (▲: reduction, +: increase).
Note 2: As for heating (heat pump air conditioner), the table shows CO_2 emissions determined by the capacity of cooling (air conditioner) devices.
Note 3: With regard to domestic hot water, CO_2 emissions were calculated based on the energy consumption of the types of machines used for validation experiments by using conversion factors listed in Table 7 and Table 8 on p.353. (value provided by Kyushu Electric Power Co., was used for the CO_2 emission coefficient)
* When the duct system is used in the ventilation system planning.

3. Economic efficiency

1) Initial cost

- The results of evaluating initial costs are shown in Table 15.
- For each elemental technology, the Table shows the results of calculating initial costs needed when methods at each level were applied, changes compared to the initial cost at level 0, and applied methods.

Table 15 Initial cost evaluation results <Zone V>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling Heating	Heating and cooling system planning (Air conditioner)		417,000 yen 0 (Living/Dining room and kitchen) Cooling COP3 (Other habitable rooms) Cooling COP3	461 ,000 yen + 44,000 yen (Living/Dining room and kitchen) Cooling COP4 (Other habitable rooms) Cooling COP3	477,000 yen + 60,000 yen (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan (Other habitable rooms) Cooling COP3	477,000 yen + 60,000 yen (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan * Appropriate device capacity setting (Other habitable rooms) Cooling COP3	477,000 yen + 60,000 yen (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan * Appropriate device capacity setting (Other habitable rooms) Cooling COP3
Ventilation	Ventilation system planning	Duct type	284,000 yen 0 Normal-efficiency fan (AC motor)	298,000 yen + 14,000 yen Normal-efficiency fan (AC motor) Increased duct diameter	386,000 yen + 102,000 yen High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	109,000 yen 0 Turbofan Outside air terminal: regular hood	109,000 yen ± 0,000 yen Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		483,000 yen 0 Conventional gas water heater (An example other than above) 528,000 yen + 45,000 yen Conventional oil water heater	544,000 yen + 61,000 yen Latent heat recovery gas water heater 580,000 yen + 97,000 yen Latent heat recovery oil water heater 916,000 yen + 433,000 yen Electric water heater with a natural refrigerant heat pump (medium boiling mode)	601,000 yen + 118,000 yen Latent heat recovery gas water heater + piping method/hot water saving devices 637,000 yen + 154,000 yen Latent heat recovery oil water heater + piping method/hot water saving devices	916,000 yen + 433,000 yen Electric water heater with a natural refrigerant heat pump (medium boiling mode)	973,000 yen + 490,000 yen Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/hot water saving devices 917,000 yen + 434,000 yen Solar water heating (solar water heater: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		484,000 yen 0 Conventional device + continuous lighting while staying in the room or on/off lighting + one-light-per-room system	539,000 yen + 55,000 yen High-efficiency device + on/off lighting + one-light-per-room system	574,000 yen +90,000 yen High-efficiency device + lighting adjustment + one-light-per-room system	734,000 yen +250,000 yen High-efficiency device + lighting adjustment + distributed multiple system (simplified)	
Consumer electronics	High-efficiency consumer electronics		— Conventional consumer electronics (made in 1997)	— Energy-efficient products (500 kWh decrease)	— Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		— Cooking stove or IH cooking heater				
Electricity	Photovoltaic power generation		0 0 Do not introduce	2,546,000 yen + 2,546,000 yen Approx. 3 kW	3,209,000 yen + 3,209,000 yen Approx. 4 kW		

Note 1: Upper values indicate initial cost (unit-price-based).
Lower values indicate increase or decrease in initial costs when the initial cost at level 0 is considered 0.
Note 2: As for cooling/heating (air conditioner), the table shows initial costs determined by the capacity of cooling devices.

2) Annual energy cost (running cost)

- The results of evaluating annual energy costs are shown in Table 16.
- For each elemental technology, the Table shows the results of calculating annual energy costs needed when methods at each level were applied, changes compared to the energy cost at level 0, and applied methods.

Table 16 Annual energy cost evaluation results <Zone V>

Use	Elemental technology		Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	Heating and cooling system planning (Cooling through air conditioner)		12,800 yen/year 0 (Living/Dining room and kitchen) Cooling COP3 (Other habitable rooms) Cooling COP3	12,200 yen/year − 600 yen/year (Living/Dining room and kitchen) Cooling COP4 (Other habitable rooms) Cooling COP3	10,900 yen/year − 1,900 yen/year (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan (Other habitable rooms) Cooling COP3	9,600 yen/year − 3,200 yen/year (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan * Appropriatedevice capacity setting (Other habitable rooms) Cooling COP3	8,400 yen/year − 4,400 yen (Living/Dining room and kitchen) Cooling COP5 + electric fan/ceiling fan * Appropriatedevice capacity setting (Other habitable rooms) Cooling COP3
Heating	Heating and cooling system planning (Heating through air conditioner)		11,300 yen/year 0 (Living/Dining room and kitchen) Heating COP4.14 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 0>	10,700 yen/year − 600 yen/year (Living/Dining room and kitchen) Heating COP5.20 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 1>	10,700 yen/year − 600 yen/year (Living/Dining room and kitchen) Heating COP5.20 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 1>	7,900 yen/year − 3,400 yen/year (Living/Dining room and kitchen) Heating COP6.22 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 4>	7,900 yen/year − 3,400 yen/year (Living/Dining room and kitchen) Heating COP6.22 (Master bedroom) Heating COP5.72 (Children's room) Heating COP5.65 <Heating level 4>
Ventilation	Ventilation system planning	Duct type	6,900 yen/year 0 Normal-efficiency fan (AC motor)	4,400 yen/year − 2,500 yen/year Normal-efficiency fan (AC motor) Increased duct diameter	3,300 yen/year − 3,600 yen/year High-efficiency fan (DC motor) Increased duct diameter		
		Through-the-wall type	2,300 yen/year 0 Turbofan Outside air terminal: regular hood	1,900 yen/year − 400 yen/year Turbofan Outside air terminal: Manufacturer verifies the combination			
Domestic hot water	Solar water heating Domestic hot water planning		103,000 yen/year 0 Conventional gas water heater (An example than above) 36,000 yen/year − 67,000 yen/year Conventional oil water heater	91,000 yen/year − 12,000 yen/year Latent heat recovery gas water heater	78,000 yen/year − 25,000 yen/year Latent heat recovery gas water heater + piping method/hot water saving devices	13,000 yen/year − 90,000 yen/year Electric water heater with a natural refrigerant heat pump (energy-efficient mode)	10,000 yen/year − 93,000 yen/year Electric water heater with a natural refrigerant heat pump (energy-efficient mode) + piping method/hot water saving devices
				33,000 yen/year − 70,000 yen/year Latent heat recovery oil water heater	27,000 yen/year − 76,000 yen/year Latent heat recovery oil water heater + piping method/hot water saving devices		
				16,000 yen/year − 92,000 yen/year Electric water heater with a natural refrigerant heat pump (medium boiling mode)			64,000 yen/year − 39,000 yen/year Solar water heating (solar water heater: flat plate type) + conventional gas water heater
Lighting	Lighting system planning		25,000 yen/year 0 Conventional device + continuous lighting while staying in the room or on/off lighting + one-light-per-room system	17,000 yen/year − 8,000 yen/year High-efficiency device + on/off lighting + one-light-per-room system	14,000 yen/year − 11,000 yen/year High-efficiency device + lighting adjustment + one-light-per-room system	13,000 yen/year − 12,000 yen/year High-efficiency device + lighting adjustment + distributed multiple system (simplified)	
Consumer electronics	High-efficiency consumer electronics		— Conventional consumer electronics (made in 1997)	— Energy-efficient products (500 kWh decrease)	— Energy-efficient products (1,000 kWh decrease)		
Cooking	Cooking devices		— Cooking stove or IH cooking heater				

Note 1: Upper values indicate annual energy cost.
Lower values indicate reduction in annual energy costs when the annual energy cost at level 0 is considered 0.
Note 2: As for heating (heat pump air conditioner), the table shows annual energy costs determined by the capacity of cooling (air conditioner) devices.

■Conditions for initial cost test calculation (Zone V)

①Cooling (Heating)

- Market prices of air conditioners were calculated based on the research results on the websites below (October, 2008).
  (1) img.yamada-denkiweb.com/item/list.php/special/2ct28/tm002/?lorder=1&ltype=1&Current_Page=1
  (2) www.yodobashi.com/enjoy/more/productslist/cat_162_539_9560938/moid_542185/sr_nm/9560884.html
- The number of air conditioners installed for each room and their capacities are as follows (See 3.1 on p.064).
  Living and dining rooms: 5 kW × 1 unit, Master bedroom: 2.8 kW × 1 unit, Children's room: 2.2 kW × 2 units
- Prices are all special prices listed on websites (including tax).
- With regard to air conditioner installation fees, we checked local consumer electronics stores and used the following prices (basic installation fee only, including tax).
  Capacity 2.8 kW or lower: 15,000 yen per unit, 2.9 kW or higher: 20,000 yen per unit
- As for electric fans, we checked local consumer electronics stores and used the price at 4,000 yen (including tax) per unit.

②Ventilation

- Regular prices listed in manufacturers' catalogues are used as unit prices, and local labor costs for the region in question are used for other prices (October, 2008).
- As for cut lengths (flexible pipes), converted unit prices for each unit of length were used.
- As for cost per man-hour, labor costs (electrical work) in the region in question are used for each specialist.
- With regard to the man-hours for labor costs, we assumed numbers within the bounds of common sense of equipment installation for a new detached house.
- Expenses regarding expendable supplies and miscellaneous materials, transportation cost and other expenses are not included.
- Prices do not include tax.

③Domestic hot water

- Regular prices listed in manufacturers' catalogues are used as unit prices, and local labor costs for the region in question are used for other prices (October, 2008).
- The range of estimates includes the water heater itself (including necessary items separately sold such as a remote control and circulation adaptor), piping around the water heater (water pipes, hot water pipes and gas pipes), piping and devices inside the building (kitchen faucets and bathroom shower faucets).
- As for cut lengths (each pipe), converted unit prices for each unit of length were used.
- As for cost per man-hour, labor costs (plumbing work, electrical work) in the region in question are used for each specialist.
- With regard to the man-hours for labor costs, we assumed numbers within the bounds of common sense of equipment installation for a new detached house.
- Expenses regarding expendable supplies and miscellaneous materials, transportation cost and other expenses are not included.
- Prices do not include tax.

④Lighting

- Regular prices listed in manufacturers' catalogues are used as unit prices (January, 2009).
- As for switches, their prices were calculated based on the cost component percentages listed in the existing "Design Guidelines for Low Energy Housing with Validated Effectiveness" (published in June, 2005).
- As for costs per man-hour, labor costs in the region in question are used for each specialist (October, 2008).
- Expenses regarding expendable supplies and miscellaneous materials, transportation cost and other expenses are not included.
- Prices do not include tax.

⑤Photovoltaic power generation

- The range of estimates includes costs of photovoltaic power generation system components, costs of wiring, processing and system installation, costs of electricity application and inspection, and other expenses. The same temporary scaffolding as that used when constructing the building is assumed to be used for the installation of the system.
- Prices do not include tax.

■Conditions for annual energy cost (running cost) test calculation (Zone V)

①Processed natural gas cost

・Processed natural gas costs were calculated based on the list of rates provided by Nihon Gas (http://www.nihongas.co.jp/). See Table.

Note 1: Calorific value: 46.04655 MJ/Nm^3

Note 2: Rate category B was applied.

Note 3: Basic rates were proportionally divided according to the composition ratio of each energy use listed in the reference energy consumption in Zone V (Kagoshima). See Table 2 on p.339.

Table: List of rates provided by Nihon Gas (Applicable period: Gas rates between April 2008 and September 2008) Unit: Yen (including tax)

Fee classification	Usage per month	Basic rate per month	Reconciliation unit price* per m^3	Base unit price per m^3
A	Up to 25 m^3	719.95	268.9994	258.3787
B	Up to 25 m^3 to 150 m^3	2,237.55	208.2464	197.6257
C	Over 150 m^3	6,731.55	178.2899	167.6692

Note 1: Unit price adjusted based on raw material costs; increase by 10.6207 yen/m^2 (unit price adjusted every six months according to changes in raw material costs).
Note 2: Gas rate = basic rate + (quantity consumed × reconciliation unit price).
* Reconciliation unit price = basic unit price + unit price adjusted based on raw material costs (Note 1); unit price used for calculating actual prices

②Kerosene cost

・Kerosene costs were calculated based on the price information provided by the Oil Information Center (http://oil-info.ieej.or.jp/).

* Research results in January 2009 were applied.

Retail price of kerosene at a gas station (Kagoshima): 1,323 yen/18 L

③Electricity cost

・Electricity costs for devices other than night heat storage devices were calculated based on the reference unit price of electric charges (22 yen/kWh including tax). Therefore, if there is a need to calculate the precise electricity energy cost, it is necessary to covert reference unit price provided by each electric power company.

* Reference unit price of electric charges: This is used for indicating electric charges specified in the manufacturing business display rules by the Home Electric Appliances Fair Trade Conference (http://www.eftc.or.jp/).

・Electricity costs for night heat storage devices were calculated based on “Denka de Night”, a seasonal and hourly rate lighting service offered by Kyushu Electric Power Co., Inc. (Table).

Note 1: Basic rates were proportionally divided according to the composition ratio of each energy use listed in the reference energy consumption in Zone V (Kagoshima). See Table 2 on p.339.

Note 2: A power distribution control discount for an electric water heater with a natural refrigerant heat pump (device capacity: 2 kW) can be applied.

Table: Denka de Night unit price table (Electric charges for meter reading in Jan. 2009; unit price adjusted based on fuel costs is 0.79 yen/kWh)

	Classification		Unit	Unit price(yen, including tax)
Basic charge	In the case of 6 kVA or lower		1 contract	1,155.00
	In the case of over 6 kVA	Up to 10 kVA	1 contract	1,575.00
		Over 10 kVA	Over 10 kVA	283.50
Electricity charge	Daytime	Summer	1 kWh	32.73
		Other seasons	1 kWh	27.23
	Active hours		1 kWh	20.55
	Nighttime		1 kWh	8.05
Discount for 8-hour rechargeable devices			1 kVA	210.00
Discount for 5-hour rechargeable devices			1 kVA	231.00
Minimum monthly charge			1 contract	420.00

Notes:
1. “Summer” is the season between July 1 and September 30; “Other seasons” means the rest of the year.
2. “Daytime” means the period of time between 10:00 and 17:00 every day.
3. “Active hours” mean the period of time between 8:00 and 10:00 and between 17:00 and 22:00 every day.
4. “Nighttime” means the period of time other than “Daytime” and “Active hours”.

Comment ● Prime energy and secondary energy

In addition to indicating energy consumption by primary energy conversion, there is a method of indicating it through secondary energy conversion. In this case, the electricity conversion factor is 3,600 kJ/kWh.

The ratio of the secondary energy conversion factor to the primary energy conversion factor (= 3,600 / 9,760 = 0.369) indicates the ratio of energy that is delivered as electricity to customers excluding any loss during power generation and transmission from the energy provided by fuels (oil and natural gas) used for generating power at a thermal power plant.

Since energy consumption at houses is sometimes labeled secondary energy, it is necessary to confirm whether it is labeled as primary or secondary energy.

Comment ● Method of calculating annual primary energy consumption based on utility bills

Electricity, gas and kerosene bills show each purchase volume. The units are kilowatts-hour (kWh) for electricity, cubic meters (m^3) for gas, and liters (L) for kerosene. Primary energy consumption, which is measured in joules (J), can be calculated by multiplying the purchase volume by the following primary energy conversion factor.

Electricity: 9,760 kJ/kWh

Gas: Processed natural gas 13A 62 MJ/m^3 (Okinawa)
Processed natural gas 13A 46 MJ/ m^3 (Kagoshima)

Kerosene: 37 MJ/L

For example, when 5,000 kWh electricity and 400 m^3 processed natural gas (13A) are used in Kagoshima, the primary energy consumption is as follows: 5,000 × 9.76 + 400 × 46 = 67,200 MJ = 67.2 GJ (1 GJ = 1,000 MJ; GJ reads "gigajoule" and MJ reads "megajoule").

6.3 Energy Consumption Estimation Methods and Design Calculation Examples

6.3.1 Overview of Energy Consumption Estimation Methods

In this section, we list the methods of estimating energy consumption (energy saving effect) that occurs when elemental technologies discussed in this document are employed. While the development of a more precise energy consumption estimation method is a task that we will continue to focus on in the future, the methods listed in this section allow us to know the rough guidelines of energy consumption and reduction in the designing process. Please make use of them since they can be used for reviewing design details as well as for making suggestions or giving explanations to owners.

From next page onward, we list two tables, "Quick reference for energy consumption ratio of elemental technology" and "Energy consumption calculation table", which can be used for energy consumption estimation.

- "Quick reference" is a table that allows you to check applicable methods for each elemental technology and the energy consumption ratio determined by such methods. This table, according to the contents of Chapter 3, 4 and 5, covers all conditions that are required for achieving each level including methods, except for the technology related to "treatment and efficient use of water and kitchen waste". The table summarizes the methods of elemental technologies for designing a house that aims to be LEHVE and the effects of the methods. Please make use of it.
- "Calculation table" is a table for estimating energy consumption for each energy use as well as the total energy consumption by using the energy consumption ratio of elemental technology obtained from "Quick reference". By comparing with the reference energy consumption, the energy consumption reduction rate can be estimated.

We list several types of "Quick reference" and "Calculation table" according to region as well as differences in the heating and cooling system operation, so please select the one that is appropriate. The types of tables listed are as follows.

Zone VI (6.3.2)

■Attached Table 1-1: Quick reference for energy consumption ratio of elemental technology (for Zone VI)

■Attached Table 1-2: Energy consumption calculation table (for Zone VI)

Zone V (6.3.3)

■Attached Table 2-1: Quick reference for energy consumption ratio of elemental technology (for Zone V in the case of partial intermittent heating and cooling)

■Attached Table 2-2: Energy consumption calculation table (for Zone V in the case of partial intermittent heating and cooling)

■Attached Table 3-1: Quick reference for energy consumption ratio of elemental technology (for Zone V in the case of whole-building continuous heating and cooling)

■Attached Table 3-2: Energy consumption calculation table (for Zone V in the case of whole-building continuous heating and cooling)

6.3.2 Energy Consumption Estimation Methods and Design Calculation Examples in Zone VI

■Attached Table 1-1: Quick reference for energy consumption ratio of elemental technology (for Zone VI)

Use	Reference energy consumption	Elemental technology*	Evaluation index/method		Energy consumption ratio (reference consumption is 1.0)				
					Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	10.3 GJ	Wind utilization/control (3.1)	Methods	(1) Opening area on cross ventilation route a: small, b: large (2) Opening area according to prevailing wind direction (3) High window a: small, b: large	1.0	0.96	0.91	0.88	
			Location 1	Wind speed 1m/s or more	☐Method not introduced	☐(1) a, (3) a	☐(1) b, (3) b	—	
			Location 2	Wind speed 1m/s or less	☐Method not introduced ☐(1) a, (3) a	☐(1) a + (2), (3) a + (2) ☐(1) b, (3) b	☐(1) b + (2) ☐(3) b + (2)	—	
				Wind speed 1 - 2m/s or less	☐Method not introduced	—	☐(1) a, (3) a ☐(1) a + (2), (3) a + (2)	☐(1) b, (3) b ☐(1) b + (2), (3) b + (2)	
				Wind speed 2m/s or more	☐Method not introduced	—	☐(1) a, (3) a	☐(1) a + (2), (3) a + (2) ☐(1) b, (3) b ☐(1) b + (2), (3) b + (2)	
		Solar shading method (4.2)	Methods	(1) Outside shading device (2) Envelope a: cavity ventilation, b: insulation, c: reflection	1.0	0.9	0.8	0.75	0.7
			Location 1	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation	☐(2) c: Reflection
				(1) Class 1 Class 2	☐No measures	☐(2) a: Cavity ventilation	—	—	☐(2) b: Insulation ☐(2) c: Reflection
				(1) Class 3	—	☐No measures	☐(2) a: Cavity ventilation		☐(2) b: Insulation ☐(2) c: Reflection
			Location 2	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection	—
				(1) Class 1	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation	☐(2) c: Reflection
				(1) Class 2 Class 3	—	☐No measures	☐(2) a: Cavity ventilation		☐(2) b: Insulation ☐(2) c: Reflection
			Location 3	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	☐(2) b: Insulation ☐(2) c: Reflection	—	—
				(1) Class 1	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection	—
				(1) Class 2	☐No measures	☐(2) a: Cavity ventilation	—	—	☐(2) b: Insulation ☐(2) c: Reflection
				(1) Class 3	☐No measures	☐(2) a: Cavity ventilation	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection
		Cooling system planning (5.1)	Methods	(1) High-efficiency air conditioner (COP) (2) Use of fan/ceiling fan	1.0	0.9	0.8	0.75	0.65
					☐COP3	☐COP4	☐COP3 + (2) ☐COP5	☐COP4 + (2)	☐COP5 + (2)
Ventilation	3.1 GJ 2.8 GJ	Ventilation system planning (5.3)	Duct ventilation	(1) Duct pressure loss decrease (2) High-efficiency device	1.0	0.7	0.5		
					☐Method not introduced	☐(1)	☐(1) + (2)		
			Through-the-wall ventilation	(1) Optimizing the combination of fan and outside air unit	1.0	0.8			
					☐Method not introduced	☐(1)			
Domestic hot water	13.8 GJ	Solar water heating (3.5)	Methods	(1) Heat collection area a: small, b: medium, c: large (2) Connection to auxiliary heat source a: none, b: three-way valve, c: solar connection unit (3) Energy-efficient circulating pump	1.0	0.9	0.7	0.5	0.3
					☐Conventional gas water heater	☐(1) a + (2) a	☐(1) a + (2) c ☐(1) b + (2) b	☐(1) b + (2) c ☐(1) b + (2) c + (3)	☐(1) c + (2) c ☐(1) c + (2) c + (3)
		Domestic hot water system planning (5.4)	Methods	(2)-1 Latent heat recovery water heater (2)-2 CO_2HP water heater (3) Piping method/hot water saving tools	1.0	0.9	0.8	—	0.6
					☐Conventional gas water heater	☐(2)-1 ☐(3)	☐(2)-1 + (3) ☐(2)-2 (medium boiling mode)	—	☐(2)-2 (energy-efficient mode) ☐(2)-2 (energy-efficient mode) + (3)
Lighting	13.6 GJ	Daylight utilization (3.2)	Conditions for daylighting	(1) Bi-directional daylighting for living/dining rooms (2) Bi-directional daylighting for living/dining/senior's rooms (3) Bi-directional daylighting for living/dining/senior's rooms + mono-directional daylighting for non-habitable room	1.0	0.97 - 0.98	0.95	0.9	
					☐Conditions for daylighting meeting with Building Standard Law	Location 1 ☐ (3)	—	—	
						Location 2 ☐ (2)	☐ (3)	—	
						Location 3 ☐ (1)	☐ (2)	☐ (3)	
		Lighting system planning (5.5)	Methods	(1) Method using device (2) Method using operation and control (3) Method using design	1.0	0.85	0.8	0.7	
					☐Conventional models	☐(1)	☐(1) + (2)	☐(1) + (2) + (3)	
Consumer electronics	21.4 GJ	Introduction of high-efficiency consumer electronics (5.6)	Guidelines for the year device was made		1.0	0.8	0.6		
					☐Year 2000 regular model (0 kWh)	☐Energy-efficient products (▲500 k/Wh)	☐Energy-efficient products (▲1,000 kWh) + standby power consumption decrease		
Other uses (cooking)	4.4 GJ				1.0				
					☐Cooking device				
Total	66.6 GJ 66.3 GJ								

Electricity		Photovoltaic power generation (3.3)	(Naha) Solar cell capacity		No reduction ☐Not to be introduced	33.7 GJ reduction ☐Approx. 3 kW	45.0 GJ reduction ☐Approx. 4 kW		

* Numbers in parentheses under each elemental technology indicate which section of Chapter 3, 4 or 5 describes it.

■Attached Table 1-2: Energy consumption calculation table (for Zone VI)

Use	Calculation formulas	Design value	Reference value	Reduction rate
Cooling	10.3 × (☐ × ☐ × ☐)	GJ	10.3J	
Ventilation	3.1 × ☐ (2.8)	GJ	3.1GJ (2.8GJ)	
Domestic hot water	13.8 × ☐ (Solar water heating or Domestic hot water system planning)	GJ	13.8GJ	
Lighting	13.6 × (☐ × ☐)	GJ	13.6GJ	
Consumer electronics	21.4 × ☐	GJ	21.4GJ	
Other uses (cooking)	4.4 × ☐	GJ	4.4GJ	
Subtotal		GJ	66.6GJ (66.3GJ)	

Electricity (reduction amount)	Power generation with solar cell (☐ 0.0 GJ ☐ 33.7 GJ ☐ 45.0 GJ)	▲ GJ		
Total		GJ	66.6GJ (66.3GJ)	

【Notes】

1. Common
(1) Reference energy consumption indicates rough estimate of annual energy consumption at reinforced concrete single-storey house for family of four located in Zone VI.
(2) Energy consumption ratio indicates energy consumption at each level when reference consumption is 0.
(3) Areas indicated by slash show that level is not set or no methods are applicable.
(4) Check off applicable method for each elemental technology and circle value of energy consumption ratio.
(5) Among elemental technologies, " 5.7 Treatment and Efficient Use of Water and Kitchen Waste " effective for water saving is exempt from estimation methods.

2. Cooling-related
(1) As for " Use and control of wind ", after selecting site conditions and outside wind speed, determine level from 1), 2) and 3) according to method used. Site conditions are classified into following two based on building coverage ratio of adjacent area (building coverage ratio of area with diameter of 50 m surrounding planned building).
Location 1: Urban location (building coverage ratio of adjacent area is over 20%)
Location 2: Suburban location (building coverage ratio of adjacent area is 20% or below)
(2) As for " Solar shading method ", after selecting site conditions and the class of outside shading device, determine level, either 1) or 2), according to method used. Site conditions are classified into following three based on horizontal distance to adjacent building in each direction.
Location 1: North and south – within 6 m; East and west – within 3 m
Location 2: North and south – over 6 m and within 10 m; East and west – over 3 m and within 6 m
Location 3: All directions – over 10 m
Outside shading device class is divided into following three according to setting of the overhang in each direction (distance between window and overhang: Y1, window height: Y2, projection of overhang: Z, block with decorative openings). (As for distance between window and overhang, only north direction of class 1 is Y1 = 0, and others are Y1≤400.)
Class 1: North - Y2~900, Z≥200; east - Y2≤1,300, Z≥600; south - Y2≤2,000, Z≥1,000; west - Y2≤1,300, Z≥1,000
Class 2: North - Y2~900, Z≥600; east - Y2~1,300, Z≥1,000; south - Y2≤2,000, Z≥1,500; west - Y2≤1,300, Z≥1,500
Class 3: North - Y2~900, Z≥600; east - Y2≤1,300, Z≥1,000; south - Y2≤2,000, Z≥1,500; west - Y2≤1,300, Z≥1,500, block with decorative openings)
(3) For "Cooling system planning", determine level according to which method is applied out of 1) and 2).

3. Ventilation-related
For "Ventilation system planning", determine level according to applied method after selecting ventilation system (duct system, through-the-wall system).

4. Domestic-hot-water-related
(1) For "Solar water heating", determine level according to which method is applied out of 1), 2) and 3).
(2) For "Domestic hot water system planning", determine level according to which method is applied out of 2) and 3).

5. Lighting-related
(1) For "Daylight utilization", determine level according to daylighting conditions of room after selecting site conditions. As for daylighting conditions, "LD" refers to living and dining rooms, "S/C" refers to seniors'/children's rooms, and "non-habitable room" refers to kitchen, hallway, entrance, washing room, bathroom and toilet. Site conditions are classified into following three.
Location 1: Location where sunlight utilization is difficult due to surrounding high-rise, dense buildings
Location 2: Location where creative measures are required for sunlight utilization due to dense surrounding buildings
Location 3: Suburban location where sunlight utilization is easy
(2) For "Lighting system planning", please determine level according to which method is applied out of 1), 2) and 3).

6. Consumer-electronics-related
For "Introduction of high-efficiency consumer electronics", determine level according to manufacturing year or annual electricity consumption reduction (assuming products that were owned around year 2000 as standard) of prime consumer electronics (refrigerator, television) and priority consumer electronics (hot water heated toilet seat, electric hot water pot, washing machine).

7. Other uses (cooking)
Since target cooking energy consumption does not vary significantly by device, use the reference value, 4.4 GJ.

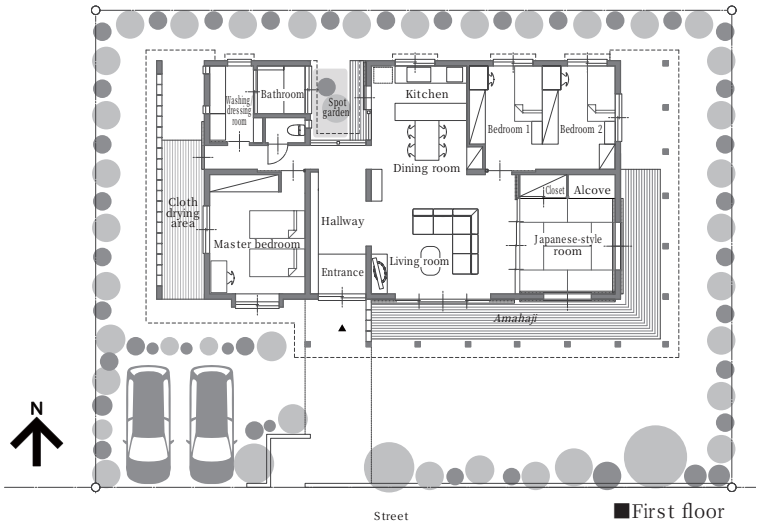
8. Electricity-related
When "Photovoltaic power generation" is adopted, select reduction (power generation) of primary energy consumption estimated based on region and solar cell capacity. Quick reference shows reduction in Naha (For reduction in other regions, see 3.3 on p.085).

9. Description in calculation table
(1) In calculation formula column, write down energy consumption ratio of each elemental technology determined in quick reference. Energy consumption design value and reduction rate can be calculated for each use.
(2) In total section, write down total of energy consumption design values, from cooling to other uses (cooking). In grand total section, write down grand total of design values obtained by subtracting electricity reduction through photovoltaic power generation.

[Zone VI: Design calculation example 1]

◆Building outline

■Design specifications
Structure: Reinforced concrete
Number of stories: One-story house
Site area: 432.0 m² (4,650 ft2)
Building area: 185.5 m² (1,996.7 ft2)
Total floor area: 145.3 m² (1,564 ft2)
Family structure: Husband and wife with two children



■First floor plan view

◆Design process outline

Design procedure I
Understanding given conditions and required conditions

Site is located in suburb of Naha. Density of surrounding buildings is low, which makes it highly possible to use natural energy.
With regard to occupant's awareness, "level of dedication to natural living" is high while "level of dedication to a stable indoor environment" is low. Occupant seeks traditional nature-oriented lifestyle or nature-oriented lifestyle.

Design procedure II
Setting design goals and policies

Maximize measures for architectural techniques (natural energy application technology, heat control technology of building envelope).
Aim to introduce highly efficient devices with regard to mechanical techniques (energy-efficient equipment technology) in certain areas (domestic hot water, consumer electronics).
Through above-mentioned efforts, strive to achieve energy reduction rate of approx. 30%.

Design procedure III
Creating design model

Reinforced concrete single-storey building has structure where three rooms are located in direction of south-facing frontage. Make connection of rooms as open as possible.
As for outside perimeter, place deep overhangs on south and east sides and block with decorative openings on west side.

(Application of main elemental technologies)

● Use and control of wind / Level 3
Condition Location 2: Suburban location (building coverage ratio of adjacent area is 20% or below), outside wind speed of 2 m/s or higher in summer
Method applied Use combination of patio doors and waist-level windows for exterior opening, and apply method 1a (combination of small opening areas). In addition, place one surface of opening in prevailing wind direction and adopt method 2.
● Solar shading method / Level 4
Condition Location 3: Horizontal distance to adjacent buildings, etc., is over 10 m
Method applied Outside shading device class 3: place over 1,500 mm deep overhangs on south and east sides and block with decorative openings on west side. Solar shading measures for envelope: coat roof surface with finishing material that offers 0.7 or higher solar reflectance (since maintenance of roof surface is relatively easy because it is single-storey building). (M value: 0.096)
● Daylight utilization / Level 3
Condition Location 3: Location where sunlight utilization is easy
Method applied Ensure bi-directional daylighting for living and dining rooms, seniors'room (Japanese-style room assumed) and children's room and mono-directional daylighting for secondary rooms (daylighting condition 3 achieved).

Design procedure IV
Analyze design model and verify effects

Energy efficiency: approx. 32%
Cost: Number of years for recovery – approx. 9.4 years (cooling, ventilation, domestic hot water, lighting)

◆Verification of energy efficiency

■Attached Table 1-1: Quick reference for energy consumption ratio of elemental technology (for Zone VI) – Case 1

Use	Energy reference consumption	Elemental technology*	Evaluation index/method		Energy consumption ratio (reference consumption is 1.0)				
					Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	10.3 GJ	Wind utilization/control (3.1)	Methods	(1) Opening area on cross ventilation route a: small, b: large (2) Opening area according to prevailing wind direction (3) High window a: small, b: large	1.0	0.96	0.91	0.88	
			Location 1	Wind speed 1m/s or more	☐Method not introduced	☐(1) a, (3) a	☐(1) b, (3) b	—	
			Location 2	Wind speed 1m/s or less	☐Method not introduced ☐(1) a, (3) a	☐(1) a + (2), (3) a + (2) ☐(1) b, (3) b	☐(1) b + (2) ☐(3) b + (2)	—	
				Wind speed 1 - 2m/s or less	☐Method not introduced	—	☐(1) a, (3) a ☐(1) a + (2), (3) a + (2)	☐(1) b, (3) b ☐(1) b + (2), (3) b + (2)	
				Wind speed 2m/s or more	☐Method not introduced	—	☐(1) a, (3) a	☑(1) a + (2), (3) a + (2) ☐(1) b, (3) b ☐(1) b + (2), (3) b + (2)	
		Solar shading method (4.2)	Methods	(1) Outside shading device (2) Envelope a: cavity ventilation, b: insulation, c: reflection	1.0	0.9	0.8	0.75	0.7
			Location 1	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation	☐(2) c: Reflection
				(1) Class 1 Class 2	☐No measures	☐(2) a: Cavity ventilation	—	—	☐(2) b: Insulation ☐(2) c: Reflection
				(1) Class 3	—	☐No measures	☐(2) a: Cavity ventilation		☐(2) b: Insulation ☐(2) c: Reflection
			Location 2	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection	—
				(1) Class 1	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation	☐(2) c: Reflection
				(1) Class 2 Class 3	—	☐No measures	☐(2) a: Cavity ventilation		☐(2) b: Insulation ☐(2) c: Reflection
			Location 3	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	☐(2) b: Insulation ☐(2) c: Reflection	—	—
				(1) Class 1	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection	—
				(1) Class 2	☐No measures	☐(2) a: Cavity ventilation	—	—	☐(2) b: Insulation ☐(2) c: Reflection
				(1) Class 3	☐No measures	☐(2) a: Cavity ventilation	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☑(2) c: Reflection
		Cooling system planning (5.1)	Methods	(1) High-efficiency air conditioner (COP) (2) Use of fan/ceiling fan	1.0	0.9	0.8	0.75	0.65
					☐COP3	☐COP4	☐COP3 + (2) ☐COP5	☑COP4 + (2)	☐COP5 + (2)
Ventilation	3.1 GJ	Ventilation system planning (5.3)	Duct ventilation	(1) Duct pressure loss decrease (2) High-efficiency device	1.0	0.7	0.5		
					☐Method not introduced	☑(1)	☐(1) + (2)		
	2.8 GJ		Through-the-wall ventilation	(1) Optimizing the combination of fan and outside air unit	1.0	0.8			
					☐Method not introduced	☐(1)			
Domestic hot water	13.8 GJ	Solar water heating (3.5)	Methods	(1) Heat collection area a: small, b: medium, c: large (2) Connection to auxiliary heat source a: none, b: three-way valve, c: solar connection unit (3) Energy-efficient circulating pump	1.0	0.9	0.7	0.5	0.3
					☐Conventional gas water heater	☐(1) a + (2) a	☐(1) a + (2) c ☐(1) b + (2) b	☐(1) b + (2) c ☐(1) b + (2) c + (3)	☐(1) c + (2) c ☐(1) c + (2) c + (3)
		Domestic hot water system planning (5.4)	Methods	(2)-1 Latent heat recovery water heater (2)-2 CO_2HP water heater (3) Piping method/hot water saving tools	1.0	0.9	0.8	—	0.6
					☐Conventional gas water heater	☐(2)-1 ☐(3)	☑(2)-1 + (3) ☐(2)-2 (medium boiling mode)	—	☐(2)-2 (energy-efficient mode) ☐(2)-2 (energy-efficient mode) + (3)
Lighting	13.6 GJ	Daylight utilization (3.2)	Conditions for daylighting	(1) Bi-directional daylighting for living/dining rooms (2) Bi-directional daylighting for living/dining/senior's rooms (3) Bi-directional daylighting for living/dining/senior's rooms + mono-directional daylighting for non-habitable room	1.0	0.97 - 0.98	0.95	0.9	
					☐Conditions for daylighting meeting with Building Standard Law	Location 1 ☐ (3)	—	—	
						Location 2 ☐ (2)	☐ (3)	—	
						Location 3 ☐ (1)	☐ (2)	☑ (3)	
		Lighting system planning (5.5)	Methods	(1) Method using device (2) Method using operation and control (3) Method using design	1.0	0.85	0.8	0.7	
					☐Conventional models	☐(1)	☑(1) + (2)	☐(1) + (2) + (3)	
Consumer electronics	21.4 GJ	Introduction of high-efficiency consumer electronics (5.6)	Guidelines for the year device was made		1.0	0.8	0.6		
					☐Year 2000 regular model (0 kWh)	☐Energy-efficient products (▲500 k/Wh)	☑Energy-efficient products (▲1,000 kWh) + standby power consumption decrease		
Other uses (cooking)	4.4 GJ				1.0				
					☑Cooking device				
Total	66.6 GJ								
	66.3 GJ								

Electricity		Photovoltaic power generation (3.3)	(Naha)		No reduction	33.7 GJ reduction	45.0 GJ reduction		
			Solar cell capacity		☑Not to be introduced	☐Approx. 3 kW	☐Approx. 4 kW		

* Numbers in parentheses under each elemental technology indicate which section of Chapter 3, 4 or 5 describes it.

■Attached Table 1-2: Energy consumption calculation table (for Zone VI) – Case 1

Use	Calculation formulas	Design value	Reference value	Reduction rate
Cooling	10.3 × (0.88 × 0.70 × 0.75)	4.76GJ	10.3GJ	53.8%
Ventilation	3.1 × 0.70	2.17GJ	3.1GJ	30.0%
Domestic hot water	13.8 × 0.80 (Solar water heating or Domestic hot water system planning)	11.04GJ	13.8GJ	20.0%
Lighting	13.6 × (0.90 × 0.80)	9.79GJ	13.6GJ	28.0%
Consumer electronics	21.4 × 0.60	12.84GJ	21.4GJ	40.0%
Other uses (cooking)	4.4 × 1.0	4.4GJ	4.4GJ	0.0%
Subtotal		45.0GJ	66.6GJ	32.4%

Electricity (reduction amount)	Power generation with solar cell (☑ 0.0 GJ ☐ 33.7 GJ ☐ 45.0 GJ)	▲ 0.0GJ		
Total		45.0GJ	66.6GJ	32.4%

・Energy performance (annual primary energy consumption reduction rate) is approx. 32.4%.

◆Verification of cost

・With regard to each elemental technology and method applied, mainly estimate the initial cost and annual energy cost of equipment. As for use of wind, solar shading method, daylight utilization and consumer electronics, their verification is not included as evaluating increases in initial cost is difficult.

・Based on the results of cost evaluation listed in Table 11 and Table 12, the table below shows the increase in initial cost and the decrease in annual energy cost in each energy use while considering standard housing around 2000 as a basis. In this case, the number of years (simple payback time) required for recovering the increase in initial cost through the reduction of energy cost is approx. 9.4 years.

・Initial cost increase: approx. 348,000 yen

・Annual energy cost reduction: approx. 37,000 yen per year

・Number of years for recovery (simple payback time)

= Initial cost increase (yen) / annual energy cost reduction (yen per year)

= 348,000 yen / 37,000 yen per year

= 9.4 years

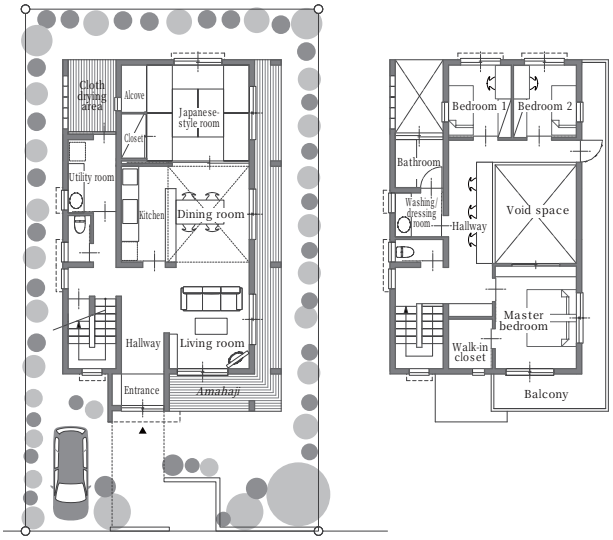
Initial cost and energy cost increase and decrease (Case 1)

Application	Initial cost increase	Annual energy cost reduction
Cooling Level 3	56,000 yen	7,000 yen/year
Ventilation Level 1	1,000 yen	3,000 yen/year
Domestic hot water Level 2	118,000 yen	20,000 yen/year
Lighting Level 2	173,000 yen	7,000 yen/year
Total	348,000 yen	37,000 yen/year

[Zone VI: Design calculation example 2]

◆Building outline

■Design specifications
Structure: Reinforced concrete
Number of stories: Two-story house
• Lot area: 215.6 m² (2,320.7 ft2)
• Building area: 102.3 m² (1,101.1 ft2)
• Total floor area: 147.8 m² (1,590.9 ft2)
Family structure: Husband and wife with two children



◆Design process outline

Design procedure I
Understanding given conditions and required conditions

Site is located in downtown of Naha. Density of surrounding buildings is relatively high, which makes it necessary to take creative measures when it comes to use of natural energy.
With regard to occupant's awareness, "level of dedication to natural living" is slightly high while "level of dedication to a stable indoor environment" is moderate. Occupant seeks nature-oriented lifestyle or machine-oriented lifestyle.

Design procedure II
Setting design goals and policies

Implement measures for architectural techniques (natural energy application technology, heat control technology of building envelope) as far as possible. As for solar shading, make as much effort as possible while taking shading effect by surrounding buildings into consideration.
Aim to introduce highly efficient devices as much as possible with regard to mechanical techniques (energy-efficient equipment technology).
Through above-mentioned efforts, strive to achieve energy reduction rate of approx. 40%.

Design procedure III
Creating design model

It is reinforced concrete two-storey building. Due to shape of site, the building has narrow south-facing frontage and greater depth.
Create void space at center so that continuity of first and second floors will be enhanced. Create high window at top of void space to promote cross ventilation and daylight utilization in dense residential area.

(Application of main elemental technologies)

● Use and control of wind / Level 1
Condition Location 1: Urban location (building coverage ratio of adjacent area is over 20%), outside wind speed of 1 m/s or higher in summer
Method applied Use combination of patio doors and waist-level windows for exterior opening, and apply method 1a (combination of small opening areas). (In addition, place top side window as high window, at top of void space and adopt method 3a.)
● Solar shading method / Level 2
Condition Location 1: Horizontal distance to adjacent buildings, etc., is 6 m or 3 m .
Method applied Outside shading device class 1: place over 1,000 mm deep overhangs on south and east sides. Solar shading measures for envelope: place spreading block on roof to secure ventilated cavity on roof (M value: 0.095).
● Daylight utilization / Level 2
Condition Location 2: Location where creative measures are required for sunlight utilization
Method applied Ensure bi-directional daylighting for living and dining rooms, seniors' room (Japanese-style room assumed) and children's room and mono-directional daylighting for non-habitable rooms (daylighting condition 3 achieved).

Design procedure IV
Analyze design model and verify effects

Energy efficiency: approx. 38%
Cost: Number of years for recovery – approx. 10.6 years (cooling, ventilation, domestic hot water, lighting)

◆Verification of energy efficiency

■Attached Table 1-1: Quick reference for energy consumption ratio of elemental technology (for Zone VI) – Case

Use	Reference energy consumption	Elemental technology*	Evaluation index/method		Energy consumption ratio (reference consumption is 1.0) Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	10.3 GJ	Wind utilization/control (3.1)	Methods	(1) Opening area on cross ventilation route a: small, b: large (2) Opening area according to prevailing wind direction (3) High window a: small, b: large	1.0	0.96	0.91	0.88	
			Location 1	Wind speed 1m/s or more	☐Method not introduced	☑(1) a, (3) a	☐(1) b, (3) b	—	
			Location 2	Wind speed 1m/s or less	☐Method not introduced ☐(1) a, (3) a	☐(1) a + (2), (3) a + (2) ☐(1) b, (3) b	☐(1) b + (2) ☐(3) b + (2)	—	
				Wind speed 1 - 2m/s or less	☐Method not introduced	—	☐(1) a, (3) a ☐(1) a + (2), (3) a + (2)	☐(1) b, (3) b ☐(1) b + (2), (3) b + (2)	
				Wind speed 2m/s or more	☐Method not introduced	—	☐(1) a, (3) a	☐(1) a + (2), (3) a + (2) ☐(1) b, (3) b ☐(1) b + (2), (3) b + (2)	
		Solar shading method (4.2)	Methods	(1) Outside shading device (2) Envelope a: cavity ventilation, b: insulation, c: reflection	1.0	0.9	0.8	0.75	0.7
			Location 1	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation	☐(2) c: Reflection
				(1) Class 1 Class 2	☐No measures	☐(2) a: Cavity ventilation	—	—	☐(2) b: Insulation ☐(2) c: Reflection
				(1) Class 3	—	☐No measures	☑(2) a: Cavity ventilation		☐(2) b: Insulation ☐(2) c: Reflection
			Location 2	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection	—
				(1) Class 1	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation	☐(2) c: Reflection
				(1) Class 2 Class 3	—	☐No measures	☐(2) a: Cavity ventilation		☐(2) b: Insulation ☐(2) c: Reflection
			Location 3	(1) Class 0	☐No measures	☐(2) a: Cavity ventilation	☐(2) b: Insulation ☐(2) c: Reflection	—	—
				(1) Class 1	☐No measures	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection	—
				(1) Class 2	☐No measures	☐(2) a: Cavity ventilation	—	—	☐(2) b: Insulation ☐(2) c: Reflection
				(1) Class 3	☐No measures	☐(2) a: Cavity ventilation	☐(2) a: Cavity ventilation	—	☐(2) b: Insulation ☐(2) c: Reflection
		Cooling system planning (5.1)	Methods	(1) High-efficiency air conditioner (COP) (2) Use of fan/ceiling fan	1.0	0.9	0.8	0.75	0.65
					☐COP3	☐COP4	☐COP3 + (2) ☐COP5	☐COP4 + (2)	☑COP5 + (2)
Ventilation	3.1 GJ	Ventilation system planning (5.3)	Duct ventilation	(1) Duct pressure loss decrease (2) High-efficiency device	1.0	0.7	0.5		
					☐Method not introduced	☐(1)	☑(1) + (2)		
	2.8 GJ		Through-the-wall ventilation	(1) Optimizing the combination of fan and outside air unit	1.0	0.8			
					☐Method not introduced	☐(1)			
Domestic hot water	13.8 GJ	Solar water heating (3.5)	Methods	(1) Heat collection area a: small, b: medium, c: large (2) Connection to auxiliary heat source a: none, b: three-way valve, c: solar connection unit (3) Energy-efficient circulating pump	1.0	0.9	0.7	0.5	0.3
					☐Conventional gas water heater	☐(1) a + (2) a	☐(1) a + (2) c ☐(1) b + (2) b	☐(1) b + (2) c ☐(1) b + (2) c + (3)	☐(1) c + (2) c ☐(1) c + (2) c + (3)
		Domestic hot water system planning (5.4)	Methods	(2)-1 Latent heat recovery water heater (2)-2 CO_2HP water heater (3) Piping method/hot water saving tools	1.0	0.9	0.8	—	0.6
					☐Conventional gas water heater	☐(2)-1 ☐(3)	☐(2)-1 + (3) ☐(2)-2 (medium boiling mode)	—	☐(2)-2 (energy-efficient mode) ☑(2)-2 (energy-efficient mode) + (3)
Lighting	13.6 GJ	Daylight utilization (3.2)	Conditions for daylighting	(1) Bi-directional daylighting for living/dining rooms (2) Bi-directional daylighting for living/dining/senior's rooms (3) Bi-directional daylighting for living/dining/senior's rooms + mono-directional daylighting for non-habitable room	1.0	0.97 - 0.98	0.95	0.9	
					☐Conditions for daylighting meeting with Building Standard Law	Location 1 ☐ (3)	—	—	
						Location 2 ☐ (2)	☑ (3)	—	
						Location 3 ☐ (1)	☐ (2)	☐ (3)	
		Lighting system planning (5.5)	Methods	(1) Method using device (2) Method using operation and control (3) Method using design	1.0	0.85	0.8	0.7	
					☐Conventional models	☐(1)	☐(1) + (2)	☑(1) + (2) + (3)	
Consumer electronics	21.4 GJ	Introduction of high-efficiency consumer electronics (5.6)	Guidelines for the year device was made		1.0	0.8	0.6		
					☐Year 2000 regular model (0 kWh)	☐Energy-efficient products (▲500 k/Wh)	☑Energy-efficient products (▲1,000 kWh) + standby power consumption decrease		
Other uses (cooking)	4.4 GJ				1.0				
					☑Cooking device				
Total	66.6 GJ								
	66.3 GJ								

Electricity		Photovoltaic power generation (3.3)	(Naha)	No reduction	33.7 GJ reduction	45.0 GJ reduction		
			Solar cell capacity	☑Not to be introduced	☐Approx. 3 kW	☐Approx. 4 kW		

* Numbers in parentheses under each elemental technology indicate which section of Chapter 3, 4 or 5 describes it.

■Attached Table 1-2: Energy consumption calculation table (for Zone VI) – Case 2

Use	Calculation formulas	Design value	Reference value	Reduction rate
Cooling	10.3 × (0.96 × 0.8 × 0.65)	5.14GJ	10.3GJ	50.1%
Ventilation	3.1 × 0.5	1.55GJ	3.1GJ	50.0%
Domestic hot water	13.8 × 0.5 (Solar water heating or Domestic hot water system planning)	6.9GJ	13.8GJ	50.0%
Lighting	13.6 × (0.95 × 0.7)	9.04GJ	13.6GJ	33.5%
Consumer electronics	21.4 × 0.6	12.84GJ	21.4GJ	40.0%
Other uses (cooking)	4.4 × 1.0	4.4GJ	4.4GJ	0.0%
Subtotal		39.9GJ	66.6GJ	40.1%
Electricity (reduction amount)	Power generation with solar cell (☑ 0.0 GJ ☐ 33.7 GJ ☐ 45.0 GJ)	▲ 0.0GJ		
Total		39.9GJ	66.6GJ	40.1%

・Energy performance (annual primary energy consumption reduction rate) is approx. 38.0%.

◆Verification of cost

- With regard to each elemental technology and method applied, mainly estimate the initial cost and annual energy cost of equipment. As for use of wind, solar shading method, daylight utilization and consumer electronics, their verification is not included as evaluating increases in initial cost is difficult.
- Based on the results of cost evaluation listed in Table 11 and Table 12, the table below shows the increase in initial cost and the decrease in annual energy cost in each energy use while considering standard housing around 2000 as a basis. In this case, the number of years (simple payback time) required for recovering the increase in initial cost through the reduction of energy cost is approx. 10.6 years.
- Initial cost increase: approx. 1,050,000 yen
- Annual energy cost reduction: approx. 99,000 yen per year
- Number of years for recovery (simple payback time)

  = Initial cost increase (yen) / annual energy cost reduction (yen per year)

  = 1,050,000 yen / 99,000 yen per year

  = 10.6 years

Increase and decrease in initial cost and energy cost (Case 2)

Application	Initial cost increase	Annual energy cost reduction
Cooling Level 4	203,000 yen	9,000 yen/year
Ventilation Level 2	89,000 yen	4,000 yen/year
Domestic hot water Level 4	490,000 yen	76,000 yen/year
Lighting Level 3	268,000 yen	10,000 yen/year
Total	1,050,000 yen	99,000 yen/year

6.3.3 Energy Consumption Estimation Methods and Design Calculation Examples in Zone V

■Attached Table 2-1: Quick reference for energy consumption ratio of elemental technology (for Zone V / in the case of partial intermittent heating and cooling)

Use	Reference energy consumption	Elemental technology*	Evaluation index/method		Energy consumption ratio (reference consumption is 1.0) Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	5.7 GJ	Wind utilization/ control (3.1)	Methods	(1) Opening area on cross ventilation route a: small, b: large (2) Opening area according to prevailing wind direction (3) High window a: small, b: large	1.0	0.95	0.88	0.82	
			Location 1	Wind speed 1m/s or more	☐Method not introduced	☐ (1) a, (3) a	☐ (1) b, (3) b	—	
			Location 2	Wind speed 1m/s or less	☐ Method not introduced ☐ (1) a, (3) a	☐ (1) a + (2), (3) a + (2) ☐ (1) b, (3) b	☐ (1) b + (2) ☐ (3) b + (2)	—	
				Wind speed 1 - 2m/s or less	☐ Method not introduced	—	☐ (1) a, (3) a ☐ (1) a + (2), (3) a + (2)	☐ (1) b, (3) b ☐ (1) b + (2), (3) b + (2)	
				Wind speed 2m/s or more	☐ Method not introduced	—	☐ (1) a, (3) a	☐ (1) a + (2), (3) a + (2) ☐ (1) b, (3) b ☐ (1) b + (2), (3) b + (2)	
		Solar shading method (4.3)	Direction of main opening surface	South	1.0	0.85	0.7	0.55	
				Southeast or southwest	1.3	0.8	0.75	0.65	
				East or west	1.1	0.8	0.75	0.65	
			Solar penetration rate of opening	True north ±30° Other than the above °	☐ Approx. 0.79	☐ 0.79 or less	☐ 0.55 or less	☐ 0.55 or less	
					☐ Approx. 0.79	☐ 0.60 or less	☐ 0.45 or less	☐ 0.30 or less	
		Heating and cooling system planning (cooling) (5.2)	Air conditioner	(1) High-efficiency air conditioner (ratedefficiency) (2) Adjustment of device capacity (3) Use of fan/ceiling fan	1.0	0.95	0.85	0.75	0.65
			Other habitable rooms: Class 0	☐ (1) (<3.8) ☐ (1) (<3.7) + (2) ☐ (1) (<3.3) + (3) ☐ (1) (<3.2) + (2) + (3)	LDK: Class 0 ☐ (1) (<3.5) ☐ (1) (<3.0) + (3)	LDK: Class 1 ☐ (1) (≧3.5) ☐ (1) (≧3.0) + (3)	LDK: Class 3 ☐ (1) (≧5.6) ☐ (1) (≧3.7) + (2) ☐ (1) (≧4.9) + (3) ☐ (1) (≧3.2) + (2) + (3)	LDK: Class 5 ☐ (1) (≧5.3) + (2) ☐ (1) (≧4.9) + (2) + (3)	
			Other habitable rooms: Class 1	☐ (1) (≧3.8) ☐ (1) (≧3.7) + (2) ☐ (1) (≧3.3) + (3) ☐ (1) (≧3.2) + (2) + (3)	—	LDK: Class 0 ☐ (1) (<3.5) ☐ (1) (<3.0) + (3)	LDK: Class 2 ☐ (1) (≧4.3) ☐ (1) (<3.7) + (2) ☐ (1) (≧3.7) + (3) ☐ (1) (<3.2) + (2) + (3)	LDK: Class 4 ☐ (1) (≧4.4) + (2) ☐ (1) (≧3.9) + (2) + (3)	
			Other habitable rooms: Class 2	☐ (1) (≧5.1) ☐ (1) (≧4.9) + (2) ☐ (1) (≧5.0) + (3) ☐ (1) (≧4.8) + (2) + (3)	—	—	LDK: Class 1 ☐ (1) (≧3.5) ☐ (1) (≧3.0) + (3)	LDK: Class 3 ☐ (1) (≧5.6) ☐ (1) (≧3.7) + (2) ☐ (1) (≧4.9) + (3) ☐ (1) (≧3.2) + (2) + (3)	LDK: Class 5 ☐ (1) (≧5.3) + (2) ☐ (1) (≧4.9) + (2) + (3)
Heating	5.0 GJ	Insulated building envelope planning (4.1)	Energy conservation standard		1.0	0.7	0.5	0.45	0.35
					☐ 1980 Standard	☐ 1992 Standard	☐ Intermediate of 1992 and 1999 Standards	☐ 1999 Standard	☐ Exceeding 1999 Standard
		Solar radiation heat utilization (3.4)	Methods	(1) Improvement of opening insulation (2) Increase in heat collection area (3) Heat storage	1.0	0.95	0.9	0.8	0.6
			Zone E	Location 2 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1) + (2)	☐ (1) + (2) + (3)	
						☐ (1) + (2)	☐ (1) + (2) + (3)		
				Location 3 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1), (2)	☐ (1) + (3)	☐ (1) + (2) ☐ (1) + (2) + (3)
						—	☐ (1), (1) + (3)	☐ (1) + (2)	☐ (1) + (2) + (3)
			Zone D* Zone C*	Location 2 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1) + (2)		
						☐ (1) + (2) ☐ (1) + (2) + (3)			
				Location 3 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	☐ (2)	☐ (1), (1) + (3)	☐ (1) + (2)	☐ (1) + (2) + (3)
						—	☐ (1), (1) + (3)	☐ (1) + (2) ☐ (1) + (2) + (3)	
		Heating and cooling system planning (heating) (5.2)	Air conditioner (LDK)	(1) High-efficiency air conditioner (rated efficiency) (2) Adjustment of device capacity	1.0	0.95	0.85	0.75	0.7
					☐ (1) (<4.9)	☐ (1) + (≧4.9) ☐ (1) (<4.0) + (2)	☐ (1) (≧4.0) + (2)	☐ (1) (≧5.3) + (2)	☐ (1) (≧6.2) + (2)
Ventilation	3.1 GJ	Ventilation system planning (5.3)	Duct ventilation	(1) Duct pressure loss decrease (2) High-efficiency device	1.0	0.6	0.5		
	1.0 GJ				☐ Method not introduced	☐ (1)	☐ (1) + (2)		
			Through-the-wall ventilation	(1) Optimizing the combination of fan and outside air unit	1.0	0.8			
					☐ Method not introduced	☐ (1)			
Domestic hot water	19.2 GJ	Solar water heating (3.5)	Methods	(1) Heat collection area a: small, b: medium, c: large (2) Connection to auxiliary heat source a: none, b: three-way valve, c: solar connection unit (3) Energy-efficient circulating pump	1.0	0.9	0.7	0.5	0.3
					☐ Conventional gas water heater	☐ (1) a + (2) a	☐ (1) a + (2) c ☐ (1) b + (2) b	☐ (1) b + (2) c ☐ (1) b + (2) c + (3)	☐ (1) c + (2) c ☐ (1) c + (2) c + (3)
		Domestic hot water system planning (5.4)	Methods	(2)-1 Latent heat recovery water heater (2)-2 CO_2HP water heater (3) Piping method/hot water saving tools	1.0	0.9	0.8	0.7	0.6
					☐ Conventional gas water heater	☐ (2)-1 ☐ (2)-2 (medium boiling mode) ☐ (3)	☐ (2)-1 + (3)	☐ (2)-2 (energy-efficient mode)	☐ (2)-2 (energy-efficient mode) + (3)
Lighting	11.3 GJ	Daylight utilization (3.2)	Conditions for daylighting	(1) Bi-directional daylighting for living/ dining rooms (2) Bi-directional daylighting for living/ dining/senior's rooms (3) Bi-directional daylighting for living/dining/senior's rooms + mono-directional daylighting for non-habitable room	1.0	0.97-0.98	0.95	0.9	
					☐ Conditions for daylighting meeting with the Building Standard Law	Location 1 ☐ (3)	—	—	
						Location 2 ☐ (2)	☐ (3)	—	
						Location 3 ☐ (1)	☐ (2)	☐ (3)	
		Lighting system planning (5.5)	Methods	(1) Method using device (2) Method using operation and control (3) Method using design	1.0	0.7	0.6	0.5	
					☐ Conventional models	☐ (1)	☐ (1) + (2)	☐ (1) + (2) + (3)	
Consumer electronics	19.9 GJ	Introduction of high-efficiency consumer electronics (5.6)	Guidelines for the year device was made		1.0	0.8	0.6		
					☐ Year 2000 regular model (0 kWh)	☐ Energy-efficient products (−500 k/Wh)	☐ Energy-efficient products (−1,000 kWh) + standby power consumption decrease		
Other uses (cooking)	4.4 GJ	———	———		1.0				
					☐ Cooking device				
Total	68.6 GJ	———	———						
	66.5 GJ								

Electricity		Photovoltaic power generation (3.3)	(Kagoshima)		No reduction	32.7 GJ reduction	43.6 GJ reduction		
			Solar cell capacity		☐ Not to be introduced	☐ Approx. 3 kW	☐ Approx. 4 kW		

* Numbers in parentheses under each elemental technology indicate which section of Chapter 3, 4 or 5 describes it.

■ Attached Table 2-2: Energy consumption calculation table (for Zone V / in the case of partial intermittent heating and cooling)

Use	Calculation formulas	Design value	Reference value	Reduction rate
Cooling	5.7 × (× ×)	GJ	5.7GJ	
Heating	5.0 × (× ×)	GJ	5.0GJ	
Ventilation	3.1 × (1.0)	GJ	3.1GJ (1.0GJ)	
Domestic hot water	19.2 × (Solar water heating or domestic hot water system)	GJ	19.2GJ	
Lighting	11.3 × (×)	GJ	11.3GJ	
Consumer electronics	19.9 ×	GJ	19.9GJ	
Other uses (cooking)	4.4 ×	GJ	4.4GJ	
Subtotal		GJ	68.6GJ (66.5GJ)	

Electricity (reduction amount)	Power generation with solar cell (☐ 0.0 GJ ☐ 32.7 GJ ☐ 43.6 GJ)	▲ GJ		
Total		GJ	68.6GJ (66.5GJ)	

【Notes】

1. Common

(1) Reference energy consumption indicates rough estimate of annual energy consumption at wooden single-storey house for family of four located in Zone V (in the case of partial intermittent heating and cooling system).
(2) Energy consumption ratio indicates energy consumption at each level when reference consumption is 1.0.
(3) Areas indicated by slash show that level is not set or no methods are applicable.
(4) Check"✓" off applicable method for each elemental technology and circle value of energy consumption ratio.
(5) Among elemental technologies, "5.7 Treatment and Efficient Use of Water and Kitchen Waste" effective for water saving is exempt from estimation methods.

2. Cooling-related

(1) As for "Use and control of wind", after selecting site conditions and outside wind speed, determine level from 1), 2) and 3) according to method used. Site conditions are classified into following two based on building coverage ratio of adjacent area (building coverage ratio of area with diameter of 50 m surrounding planned building).
Location 1: Urban location (building coverage ratio of adjacent area is over 20%)
Location 2: Suburban location (building coverage ratio of adjacent area is 20% or below)
(2) As for "Solar shading method", after selecting direction of main opening surface, determine level according to solar penetration rate of opening facing true north ±30° and other directions. Where there are multiple openings, determine level based on lowest solar penetration rate.
(3) For "Heating and cooling system planning" (cooling), determine level according to which method (class) is applied out of 1), 2) and 3). In this case, first select class of other habitable rooms (other than LDK), and then select LDK class. In addition, descriptions of following levels are omitted from attached table.
Level 2- (0.9): Other - class 0 + LDK - class 2, Other - class 1 + LDK - class 1, Other - class 2 + LDK - class 0
Level 3- (0.8): Other - class 0 + LDK - class 4, Other - class 1 + LDK - class 3, Other - class 2 + LDK - class 2
Level 4- (0.7): Other - class 1 + LDK - class 5, Other - class 2 + LDK - class 4

3. Heating-related

(1) As for "Insulated building envelope planning", select applicable insulation level by using existing energy conservation standard as guideline.
(2) As for "Use of solar radiation heat", insulated building envelope level must be 3 or higher. Determine level according to which method is applied out of 1), 2) and 3) after selecting PSP zone classification, site conditions and direction of heat collection opening (true south considered as basic 0°). Site conditions are classified into following two categories according to degree of obstruction of sunlight. *It is assumed that heating load is large in Zone D and Zone C (See Section 3.4 on p.094).
Location 2: Obstruction of sunlight is 25%
Location 3: Obstruction of sunlight is 0%
(3) "Heating and cooling system planning" (heating) targets LDK only. Determine level according to method applied, either 1) or 2).

4. Ventilation-related

For "Ventilation system planning", determine level according to applied method after selecting ventilation system (duct system, through-the-wall system).

5. Domestic-hot-water-related

(1) For "Solar water heating", determine level according to which method is applied out of 1), 2) and 3).
(2) For "Domestic hot water system planning", determine level according to which method is applied out of 2) and 3).

6. Lighting-related

(1) For "Daylight utilization", determine level according to daylighting conditions of room after selecting site conditions. As for daylighting conditions, "LD" refers to living and dining rooms, "S/C" refers to seniors'/children's rooms, and "non-habitable room" refers to kitchen, hallway, entrance, washing room, bathroom and toilet. Site conditions are classified into following three.
Location 1: Location where sunlight utilization is difficult due to surrounding high-rise, dense buildings
Location 2: Location where creative measures are required for sunlight utilization due to dense surrounding buildings
Location 3: Suburban location where sunlight utilization is easy
(2) For "Lighting system planning", please determine level according to which method is applied out of 1), 2) and 3).

7. Consumer-electronics-related

For "Introduction of high-efficiency consumer electronics", determine level according to manufacturing year or annual electricity consumption reduction (assuming products that were owned around year 2000 as standard) of prime consumer electronics (refrigerator, television) and priority consumer electronics (hot water heated toilet seat, electric hot water pot, washing machine).

8. Other uses (cooking)

Since target cooking energy consumption does not vary significantly by device, use the reference value, 4.4 GJ.

9. Electricity-related

When "Photovoltaic power generation" is adopted, select reduction (power generation) of primary energy consumption estimated based on region and solar cell capacity. Quick reference shows reduction in Kagoshima (For reduction in other regions, see Section 3.3 on p.085).

10. Description in calculation table

(1) In calculation formula column, write down energy consumption ratio of each elemental technology determined in quick reference. Energy consumption design value and reduction rate can be calculated for each use.
(2) In total section, write down total of energy consumption design values, from cooling to other uses (cooking). In grand total section, write down grand total of design values obtained by subtracting electricity reduction through photovoltaic power generation.

■Attached Table 3-1: Quick reference for energy consumption ratio of elemental technologies (for Zone V / in the case of whole-building continuous heating and cooling)

Use	Reference energy consumption	Elemental technology*	Evaluation index/method		Energy consumption ratio (reference consumption is 1.0)				
					Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	27.1 GJ	Solar shading method (4.3)	Direction of main opening surface	South	1.0	0.85	0.7	0.55	
				Southeast or southwest	1.3	0.8	0.75	0.65	
				East or west	1.1	0.8	0.75	0.65	
			Solar penetration rate of opening	True north ±30° Other than the above	☐ Approx. 0.79	☐ 0.79 or less	☐ 0.55 or less	☐ 0.55 or less	
					☐ Approx. 0.79	☐ 0.60 or less	☐ 0.45 or less	☐ 0.30 or less	
		Heating and cooling system planning (cooling) (5.2)	Methods	Central heating (1) High-efficiency device (2) Temperature control function added	1.0	0.75	0.6		
					☐ Method not introduced	☐ (1)	☐ (1) + (2)		
Heating	13.4 GJ	Insulated building envelope planning (4.1)	Energy conservation standard		1.0	0.6	0.5	0.4	0.3
					☐ 1980 Standard	☐ 1992 Standard	☐ Intermediate of 1992 and 1999 Standards	☐ 1999 Standard	☐ Exceeding 1999 Standard
		Solar radiation heat utilization (3.4)	Methods	(1) Improvement of opening insulation (2) Increase in heat collection area (3) Heat storage	1.0	0.95	0.85	0.75	0.65
			Zone E	Location 2 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1) + (2)	☐ (1) + (2) + (3)	
						☐ (1) + (2)	☐ (1) + (2) + (3)		
				Location 3 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1), (2)	☐ (1) + (3)	☐ (1) + (2) ☐ (1) + (2) + (3)
						—	☐ (1), (1) + (3)	☐ (1) + (2)	☐ (1) + (2) + (3)
			Zone D* Zone C*	Location 2 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1) + (2) ☐ (1) + (2) + (3)		
						☐ (1) + (2) ☐ (1) + (2) + (3)			
				Location 3 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	☐ (2)	☐ (1), (1) + (3)	☐ (1) + (2)	☐ (1) + (2) + (3)
						—	☐ (1), (1) + (3)	☐ (1) + (2) ☐ (1) + (2) + (3)	
		Heating and cooling system planning (heating) (5.2)	Methods	Central cooling (1) High-efficiency device (2) Temperature control function added	1.0	0.8	0.55		
					☐ Method not introduced	☐ (1)	☐ (1) + (2)		
Ventilation	4.7 GJ	Ventilation system planning (5.3)	Duct ventilation	(1) Duct pressure loss decrease (2) High-efficiency device	1.0	0.6	0.5		
					☐ Method not introduced	☐ (1)	☐ (1) + (2)		
Domestic hot water	19.2 GJ	Solar water heating (3.5)	Methods	(1) Heat collection area a: small, b: medium, c: large (2) Connection to auxiliary heat source a: none, b: three-way valve, c: solar connection unit (3) Energy-efficient circulating pump	1.0	0.9	0.7	0.5	0.3
					☐ Conventional gas water heater	☐ (1) a + (2) a	☐ (1) a + (2) c ☐ (1) b + (2) b	☐ (1) b + (2) c ☐ (1) b + (2) c + (3)	☐ (1) c + (2) c ☐ (1) c + (2) c + (3)
		Domestic hot water system planning (5.4)	Methods	(2)-1 Latent heat recovery water heater (2)-2 CO_2HP water heater (3) Piping method/hot water saving tools	1.0	0.9	0.8	0.7	0.6
					☐ Conventional gas water heater	☐ (2)-1 ☐ (2)-2 (medium boiling mode) ☐ (3)	☐ (2)-1 + (3)	☐ (2)-2 (energy-efficient mode)	☐ (2)-2 (energy-efficient mode) + (3)
Lighting	11.3 GJ	Daylight utilization (3.2)	Conditions for daylighting	(1) Bi-directional daylighting for living/dining rooms (2) Bi-directional daylighting for living/dining/senior's rooms (3) Bi-directional daylighting for living/dining/senior's rooms + mono-directional daylighting for non-habitable room	1.0	0.97 - 0.98	0.95	0.9	
					☐ Conditions for daylighting meeting with the Building Standard Law	Location 1 ☐ (3)	—	—	
						Location 2 ☐ (2)	☐ (3)	—	
						Location 3 ☐ (1)	☐ (2)	☐ (3)	
		Lighting system planning (5.5)	Methods	(1) Method using device (2) Method using operation and control (3) Method using design	1.0	0.7	0.6	0.5	
					☐ Conventional models	☐ (1)	☐ (1) + (2)	☐ (1) + (2) + (3)	
Consumer electronics	20.4 GJ	Introduction of high-efficiency consumer electronics (5.6)	Guidelines for the year device was made		1.0	0.8	0.6		
					☐ Year 2000 regular model (0 kWh)	☐ Energy-efficient products (−500 k/Wh)	☐ Energy-efficient products (−1,000 kWh) + standby power consumption decrease		
Other uses (cooking)	4.4 GJ	———	———		1.0				
					☐ Cooking device				
Total	100.5 GJ	———	———						
Electricity		Photovoltaic power generation (3.3)	(Kagoshima) Solar cell capacity		No reduction	32.7 GJ reduction	43.6 GJ reduction		
					☐ Not to be introduced	☐ Approx. 3 kW	☐ Approx. 4 kW		

* Numbers in parentheses under each elemental technology indicate which section of Chapter 3, 4 or 5 describes it.

■Attached Table 3-2: Energy consumption calculation table (for Zone V / in the case of whole-building continuous heating and cooling)

Use	Calculation formulas	Design value	Reference value	Reduction rate
Cooling	27.1 × (☐ × ☐ × ☐)	GJ	27.1GJ	
Heating	13.4 × (☐ × ☐ × ☐)	GJ	13.4GJ	
Ventilation	4.7 × ☐	GJ	4.7GJ	
Domestic hot water	19.2 × ☐ (Solar water heating or domestic hot water system)	GJ	19.2GJ	
Lighting	11.3 × (☐ × ☐)	GJ	11.3GJ	
Consumer electronics	20.4 × ☐	GJ	20.4GJ	
Other uses (cooking)	4.4 × ☐	GJ	4.4GJ	
Subtotal		GJ	100.5GJ	
Electricity (reduction amount)	Power generation with solar cell (☐ 0.0 GJ ☐ 32.7 GJ ☐ 43.6 GJ)	▲ GJ		
Total		GJ	100.5GJ	

【Notes】

1. Common

(1) Reference energy consumption indicates rough estimate of annual energy consumption at wooden single-storey house for family of four located in Zone V (in the case of whole-building continuous heating and cooling system).

(2) Energy consumption ratio indicates energy consumption at each level when reference consumption is 1.0.

(3) Areas indicated by slash show that level is not set or no methods are applicable.

(4) Check"✓" off applicable method for each elemental technology and circle value of energy consumption ratio.

(5) Among elemental technologies, "5.7 Treatment and Efficient Use of Water and Kitchen Waste" effective for water saving is exempt from estimation methods.

2. Cooling-related

(1) As for "Solar shading method", after selecting direction of main opening surface, determine level according to solar penetration rate of opening facing true north ±30° and other directions. Where there are multiple openings, determine level based on lowest solar penetration rate.

(2) For "Heating and cooling system planning" (cooling), determine level according to which method is applied out of 1) and 2).

3. Heating-related

(1) As for "Insulated building envelope planning", select applicable insulation level by using existing energy conservation standard as guideline.

(2) As for "Use of solar radiation heat", insulated building envelope level must be 3 or higher. Determine level according to which method is applied out of 1), 2) and 3) after selecting PSP zone classification, site conditions and direction of heat collection opening (true south considered as basic 0°). Site conditions are classified into following two categories according to degree of obstruction of sunlight. *It is assumed that heating load is large in Zone D and Zone C (See Section 3.4 on p.094).
Location 2: Obstruction of sunlight is 25%
Location 3: Obstruction of sunlight is 0%

(3) For "Heating and cooling system planning" (heating), determine level according to method applied, either 1) or 2).

4. Ventilation-related

For "Ventilation system planning", determine level according to which method is applied out of 1) and 2).

5. Domestic-hot-water-related

(1) For "Solar water heating", determine level according to which method is applied out of 1), 2) and 3).

(2) For "Domestic hot water system planning", determine level according to which method is applied out of 2) and 3).

6. Lighting-related

(1) For "Daylight utilization", determine level according to daylighting conditions of room after selecting site conditions. As for daylighting conditions, "LD" refers to living and dining rooms, "S/C" refers to seniors'/children's rooms, and "non-habitable room" refers to kitchen, hallway, entrance, washing room, bathroom and toilet. Site conditions are classified into following three.
Location 1: Location where sunlight utilization is difficult due to surrounding high-rise, dense buildings
Location 2: Location where creative measures are required for sunlight utilization due to dense surrounding buildings
Location 3: Suburban location where sunlight utilization is easy

(2) For "Lighting system planning", please determine level according to which method is applied out of 1), 2) and 3).

7. Consumer-electronics-related

For "Introduction of high-efficiency consumer electronics", determine level according to manufacturing year or annual electricity consumption reduction (assuming products that were owned around year 2000 as standard) of prime consumer electronics (refrigerator, television) and priority consumer electronics (hot water heated toilet seat, electric hot water pot, washing machine).

8. Other uses (cooking)

Since target cooking energy consumption does not vary significantly by device, use the reference value, 4.4 GJ.

9. Electricity-related

When "Photovoltaic power generation" is adopted, select reduction (power generation) of primary energy consumption estimated based on region and solar cell capacity. Quick reference shows reduction in Kagoshima (For reduction in other regions, see Section 3.3 on p.085).

10. Description in calculation table

(1) In calculation formula column, write down energy consumption ratio of each elemental technology determined in quick reference. Energy consumption design value and reduction rate can be calculated for each use.

(2) In total section, write down total of energy consumption design values, from cooling to other uses (cooking). In grand total section, write down grand total of design values obtained by subtracting electricity reduction through photovoltaic power generation.

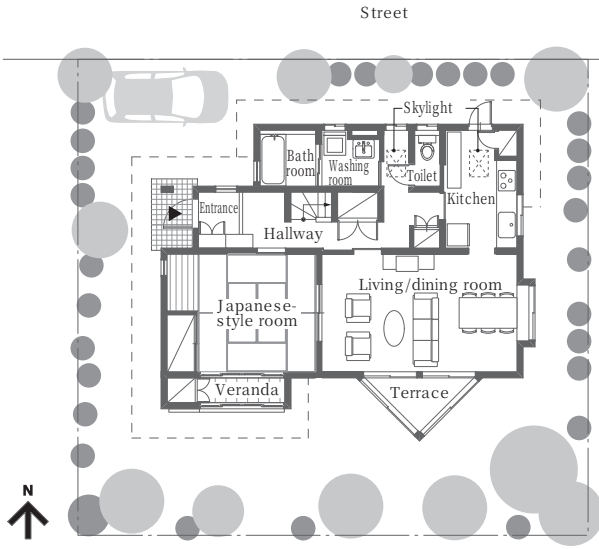
6

Chapter 6
Energy Saving Effect Evaluation and its Utilization in Design

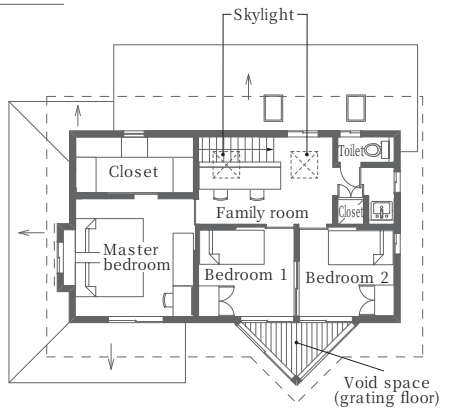
■Design specifications
Structure : Wooden
Number of stories : Two-storey house
Site area : 210.0 m² (2,260 ft²)
Building area : 77.8 m² (837.43 ft²)
Total floor area : 128.3 m² (1,381 ft²)
Family structure : Husband and wife with two children

Zone V: Design calculation example 1

◆Building outline



■First floor plan view



■Second floor plan view

◆Design process outline

Design procedure I
Understanding given conditions and required conditions

Site is located in suburb of Kagoshima. Density of surrounding buildings is low, which makes the possibility of using natural energy relatively high.
With regard to occupant's awareness, "level of dedication to natural living" is slightly high while "level of dedication to a stable indoor environment" is moderate. Occupant seeks nature-oriented lifestyle or machine-oriented lifestyle.

▼

Design procedure II
Setting design goals and policies

Make as much effort as possible to implement measures for architectural techniques (natural energy application technology, heat control technology of building envelope) and be creative in designing spatial structure and opening layout for wind utilization.
Aim to introduce highly efficient devices as much as possible with regard to mechanical techniques (energy-efficient equipment technology) (partial intermittent system to be used for heating and cooling).
Through above-mentioned efforts, strive to achieve energy reduction rate of approx. 40%.

▼

Design procedure III
Creating design model

Wooden two-storey building has plane structure where three habitable rooms are located in the south and moisture-prone rooms and stairs are placed in the north.
Create sunroom which connects to second floor in south of living room on first floor in order to promote cross ventilation and use of solar radiation heat. In addition, use structure where securing cross ventilation route inside room is taken into consideration.

(Application of main elemental technologies)

● Use and control of wind / Level 2
Condition Location 2 : Suburban location (building coverage ratio of adjacent area is 20% or below), outside wind speed of 1 - 2 m/s or lower in summer
Method applied Use combination of patio doors and waist-level windows for exterior opening, and apply method 1a (combination of small opening areas). In addition, place one surface of opening in prevailing wind direction and adopt method 2.
● Solar shading method / Level 3
Condition Direction of main opening surface: South
Method applied Select glass specifications in way that solar penetration rate of opening is 0.55 or below when facing true north ±30° and is 0.3 or below when facing other directions. Then, set up solar shading components, overhangs, etc.
● Daylight utilization / Level 2
Condition Zone E, Location 3: No influence caused by obstruction of sunlight, direction of opening for heat collection: True south ±15°, insulated building envelope planning at level 3 or higher
Method applied Enhance insulation performance of opening and apply method 1.

▼

Design procedure IV
Analyze design model and verify effects

Energy efficiency: approx. 39%
Cost: Number of years for recovery – approx. 28.2 years (cooling/heating, ventilation, domestic hot water, lighting)

◆Verification of energy efficiency

■Attached Table 2-1: Quick reference for energy consumption ratio of elemental technology (for Zone V / In the case of partial intermittent heating and cooling) – Example

Use	Reference energy consumption	Elemental technology*	Evaluation index/method		Energy consumption ratio (reference consumption is 1.0) Level 0	Level 1	Level 2	Level 3	Level 4
Cooling	5.7 GJ	Wind utilization/ control (3.1)	Methods	(1) Opening area on cross ventilation route a: small, b: large (2) Opening area according to prevailing wind direction (3) High window a: small, b: large	1.0	0.95	0.88	0.82	
			Location 1	Wind speed 1m/s or more	☐Method not introduced	☐ (1) a, (3) a	☐ (1) b, (3) b	—	
			Location 2	Wind speed 1m/s or less	☐ Method not introduced ☐ (1) a, (3) a	☐ (1) a + (2), (3) a + (2) ☐ (1) b, (3) b	☐ (1) b + (2) ☐ (3) b + (2)	—	
				Wind speed 1 - 2m/s or less	☐ Method not introduced	—	☐ (1) a, (3) a ☑ (1) a + (2), (3) a + (2)	☐ (1) b, (3) b ☐ (1) b + (2), (3) b + (2)	
				Wind speed 2m/s or more	☐ Method not introduced	—	☐ (1) a, (3) a	☐ (1) a + (2), (3) a + (2) ☐ (1) b, (3) b ☐ (1) b + (2), (3) b + (2)	
		Solar shading method (4.3)	Direction of main opening surface	South	1.0	0.85	0.7	0.55	
				Southeast or southwest	1.3	0.8	0.75	0.65	
				East or west	1.1	0.8	0.75	0.65	
			Solar penetration rate of opening	True north ±30° Other than the above °	☐ Approx. 0.79	☐ 0.79 or less	☐ 0.55 or less	☑ 0.55 or less	
					☐ Approx. 0.79	☐ 0.60 or less	☐ 0.45 or less	☑ 0.30 or less	
		Heating and cooling system planning (cooling) (5.2)	Air conditioner	(1) High-efficiency air conditioner (ratedefficiency) (2) Adjustment of device capacity (3) Use of fan/ceiling fan	1.0	0.95	0.85	0.75	0.65
			Other habitable rooms: Class 0	☐ (1) (<3.8) ☐ (1) (<3.7) + (2) ☐ (1) (<3.3) + (3) ☐ (1) (<3.2) + (2) + (3)	LDK: Class 0 ☐ (1) (<3.5) ☐ (1) (<3.0) + (3)	LDK: Class 1 ☐ (1) (≧3.5) ☐ (1) (≧3.0) + (3)	LDK: Class 3 ☐ (1) (≧5.6) ☐ (1) (≧3.7) + (2) ☐ (1) (≧4.9) + (3) ☐ (1) (≧3.2) + (2) + (3)	LDK: Class 5 ☐ (1) (≧5.3) + (2) ☐ (1) (≧4.9) + (2) + (3)	
			Other habitable rooms: Class 1	☐ (1) (≧3.8) ☑ (1) (≧3.7) + (2) ☐ (1) (≧3.3) + (3) ☐ (1) (≧3.2) + (2) + (3)	—	LDK: Class 0 ☐ (1) (<3.5) ☐ (1) (<3.0) + (3)	LDK: Class 2 ☐ (1) (≧4.3) ☐ (1) (<3.7) + (2) ☐ (1) (≧3.7) + (3) ☐ (1) (<3.2) + (2) + (3)	LDK: Class 4 ☐ (1) (≧4.4) + (2) ☑ (1) (≧3.9) + (2) + (3)	
			Other habitable rooms: Class 2	☐ (1) (≧5.1) ☐ (1) (≧4.9) + (2) ☐ (1) (≧5.0) + (3) ☐ (1) (≧4.8) + (2) + (3)	—	—	LDK: Class 1 ☐ (1) (≧3.5) ☐ (1) (≧3.0) + (3)	LDK: Class 3 ☐ (1) (≧5.6) ☐ (1) (≧3.7) + (2) ☐ (1) (≧4.9) + (3) ☐ (1) (≧3.2) + (2) + (3)	LDK: Class 5 ☐ (1) (≧5.3) + (2) ☐ (1) (≧4.9) + (2) + (3)
Heating	5.0 GJ	Insulated building envelope planning (4.1)	Energy conservation standard		1.0	0.7	0.5	0.45	0.35
					☐ 1980 Standard	☐ 1992 Standard	☐ Intermediate of 1992 and 1999 Standards	☑ 1999 Standard	☐ Exceeding 1999 Standard
		Solar radiation heat utilization (3.4)	Methods	(1) Improvement of opening insulation (2) Increase in heat collection area (3) Heat storage	1.0	0.95	0.9	0.8	0.6
			Zone E	Location 2 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1) + (2)	☐ (1) + (2) + (3)	
						☐ (1) + (2)	☐ (1) + (2) + (3)		
				Location 3 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☑ (1), (2)	☐ (1) + (3)	☐ (1) + (2) ☐ (1) + (2) + (3)
						—	☐ (1), (1) + (3)	☐ (1) + (2)	☐ (1) + (2) + (3)
			Zone D* Zone C*	Location 2 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	—	☐ (1) + (2)		
						☐ (1) + (2) ☐ (1) + (2) + (3)			
				Location 3 Direction 0 - 15° Direction 15 - 30°	☐ Method not introduced	☐ (2)	☐ (1), (1) + (3)	☐ (1) + (2)	☐ (1) + (2) + (3)
						—	☐ (1), (1) + (3)	☐ (1) + (2) ☐ (1) + (2) + (3)	
		Heating and cooling system planning (heating) (5.2)	Air conditioner (LDK)	(1) High-efficiency air conditioner (rated efficiency) (2) Adjustment of device capacity	1.0	0.95	0.85	0.75	0.7
					☐ (1) (<4.9)	☐ (1) + (≧4.9) ☐ (1) (<4.0) + (2)	☐ (1) (≧4.0) + (2)	☐ (1) (≧5.3) + (2)	☑ (1) (≧6.2) + (2)
Ventilation	3.1 GJ	Ventilation system planning (5.3)	Duct ventilation	(1) Duct pressure loss decrease (2) High-efficiency device	1.0	0.6	0.5		
					☐ Method not introduced	☐ (1)	☑ (1) + (2)		
	1.0 GJ		Through-the-wall ventilation	(1) Optimizing the combination of fan and outside air unit	1.0	0.8			
					☐ Method not introduced	☐ (1)			
Domestic hot water	19.2 GJ	Solar water heating (3.5)	Methods	(1) Heat collection area a: small, b: medium, c: large (2) Connection to auxiliary heat source a: none, b: three-way valve, c: solar connection unit (3) Energy-efficient circulating pump	1.0	0.9	0.7	0.5	0.3
					☐ Conventional gas water heater	☐ (1) a + (2) a	☐ (1) a + (2) c ☐ (1) b + (2) b	☐ (1) b + (2) c ☐ (1) b + (2) c + (3)	☐ (1) c + (2) c ☐ (1) c + (2) c + (3)
		Domestic hot water system planning (5.4)	Methods	(2)-1 Latent heat recovery water heater (2)-2 CO_2HP water heater (3) Piping method/hot water saving tools	1.0	0.9	0.8	0.7	0.6
					☐ Conventional gas water heater	☐ (2)-1 ☐ (2)-2 (medium boiling mode) ☐ (3)	☑ (2)-1 + (3)	☐ (2)-2 (energy-efficient mode)	☐ (2)-2 (energy-efficient mode) + (3)
Lighting	11.3 GJ	Daylight utilization (3.2)	Conditions for daylighting	(1) Bi-directional daylighting for living/ dining rooms (2) Bi-directional daylighting for living/ dining/senior's rooms (3) Bi-directional daylighting for living/dining/senior's rooms + mono-directional daylighting for non-habitable room	1.0	0.97-0.98	0.95	0.9	
					☐ Conditions for daylighting meeting with the Building Standard Law	Location 1 ☐ (3)	—	—	
						Location 2 ☐ (2)	☐ (3)	—	
						Location 3 ☐ (1)	☐ (2)	☑ (3)	
		Lighting system planning (5.5)	Methods	(1) Method using device (2) Method using operation and control (3) Method using design	1.0	0.7	0.6	0.5	
					☐ Conventional models	☐ (1)	☐ (1) + (2)	☑ (1) + (2) + (3)	
Consumer electronics	19.9 GJ	Introduction of high-efficiency consumer electronics (5.6)	Guidelines for the year device was made		1.0	0.8	0.6		
					☐ Year 2000 regular model (0 kWh)	☐ Energy-efficient products (−500 k/Wh)	☑ Energy-efficient products (−1,000 kWh) + standby power consumption decrease		
Other uses (cooking)	4.4 GJ	———	———		1.0				
					☑ Cooking device				
Total	68.6 GJ	———	———						
	66.5 GJ								
Electricity		Photovoltaic power generation (3.3)	(Kagoshima)		No reduction	32.7 GJ reduction	43.6 GJ reduction		
			Solar cell capacity		☑ Not to be introduced	☐ Approx. 3 kW	☐ Approx. 4 kW		

* Numbers in parentheses under each elemental technology indicate which section of Chapter 3, 4 or 5 describes it.

■Attached Table 2-2: Energy consumption calculation table (for Zone V / In the case of partial intermittent heating and cooling) – Example

Use	Calculation formulas	Design value	Reference value	Reduction rate
Cooling	5.7 × (0.88 × 0.55 × 0.75)	2.07GJ	5.7GJ	63.7%
Heating	5.0 × (0.45 × 0.85 × 0.7)	1.34GJ	5.0GJ	73.2%
Ventilation	3.1 × 0.5	1.55GJ	3.1GJ	50.0%
Domestic hot water	19.2 × 0.8 (Solar water heating or domestic hot water system)	15.36GJ	19.2GJ	20.0%
Lighting	11.3 × (0.9 × 0.5)	5.09GJ	11.3GJ	55.0%
Consumer electronics	19.9 × 0.6	11.94GJ	19.9GJ	40.0%
Other uses (cooking)	4.4 × 1.0	4.4GJ	4.4GJ	0.0%
Subtotal		41.8GJ	68.6GJ	39.1%
Electricity (reduction amount)	Power generation with solar cell (☑ 0.0 GJ ☐ 32.7 GJ ☐ 43.6 GJ)	▲ 0.0GJ		
Total		41.8GJ	68.6GJ	39.1%

- Energy efficiency (annual primary energy consumption reduction rate) is approx. 39.1%.

◆Verification of cost

- With regard to each elemental technology and method applied, mainly estimate the initial cost and annual energy cost of equipment and insulation. As for use of wind, solar shading method, daylight utilization and consumer electronics, their verification is not included as evaluating increases in initial cost is difficult.
- Based on the results of cost evaluation listed in Table 15 and Table 16, the table below shows the increase in initial cost and the decrease in annual energy cost in each energy use while considering standard housing around 2000 as a basis. In this case, the number of years (simple payback time) required for recovering the increase in initial cost through the reduction of energy cost is approx. 28.2 years.
  - Initial cost increase: approx. 1,330,000 yen
  - Annual energy cost reduction: approx. 47,200 yen per year
  - Number of years for recovery (simple payback time)

    = Initial cost increase (yen) / annual energy cost reduction (yen per year)

    = 1,330,000 yen / 47,200 yen per year

    = 28.2 years

Initial cost and energy cost increase and decrease (Example)

Application		Initial cost increase	Annual energy cost reduction
Cooling	Level 3	60,000 yen	3,200 yen/year
Heating	Level 4	800,000 yen (insulated building envelope level 3)	3,400 yen/year
Ventilation	Level 2	102,000 yen	3,600 yen/year
Domestic hot water	Level 2	118,000 yen	25,000 yen/year
Lighting	Level 2	250,000 yen (distributed multiple simple type)	12,000 yen/year
Total		1,330,000 yen	47,200 yen/year

Note: Initial cost of insulated building envelope is taken from value listed in Figure 9 (Section 4.1) on p.131.