Sustainable way of living

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The sun gives us 15,000 times the energy that we use. To realize a sustainable way of living, a variety of experiments have been done in the past 23 years at the above site. (A) Solar energy use; Solar oven and solar cooker, Septic tank, Ground heat use, Windmills, Solar panels for water heating, Charcoal making and its use for cooking, Solar room and its energy use, House design as a receptor of solar energy etc, (B) Local material use; Thatched roof, Cobbed wall and Rain water use, (C) No contamination; Septic tank and Cleansing ponds, (D) Self-sufficiency; Veggie gardens, Fruit and nut trees, Rice and crops, and (E) Joyful life; Music gatherings at the amphitheater on the site. It is emphasized that a house is a receptor of solar energy and its planning is primarily important. It must be done not qualitatively but quantitatively. Heterogeneous fields i.e. noise level, temperature and light value in a living space are calculated, and then they have to be estimated synthesized. Synthesized evaluation of a room environment with the above three factors is given. Synthesized estimation of a living environment with eight factors including a noise environment is also mentioned. It is not difficult to live sustainable relying on solar energy and energy crisis and environmental problems vanish. I believe that it is the only way to establish one's freedom.

Keywords : Sustainability, solar energy, ground heat, septic tank, cleansing ponds, environmental planning, solar cooker, solar oven, solar room, thermo-siphon, self-sufficiency, vernacularism, joyful life, synthesized evaluation

INTRODUCTION

The sun gives us impartially great energy to us. If we use it properly for our daily life, energy problem or crisis never happens. These days each one relies on others in the social structure too much. It is strongly promoted with the strong stream of economy towards easiness and convenience not having spiritual consideration. Accordingly, they don't pay attention on energy problem and environment. Energy saving is aimed on the Kyoto Protocol to go back to the consumption in the year 1990. However, we used already huge amount of energy then. We have to aim "zero energy" to get back our environment.

If one collects solar energy for his daily life, does not contaminate surroundings and lives self-sufficient, environments are not polluted and contaminated. One gets free time and space, and one's life is liberated. If one gets any living ways from nature, one becomes free. If we live in such a way, we can live until the solar system finishes. I define it as a sustainable way of living for a narrow sense.

Do we have any wonderful future in our society? What and where are we looking for? I strongly recommend finding time and space for an individual to be free being away from the place where human nature is lost relying on the existing social structure. We can live our meaningful future to have spiritual progress and develop one's creativity only by sustainable life.

Further to say, the great energy of the sun finishes after 4.5 billions of years. All the creatures on the earth become extinct. Could we finish our existence just devour the great energy given? Turning our lives toward spiritual progress, we must find by then the solution to the next plane with the entire human corporation. This attitude is defined as broad sense for sustainability.

How can we realize to live in such a way? In this project, the next five items have been discussed practically,

(1) To obtain one's necessary energy from the sun directly and/or indirectly
(2) To build a house with natural materials locally sourced
(3) Not to contaminate the surrounding and environment from daily wastes
(4) Self-sufficiency based on organic farming
(5) Joyful life

Firstly, these items are mentioned at the first chapter "practical methods for sustainable living." Each item is based on well known knowledge. It means that everyone can do it. Though each amount of energy is small and it is collected carefully, it is shown to be enough to live modest. Joyful life is very important for living. A few examples are given.

It is shown how technology can support a sustainable way of living in the second chapter "Architectural planning for sustainable living". Quantitative planning method is explained there, reviewing a few of my past papers.

It is also mentioned the importance of establishment of a village for sustainable living.

1. PRACTICAL METHODS FOR SUSTAINABLE LIVING

1-1. OBTAINING DAILY NECESSARY ENERGY FROM THE SUN DIRECTLY AND INDIRECTLY

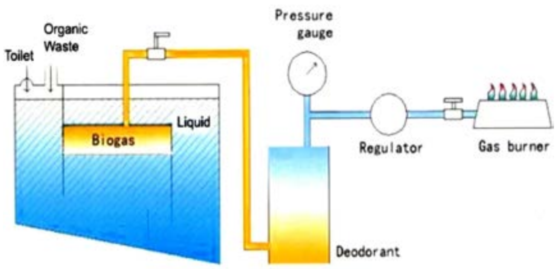
It is primarily important to plan the house how properly it receives solar energy with thermal environmental planning. There are many other ways to be added as follows.

Fig. 1. Ozeki septic tank to change any organic inputs into bio-gas

(1) Bio-gasification of daily human organic wastes [1] [2] [3]

Any organic matters are changed by an Ozeki septic tank (see Figure 1) into biogas, if they are given with proper amount of water. The Ozeki septic tank has three sections filled with water. It is done in anaerobic activity.

The process of bio gasification has two steps. The first stage is acid fermentation, i.e. liquefaction process. There, complex organic wastes are first broken down by the activity of facultative anaerobes into soluble low molecular weight materials. Then they are decomposed by obligate anaerobes activity into low fatty acid.



Section of Ozeki septic tank

In the second stage, i.e. bio gasification process, the low fatty acid is transformed by the methanogen activity into methane and carbon dioxide etc which all together are called bio gas.

By using the Ozeki septic tank which does not produce any sludge type of things, the eutrophication caused by organic wastes including bodily wastes can be avoided. It is a very important and basic attitude to solve any pollution at the source. Accordingly, the sewage system is not necessary, and the energy to burn it can be saved if it is burnt.

Human discharge from toilets of public transport stations such as airports, bus and train stations, public meeting places, restaurants and so forth, leftovers and refuse from restaurants, exhausts from stock farms, and so on, could all be converted into energy. If throwaway plastic plates are replaced by plates made of potato, corn etc, they can be thrown altogether with leftover foods.

When it is used for a family, the biogas is not enough to cover the necessary cooking energy, but it is produced surely every day per person.

The biogas is kept under water in the septic tank and pushed out by water pressure. It is safe against explosion, even if a fire occurs above the septic tank.

It composes a delay system to a certain extent, though it must not be forgotten to enable proper movement of solids in the bottom, because the methane bacteria need new feed. As the inorganic liquid in the last section of the tank must include a lot of mineral and trace elements for plants, it will be given back to them.

(2) Solar oven and solar cooker [1] [2]

The solar oven shown in Figure 2 gets 260°C of air in the upper part and 40°C less in the bottom which can be used for a variety of cooking. The open mouth of the reflector on the side walls faces directly to the sun. The direct sunlight and its reflection at the inside walls go through a heat-resistant glass pane to the thermally insulated box in the bottom whose inside surfaces are painted in black. The reflector is made of cardboards and mirror plates, and easily attached to or removed from the bottom box. Baked breads and a cake are shown in Fig.3. One of the days had some clouds.

Figure 2 Solar oven in the left and solar cooker in the right

Fig.3 Baked breads and a cake in the solar oven on two different days

The solar cooker in the right of Figure 2 has a pot at the focus of a parabola reflector and it is covered by heat-resistant glass with about 4cm air space to have air gap in between. The glass cover avoid for the pot not to touch colder air around. Plant oil of 300cc got 250°C after 30 minutes on a fine day. Tempura and brown rice were well cooked.

These tools must be used from 10am to 2pm because at other time the solar energy is lost by the atmosphere.

(3) Wind mill power generation

300w and 1kw wind mill generators are reinstalled. The obtained electricity is stored in gel batteries of 245 AH. They are charged from the grid when it is not enough. Because of the effort to collect solar energy the average monthly consumption of electricity in the last year was 58.9kWh per month. It is about 1.96kWh a day.

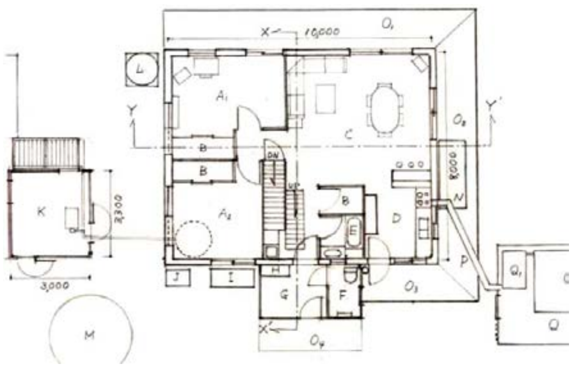
Since they depend on the wind, a few other ways are started to discuss to produce electricity: Stirling engine, bimetal, wood gas, steam engine etc.

(4) Air conditioning in summer and winter

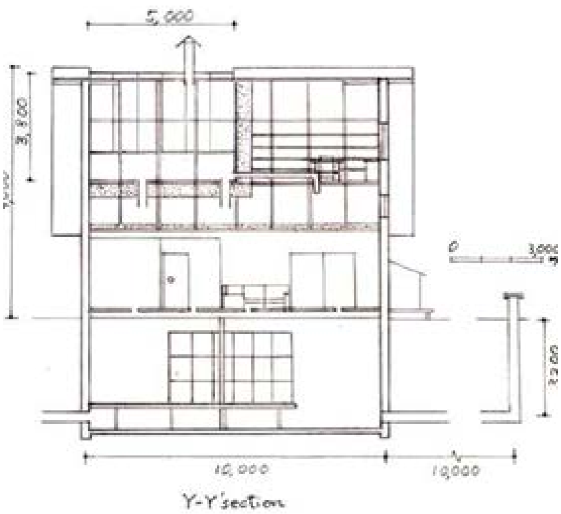
(4-1) Ground heat use through cool tubes in summer [1]

There is a layer at about 8m below the surface where it keeps the average air temperature on the surface. The surface air temperature at Kaiwaka changes roughly 0 to 30° C and the layer is supposed to stay at 15° C.

As the amplitude of the annual temperature change in the ground decreases rapidly exponentially, the ground temperature even at 3.2m below the surface changes by ±2° from the average.



Plan of the experimental house



Sections of the experimental house

Fig.4 Architectural drawing of the experimental house

Three Hume concrete pipes of 30cm inside diameter are buried at 3.2m deep for 10m long at each side of the basement as shown in Fig.4. They are about 3m apart and connected from the vents on the ground to one of the side walls of the basement. Only one side of them is open not to have short circuited with each other in the basement. The air temperature in the basement changes from 12.5° to 16.5°.

The air in the solar room on the roof is heated and leaves through the chimney. This produces the lifting power for the cool and heavy air in the basement. The concrete floor surface under the wooden floor in the basement is used for heat exchange too. The basement ceiling has 12 ventilation holes of 10cm diameter for the air to be moved to the ground floor. The house is constructed air tight, and with high thermal insulation and heat storage for this purpose.

(4-2) Circulation of hot air in the solar room through the house in winter [2]

In winter the solar room system is used differently. The hot air near the ceiling of the solar room is taken down with an electrical fan and a vertical air duct to the basement and is distributed there. It circulates through the house (see Fig.5). The heat that is obtained in the day time is stored inside the house and radiated in the night. The system was installed a few years ago and I didn't use any heater since then. I wore thick closes such as a sweater in the winter, though.

A tin air duct of 120cm long with 15cm diameter is connected down to the basement at a length of about 9 m. In the basement, six branches are stretched from the horizontal central air duct that is connected at the bottom of the vertical air duct and that runs 51cm below the ground floor. Warm air was distributed at the ends of the six air ducts. A manual damper was given in the vertical air duct not to have reverse flow in the night. The electrical fan is operated by a thermostat and switched on when the air temperature near the fan becomes higher than 24deg. and used 19Wh.

The ventilation holes in the ground floor were shut earlier than the air temperature near the fan went below 24deg.. The hot air layer kept under the ground floor insulates the basement cold air not to be transferred to the ground floor.



Tools for venti-lation holes

Air ducts in the basement

Fig. 5. Air duct system to circulate warm air in the house

Apart from the air circulation, silver shade screens were attached inside the windows and the door for my bed room in the night to avoid the negative radiation from the sky.

(5) Hot water obtained with thermo-siphon [1] [2]

A solar panel, of 125cm wide, 180cm high and 7.7cm deep, has eight copper pipes of ca. 9mm inside diameter which run from bottom to top (see Fig.6). Each pipe has a copper wing panel of 142mm wide painted in black. The copper pipes are connected at the bottom and the top. They are covered by a glass pane. The pipes are thermally insulated beneath. The pipes are filled with water by gravity and connected to the hot water cylinder of 380l capacity in the house which is about 1.5m higher than the panels' top. The panel is inclined at 45degrees for the height of winter.

The wings are heated by the sun and the heat is transferred to the pipes and then to the water inside. The hot water gathers at the top of the panel and moves to the hot water cylinder with its own lifting power. The cold water in the hot water cylinder in the bottom is forced to move back to the bottom pipe of the solar panel. Thus the water naturally circulates between the pipes and the hot water cylinder being heated by the sun and the heat is stored in the hot water cylinder. It is called thermo-siphoning (see Fig.7).

Two solar panels are installed on the northern wall of the shed. There is a fire place with a wetback in the shed. It is swift-jointed to the pipes from the solar panels and used on cloudy days in winter. The hot water is used for shower and doing dishes.

Fig.6 Solar panels in the above and the wet back in the shed to make hot water

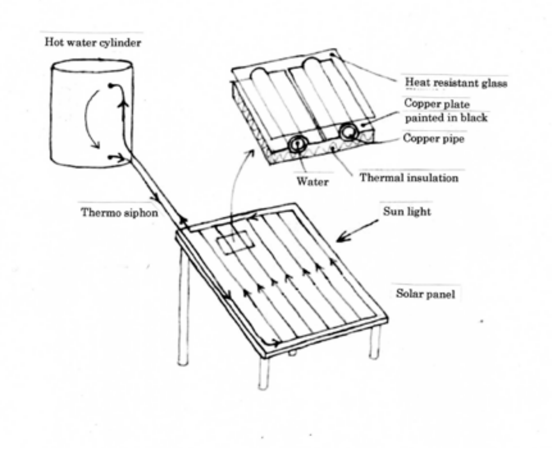


Fig.7.Thermo-siphoning at the solar panel

(6) Charcoal making of coppiced trees and a cooking range [2]

Tree branches are burned into charcoal after they dried. Charcoal is the main fuel for cooking. See Figure 8. Fire wood has been used as fuel for long time. It fixes carbon dioxide in the air to carbon through photosynthesis. One drum can full of cut branches, even pieces of them, produce five bucketfuls of charcoal. Eight meals for two persons were cooked with a bucketful of charcoal. The drum can full charcoal serves for 80 meals cooking. Carbon monoxide produced at cooking is monitored with a detector.

The wood gas which is produced at charcoal making is interesting to be discussed.

Fig. 8. Charcoal-maker in the left and cooking range with charcoal in the right

The carbonating process at a charcoal maker is imperfect combustion itself. The gas produced there, i.e. wood gas, includes carbon monoxide and hydrogen. Its energy is said three times the energy remaining in charcoal. Namely, wood fixes the solar energy and stores it.

At the growing process, trees convert carbon dioxide into oxygen through photosynthesis and give us a relaxing atmosphere. After they are matured, they are used as timber, energy sources etc. Although they take time, we must not stop growing them and leave them for following generations. Wood is very important for sustainable living.

One of the largest subjects for this project is to establish a life where we rely on solar energy. After 23 years, the solar energy collection which was planned in the beginning of this project comes to the end of the first stage.

Namely, on a fine day a solar oven and a solar cooker are used and on other days a charcoal cooking range. For air conditioning at the house, in summer outside air is cooled using the ground heat, and in winter hot air collected in the solar room is circulated through the house storing the heat for the night. Hot water is stored in the hot water cylinder with the solar panels and the wet back with thermo-siphoning. The electricity for a PC, night lights, a refrigerator is obtained from the wind mills. When we live modest, the solar energy surrounding us gives us enough energy.

In such a way, we have tried to utilize solar energy with a broad view. Obtainable energy changes locally in the year and how much could be collected in total should be referred to the amount and the pattern of energy use of the family in order for appropriate planning to be made. On this point, the storage of energy is very important. Each energy source has a delay system, which should be considered during planning.

1-2. BUILDING A HOUSE WITH LOCAL NATURAL MATERIAL [1]

Local natural material is adapted to the local climate and goes back to nature without harming the environment when it is dismantled. Clay from the excavation of the basement is used for plastering, bulrush is used for thatching (see Fig. 9), and rain water is collected from tin roofs, not the thatched part, for daily use (see Fig. 10). Vernacularism is very important.

1-3. NO CONTAMINATION AROUND THE HOUSE [1] [4]

Every public nuisance should be solved at the contamination source where it is easier to treat and it might be recycled. Once mixed, rubbish is the result. All organic matters are processed by the Ozeki septic tank into biogas as mentioned earlier. The carbon dioxide produced in the kitchen is guided to the greenhouse through an air duct and is expected to be changed into oxygen by photosynthesis (see Fig. 11).

The gray water runs through the zigzag channels of three cleansing ponds where water plants, e.g. rice, water cress, duck weed, water lily etc are planted, and it is cleansed (see Fig. 11). Water test at a local lab told that it was cleansed quite well.

In this way, only if human activities do not inflict any waste and harm on our precious earth, can a sustainable system be established.

1.4. SELF-SUFFICIENCY BASED ON ORGANIC FARMING [1] [2]

Orchards for fruit and nut trees, veggie gardens and a rice paddy are producing daily foods (see Fig. 12). The rice paddy has 131m^2. It is grown perennial.

The eldest three lines had the thirteenth harvest. The character would be useful for sustainable living even to have less harvest per plant than that of annual transplantation. A variety of fruits and nuts are harvested more than enough. Veggies can be picked every day through the year. I appreciate to eat them without the anxiety against chemicals.

1.5. JOYFUL LIFE [1] [2]

If the above four items are given, they are just materialistic. We would like to have joy and spiritual progress on daily life. A music gathering has been held once in a year in March at our hand

Fig. 9 Thatching roof with bulrush

Rain water tank and sludge trap Hand pump and two filters

Fig. 10 Rain water collection

Fig. 11 Cleansing gray water and CO_2 in the green house

Rice paddy in autumn

Veggies harvest on a day

Fig. 12 Self-sufficiency

Chanting by Japanese monks

Audience at a music gathering

Japanese drummers in the night

Japanese drummers in the day time

Fig. 13 Music gathering at the hand made amphitheater

Fig. 14 One's expression

Fig. 15 Strolling at the site

made amphitheatre whose slope was learnt from Greek amphitheatre [5] [6] (see Fig. 13). Unfortunately, it has to be stopped by the tenth in 2008.

It is joyful to express one's expression and to make furniture with off cuts (see Fig. 14). Nature gives us wonderful environment (see Fig. 15). We can find a lot of interest and joy on a sustainable life. An individual is liberated and becomes free, and gets back creative time and space of oneself.

2. ARCHITECTURAL PLANNING FOR A SUSTAINABLE WAY OF LIVING

As the principles of architectural planning, it should be discussed and planned for housing and farming, respecting fully given landform and plantation. It is important to obtain the local meteorological data and/or observation at the place and to know how extreme seasons are. If two extreme seasons are bad like big cities in Japan, then we might need to have a cool tube system to use the ground heat. The sun set and sun rise are important to know how they happen. In case of Japan it should be careful for summer and winter.

Topography, geology, population, social customs including culture, festivals, events etc need to be found and understood, and it should be planned with them. Using the privilege of seasons, it should be designed to enjoy them. It is commonly said through countries that a house needs breathing through walls. We need to learn from local construction and material.

About the items which are mentioned earlier they should be introduced to house planning practically discussed for the site. At least we have to monitor and analytically understand the details of seasonal changes and reflect them on the planning.

2.1 FLOW CHART FOR ARCHITEC-URAL PLANNING [1] [7]

In order to support an architect who plans a house for sustainability, a flow chart in Fig.16 can be considered.

Evaluations for cost performance and structural engineering are well established. Data base is prepared with a variety of values but every material should have not only its particular physical value but should be given in general for a wide range of use.

At architectural environmental planning, the evaluation by the estimation functions given later is fed back to an architect and then to the client with a few ways. Physical field calculation for each factor is given at my home page [1] (See Chapter 5).

One of the important items here is to judge sustainability and it must be discussed not only how to build a house but how to live there. An estimation function for that is being sought, but it has a possibility for instance to find the total point for the house, comparing with each item that is practiced at the Experimental House and estimate it.

Indeed, we wish not to give any loads to our earth through the activity of construction and the way to live there.

A computer program is urgently needed to process in real time the

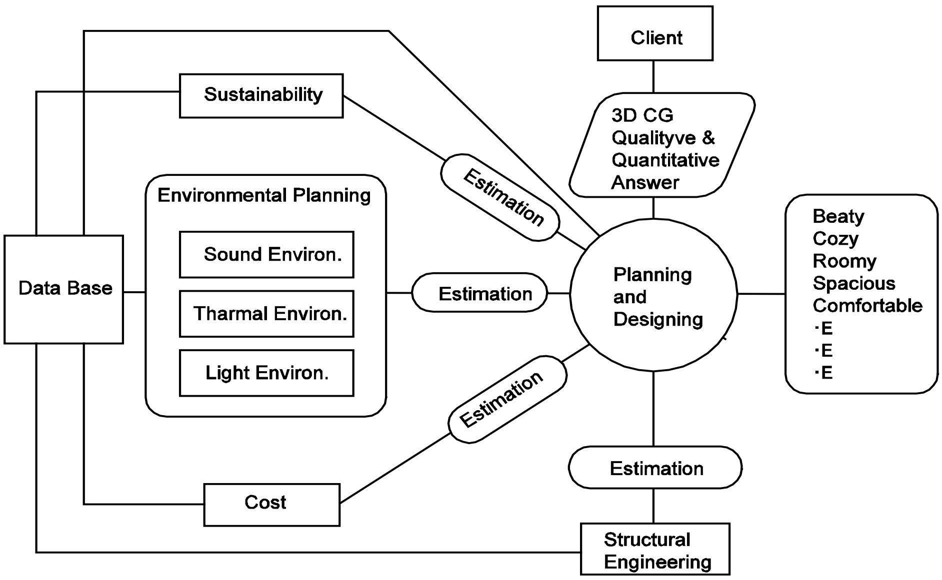


Fig. 16 Flow chart for sustainable house planning

evaluation for the flow chart. Especially, total estimation on architectural environmental planning is needed. Every architectural environmental factor is ready to join to make it and if they are brought together a good computer program will be created

2.2 NECESSARY AREA TO HAVE A SUSTAINABLE LIFE [1] [7]

The figures are given in Table 1 that were obtained from the past experiments and discussion on this project. It is estimated for a family of four members. If the figures are given to Japan, 20% of the land is needed for the population. It is practically possible.

The fundamental concept for sustainable living is a planning of a house relying on solar energy. When it is planned at other place, the latitude α_1 of Kaiwaka (about 36.1degrees) must be referred to. If the latitude of the place is α_2, the necessary area is $\cos\alpha_1 / \cos\alpha_2$ times

Table 1 Necessary area for sustainable living

House	Rice paddy	Veggie garden	Grain field	Orchard	Coppice	Support others	Green house	Passage	Total
80 ㎡	500 ㎡	120 ㎡	300 ㎡	300 ㎡	500 ㎡	500 ㎡	50 ㎡	150 ㎡	2,500 ㎡

2.3 CALCULATION OF FIELDS FOR NOISE, TEMPERATURE AND LIGHT [1]

2.3.1 NOISE LEVEL IN Leq(A)

The sound level outside a window is calculated by the distance decrease from a sound source, its diffraction decrease by an obstacle in between and its reflection around.

The sound energy that transmits through the window is treated to compose a defused sound field in a room. A sound level in the room is obtained at each octave band, and converted with the A weight to its hearing level, then through the octave bands they are summed and expressed with dB(A). They are averaged for time change and to have a Leq(A).

Diffractions for a semi-infinite thick barrier and a rectangular body are discussed in refs [8] and [9], and hearing weight is discussed in refs [10] and [11].

2.3.2 PREDICTION OF A THERMAL ENVIRONMENT IN SET*

When we talk about solar energy collection, thermal environmental planning of a house how to get solar energy into it is primarily important. For that, a field needs to be solved to link the heat balance with the thermal transfer equation and the Bernoulli's formula.

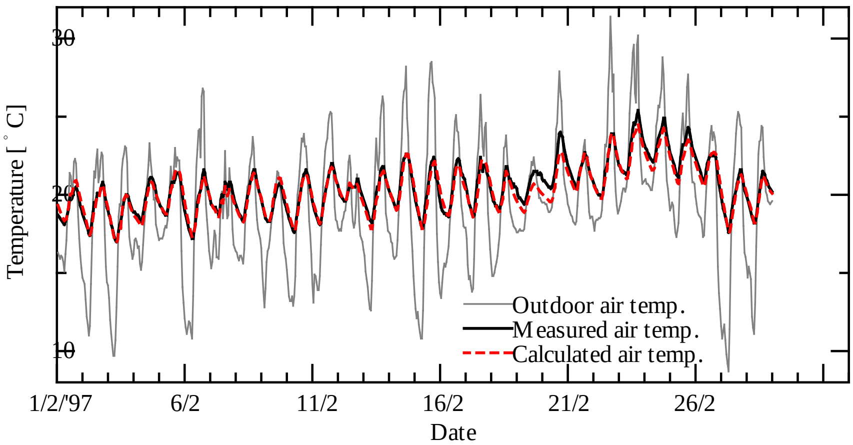
The thermal transfer in a boundary is calculated one-dimensionally to its normal. It is solved with the finite difference equation of thermal transfer (see Chapter 5 of ref. [1]). It is in non-steady expression and includes the effect of heat storage. It affects on an indoor climate meaningfully and the thermal environment must be well planned with it.

Fig. 17 shows the comparison of the temperature measurement in the house with the calculation by Dr. Hirotaka Azumi [12] (He passed away on Dec 12, 2010). This computer program simulates the measured results well, especially their behaviors and is practically useful.

2.3.3 LIGHT FIELD CALCULATION IN Lx

A light environment does not affect much on synthesized estimation, as it is mentioned later, and the method to use equivalent reflection coefficients is proper (see Chapter 5 of ref. [1]). A bag has a mouth and gets incident light. It is reflected inside the bag and reflects back at the mouth. The equivalent reflection coefficient for the mouth is obtained as the ratio of the equivalently reflected light to the incident light. When there are two large parallel surfaces, the diffused illuminance on each inside surface is obtained with their surface reflection coefficients.

In a room, a plane is cut at a work desk. The upper and lower bag's equivalent reflection coefficients are calculated. Then the diffused



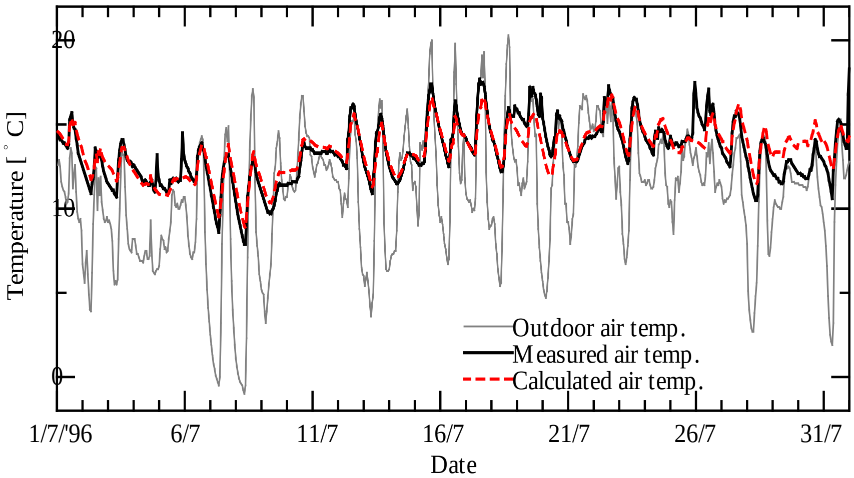


Fig. 17 Temperature changes at the northern bed room in winter above and in summer below in 1996 to 97

illuminance on the work level is obtained. The illuminance on the desk is given with the direct and the diffused lights.

2.4. SYNTHESIZED EVALUATION OF AN INDOOR CLIMATE [1] [13]

The synthesized estimation method for three heterogeneous factors, noise, temperature and light is given on the subjective scale - neutral, slightly uncomfortable and uncomfortable (see Table (2)). The scale is used commonly for the three factors which are usually expressed on their specific subjective scales only. It was developed by using the second theory of quantification by Hayashi.

Table 2 Scores for each category to estimate an indoor climate

Factor	Summer	$N = 538$	$\eta = 0.77$	Winter	$N = 549$	$\eta = 0.62$
	Category	Score	PCC*	Category	Score	PCC
Thermal condition (SET*)	21.8	0.762		15.0	−1.480	
	26.2	0.706	0.762	18.5	0.051	0.569
	30.7	0.180		22.7	0.688	
	34.6	−1.637		26.1	0.697	
Noise (Leq)	40	0.168		40	0.436	
	50	0.151	0.257	50	0.337	0.325
	60	0.052		60	−0.097	
	70	−0.374		70	−0.676	
Illuminance (lx)	170	−0.057		170	−0.271	
	700	0.006	0.053	700	0.207	0.158
	1480	0.052		1480	0.080	

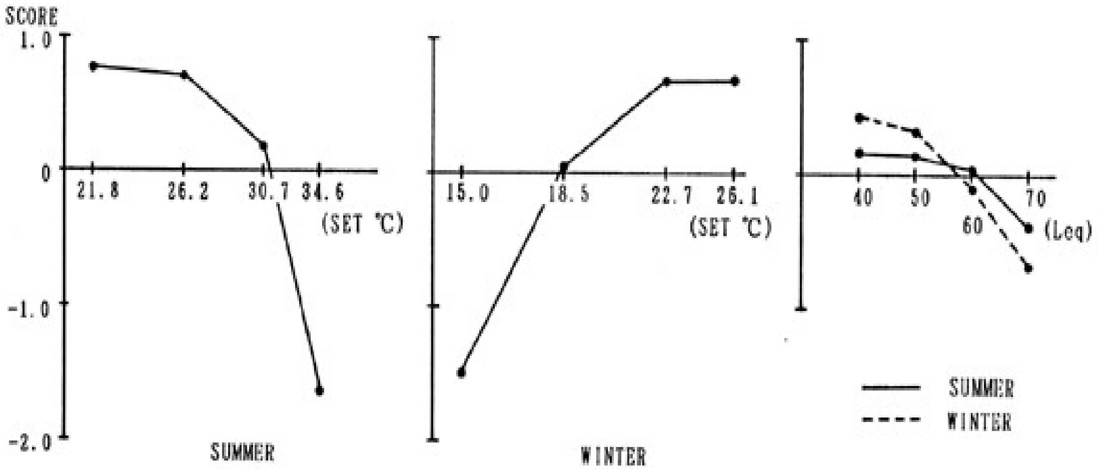
*PCC = Partial correlation coefficient.

Table3 Dividing points for indoor climate estimation

Dividing point	Summer	Winter
z_1: between U and SU	−0.85	−0.82
z_2: between SU and N	0.55	0.53

N = neutral; SU = slightly uncomfortable; U = uncomfortable.

Practical use is exampled as follows; When a noise level is 55Leq, thermal condition is 28.4SET* and illumination is 700lx, noise score gets 0.102, thermal score 0.443 and illumination score 0.006, and the total score is 0.551. Referring to Table 3, this environment will be predicted to be "neutral". How should thermal condition TC be designed, when the "neutral" condition is aimed, and noise level 50Leq and illumination 700lx are given? The total score must be higher than 0.55. The two other inevitable factors give noise score 0.151 and light score 0.006. From the inequality 0.151+TC+0.006>0.55, TC



Thermal environment Noise environment

Fig. 18 Un-comfortableness score vs. specific physical scale

must be higher than 0.393. By the interpolation the thermal condition must be kept lower than 28.9SET*.

Un-comfortableness scores for sound and thermal environments are expressed on the vertical axis with the specific physical scale of each factor on the horizontal axis in Figure.18. The specific physical scales for the loudness of a noise and thermal sensation are supposed to be simulated the specific subjective scales and they change linearly or smoothly on their physical scales, but these curves have points of inflection. It is interesting that the un-comfortableness suddenly increases from there. It shows actually a functional expression for un-comfortableness towards physical parameters. In this way, we can find the relationship between the un-comfortableness scale and specific subjective scale for an environmental factor through its physical simulation.

2.5. EVALUATION OF A LIVING ENVIRONMENT [1] [14]

This is also a prediction method obtained by the second theory of quantification (see Table 4). When this methodology is applied each involved factor must be independent. We picked up 23 factors to judge a living environment at social surveys in Japan, but some of them got large internal correlation and had to give up those factors. The quantification was done with 8 factors but practical probability was slightly more than 70%. If this method is applied to the experimental house at Kaiwaka,

Table 4 Scores for each category to estimate a living environment

Factor	Category	Score	Deviation
Convenience for shopping	v. good	0.486	
	good	0.177	
	s. good, neut., s. bad	-0.090	
	bad	-0.251	
	v. bad	-0.720	
Sunny in winter	v. good	0.303	
	good	0.132	
	s. good, neut., s. bad	-0.093	
	bad	-0.657	
	v. bad	-0.783	
Light in the night	v. good, good, s .good	0.181	
	neut	0.068	
	s. bad, bad	-0.113	
	v. bad	-0.586	
Noise	v. good	0.414	
	good	0.241	
	s. good, neut., s. bad	0.137	
	bad	-0.247	
	v. bad	-0.578	
Safety for commute& school	v. good, good, s. good	0.023	
	neut.	0.111	
	s. bad, bad, v. bad	-0.245	
Greens around	V .good	0.216	
	good, s. good	0.212	
	neut.	-0.100	
	s. bad, bad	-0.505	
	v. bad	-0.708	
Public moral around	v. good	0.572	
	good, s. good	0.382	
	neut.	-0.280	
	s. bad, bad	-0.666	
	v. bad	-0.743	
Safety for children's play	v. good, good, ,s. .good	0.243	
	neut.	-0.063	
	s. bad, bad, v .bad	-0.175	

v; very, s; slightly, neut.; neutral. Square root of correlation ratio; 0.73. Samples: 540

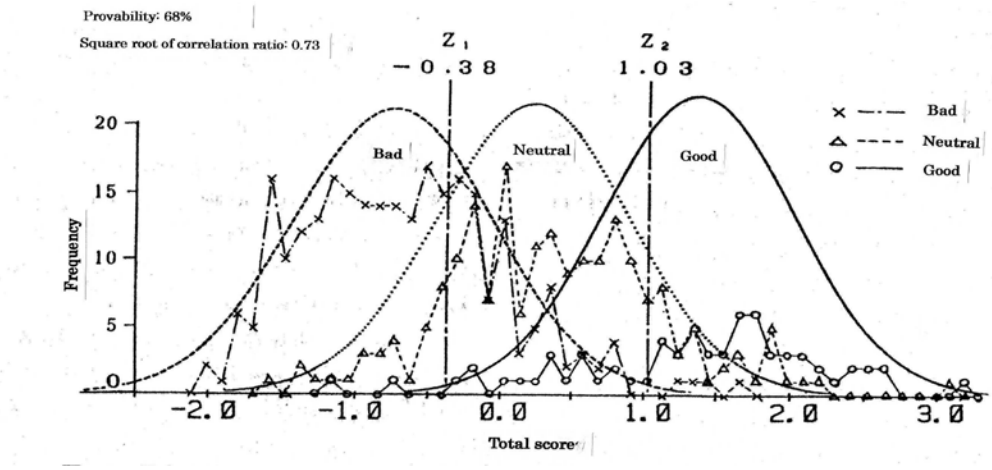


Fig. 19 Dividing points for the prediction of a living environmental

Convenience for shopping-bad;-0.251
Sunny in winter-very good; 0.303
Light in the night-bad; -0.113
Noise-good; 0.241
Safety for commute and school-good; 0.023
Greens around-very good; 0.216
Public moral around-good; 0.382
Safety for children's play-neutral; -0.068

, and the total score is 0.733. It is referred to the dividing points in Fig. 19 and it is predicted "Neutral". It is very close to "Good". For instance, if the inconvenience for shopping is improved to "Good", the living circumstances are estimated as "Good". The result coincides to my daily impression.

2.6 UTOPIA VILLAGE SCHEME

When such families are gathered and construct a village, we can create a higher level of living with cooperation.

Willing volunteers gather, learn sufficiently at least farming, carpentry, basic science etc, observe the site at least for a year. It must be done with the principles of Architecture mentioned before. Learning the knowledge of ancestors or natives, using it efficiently and adding new knowledge, we make a master plan of the village together.

The first house is built together for a family to be able to live from the day. The family work for the next house fully with others. When it is expanded, a sustainable village is composed naturally. An experienced person can help to construct next village. There we must have low hierarchy and an individual is equally respected, we never need a village chief and a structured society.

During the construction process, real and meaningful science will be created and developed toward the sustainable way of living. Wonderful space of sustainable living would be found where each one is liberated, becomes to be free and develops one's creativity. They can polish it with each other and create the village as the space to enrich and improve.

In the space everyone talks about life purpose and the world after the sun dies. I dream to have a utopia village here in NZ and Japan.

RESUME

It was shown that a sustainable way of living is very possible, showing with the results of experiments which have been done at Kaiwaka experimental house for 23 years. Methods to get energy from the sun were explained and they are shown enough to live modest. House construction to use surrounding materials, no contamination from daily wastes, and self-sufficiency with organic farming were mentioned as well. It was shown also that if people gather their creations, we can realize joyful moment and space.

Accordingly, an individual becomes free, enjoys life and thinks deeply life purpose, I emphasized.

In addition, Architectural environmental planning methods were given with quantitative estimation to aim sustainable living. Architectural planning tends to do qualitatively, but they would be helpful to plan quantitatively sustainable living.

If we are away from nature, we may not able to go back there, forgetting farming of other days and losing the ability to observe and grasp holistically nature for the coexistence with it. Already the defect from nature makes them deformed; a kid who can not touch worms, a man who thought a potato grows on a tree, a kid who said that it was wrong pointing at a flying bird-because it was different from his book, a university student who feels scared if he sees the crystal starlit night sky, because it imagines him infinity.

Further problems are confusions and vicious circles which are caused by human selfish inventions. Starting to build a house under the blessing of the sun, it is important to advocate the return to nature.

Once earth and water are contaminated, we never can get back to former. This is not a subject to deposit to society and politics, but is asked for everyone being related to one's way of living.

The proposed sustainable planning is just a process to be improved. It is not good to fix a necessary area. We have to review how it has good fusion with nature and keep improving depending on the site. However, if it has a start it will give creation and ideas one after another.

Indeed the sun has a life to finish after 4.5 billions of years. Not only human beings but all the creatures on the earth die. Where in the world do they go? I think this is the last subject that was given by the creator to us all. The real human cooperation is, beyond generations, to solve the subject and find the next world, I think. In other words, a sustainable way of living means processing one's life impact closed in and not to giving any load on nature. There, it is just a physical matter to live, but it is left for a man to think.

Here, I emphasize again that we use a variety of thin energy of common knowledge for every one to be able to apply. We are not doing this because of energy and environment crisis. They are naturally solved with the sustainable way of living. Its purpose is to get each one's freedom. So, we live modest and sustainable. It is never for other people, but for oneself. We must not impose it to others.

There are some people saying, some body will find new energy. But they have to remember that they will be forced to be used again in the structure. We constructed a society to rely on other people too much.

Every one has to die. It must not be discontinuous from one's earthly life.

REFERENCES

[1] http://www.ecohouse.co.nz.
[2] YouTube at; yoshiecohouse.
[3] Ozeki, A., Sakurai, Y., Niwa, F. (2000). Biogas generated from organic waste in Ozeki septic tank. (booklet) or Ozeki, A., Sakurai, Y., Niwa, F. (1999) Bio-gasification of organic wastes by septic tank (in Japanese). J. of the Japanese Solar Energy Society, 25(2), 53-60.
[4] Sakurai, Y. (1996). Clarification of carbon dioxide after cooking and drained water by the photosynthesis of plants in the green house (in Japanese). J. of the Japanese Solar Energy Society, 22(4), 34-37.
[5] Sakurai, Y. (1987). The early reflections of the impulse response in an auditorium. J. of Acoust. Soc. Jpn. (E), 8, 4, 127-138.
[6] Sakurai Y., Ishida, K. and Morimoto, H. (1993). The reflection of sound at grazing angles by auditorium seats. Applied Acoustics, 39, 209-227.
[7] Sakurai, Y. (2011). Architectural planning for sustainable living. Inter-noise 2011 Osaka, SS32, Sept.
[8] Sakurai, Y. & Morimoto, H. (1998). Diffraction of a semi-infinite thick barrier. INTERNOISE 98, Christchurch, NZ, 16-18 November.

[9] Morimoto, H. & Sakurai, Y. (1998). Diffraction around a rectangular body. INTERNOISE 98, Christchurch, NZ, 16-18 November.

[10] Sakurai, Y. & Morimoto, H.(1989). The transient response of human hearing system. J. Acoust. Soc. Jpn (E), 10(4), 221-228.

[11] Sakurai, Y. and Morimoto, H. (1989). Binaural hearing and time window in the transient. J. Acoust. Soc. Jpn (E), 10, 4, 229-233.

[12] Azumi, H. (2001). A study on indoor thermal prediction of the house for a sustainable life (in Japanese, his doctor's dissertation).

[13] Sakurai, Y., Noguchi, T., Horie, G. and Matsubara, N.(1990). Quantification of the synthesized evaluation of the combined environment", Energy and buildings (Elsevier), 14, 169-173.

[14] Sakurai, Y., Ishimaru, K., Kumon, H. and Horie, G. (1988). Quantitative environmental planning based on the analysis using the theory of quantification II (in Japanese). Journal of the Architectural Institute of Japan, 387, 53-60.