USER FRIENDLY TOOL TO USE TEXT BASE INPUT DATA FOR SOLAR BUILDING SIMULATIONS

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1. Introduction

The building heat load and energy system simulation programs are often used mainly for the research purposes rather than for the practical design. The simulation is merely used in the design stages of buildings because the preparation of the input data of a simulating building is usually a complicated work.

However, in designing the comfort and energy efficient buildings, the effective use of the simulation is a contemporary issue to reduce the energy use from buildings. Therefore, the necessity of predicting the energy use by the simulation is increased in the design stages of energy efficient buildings. Moreover, recently, multiple high performance housing equipments and systems are developed. Especially, in designing the roof integrated solar air collector and underfloor heat storage, the designers have to understand the theory to determine the collector areas, the air flow rate of the fan and heat storage capacity of underfloor slab and so on. To check up these points, using the building energy performance system simulation program is very important.

From such a background, for example, *Energy-plus*[1], [2]and *Thermo-Render*[3] have been added the function which can directly provide the input data from the drawing data obtained by the 3D-CAD. Although it is a convenient way that the simulation can be directly performed the input data using the 3D-CAD, only the users using it can receive a benefit.

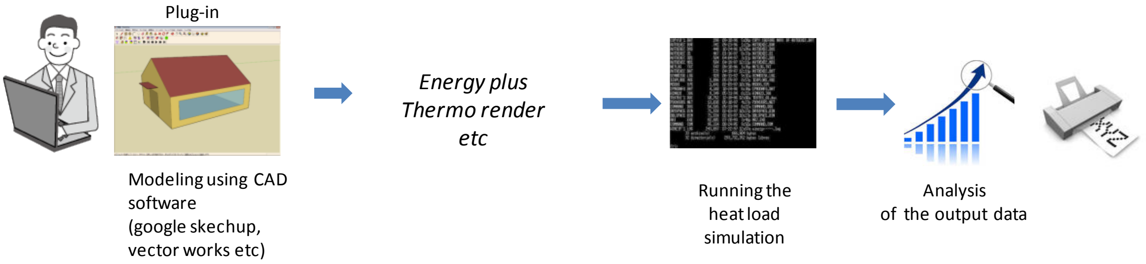


Fig. 1: Execution of the heat load simulation using the CAD software

So, in this research, the user-friendly tool of building heat load simulation program aiming at design supports for the roof integrated solar air collector for space and DHW heating system for the designers at the practical design stage has been developed using *Microsoft Excel*. This tool is called as *SunSons for Windows*[4].

2. Outline of building solar heating system

Fig.2 shows the systematic diagram of the roof integrated air solar collector for space and DHW heating system called as *OM solar system* [4] since 1987 in Japan. The solar heat collection area of the roof consists of the pre-heat solar collector and the glazed solar collector. PV panels are possible to be installed on the pre-heat collector. The outdoor air is warmed by solar collector and flows into the underfloor spaces and the collected heat is stored in the concrete underfloor slab. And then, the heat is radiated from underfloor spaces. Moreover, the warmed outdoor air by the solar collector is used also for the hot water heating in summer, autumn and spring.

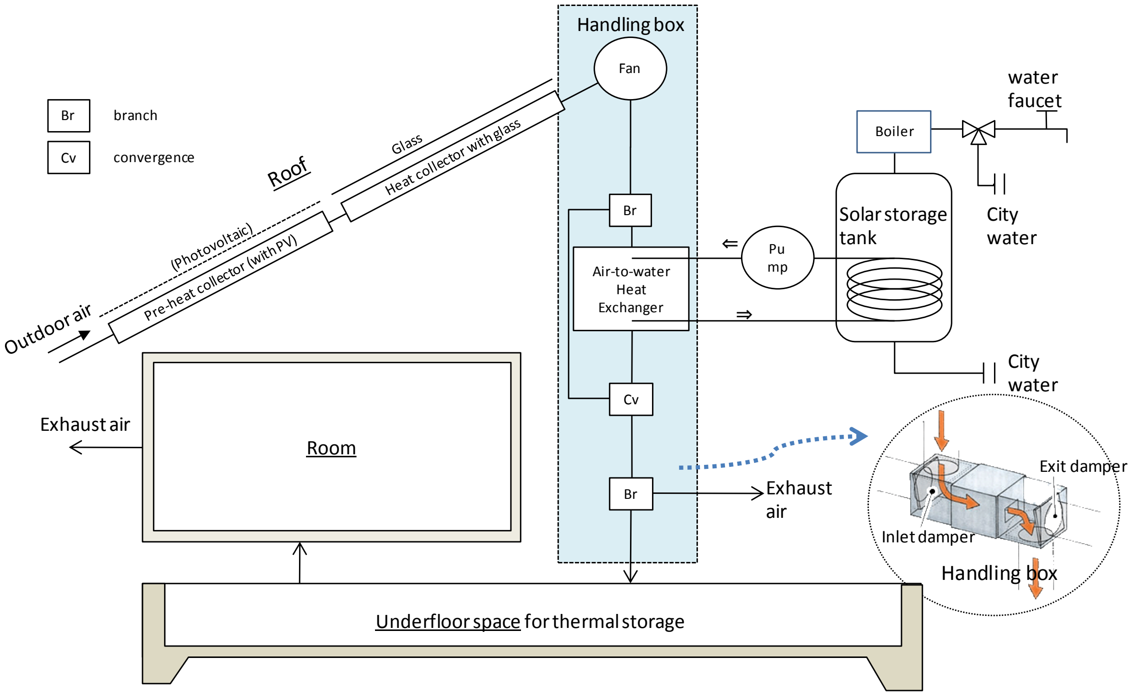
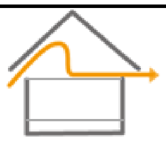
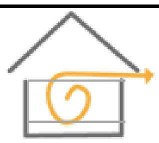
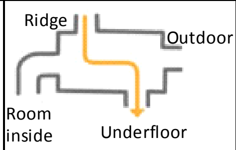
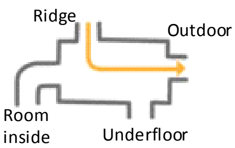
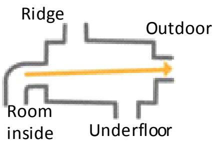
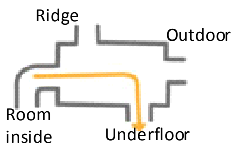


Fig. 2: the roof integrated solar air collector for space and DHW heating system

Tab. 1: Control of Handling box

	Floor heating Outdoor air cooling at summer night	Exhaust	Ventilation	Circulation
Air flow	From the roof to underfloor space	From the roof to outside	From inside to outside	Circulation of indoor air
Air flow path				
Switching of the handling box				

The roof integrated solar heating system is designed to be controlled shown as Tab. 1. These operations are controlled by switching the dumper of the handling box. At night in summer, cooled air through the influence of radiative cooling is carried to the underfloor and is stored in the foundation. At daytime in summer, outdoor air warmed by heat collection areas of the roof is used as hot water. Without the solar hot water system, it is exhausted. In winter, the warmed outdoor air flows into the underfloor space and heats the underfloor slab, then flows into the heating room. Furthermore, it is possible to allow indoor air to circulate too.

In the basic design of the solar house with integrated air collector, the process is divided into seven steps as shown Tab. 2. When the heat load simulation is used by a designer at the practical design stage, the designer often expects to avoid complicated work to prepare the input data for the simulation. Therefore, the easy-to-use graphical user interface for input-output support tool in the heat load simulation program has been developed using *Microsoft Excel*. This tool is easily able to be examine the designed solar heating systems, to be printed the formal reports on the energy saving and to be used for the business activities.

Tab. 2: Design process of the roof integrated solar heating system

Step1	Size of the heat storage area in the underfloor spaces. Size of the solar-heated room	
Step2	Size and specification of the roof integrated solar collector	
Step3	Layout of the handling box and ducts	
Step4	Layout of the solar heated air outlets on the floor.	
Step5	Layout of the remote-controller panel and the thermo sensors	
Step6	Design of the solar hot water heating system	
Step7	Specific of the auxiliary space heating system if necessary	

3. Program Flow

Fig.3 shows the program flow of *SunSons*.

1. Data input

A designer inputs the data in the specially designed graphic environment with the easy-to-use windows and the pull-down menus. And then, the text input data for *EESLISM*[5], a generalized energy and environment simulation program applicable to the solar buildings is created.

2. Input data check

3. Execution of *EESLISM*

4. Output data analysis

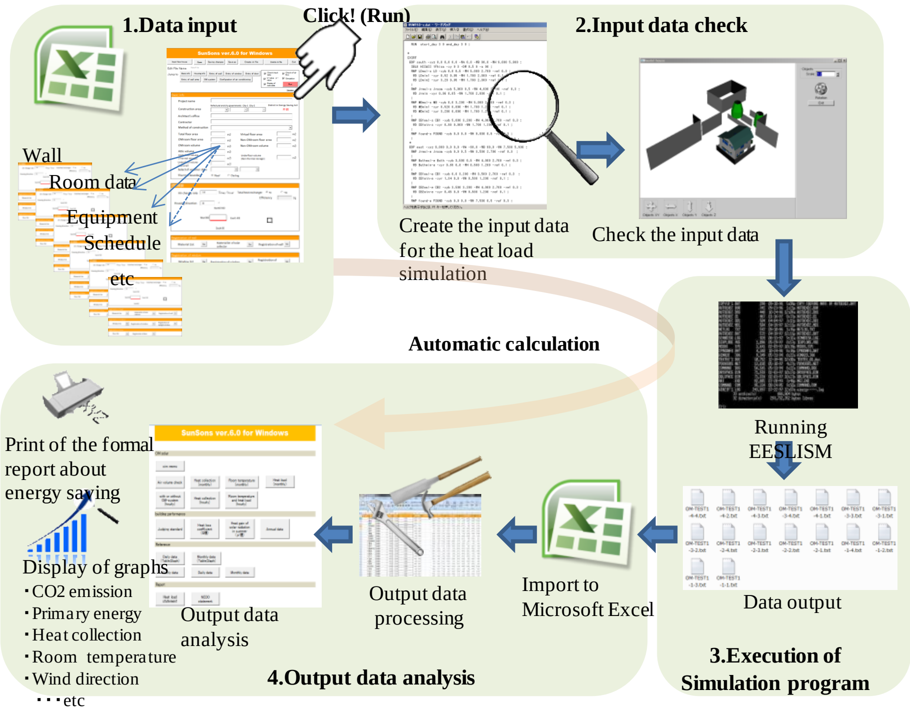


Fig. 3: Program flow of *SunSons*

4. Data input

The information of the house is input using the control box of *Microsoft Excel*. In this section, the input method of the outside obstacles is shown. When the outside obstacles or the designed house is input, to input all the vertex coordinates of the outside obstacle etc. by three-dimensional coordinate is very difficult. Therefore, the input method must be as easy as possible. And so, only one vertex is input by three-dimensional coordinate. In addition, angle of direction, angle of tilt, width, height and depth of the obstacles are input. The outside obstacles are able to be input easily as rectangles (like eaves and screen etc.) and the three-dimension (like balcony, cube and tree etc.) as shown in Fig. 4. The outside obstacles input as three-dimension are broken down into the polygons. Apart from these, in consideration of complicated form's obstacles, to input directly all vertex coordinates by the three-dimensional coordinate is possible too.

Fig. 5 shows input of the designed house. At first, outer wall of each aspect (called as *BDP*) is defined. The bottom-left vertex coordinate(x, y, z), angle of direction, angle of tilt, width and height of *BDP* are input. Next, outer wall of each room in *BDP* (called as *RMP*) is defined. The bottom-left vertex coordinate(x, y), width and height of *RMP* are input. At last, windows (called as *WD*) in *RMP* are defined. The bottom-left vertex coordinate(x, y), width and height of *WD* are input.

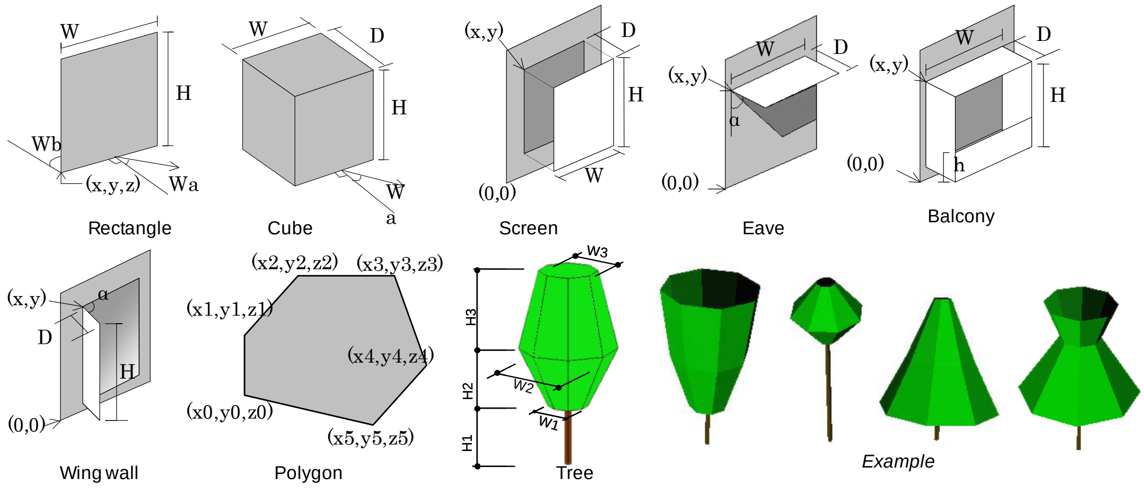


Fig. 4: Input of outside obstacles

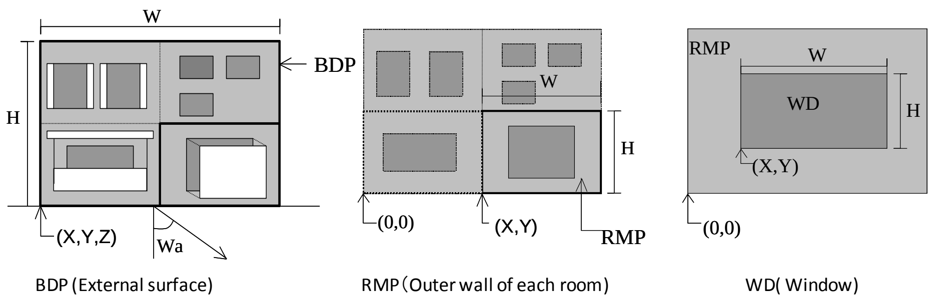


Fig. 5: Input of the designed house

5. Data check

In shown as Fig. 6, after the input data, the entry data are confirmed. If the number of errors is zero, text input file for *EESLISM* is created. In the case of consideration of the outside obstacles, before executing the simulation, housing and outside obstacles layouts are able to be confirmed using the computer graphics tool called as *KAGESUN*[6] which was developed by the author. This tool is able to look down upon the building layouts from every angle by mouse operation and to check whether input data is right or wrong instinctively.

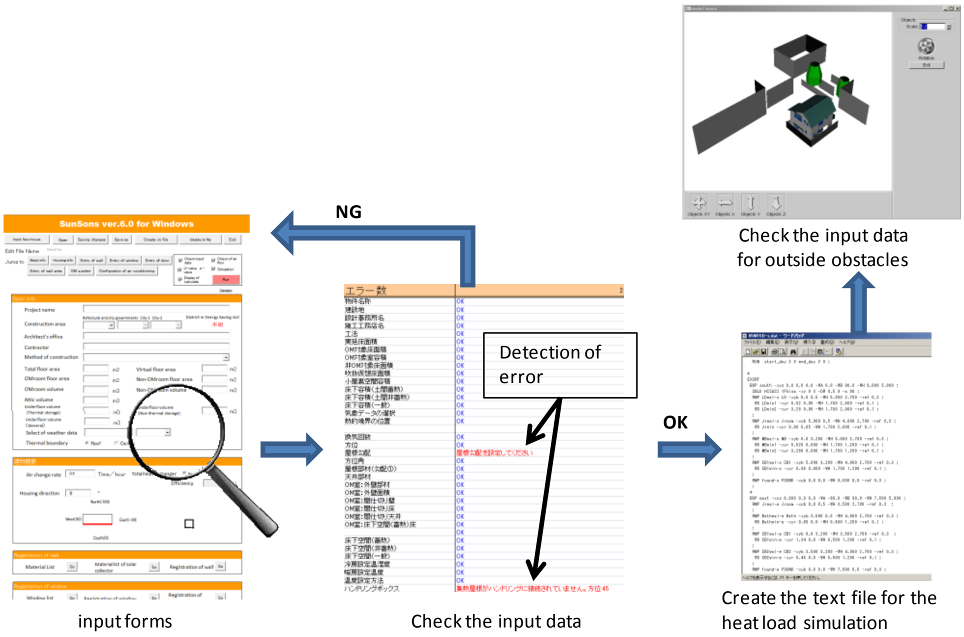


Fig. 6: Check the input data

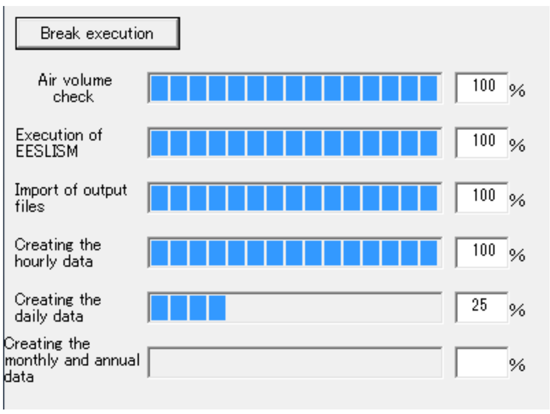
6. Execution of simulation (EESLISM)

After input data check, EESLISM is executed. Tab. 3 shows calculation pattern. At first, the suitable fan is chosen as ridge temperature does not exceed 80 degrees C (Case 0). Next, three cases (The solar air heating system with the air conditioners as the auxiliary heating (Case 1), only the air conditioners (Case 2) and only the solar air heating system (free floating room temperatures, Case 3)) are calculated.

Fig. 7 shows progress bar displayed during *EESLISM* execution. After *EESLISM* execution, the necessary output files are imported to the *SunSons*. Next, the hourly, daily, monthly and annual data are created. And then, some graphs needed for analysis of The roof integrated solar heating system are created.

Tab. 3: Calculation pattarn

Case 0	Air flow rate check of the fan
Case 1	The solar air heating system with the air conditioners as the auxiliary heating
Case 2	Only the air conditioners
Case 3	Only the solar air heating system (free floating room temperatures)



1.Checking the air flow rate of the fan

2. Execution of *EESLISM*

3. Import of the output files to Microsoft EXCEL

4.Createing the hourly data

5. Creating the daily data

6. Creating the monthly and annual data

Fig. 7: Progress form during execution of a program

7. Output data analysis

The designer can obtain the information in shown as Fig. 8.

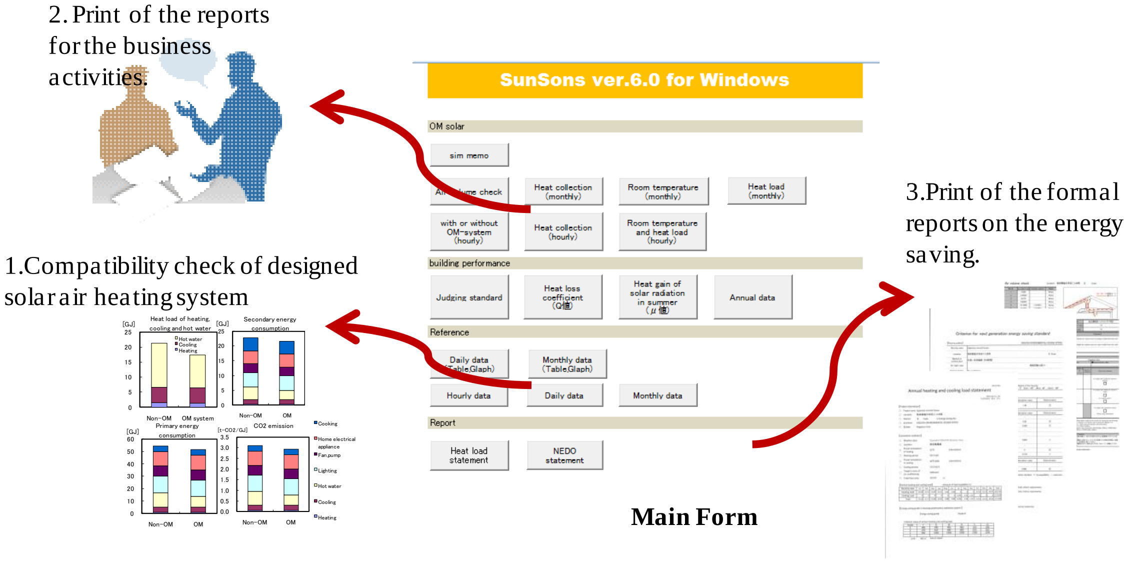


Fig. 8: Output data analysis by *SunSons*

1. Compatibility check of designed facility system

- Choice of the suitable fan
- Verification of the effects of the roof integrated solar air heating system (room temperature, heating load, secondary energy consumption, production of electricity, CO2 emission and so on) in shows as Fig. 9.

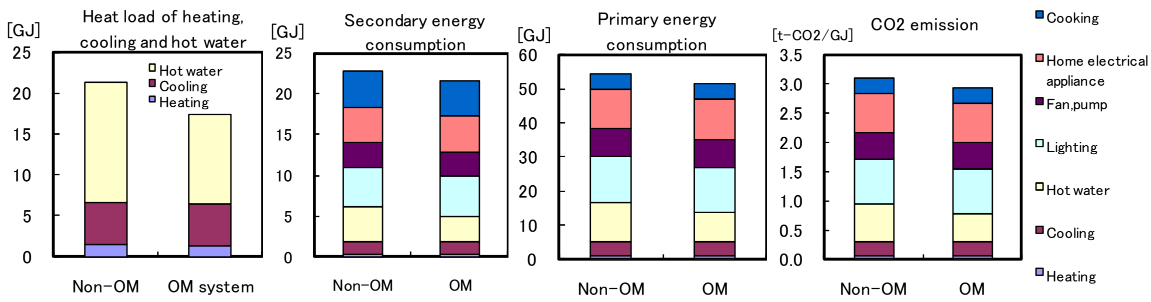


Fig. 9: Example: effects of the roof integrated solar air heating system (Heat load, Secondary energy, Primary energy and CO2 emission)

2. Printout of the report for business activities

Fig. 10 shows the A3 size report for sales called as *Simulation Note*. Simulation note is organized by the effects of the roof integrated solar heating system and is helpful in providing an explanation to a customer.

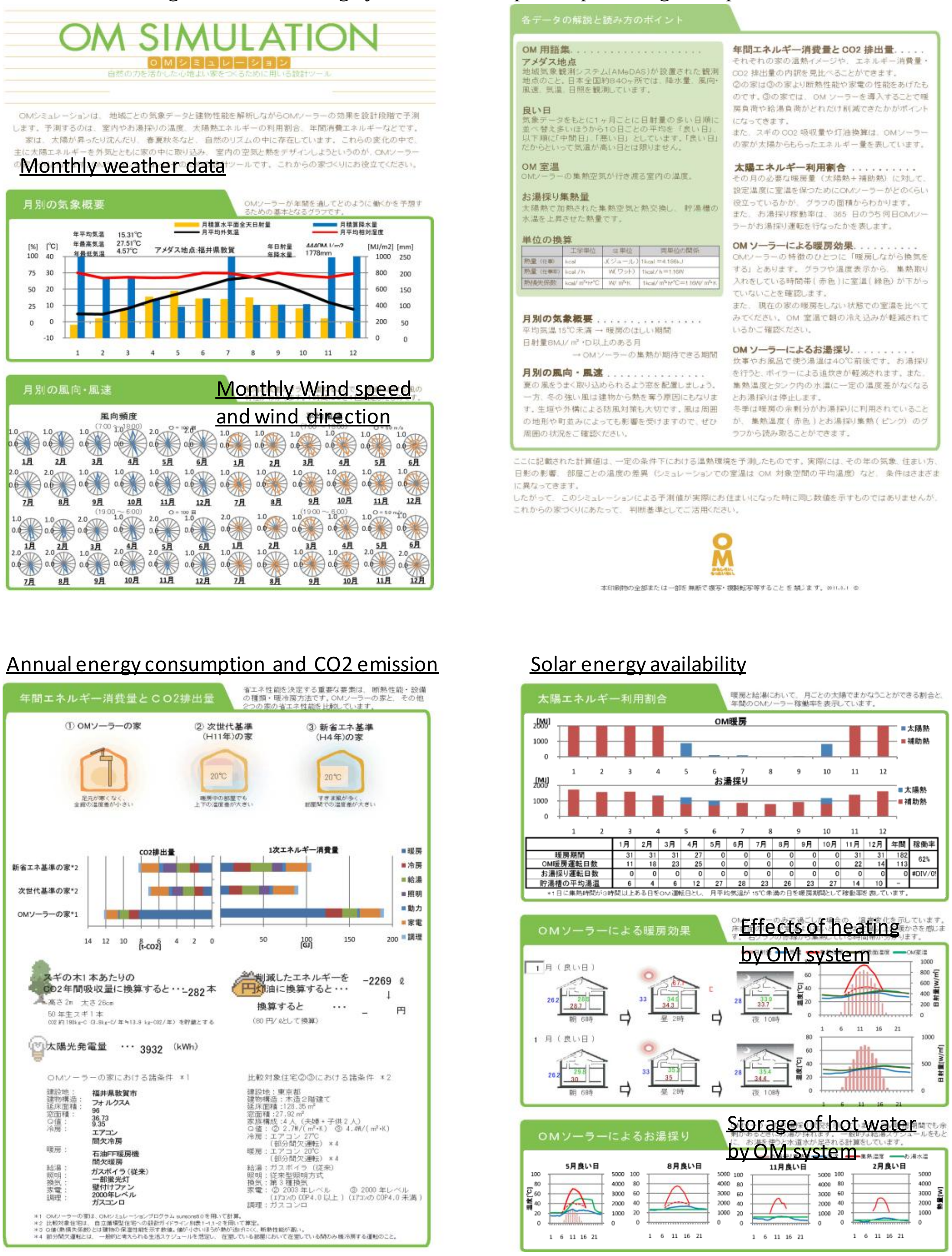
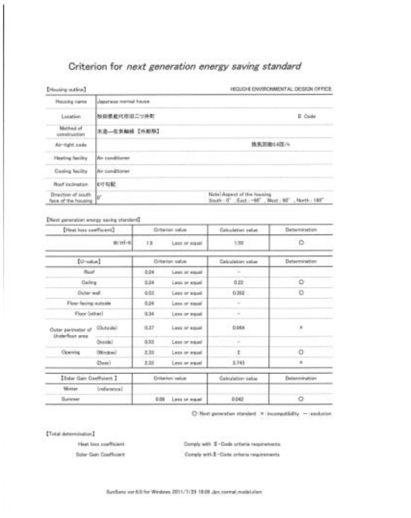


Fig. 10: Report for sales (simulation note)

3. Printout of the formal reports on the energy saving

Fig. 10 shows the reports to be submitted on the energy saving. One is the criterion for next generation energy saving standard, the other is annual heating and cooling load statement.

Therefore, to use this user-friendly tool can be saved the trouble of creating these reports and be made a contribution to work saving of total residential design.



Criterion for next generation energy saving standard

Annual heating and cooling load statement

Fig. 10: Printout of the formal reports on the energy saving

8. Conclusion

The simulation is merely used by the designers of the solar houses because the preparation of the input data for the simulating building energy performance is usually a complicated work. Especially, In designing the theory to determine the solar air collector and underfloor heat storage, the designers have to understand the heat collector areas, the air flow rate of fan and heat storage capacity of underfloor slab etc. To check up these points, using the building energy performance simulation program is very important.

In order to use the energy performance simulation program for the practical design, user-friendly input-output support tool by *SunSons* has been developed.

Using the user-friendly tool *SunSons* can be saved the efforts for preparing the complicated input data for the simulation program.

Moreover, the output data to be used analyzing the simulation results are automatically shown just after finishing the simulaton.

The formal reports and the reports for business activities are also created automatically.

Therefore, *SunSons* can be made the design work more efficient.

9. References

[1] Johannes Aschaber1 et al, 2009. TRNSYS17: NEW FEATURES OF THE MULTIZONE BUILDING MODEL. Building simulation 2009, 1983-1988.

[2] Stephen K Wittkopf et al, 2009. DEVELOPMENT OF A SOLAR RADIATION AND BIPV DESIGN TOOL AS ENERGYPLUS PLUGIN FOR GOOGLE SKETCHUP. Building simulation 2009, 1989-1996.

[3] Thermo Render web site, latest access/2011.8.13, http://aanda.rsjp.net/products/ThermoRender/

[4] OM solar web site, latest access/2011.8.13, http://omsolar.jp/index.html

[5] Udagawa M. and Sato M. (1999). Energy simulation of residential houses using EESLISM. Proceedings of Building Simulation '99, 13-15 September, Kyoto, Japan, Vol. 1, pp. 91-98.

[6] Yoshiki Higuchi1 et al, 2007. EFFECTS OF TREES ON THE ROOM TEMPERATURE AND HEAT LOAD OF RESIDENTIAL BUILDING. Building simulation 2007, 223-230.