CADDET energy efficiency
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saves energy

Architectural planning and design saves energy in research facility

Summary

When the Home Laboratory of the Research Institute of Innovative Technology for the Earth (RITE) was constructed, the aim was to harmonise the building with its environment, while simultaneously integrating energy-saving measures. Moreover, as this is an advanced technology research laboratory, it is very important to combine energy-saving measures, working environment and research functions through careful planning and design. These measures resulted in a 29% reduction in primary energy consumption and a 26.5% reduction in air-conditioning load.

RITE Home Laboratory was awarded the Technical Prize for Design and Installation of Building Facilities at the 34th SHASE (Society of Heating, Air-conditioning, and Sanitary Engineers of Japan) Awards on 14 May 1996.

Highlights

- **Architectural planning combines energy savings with building function**
- **Passive HVAC approach utilises natural phenomena**
- **Air-conditioning system uses energy efficiently**
- **29% Savings in primary energy use**

Photo: Aerial view of RITE's Home Laboratory.

Aim of the project

RITE's Home Laboratory, completed in 1993, was planned and designed to make the environmental load as small as possible by incorporating a variety of energy-saving measures. Providing comfortable working conditions and securing environmental control needed to conduct research at the forefront of technology were also considerations in the building's design.

The Principle

RITE's Home Laboratory, built on a site of some 40,000 m^2, has a building area of approx. 5,700 m^2, and a total floor area of around 6,900 m^2. The floor area comprises a study and laboratory zone of 4,300 m^2, office/service zones of 1,800 m^2 and an 800 m^2 atrium. Due to their intrinsic function, research facilities are apt to be energy intensive and are therefore excellent candidates for reducing energy consumption. The Laboratory was planned and designed with special emphasis on the following three points:

- using a building layout and form that combines a good working environment, substantial energy savings, and a stable condition for scientific experiments into one concept;
- applying a passive HVAC approach utilising natural phenomena;
- contriving air-conditioning systems designed to use energy efficiently, as well as providing a comfortable working environment.

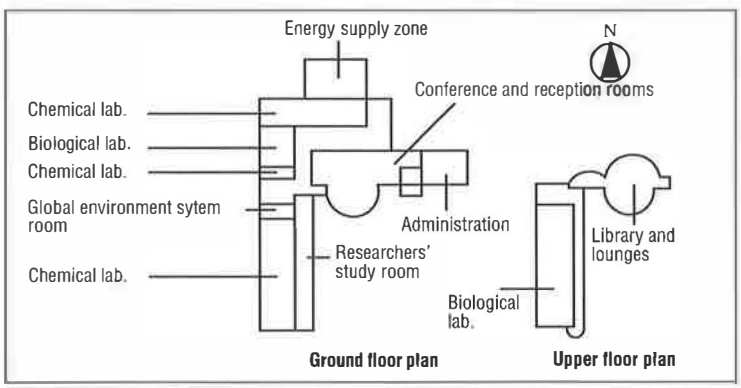
The Situation

Figure 1 shows the layout of the RITE Home Laboratory building. The laboratory area is built as a semi-underground construction in the north-west part of the site, where a stable environment for scientific experiments is easily achieved. The study and office areas (researchers' study rooms, offices, meeting rooms, etc.) are arranged in an L-shape on the south-east side above ground, where the building can utilise the benefits of nature, such as sunlight and cool winds. The energy supply area is located on the north side, from which energy can be delivered to the building over the shortest distance. In addition, to minimise thermal loads from outside, the eaves are deep enough to provide sufficient solar shading.

The passive HVAC approach utilising natural phenomena is illustrated in Figure 2. Water, mainly composed of reclaimed rainwater, is circulated around the building. This water flows from a spring through a shallow brooklet and waterfall to a pond, providing the cool air for the building. Biofilms of stones in the brooklet and pond naturally clean the water which is then also used as non-potable water and for the water-cooled operation of an air-source heat pump. Ventilation caused by temperature difference and air monitors provide the building with adequate natural air draft during the intermediate seasons. To mitigate outdoor air loads, fresh air (precooled or preheated in underground cool tubes) is taken into the building. During the winter, the study and office areas take in outdoor air which is preheated by being passed through double roofs called air flow roofs.

Chilled and hot water is effectively used all year round by the low-grade chilled/hot water storage in stratified thermal storage tanks and by the cascading use of thermal energy. The thermal storage system, located in underfloor slabs with outside insulation, reduces the pull-up loads of air conditioning in winter and pull-down loads in summer. In addition, the aforementioned water-cooled operation of the air-source heat pump enhances the COP of the heat-pump

Figure 1: Layout of RITE Home Laboratory Building.



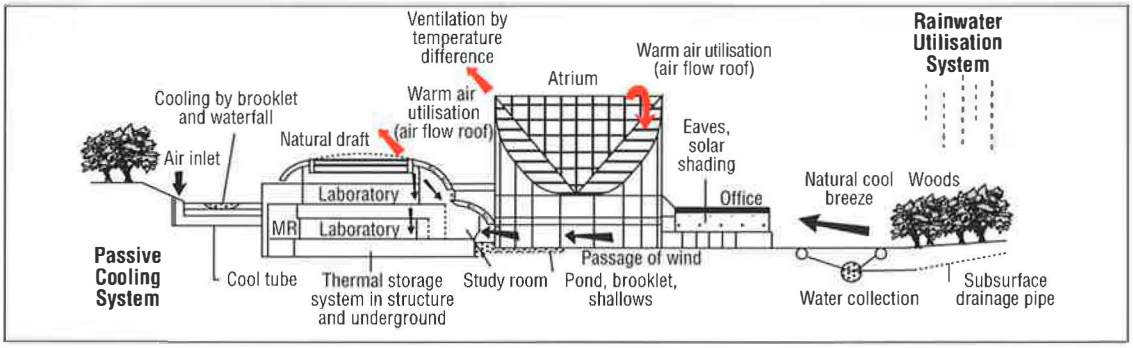


Figure 2: Passive HVAC approach utilising natural phenomena.

equipment at night during summertime. The study and office areas are cooled or heated by the radiation effect of the floors as well as by cool or hot air supplied from the outlets in the floors. The cascading use of thermal energy mainly targets the reuse of chilled or hot water previously used to air condition the building and drive primary air-handling units for preheating and precooling the outdoor air used to air condition the laboratories. Each of the 20 laboratories has a dedicated air-conditioning unit to deal with the variety of experiments undertaken in each laboratory.

In 1994, the RITE Home Laboratory consumed 450 kWh/m^2 (387 Mcal/m^2) of primary energy. The annual air-conditioning load amounted to 2,327 MWh (2,001 Gcal). The primary energy consumption and air-conditioning load were estimated as 634 kWh/m^2 (545 Mcal/m^2) and 2,941 MWh (2,529 Gcal), respectively, if the aforementioned energy-saving approaches and technologies had not been adopted. Thus, the air-conditioning load was reduced by 26.5% and primary energy use by 29% (Figure 3). The total primary energy consumption of the laboratory in 1994 was 1,129 kWh/m^2 (971 Mcal/m^2).

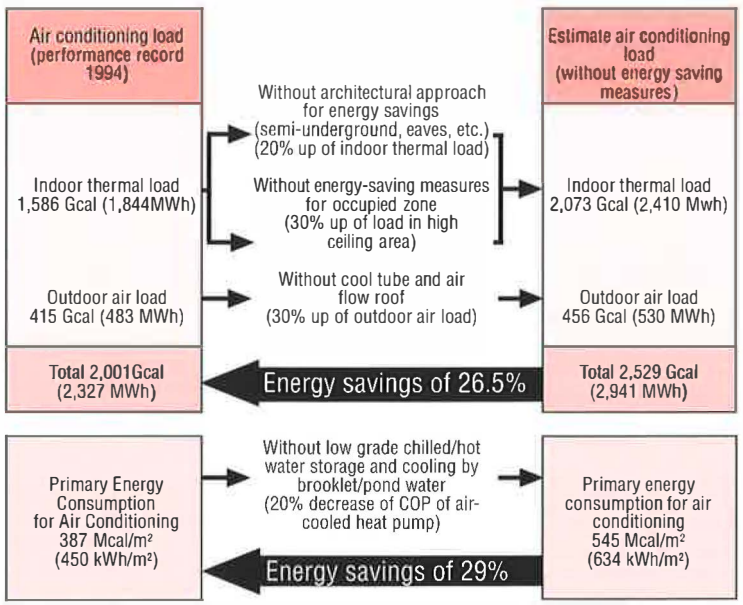
The Organisation

The Research Institute of Innovative Technology for the Earth (RITE) was founded in 1990 as a central research organisation for the development of innovative environmental technology in Japan.

Economics

The aforementioned energy-saving measures give the laboratory energy-cost savings corresponding to the decreased energy consumption for air conditioning, as well as investment cost reductions for the diminished air-conditioning load.

Figure 3: Energy savings effect.



Host Company

The Research Institute of Innovative Technology for the Earth
9-2, Kizu-dai, Kizu-cho, Soraku-gun, Kyoto 619
Japan
Tel.: +81-774-752300
Fax: +81-774-752314
Contact: Mr H. Takeda

Design Company

Nikken Sekkei Ltd., Osaka Head Office
4-6-2, Korai-bashi, Chuo-ku,
Osaka-shi, Osaka 541
Japan
Tel.: +81-6-2032367
Fax: +81-6-2034278
Contact: Mr T. Yoshida

Information Organisation

New Energy and Industrial Technology Development Organisation, Information Center
1-1, Higashi Ikebukuro 3-chome,
Toshima-ku, Tokyo 170
Japan
Tel.: +81-3-39879412
Fax: +81-3-39878539
E-mail: caddet@nedo.gp.jp

Please write to the address below if you require more information.

CADDET energy efficiency IEA * OECD

Swentiboldstraat 21,

6137 AE Sittard,
PO Box 17, 6130 AA Sittard,
The Netherlands,
Telephone: +31-46-4202224,
Telefax: +31-46-4510389,
E-mail: caddet@caddet-ee.org
Internet: http://www.caddet-ee.org

* IEA: International Energy Agency
OECD: Organisation for Economic Co-operation and Development

IEA

The IEA was established in 1974 within the framework of the OECD to implement an International Energy Programme. A basic aim of the IEA is to foster co-operation among the 24 IEA Participating Countries to increase energy security through energy conservation, development of alternative energy sources, new energy technology, and research and development (R&D).

This is achieved, in part, through a programme of energy technology and R&D collaboration currently within the framework of 40 Implementing Agreements, containing a total of over 70 separate collaboration projects.

The Scheme

CADDET functions as the IEA Centre for Analysis and Dissemination of Demonstrated Energy Technologies. Currently, the Energy Efficiency programme is active in 15 member countries.

This project can now be repeated in CADDET Energy Efficiency member countries. Parties interested in adopting this process can contact their National Team or CADDET Energy Efficiency.

Demonstrations are a vital link between R&D or pilot studies and the end-use market. Projects are published as a CADDET Energy Efficiency 'Demo' or 'Result' respectively, for ongoing and finalised projects.

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