Ecollab.
eco + collaboration + laboratory
Graduate School of Environmental Studies Tohoku University
While our graduate school has diverse research fields in different campuses and the main school building has to be multi-functioned for administrative purposes, the environment of our school campus was not optimal. To remedy this state, a new building plan was drawn up in the summer of 2007. With the aim of providing a symbolic and novel building which stands for environmental science, our project for the new school building started.

On November 22, 2007, we held a competition for architectural design proposals. Based on the selected basic design plan, the preliminary design was completed in the same fiscal year, and the implementing design was finished by the spring of 2009. Construction began in the same summer following approval from Sendai city, and the facility was completed by the end of the fiscal year.

“Ecollab.” is a facility that employs specific materials and techniques and secures flexibility for change of use in the building. Also, for the purpose of supporting local production and local consumption, we used solid wood cut from the cedar forest of the Field Science Center, Graduate School of Agricultural Science and the same local area in northern Miyagi. Using cedar lumber from the field science center was also an eco-friendly idea since the trees were originally scheduled to be thinned.

I really wish that this nature-friendly architecture “Ecollab.”, built by the Graduate School of Environmental Studies, becomes a center for new creativity and encourages us to redefine our relationship with nature.

To accomplish the project, we had great support from successive Deans (Shoji Taniguchi and Kazuyuki Tohji), the Deputy Chair of the Building Board (Koji Ioku), all committee members and staff of the graduate school. Furthermore, we also received much assistance from staff of the School of Engineering. The project would not have been accomplished without the dedicated support from staff members. We would like to express our gratitude to all of those involved in the Graduate School of Agricultural Science, as well as those involved for building Ecollab.

1. Basic Concept for Designing

Ecollab. was designed not only as a symbolic research facility of the Graduate School of Environmental Studies but also as a modern, simple yet airy space with flexibility for advanced research experiments. Also, functionalities such as insulation and air-tightness were considered while the wooden architecture’s strength - warmth and softness were encouraged.

2. Space Concept

The basic concept is “open space for inside and outside of the school”: not just for researchers and students but also for local citizens.

(1) Exterior space: gently connected to interior space
- 1F: Provides expansive atmosphere with open glass sides in the south and east-west.
- 2F: Creates an image of floating grid screen on the grass and soft atmosphere.
- PH: Skylight windows for both lighting and ventilation glow like a huge symbolic lantern after dark.

(2) Interior space: changes the image of an exclusive research facility into inclusive laboratories with open ceiling and glass sides, overlooks horizontally and vertically enough to let you feel the presence of residents.

(3) Design that features the nature of tree structure: a simple way of using structural members of beam and roofing boards features the nature of tree structure - fiber and softness – and creates space with a feeling of both tension and calmness.

3. Environmentally-focused Design

(1) Natural ventilation: using the open ceiling space (a path for the wind) from the entrance hall to the skylight windows, convection generated by the temperature difference between outside and inside goes up and down, and by this process it automatically activates wind-power ventilation. In summer, not much electric power is needed because the system lets the indoor heat go up through automatic ventilation windows on the skylight. In winter on the other hand, the air-swing fan on the skylight blows warm air down to the first floor to warm up the entrance hall.

(2) Lighting: thanks to the daylight from the skylight windows, there is little need to use artificial light in the entrance hall during the daytime. Also, the use of latest highly-efficient lighting (LED) makes it possible to reduce the electricity consumption.

(3) Humidity control: to make the most of the humidity control function that wood has, walls and ceilings were furnished by cedar wood. Furthermore, to maintain the stable indoor environment, the walls are made using material that naturally controls humidity.

(4) Local production for local consumption: making an effective use of local resources such as tree thinning supports the maintenance of mountains and forests. The design plan of construction, framework, and finishing of the facility was to use local materials such as thinned cedar trees in the Kawatabi farm operated by the Graduate School of Agricultural Science, Tohoku University, and local builders and carpenters. To support the local economy, a traditional wood framing technique that is familiar to local artisans was adopted.
1. Mountains in Kawatabi area, where the cedar trees were born.
2. Winter season is the best for logging when trees go dormant.
3. 40~80-year-old trees were selected for logging.
4. After logging, wood and leaves dried.
5. Logs delimbed and cross-cut by a processor.
6. Logs piled up on the ground.
7. Logs carried out.
8. Barking process by a ring barker.
10. Beam end finishing.
11. After sawing, lumber seasoned in the smoke house.
12. Seasoned lumber carried out.
14. Double beamed technique and batter brace framing strengthen the building.
16. Steel-frame stairs installed.
18. Completed.
20. Processing done one by one by hand working. Traditional technique supports advanced technology for Ecollab.
22. Join technique for doubled beam.
23. Double beamed technique and batter brace framing strengthen the building.
25. Steel-frame stairs installed.
27. Completed.
It has been considered that the power system at home has to run on AC (alternating current). Meanwhile, hardware nowadays has both high functionality and energy saving thanks to computerized control and digitalization. This means that the power has been supplied by AC and used as DC (direct current). So if the power is supplied by DC, we can unconsciously and easily reduce the power loss (10%) on AC/DC conversion. Solar power generation means that the power has been supplied by AC and used as DC (direct current). So if the power is supplied by DC, we can unconsciously and easily reduce the power loss (10%) on AC/DC conversion.

Solar panels of 5.8kW and 10kW of lithium-ion storage batteries and is a demonstration experiment.

**Olivine-type iron phosphate lithium-ion secondary battery**

The Lithium-ion battery has no self-discharge but high charging performance. It also does not reduce its capacity in recharging even though there is some remaining, and can take in even just small amounts of power. With this feature, Ecollab. uses the secondary batteries not only for power backups but also for take-in and for a stable supply of renewable energy which is unstable and weak at its source.

**DC power feeding allows 0 conversion loss**

Thinking about the conventional solar power generation system, DC power is generated by the photovoltaic system and generally the power is converted to AC for use. But for digital devices such as laptop computer and liquid crystal display TVs which are operated on DC, the power has to be converted once again from AC to DC before it can be used. For each conversion there is a conversion loss of 10%. Since more and more appliances run on DC nowadays, this loss cannot be ignored anymore.

**From electric power selling to captive consumption**

Captive consumption is difficult to implement with the conventional method of solar power generation system used for power selling, because the system needs a power conditioner. Also, solar power output fluctuates in a way that might compromise the quality of commercial power when selling. By installing the storage batteries at Ecollab, there is no need for a conditioner and this allows us to use power independently of the commercial power. Instead of selling power, we manage to use renewable energy all generated in the building.

**Stable power supply when generated power fluctuates**

When the weather turns bad and not enough solar power is generated for consumption, the deficit will be supplemented by the storage battery to stabilize the power supply. Power supply from lithium-ion storage batteries is also possible for a certain amount of time at night or during power failure.

**DC power supply to appliances**

To cut the power conversion loss in Ecollab., DC power which is generated in the solar power system is directly provided to some of the lighting and air conditioners. The result of an AC operation test shows that an average 62% of consumed power for a day is generated in the solar power system.
To transition to a low carbon lifestyle without lowering our quality of life, it is necessary to introduce high-tech energy control based on DC power feeding, and to smoothly add “use of natural energy,” “reduction of waste,” and “saving every small energy” into a daily rhythm. To make this possible, one of the models in the house is the “DC Life Space”.

The DC Life Space consists of four elements; a “DC table” which has provided the basic supply infrastructure of DC power feeding and plumbing in the kitchen, “rise-and-fall floor” which allows you to rest, eat, work depending on height and distance from the DC table, “LED lighting” that runs on DC power and can be operated by computer or information equipment, and “curtains” that softly separate the space in the layers of lighting and natural lights.

LED lighting which can control and keep a comfortable brightness in response to human activities can provide sufficient lighting by combining its base light and the one close to the user. This can enhance the power saving effect and make a more comfortable living environment.

The straight-line DC table which can be called a “modern fireplace” has the functions of bathroom, kitchen, dining, study, and living room. In the DC Life Space, power feeding points are all consolidated in the DC table. Having a table as a “charging station” in the house makes charging much easier to introduce in daily life. When wireless charging system technology is realized, it will become easier to store power generated by bicycle.

By designing the details of relationships between objects around us and energy, we made a space which does not separate your activity by wall or room but naturally connects your daily life as a sequence of actions. We hope you will be able to see the lifestyle that gently connects living a life and generating energy.
On March 11, 2011, an unprecedented earthquake struck Eastern Japan. Power was lost, snow fell, and we all spent an uncomfortable night in the darkness. This is when Ecollab. showed its stand-alone power function. After the earthquake, university students and staff who were unable to return home gathered at Ecollab. and turned on lights running on rechargeable batteries, charged cell phones, and had dinner together. The charge and discharge system, solar panels and batteries were then delivered to a disaster area in Ishinomaki, and supplied electricity to the area where the public power supply was not recovered for over a month.

Following the disaster, we realized the importance of stand-alone power in the home, and Ecollab. is continuing to improve its functions as it pushes forward with the important mission of creating disaster-proof houses and communities.

By learning from the experience of the earthquake disaster, we contribute to creating a safe and reliable community that will never run out of energy, with the use of renewable energy as the public power source in both emergency and normal conditions. To make it possible, we installed power feeding ports and a multi-purpose power feeding station in the Ecollab. yard after the disaster. Solar power energy is supplied to the equipment through the storage battery, and the power is provided for free to anyone to recharge devices. At the multipurpose power feeding station, an electronic vehicle (EV) is used for power transfer and backup independent of commercial power. If we use the EV as a “mobile storage battery” which transfers power from the power feeding station, it is possible to broaden the supplying area beyond just the inside of Ecollab. The Graduate School of Environmental Studies has been working on this kind of project to introduce a power feeding system using natural energy and establish “local energy centers”.

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