ENVS-634-660 Green Design and the City **Instructor: Professor Richard W. Berman**
Project2: Building **Masayoshi Oka**

Eco-House

The term “Eco-House” is getting familiar and/or popular these days which implies that the awareness toward environmental issue had increased by way of reducing energy utilization and natural resource consumption. It is indeed interesting to see these houses where, not necessary advanced but, efficient and meaningful technologies are implemented. The concepts of these houses are to offer ecological lives that are environmentally and physically friendly [1]. In order to create such, photovoltaic system to generate electricity [2] (Figure 1-1), solar panel to generate heat and hot water [3] (Figure 1-2), rain storage tank to substitute water supply [4] (Figure 1-3), and/or other technical implementation could be contemplated. Needless to say, each system stated above eases electric energy, heating energy, and water consumption, respectively. There are of course many other ways to come up with Eco-House, but it is also important to note that physical aspects should also be considered since we spend most of our daily life indoors and certainly want to be safe and comfortable. Thus, here I would like to focus mainly on Eco-House that has a capability of being physically and environmentally friendly.

Figure 1-1.

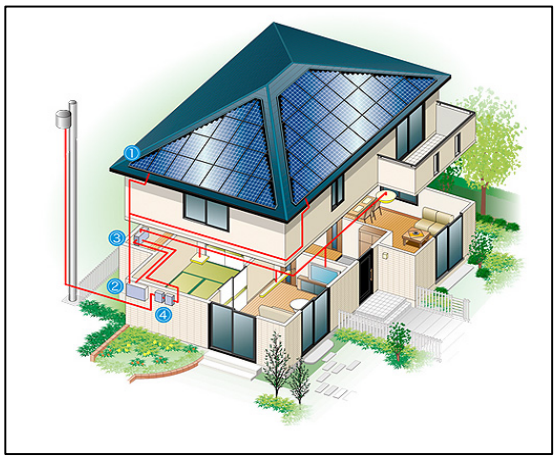


Figure 1-2.

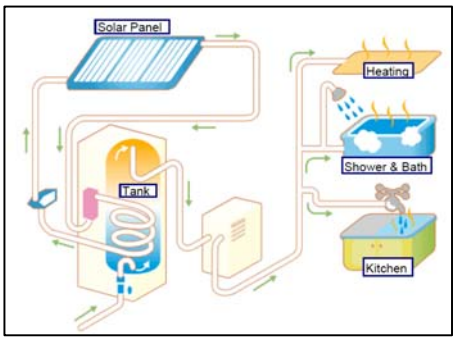
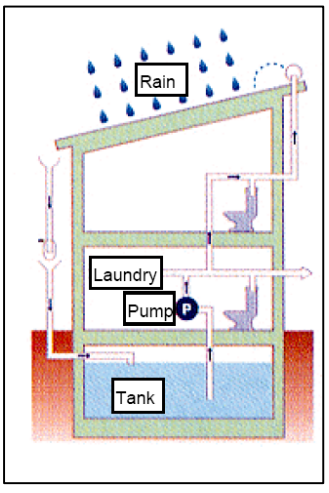


Figure 1-3.



Source: Sharp Corp. (left), Solar System Development Association (middle), and Tokyo Electric Power Company (right).

According to the U.S. Environmental Protection Agency (EPA), indoor air is the worst pollution problem [5]. The sources of indoor air pollution includes: combustion source (such as oil, gas, kerosene, coal, wood, and tobacco products); building and furnishings materials (such as asbestos-containing insulation, wet or damp carpet, and cabinetry or furniture made of certain pressed wood products); products for household cleaning and maintenance, personal care, or hobbies; central heating and cooling system and humidification devices; and outdoor sources (such as radon, pesticides, and other outdoor air pollution [5]. Frighteningly, indoor air pollution affects our health by both immediate and long term effects.

Immediate effects may be noticed by irritation of the eyes, nose, and throat, headaches, dizziness, and fatigue [5]. Additionally, symptoms of some diseases (such as asthma, hypersensitive pneumonitis, and humidified fever) may also be an indication of immediate effect [5]. These immediate effects are usually short-term and treatable where, in some cases, simply removing the individual from the exposed source of the pollution [5]. Household products and building materials are responsible for emitting formaldehyde and/or respirable particles that develops so-called “Sick House Illness” where symptoms are headaches, watery eyes, nausea, skin disorders and fatigue [6].

Although immediate effect could be noticed, the likelihood of immediate reaction to indoor air pollution various tremendously from person to person [5]. Therefore, it will be fortunate for those individual who are sensitive to pollutants. However, of course, there are many people who are not sensitive enough to have an immediate response to indoor pollutants. Certainly, some effects may show up either years after exposure has occurred or only after long or repeated periods of exposure [5]. Unlike the immediate effect, long-term effects can be severely debilitating and fatal that includes some respiratory diseases, heart disease, and cancer [5].

Indoor air pollution is increased by inadequate ventilation where enough outdoor air does not come in to dilute the indoor quality and indoor air pollutants are not carried out of the homes [5]. In addition, high temperature and humidity contributes to increase the level of the pollutant [5 & 6]. Therefore, three basic strategies to improve the indoor air quality would be (1) source control, (2) ventilation improvement, and (3) installation of air cleaner [5].

The most effective way to improve the indoor air quality is source control by way of removing individual source of pollution or reducing their emissions by sealing or enclosing [5]. Second approach is to lower the concentration of indoor air pollutants by increasing the incoming outdoor air by opening window and doors, operating window or attic fans, or running a window air conditioner with the vent control open that permits the outside air to flow indoors [5]. Third recommendation is utilization of an air cleaner to effectively remove airborne particles and pollutants [5].

In many cases, source control is more cost-effective approach to protect the indoor air quality than just increasing ventilation and/or use of air cleaner since both could increase energy consumption [2]. Certainly, it is obvious that if source control was set aside, increased ventilation and use of air cleaner would not be sufficient and individuals who are indoors will continue to be exposed to the pollutants. Therefore, source control would be a primary means of improving indoor air quality, which is also a minimum requirement.

However, it also important to know that there are possibilities to benefit from the increased ventilation not only in terms of air quality, but also to reduce energy demands. One alternative was introduced by the OM Solar Association in Japan [7] where passive solar system could reduce indoor temperature during the summer and increase them during the winter (Figure 2-1). Under this circumstance, it is obvious that the household will reduce air conditioning and heater use during the summer and winter, respectively. Please note that majority of houses does not have a central heating system where electric, gas, and/or kerosene heaters are the main sources used in Japan. The OM solar system is an infrastructure that utilizes a fan to enhance ventilation to cool and/or warm the indoor temperature by controlling the central fan [7] (OM Switch). The flow of the air is also controlled by this according to the season [7].

During the daytime of hot summer, central fan intakes both outdoor and indoor air which is exhausted from the roof [7] (Figure 2-2). In this process, central fan ventilates the heated hot air not to accumulate inside [7]. However, during the nighttime of summer, it intakes cooler air from the outside and then ventilated into the entire house [7]. Therefore, by just a simple change of air flow direction (by switching the central fan) the system is capable of cooling the house [7]. Similar to the nighttime of summer,

the air circulation of central fan is set to ventilate warm air during the daytime of sunny winter [7] (Figure 2-3). Indeed, outdoor air is heated from the sunlight while passing the roof duct and this warm air is sent to the under floor concrete base to heat the house from bottom up [7]. This is done during the daytime, but central fan should be turned off before the sunset to avoid cold air to flow inside [7]. As a result of this simple but effective air circulation, this solar passive system provides indoor comfort from the full use of natural cooling and warming process.

Interestingly, this system does not merely provide comfort, but it is also believed to be effective in reducing CO_2 emission and energy consumption [7]. As Figure 2-4 shows, solar passive system alone annually reduces 30% of CO_2 emission and 41% energy consumption, and if the system is joined with photovoltaic system, it is possible to reduce 50% of CO_2 emission and 66% energy consumption annually [7]. Considering these performances, the OM Solar Association states that the system can be deployed anywhere as long as it is adjusted to the weather of the specific location [7]. And, of course, they declare that their system is the most environmentally friendly building [7].

Figure 2-1.

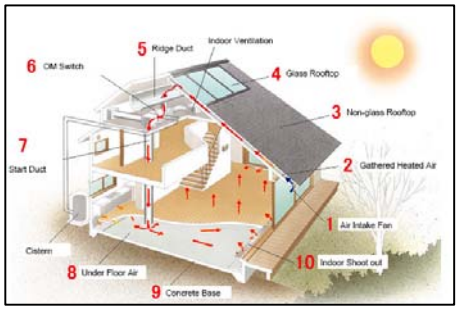


Figure 2-2.

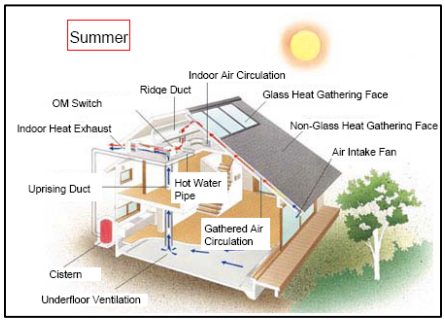


Figure 2-3

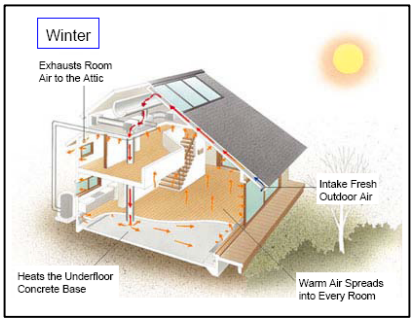
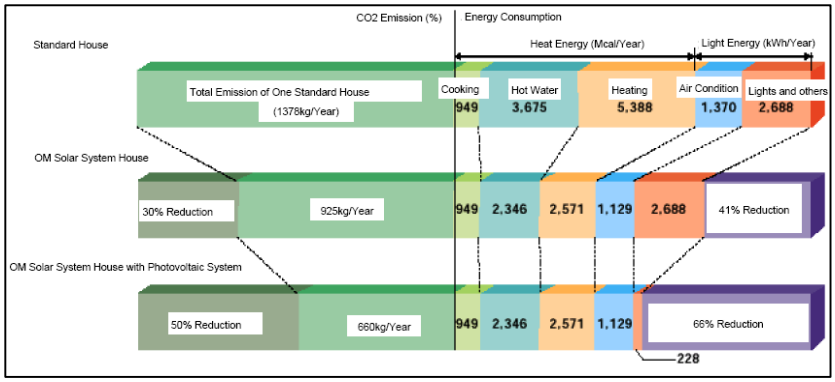


Figure 2-4.



Source: OM Solar Association

Although this system seems to be an ideal solution for the future building, the cost of building the house which utilizes this system may well raise a problem. Unfortunately, the website did not indicate any cost estimates (assuming that it varies according to the size) thus it is not clear how much it will be. Therefore, it will be interesting to conduct the cost-benefit analysis and determine whether this system could be denoted as a sustainable building for the future. People who are currently living in a house that incorporated this system have written positive responses [7], but it is necessary for the individuals to study further based on their needs and budget. Nonetheless, I believe this system has a potential to become a sustainable infrastructure for the future.

<Reference>

[1] Eco-$mart, Inc.: http://www.ecosmartinc.com/index.html

[2] Sharp Corp., Sunvista: http://www.sharp.co.jp/sunvista/index.html (Japanese)

[3] Solar System Development Association: http://www.ssda.or.jp/index.php (Japanese)

[4] Tokyo Electric Power Company: http://www.tepco.co.jp/ (Japanese)

[5] U.S. EPA: http://www.epa.gov/ebtpages/airindoorairpollution.html

[6] The University of Florida, Institute of Food and Agricultural Science (UF/IFAS): http://edis.ifas.ufl.edu/HE638

[7] OM Solar Association: http://www.omsolar.co.jp/ (Japanese)