Development of a Cable Type Sky Solar System to encourage both to accelerate natural energy development and to promote the intensive agricultural farming

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Abstract

The Cable Type Sky Solar System developed for the double use of the land was born from the recovery plan for Fukushima in 2011 and developed to encourage both to accelerate the natural energy development in the sky and to promote the intensive agricultural farming development on the land.

It would be more useful for the tropical area, Asia monsoon, and desert area.

Four types of the Sky Solar System that have been developed by Prof. Ben Nakamura and executed in many areas of Japan. All types of the Sky Solar System are elevated in the sky, by a) Cable Type, b) High Pole Type (Post and Beam), c) Carport Type, and Building Integrated type, which allow both generating the electricity above and normal activities such as agricultural farming, flood controlling, car parking, traffic infrastructure, etc.

The Cable Type Sky Solar System is especially designed to assist intensive agricultural farming, flower planting, bonsai (dwarfed pine tree in a base), mushroom farming, etc. The Sixth Agricultural Industry (First for agricultural industry plus Second for manufacturing industry plus Third for commercial industry), which has been centered in governmental policy for the Japanese Agricultural Ministry in these 3 years, will be reinforced by the Cable Type Sky Solar System.

In the system we have developed, photo-voltaic panels are hung on the cable to generate electric energy, and below the solar panels, all daily activities can take place.

This Sky Solar System will be useful for the desert area, in order to preserve water for vegetables and to spread the green area and has interested Egyptian Engineers and the people of the Wales in Great Britain.

Introduction

For the recovery of the Great East Japan Earthquake and Nuclear Electricity Generation Accident

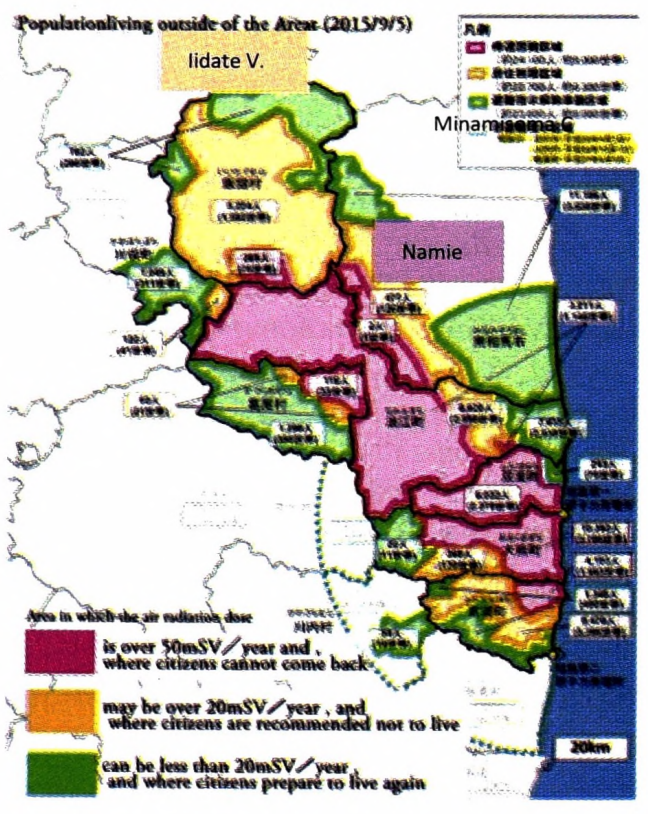
The Cable Type Sky Solar System developed for the double use of the land is born in the recovery plan for Fukushima in 2011.

Report from Fukushima 2015

Seamen has lost their sea, farmers have lost their lands, merchants have lost their commercial markets, not by their own will. Families have been separated to live in several houses, their communities have been separated in many areas.

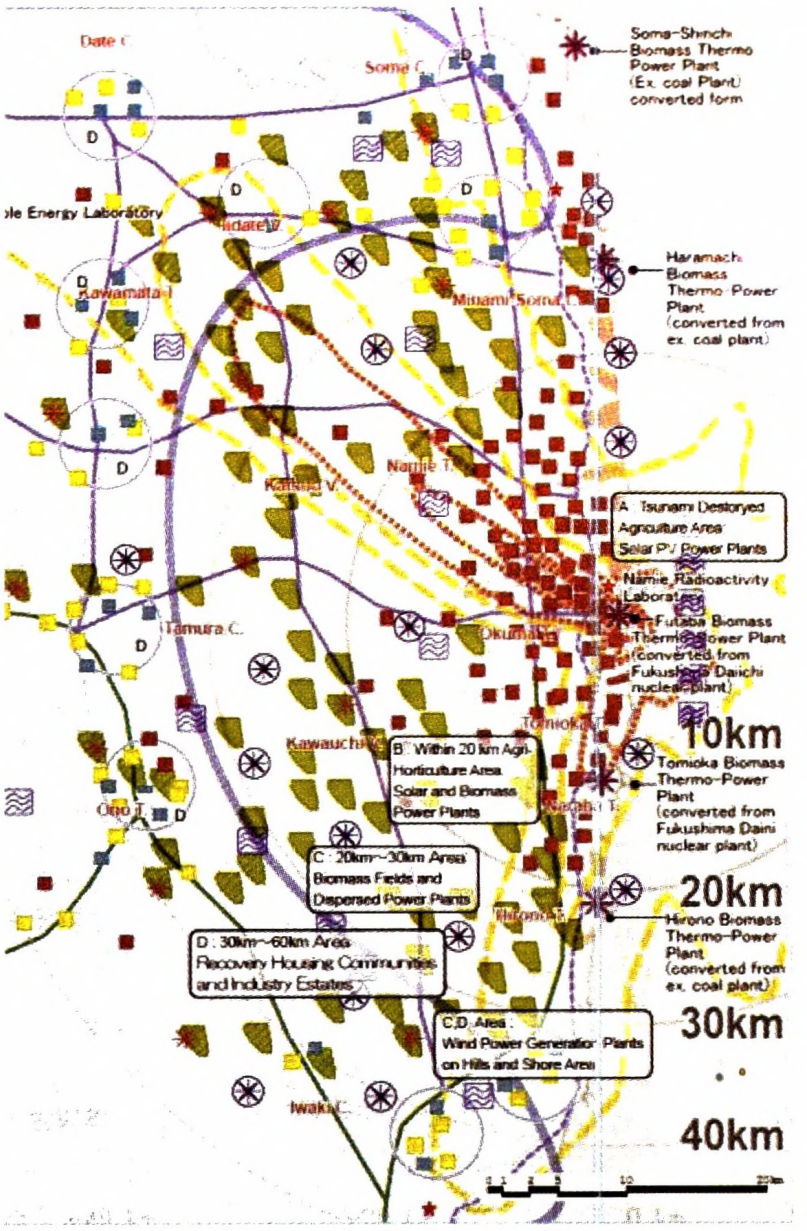
In the year 2015, still 70,000 people lived apart from home, still the shore line of the Namie Town has not been clean up owing to the high quantity of the nuclear radioactive contaminations, and still many people lived in emergency houses. The city governments have only managed to build the 15m high retaining walls to defend against the next tsunami which, nobody knows, will attack one hundred years later. By its tremendous disaster, the tsunami and Nuclear Electricity generation plants burst accident, the people escaped from their houses, without any belongings. After the disaster, I wanted to stretch out helping hands not only for getting the spiritual relief, but also for getting the economical affordability, by the land rent to the elevated sky solar system.

Fig. 1. Population living apart from home land in 2015



After the Fukushima Disaster of 3. 11, 2011, I have calculated very quickly, the possible amount of the natural / renewable energy, to be developed in Hama Shore Area of Fukushima Prefecture.
With this result, I could show there wasl no need for Nuclear Energy owing to there being enough power through renewable energy.
We organized the "Fukushima Conference" together with Prof. Akasaka, anthropologist, since May, to propose Natural Energy Special District Scheme to Fukushima Pref. with about 50 specialists up to the end of August. Then, The Fukushima Prefectural government could make the declaration for the Non-Nuclear Society in Fukushima.
I have discussed with the people of Minami-Soma City, Namie Town, and Iidate Village, and proposed the Plan to recover in more than 20 years, to remove the salt and the contamination of the nuclear explosion from the land. It is very important for the people not losing the hope, and keeping their mind on the hope to be back to their home land.
This had led to the development of the Sky Solar System, with which it is easy to satisfy the needs of energy domestic demands.

Fig. 2. Recovery Plan by Renewal Energy 2011 - Nakamura



Fukushima Hama Shore Area has small population in thousands of 1,943 in 2014, (2,024 -2011.) for Fukushima Pref, 179 in 2014 (195-2011) for So-so Area and 327 in 2014.(341-2011.) for Iwaki Area.
The population of the densely populated Tokyo Metropolitan area in thousands was 36,700 in 2010.
The electric energy consumption per capita in 2010 in Japan is 4.2mwh/y for average family use.
The Tokyo demand for family use would be 154,000,000mwh/y. In So-so (N-E), it would be 819,000mwh/y, and in Iwaki (S-E), 1,432,000mwh/y.
Fukushima Nuclear Dai-ichi generated 4,696,000Kw. Renewable Supply from the Nakamura Plan would be

Fig. .3. Sky Solar executed in Japan between 2012-2015, by Ben Nakamura

Solar	6,150,000Kw	(123*50mw*14%),
Wind	5,000,000Kw	(1*1000mw*5*20%),
Ocean wind	20,000,000Kw	(20*1000mw*20%)
Biomass	50,000,000Kw	(100*500kw*80%)

Sky Solar System Development

The development criteria for the Sky Solar System are as follows:

- In Japan, the area capacity of the flat lands for normal solar panel on the ground is very small, and has to compete with normal land use.
- Normal Solar System needs land fill, cut and dig roots, and leveling the land, therefore, the cost for the land preparation is high.
- The cost for the preparation against natural disasters like earthquake, tsunami, and typhoon is also very high, because normal type is not needed to check the structural standard for the architecture.
- The solar panels put on ground require the prohibition of people entering the site.
- Elevated Solar Panels need to be adapted to the architectural standards in order to allow people entering the space underneath the panels.

Would you be prepared to hand your precious land for sole use for solar panels for 20 years?
On the other hand, Sky Solar System allows the multiple land use, under the elevated solar system, such as recreational park, car parking, road, fruit farm, pasture field, and agro-factory.

Sky Solar Systems

Five Types developed by Nakamura and executed, in the last 4years, in many areas in Japan are shown in Fig.3. All are elevated in the sky, by a) Cable Type (Fig. 4-6), b) High Pole Type (Post and Beam) (Fig. 7-16), c) Carport Type (Fig. 17-19), d) Glass House Type (Building Integrated Photo-Voltaic, BIPV) (Fig. 20-21), and e) Solar Curtain Wall Type (BIPV) (Fig, 22-24), which allow both generating electricity above and normal activities like agricultural farming, flood control, car parking, traffic infrastructure underneath

a) Cable Sky Solar

Cable Type Sky Solar System is required for intensive agricultural farming, flower planting, bonsai (dwarfed pine tree in a base), mushroom farming, etc. The Sixth Agricultural Industry (First for agricultural industry plus Second for manufacturing industry plus Tertiary for commercial industry), which has been centered in governmental policy for the Japanese Agricultural Ministry for 3 years, will be fortified by the Sky Solar System.
In the Cable Type Sky Solar system, we have developed that the photo-voltaic panels are hung on the cable to generate the electric energy, and underneath the solar panels, any daily activities will be allowed

Fig.4. Cable Type Sky Solar
executed in japan

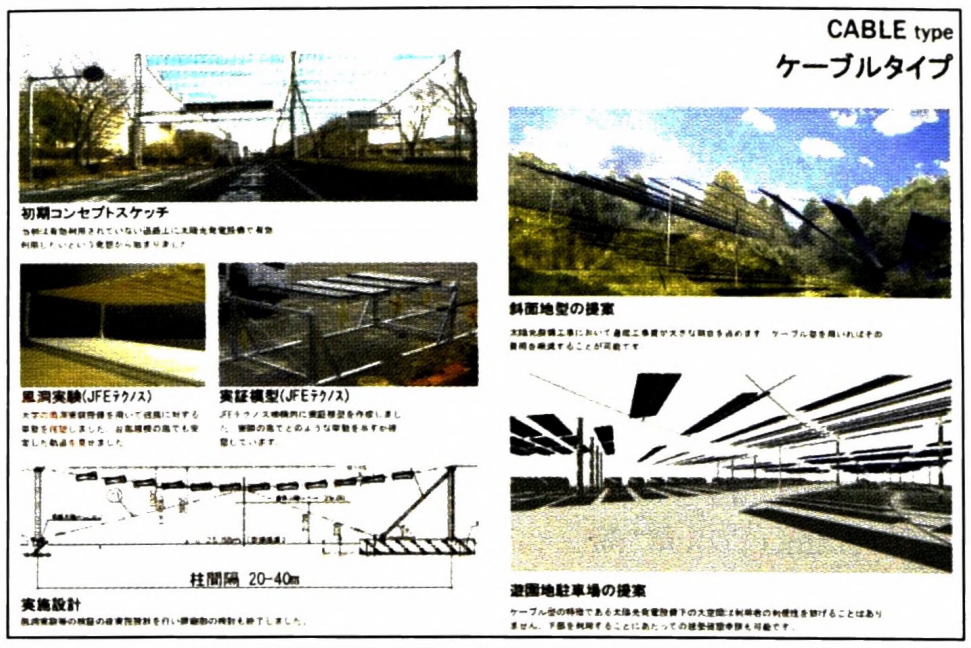


Fig.5 Cable Type

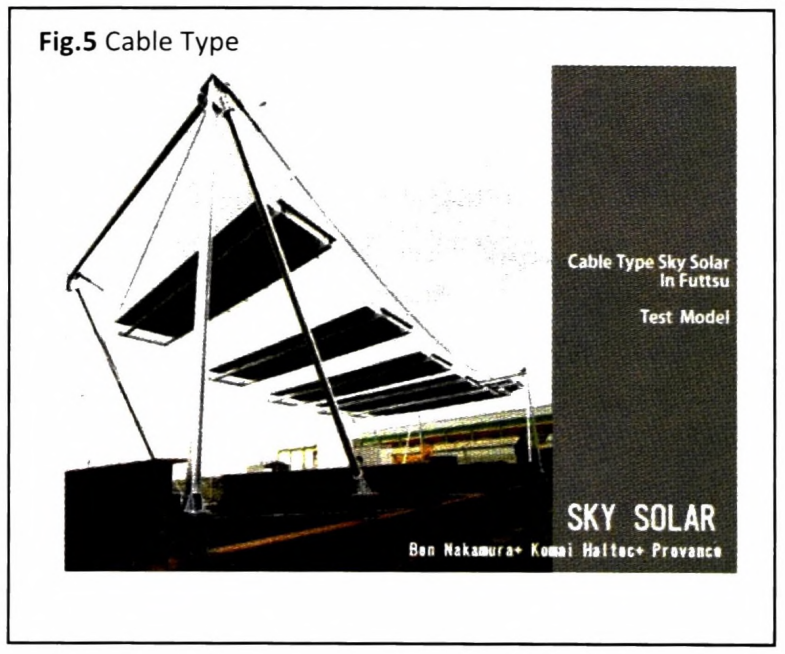


Fig.6. Cable Type Sky Solar on the flood control pond

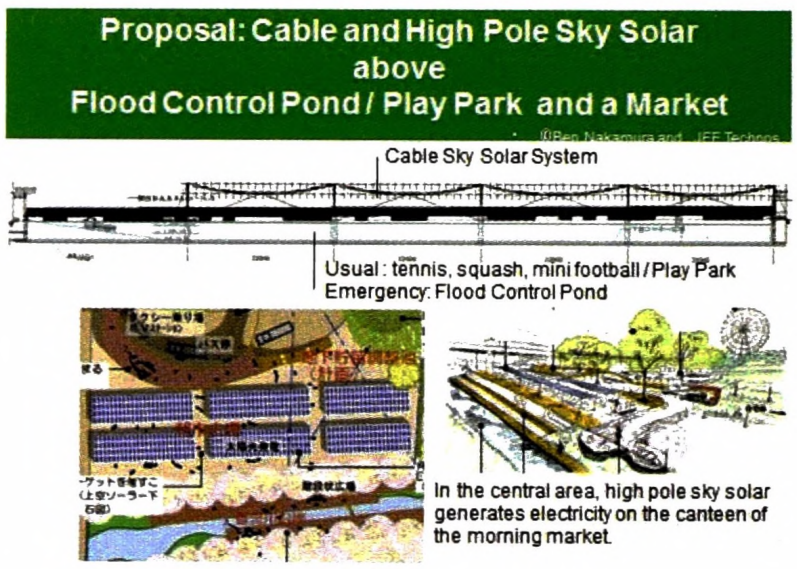


Fig.7 High Pole Type Sky Solar

Fig.8. High Pole Type Sky Solar

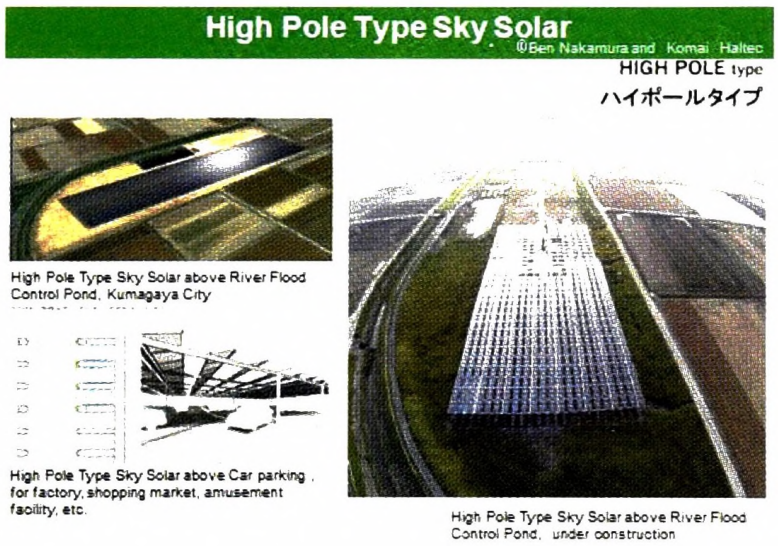


Fig.9. High Pole Type above linear motor railway

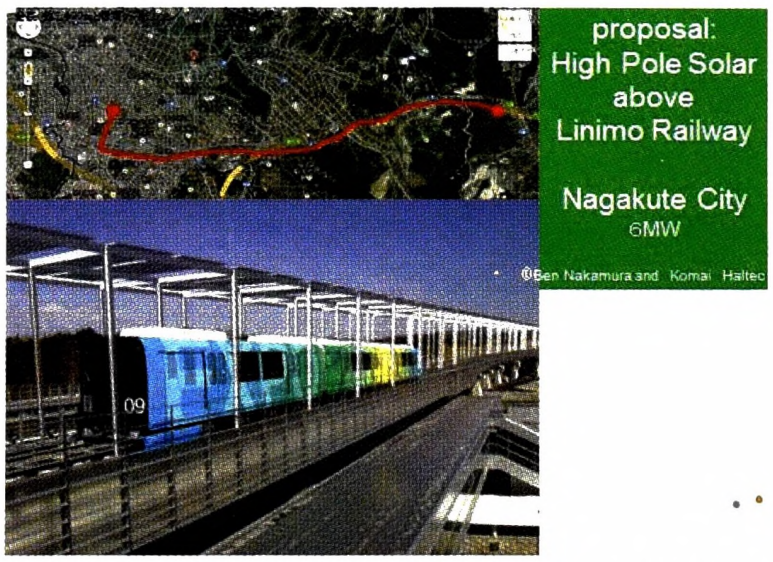
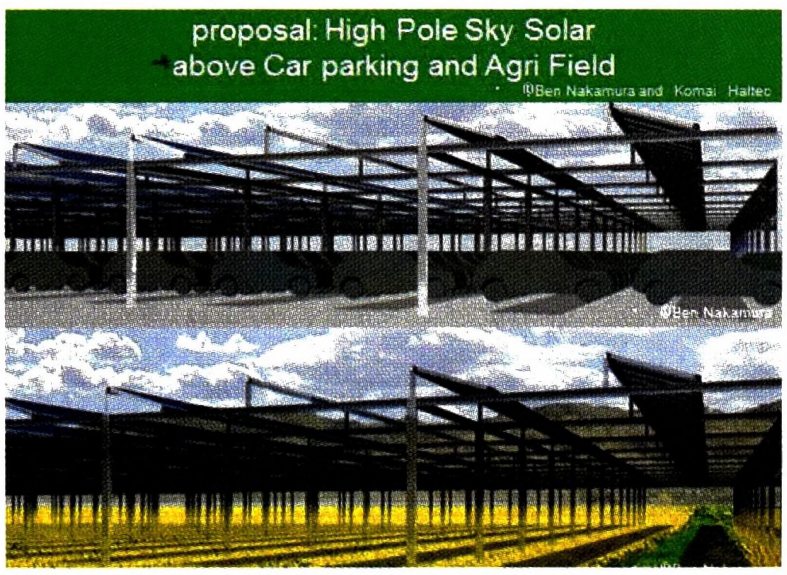


Fig.10.. High Pole Type above Car parking or Agri. Field



. ▪ Cable Bridge Technology is applicable.

▪ Solar panels placed between 10m distance cables

▪ Cable length depends on the site, 300~500m

▪ Height is 4m at the lowest point

▪ Poles are set apart by 20~50m to make sure the system would be stable during hard winds

▪ Cost of structures similar to that of High Pole type

▪ Hardness of the ground is important for the end anchor.

▪ Maintenance is using higher placed work vehicle

▪ Angle of panels depends on the latitude

▪ In the snow area, steeper angles for the Panels are needed

b) High Pole Sky Solar

High Pole Type Solar System is a post and beam steel structure, with posts at around 8m intervals and the height of the beam is almost 4m. I needed to calculate the structural engineering to meet the standards of architecture in Japan to ensure safety of the people for at least 20 years.

The solar panels on the beams are tilted by the angle of the sun, however, the strength of Japanese solar energy is very high, and the efficiency of the angle is not so big, I designed the angle at almost 10 degree, to obtain economic efficiency. The panels are put on the beams in a louvre pattern with the light through the louvre at almost 20-30% of the top sky light.

The acceptable land use activities under the High Pole Type system are:

1. River flood control reservoir
2. Railroad
3. Carport for shading
4. Agriculture less solar energy products
5. Desert area to spread to greening

No. 4. Agriculture use is the same, as mentioned in the Cable Type, for multiple use.

Fig.11. High Pole Type above Agriculture Industry

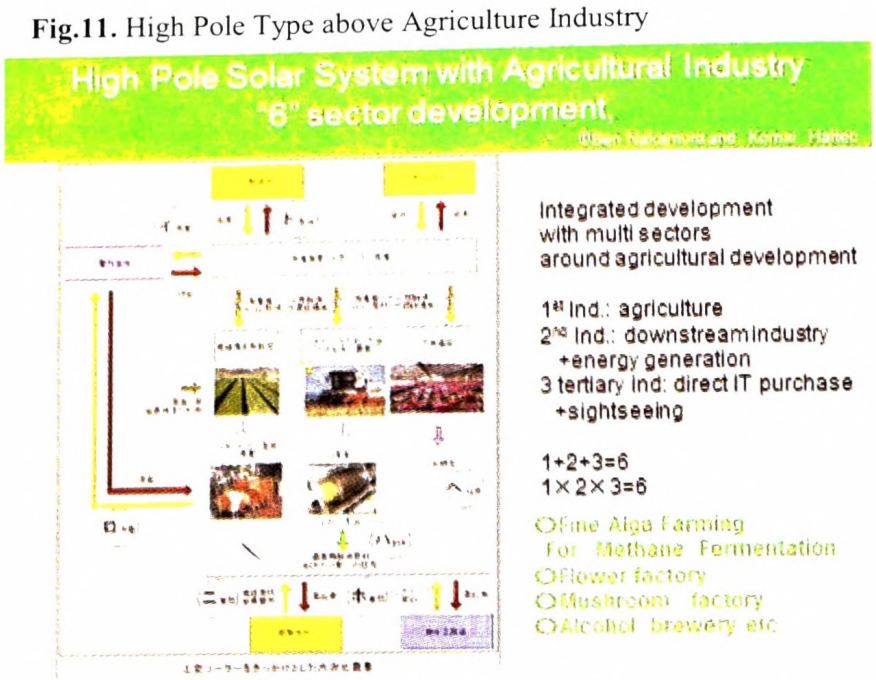


Fig.13. High Pole Type above Flower Factory

Fig.15. High Pole Type above Brewery

Fig.17 Carport Type Sky Solar for the factory

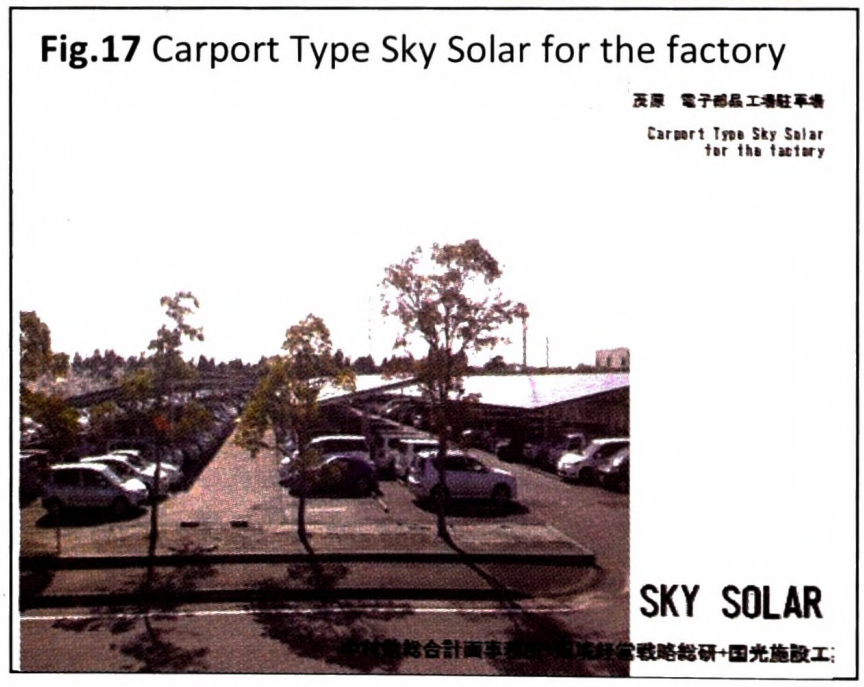
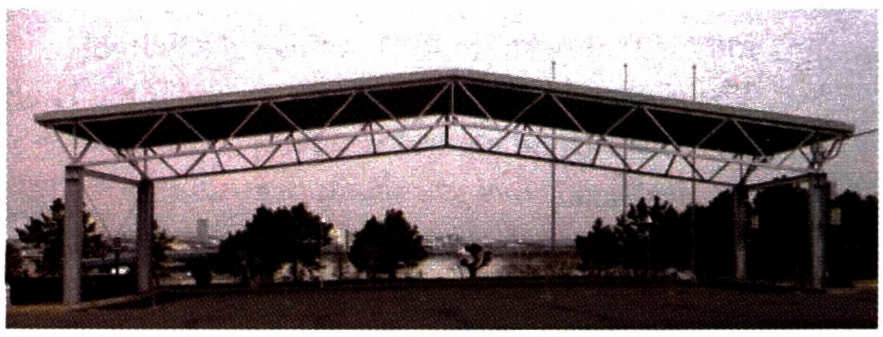


Fig.12. High Pole Type above Pine Bonsai nursery

Fig.14. High Pole Type above Flower Amusement Park

Fig.16. High Pole Type above Mushroom Factory

Fig.18.. Carport Type above Bus Station



Figures 7-16 are examples of high pole solar system originating from the author's group
The light intake capacity of the crop species are as follows:
rice 40-50klx, tomato 70, lettuce 25, grapes and peaches 40, flowers 5-10-15.

Sunlight has 100klx in day time on a fine day and 10klx on a cloudy day. Therefore, even for the rice, almost 50% can be in shade.

c. Carport Sky Solar

Carport Type Sky Solar system is to make the roof of a car park solar.
Normal type requires 5m to 7.5m span for 2 – 3 vehicles.
Bus carport needs long span and the 4m height, which needs truss structure system as shown Fig. 18.
In the heavy snow area, the weight of the snow are critical. The slope of the panels are more than 30 degree, and the lower space should need enough clearance for the snow moving vehicle. Fig. 19 is from Aizu Wakamatsu city, where, Fukushima Pref. and the City government subsidized installation of an emergency electric generator for a mountain basin to deal with occasion disaster caused by heavy snow. These challenge aim to make the city resilient against disaster, one of the new regional strategies after the 3.11 disaster.

Fig. 19. Carport Type for the Heavy Snow Area

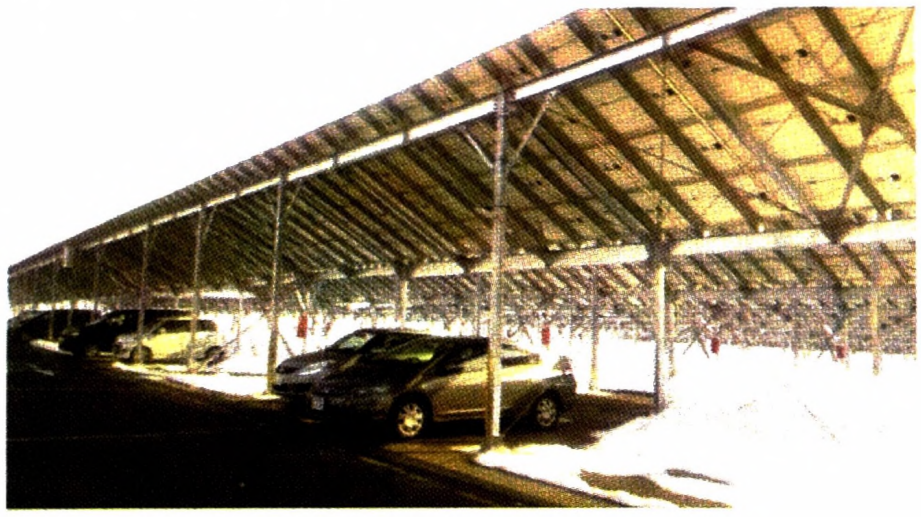


Fig.20. Glass House Type for agriculture products

Fig.21. Solar Curtain Wall Type for building integrated

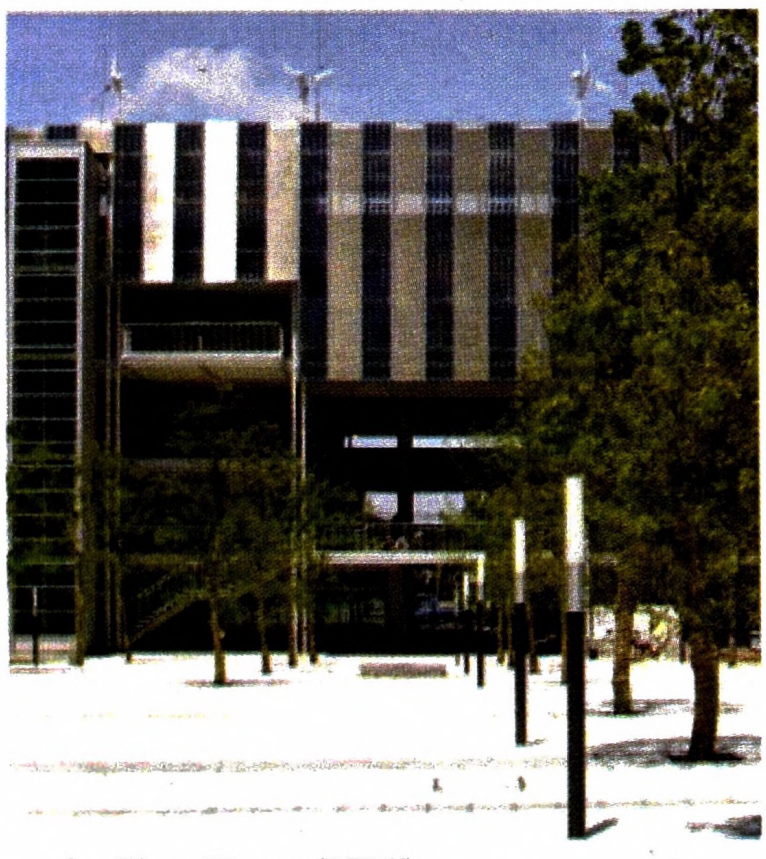


Fig.22. Solar Curtain Wall Type for Daito Bunka University

d. Glass House (BIPV)

The Glass House Type Sky Solar System (BIPV) is made sandwich in the laminated grass and designed as patterned.
The gap between cells are from 20 to 50mm, according to the light intake requirement of the vegetable

e. Solar Curtain Wall (BIPV)

Solar Curtain Wall Type (BIPV) was developed ten years ago, for a project of a University building.
I developed the Building Integrated Photo Voltaic System for the south façade of the Lecture building of Daito Bunka University, Itabashi Campus.

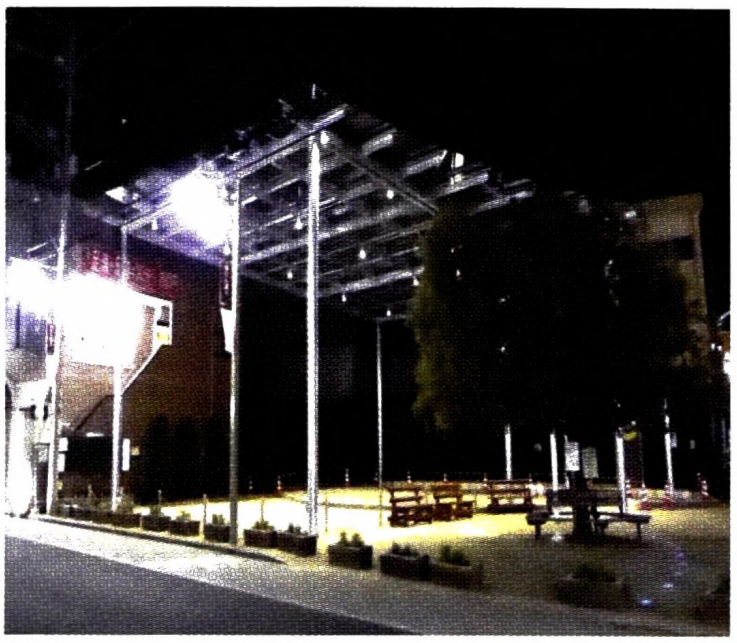
The Building Integrated Photo Voltaic system (BIPV) is the updated technology for the architectural design to create energy on the surface of the buildings. In this example there is direct gain of solar energy into the space to provide a warm environment for the students in the cold winter. Multiple efficiency of energy creation with comfortable space but less energy consumption is the basis for architects to design the buildings

Solar Curtain Wall in Urban Design

In the Higashi Matsuyama City, in the small plaza along the shopping street, I designed the Curtain Wall type as the roof of the plaza. It helps to light the streetlamp in the nighttime, as well as in an emergency during disasters This plaza is used for the festival station for floats for music drams, which need 7m high space. Generating energy with building materials will make the city more resilient.

Fig.23. Solar Curtain Wall Type for Daito Bunka University

Fig.24. Solar Curtain Wall Type for City Plaza



Scope of world w' .e contribution

a) For Wales in Great Britain, I was invited

b) by a peace group to make a proposal to develop renewable energy in Anglesey Island as a "Natural Energy Island", and propose to the people a renewal energy development as an alternative to a nuclear generation plant.

c) For the desert area of Cairo, Egypt, I proposed to develop the Sky Solar System on the desert skirt along the River Nile river. The space structure is along the Nile, with the built environment built along the river and over the city area and a huge area of sandy desert area covers the land.

If the Sky Solar System is developed in this fringe area, the shaded area will spread to the desert, and green vegetable can be produced under the solar panels.This will encourage both to accelerate the natural energy development in the sky and to promote the greening of the land to the agricultural farming for the people.
The idea to create the shaded area under the solar panels and create multiple activity land use will be more useful in the tropical area, Asian monsoon area and desert area.

Fig.25. Sky Solar System for Anglesey Island of Wales

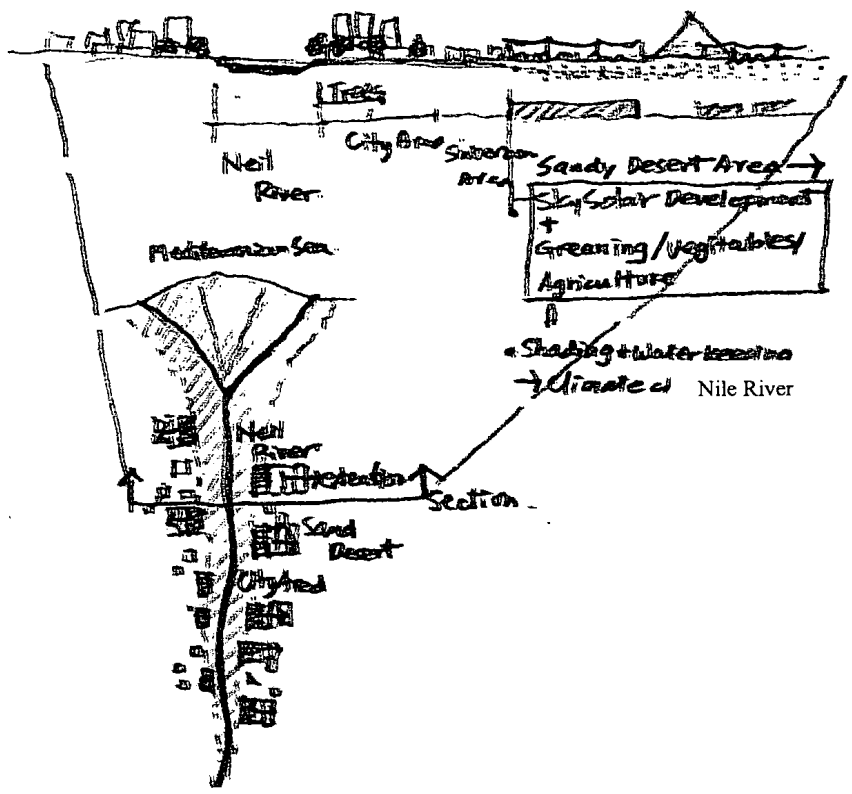
Fig.26. Sky Solar System above Copper Mine

d) I am promoting the development of the Sky Solar System in tropical areas in Asia with Thai colleagues in Bangkok.

This Sky Solar System will be useful for the desert area, in order to maintain the water for the vegetables and to spread the green area instead, and so far, interest has been shown by Egyptian Engineers and the people of the Wales in Great Britain.

Fig.28. Cairo City and Nile River

Fig.27. Sky Solar System Proposal for the sand desert in Cairo Copper



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