Learn, discuss and share.

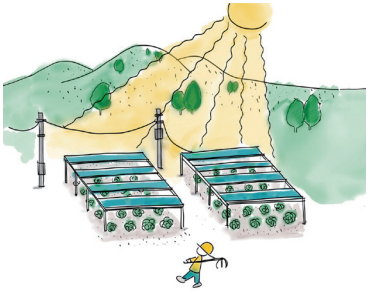
Spring 2023

Business & Industries Climate Action Group

CRP JAPAN Action Groups

What is solar sharing?

▶ Also known as agrivoltaic farming, solar sharing is a system of **placing elevated photovoltaic (PV) panels over agricultural land, making it possible to simultaneously produce energy and crops by "sharing" the light of the sun.**



Akira Nagashima focused on light saturation in plant photosynthesis to develop the basic concept of agrivoltaics in 2003, naming it "solar sharing," and later publishing the patent.

Light saturation generally refers to the point in plant photosynthesis where increased light intensity no longer increases photosynthesis. This means that light over this amount doesn't contribute to growth and is simply surplus. **Giving plants the sunlight they need and "sharing" the surplus light with PV panels makes it possible to simultaneously produce both crops and energy,** offering potential solutions to a number of issues in Japan and around the world.

Data: Shading rate and crop type

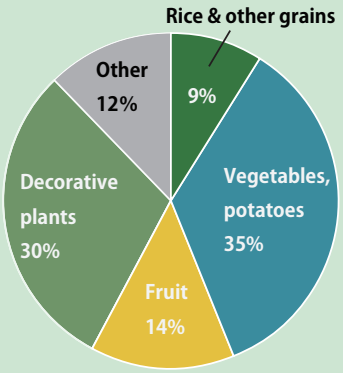
Shading rate is the amount of shade created by the PV panels, and is expressed by as follows.

$$\frac{\text{the total area of panels}}{\text{the area of farmland where the frames are installed}} \times 100\ [\%]$$

Solar sharing is set up in a way to normally have about a **30% shading rate.**

Different plants have their own **light requirements** that dictate the strength of light they prefer in order to grow, making it necessary to construct each facility to have a shading rate that suits the desired agricultural crop.

As shown by the chart at the right, **rice and other grains, vegetables and potatoes, fruits, decorative plants and other crops** are all currently being grown on solar sharing farmland.



Ratios of different crops that are grown beneath agrivoltaic facilities (based on number cases where a crop is grown)

Japan's Ministry of Agriculture, Forestry and Fisheries Rural Development Bureau Detailed Survey of Agrivoltaic Farming Facilities(End of FY2020)

Issues facing Japan that we believe solar sharing can help solve

Fighting climate change

The Japanese government has set a goal of reducing greenhouse gas emissions by 46% over FY2013 by FY2030, and achieving net zero emissions by FY2050.

- Renewable energy reduces CO2 emissions
- Regenerating abandoned or disused farmland creates carbon sinks

Improving energy self-sufficiency

Japan's FY2021 self-sufficiency rate for primary energy (including nuclear) was 13.4%, which is very low for an industrialized country. Japan is largely dependent upon imports of fossil fuels like oil, coal and natural gas (LNG).

- Distributed renewable energy improves energy self-sufficiency
- Agrivoltaics expand community-based solar power generation

Improving food self-sufficiency

Japan's FY2021 food self-sufficiency rate by calorie supply basis was 38%. With countries like Canada (233%), Australia (169%) and the US (121%) all exceeding 100%, this puts Japan at the bottom of the list of the world's major countries.*

*Canada, Australia, US, France, Germany, UK, Italy, Switzerland, Japan

- Regenerating abandoned or disused farmland can improve food self-sufficiency
- Increasing income helps retain farmers and attract the next generation

Revitalizing local communities

Japan is experiencing ongoing centralization towards major cities, with 35.4% of the population living in the Greater Tokyo Area and 52.5% living in or around Tokyo, Osaka and Nagoya. Most other areas are experiencing depopulation.

- Distributed energy can be used within the community
- Active farming increases local food self-sufficiency and revitalizes communities

This is what's amazing about solar sharing!

1. The benefits of earning income through agrivoltaic farming

a) Helps stabilize farming operations with additional income.

b) Promotes continued stable farming and the regeneration of abandoned/ disused farmland.

c) Keeps costs down by providing self-generated energy for farming equipment and facilities.

2. The benefits of providing partial shade

a) Regulates excess light to help improve the quality of agricultural products.

b) Becomes an opportunity to venture into new types of crops.

c) Provides shade in the summer when heat makes farmwork in open fields difficult.

d) Reduces ambient dryness, helping conserve irrigation water.

3. The benefits of the facilities themselves

a) Frames can be used to hang insect and bird nets, sun shades or security cameras.

b) Inhibits radiative cooling in winter, reduces snow accumulation and promotes melting.

4. The benefits to society

a) Helps local communities reach decarbonization goals by utilizing farmland to generate solar power.

b) Combines fighting climate change with supporting the survival of farming to provide unique branding for local agricultural products.

c) Contributes to national food security by regenerating abandoned/ disused farmland.

d) Provides opportunities to encourage new farmers and expand the so-called 6th industry* by introducing carbon-absorbing farming methods like no-till, and new systems that utilize IoT.

Working in the shade, even in hot weather

Growing soybeans using no-till farming (Sosa City)

Solar Sharing FAQ

1. Are there any crops particularly suited to solar sharing?

Using solar sharing setups that provide up to a 35% shading rate, there should be no problem growing almost any kind of crops (see chart at the bottom of page 2). There are plenty of examples of farms growing a truly wide variety of crops by setting the panel shading rate and other variables to suit individual types of produce.

2. Does the equipment get in the way of farm work?

The height and distance between the frames are to be set up in a way that provides enough space for efficient use of machinery and other farming equipment, so that they don't impede work (see photo at the bottom of page 6 of farming being done by tractor).

3. Can solar sharing really make abandoned farmland productive again?

Even land that has been abandoned because there is no one to tend to it can be returned to farmland by using the income from selling electricity produced by solar sharing. In Japan, designated Type 1 agricultural land cannot be converted to other uses, which has been a hurdle to effective land use. This makes solar sharing even more promising as a way to revitalize farmland.

4. What are the requirements for installing solar sharing?

Because the area of farmland where the foundation of the frames is installed will be used for non-agricultural purposes, it may be necessary to acquire a permit for temporary alternative use from a local board of agriculture. In Japan this is contingent on ensuring that proper farming continues beneath the power facility, and actual harvest volumes of the crops must be reported to the relevant committee each year. It is also necessary to reapply for the permit every three years (or every 10 if certain conditions are met), which requires showing that the equipment is not impeding crop production.

5. How will the PV panels be disposed of at the end of their life?

Reusable panels are collected by a specialized contractor that ensures they are reused, and all other types are collected by a recycling contractor that separates them into component elements like aluminum and glass to be recycled. As of November 2022, there are 31 intermediate processing companies throughout Japan that have developed technology for recycling and appropriate disposal of PV panels, and this number is expected to increase in the future.

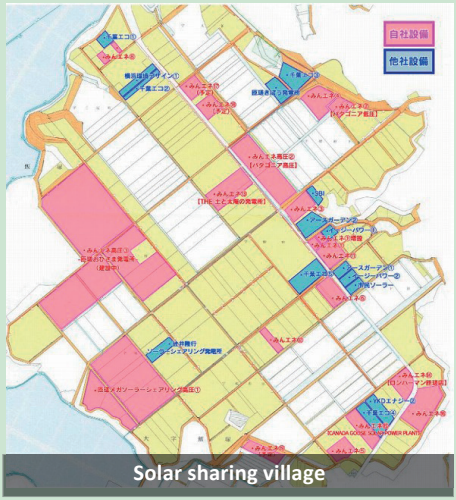
Since July 2022, power producers have also been required to set aside funds to cover disposal costs.

Solar Sharing in action

1. Shimin Energy Chiba K.K. (Sosa City, Chiba Prefecture)

More than 40 years ago, about 80 ha of open farmland were developed in the local area using government funding, yet much of this was later abandoned. Starting in December 2013, there were a number of private investments related to the environment and renewable energy in Chiba that created continued interest in building “people’s power plants,” which led to the establishment of Shimin Energy Chiba LLC in July 2014 and the prefecture’s first 35 kW community power plant.

Since establishing an additional company in charge of farming , the group has attracted more and more advocates and expanded their list of affiliates and facilities over eight years. They are growing rapidly, and currently have a total of 400 million yen in capital and a generation capacity of 6 MW. The area is thus now known as “solar sharing village.”



Solar sharing village

As the soil here is not fertile, they primarily farm soybeans, azuki beans and barley using organic farming methods below the PV panels. The soybeans are processed into products like miso paste and coffee substitute to also tap into the 6th industry.

With the help of Professor Masakazu Komatsuzaki of Ibaraki University and Professor Nobuhiro Kaneko of Fukushima University, they are also trialing no-till farming, which helps improves soil health through microorganisms. In the spirit of a non-profit limited liability company, profits after expenses are put back into renewable energy and other environmental initiatives rather than split between investors.


Working beneath the photovoltaic (PV) panels

2. Nihonmatsu Agricultural Solar K.K. (Nihonmatsu City, Fukushima Prefecture)

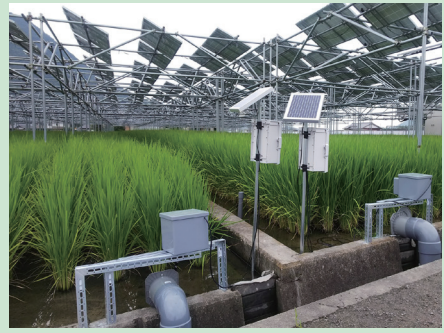
Nihonmatsu Agricultural Solar is an agricultural power generator that is operated by three companies: Civic Power Plant Gochikan LLC, a community power company that is working to increase community self-sufficiency, local co-op MIYAGI COOP, and the Institute for Sustainable Energy Policies that supports them. The 4-MW power generation facility stands on 6 ha of farmland that is owned and operated by Sunshine, a corporation qualified to own cropland.

Looking out onto Mt. Adatara, the facility produces electricity to serve 500 households — about 2.5% of those in Nihonmatsu City — and crops such as Shine Muscat grapes, perilla and buckwheat. It is a working example of a new kind of land utilization where agricultural and energy production don't need to compete, even in Japan where flat land is at a premium.

3. Sanuki Paddy Fields K.K. (Marugame City, Kagawa Prefecture)

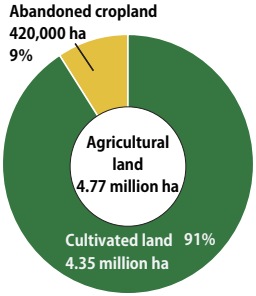
As an agricultural management company, they use smart farming to raise productivity and make other improvements. Of their total 3.7 ha of farmland, they have installed PV panels over about 0.6 ha of paddy fields, which generate 444 kW of electricity. They combine this with smart technologies, including innovations such as remote-operated automatic water gates powered by a smart farming management platform and drones.

They also partner with research institutes and universities, and have gained knowledge and experience in stabilizing panels' impact on crops and harvest volumes. The panels partially block direct sunlight, mitigating the rise in water temperature in the field and helping reduce damage caused by heat stress.



The potential of solar sharing
If solar sharing was installed on 10% of Japanese farmland…

We have done some calculations about solar sharing and found that, if it was expanded to a further 10% of the total 4.77 million ha of farmland in Japan (and abandoned farmland makes up 9% of total agricultural land), the energy output would cover **about 37% of national electricity needs**, and would be equivalent to that of **53 nuclear power plant unit.**



Note: The calculation was performed using the following conditions.

1. A facility use rate for solar sharing of 15.5% based on the latest statistics available from Japan's Agency for Natural Resources and Energy on general solar power plant operations.
2. A generation capacity of 50 kW per 1,000 sqm of solar sharing-equipped farmland.
3. A generation capacity of 1 million kW per nuclear power plant unit, based on the average of the remaining reactors.
4. A facility use rate for nuclear power plants of 70%, considering downtime for regular inspections and other factors.
   Further details on the calculation can be found through the QR code below (in Japanese).

● Our hope for solar sharing

About two thirds of Japan is mountainous, and with so little flat land, there is great need for more community-based solar power facilities on rooftops and land that isn't being used efficiently.

Solar sharing has been devised to better utilize agricultural land, and we hope to see greater adoption of this home-grown technology across different types of farmland, including abandoned cropland. Japan is often seen as a passive player when it comes to addressing climate change, so we are proud and excited to let the world know about the appeal and value of solar sharing.

CRP (Climate Reality Project) is the worldwide non-profit organization focusing on climate change education and advocating for climate solutions.
Business industry group is one of the active seven groups in Japan brunch.

Here's the QR code for the list of reference. (only in Japanese)

The Climate Reality Project JAPAN

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