# 地域における脱炭素社会構築の可能性に関する考察
## － やまなしの無尽文化を活用した市民・行政・企業の連携 －

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# Mujin and Decarbonization:
# Japanese Local Cultural Uniqueness and Carbon-Neutral Economy Development

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**Abstract**

Mitigating global warming and climate change is a global necessity. Governments, the private sector, and the public must establish a carbon-neutral society with solutions tailored to the needs of local communities. We approach carbon emissions and environmental waste from an economic perspective based on the traditional Yamanashi cultural practice of Mujin-a unique social security system of mutual aid that is still in effect in the Yamanashi Prefecture. Our approach continues in the same spirit as Mujin by supporting local communities with the benefits and revitalization produced through environmental conservation.

キーワード：無尽、脱炭素、カーボンニュートラル、気候変動、パートナーシップ
key words: Mujin, decarbonization, carbon-neutral, climate change, partnership

## 1. A History of Climate Change Policy

Climate change is the long-term change in average weather patterns due to the rising atmospheric and oceanic temperatures caused by the abundance of greenhouse gases-such as carbon dioxide（$CO_2$）-in the atmosphere, and is directly associated with human activity.[2)]

Greenhouse-gas concentrations have been increasing since the industrial revolution, with the large scale exploitation of fossil fuels such as oil and coal. Figure 1 shows the global $CO_2$ emissions[3)]: annual $CO_2$ emissions until the middle of the 19th century remained almost unchanged at 2000 million metric ton per year or less but increased markedly in the second half of the 19th century. Since the 1950s, $CO_2$ emissions have been increasing exponentially and have been of concern to the international community since the 1970s.

The 1972 United Nations Conference on the Human Environment was the first international conference regarding human interactions with the environment and resulted in the launch of the United Nations Environment Program（UNEP）. The 1992 Rio de Janeiro Earth Summit addressed post-Cold War environmental and development issues; participants included many NGO representatives and UN member states, who adopted the Agenda 21, i.e., an action plan for sustainable development and global partnerships. The Government of Japan

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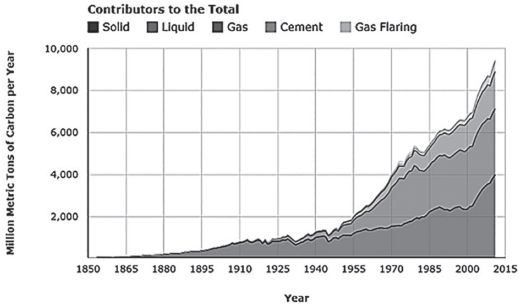


Source: Boden, T.A., G. Marland, and R. J. Andres. 2015. Global, Regional, and National Fossil-Fuel $CO_2$ Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi: 10.3334/CDIAC/00001_V2015.

**Figure 1: Annual total $CO_2$ emissions by world region: CDIAC**

enacted the ‘Basic Environment Law' in 1993 and built a policy framework for the realization of a sustainable society. In 1997, the 3rd Conference of the Parties of the United Nations Framework Convention on Climate Change（COP3）was held in Japan: ‘A promise; Kyoto Protocol' was adopted, aiming at reducing greenhouse-gas emissions by approximately 5% with respect to the 1990 levels between 2008 to 2012.

Under the 2015 Paris Agreement, it was adopted internationally that ‘holding the increase in the global average temperature to well below 2 ℃ above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 ℃ above pre-industrial levels' is necessary[4]; the 2018 Intergovernmental Panel on Climate Change（IPCC）report indicated that this goal is realistic only by reducing $CO_2$ emissions to virtually zero by 2050[5]. As a result, each country has considered decarbonization policies based on international agreements.

## 2. Yamanashi's Current Initiatives

National efforts to comply with the Paris Agreement resulted in policies implemented at the prefectural and regional levels. In Japan, the “Yamanashi Prefecture Global Warming Countermeasures Implementation Plan” was formulated in March 2009; the “Yamanashi Energy Vision” was formulated in accordance with the new greenhouse-gas emission targets under the national “Global Warming Countermeasures Plan” [6] in March 2016. As a consequence, using energy-saving electrical equipment is currently mandatory in Yamanashi and companies reliant on automobiles require an “automobile environment plan” . For the public, the Yamanashi prefectural government created ‘Eco Memo' to promote local, environmentally friendly activities and waste reduction by allowing citizens to convert personal electricity consumption into $CO_2$ emissions and also translate this energy consumption into garbage-bag production[7].

Yamanashi Prefecture has implemented other regional carbon reduction efforts: in Otsuki City, an eco-friendly woody-biomass power plant[8] was established in 2010 and can generate approximately 30,000 times the annual power consumption of ordinary households, or 9% of all 330,000 households in the prefecture; in Tsuru City, a small personal-consumption hydroelectric power plant generates electricity for the Tsuru City Hall[9] ; in Hokuto City, which is among the areas with the highest sunshine duration nationally, the installation of solar power generation facilities

**Table 1: Yamanashi Clean Energy Goal**

Table 1 Yamanashi Clean Energy Goal

| Introduction of clean energy | 2011 | 2012 | 2013 | 2014 (provisional value) | 2015 (short-term goal) | 2020 (Medium-term goal) | 2050 (long-term goal) |
|---|---|---|---|---|---|---|---|
| Residential solar (Number of installed units, Detached house popularizing rate) | 45,000 kW About 11,000 units 4.9% | 62,000kw About15,000 units 6.5% | 80,000kw About 18,000 units 8.1% | 89,000kw About 21,000 units 8.5% | 90,000kw About 20,000 units 8.6% | 200,000kw About 45,000 units 20% | 1,160,000kw About 116,000 units 50.0% |
| Mega solar, solar power for business | 22,000 kW (with 3 megasolar sites) | 28,000kw (with 7 megasolar sites) | 117,000kw (with 23 megasolar sites) | 23,2000kw (with 32 megasolar sites) | 70,000kw (with 3 megasolar sites) 22 places | 100,000kw (with 30 megasolar sites) | 600,000kw (Solar power for business etc) Penetration100% 0 |
| small water power | 9000 kW with 6 prefecture's sites out of 24 sites | 9700kw with 7 prefecture's sites out of 28 sites | 9700kw with 7 prefecture's sites out of 28 sites | 10,000kw with 8 prefecture's sites out of 32 sites | 10,000kw with 8 prefecture's sites | 14,000kw with 16 prefecture's sites | 30,000kw |
| water power (Excluding pump power plants) | 470,000kw | 470,000kw | 470,000kw | 470,000kw | 470,000kw | 470,000kw | 500,000kw |

Source: Created by the author based on the material of Yamanashi Prefecture Energy Bureau Energy Policy Division

is in progress[10].

In 2020, the international, experimental "4 per 1,000" initiative started[11] . The initiative processes grape and peach tree branches from thinned trees produced by agriculture in the prefecture, turns them into charcoal and buries them in the soil. Carbon remains in the charcoal, thereby suppressing $CO_2$ emissions. If the amount of carbon in the soil is increased by 0.4% (i.e., 4 per 1,000) each year, the atmospheric $CO_2$ increase can be offset, and global warming can be mitigated.

Hydrogen is another attractive energy source, which can be easily transported and stored. The "P2G system", an emerging technology developed in research institutes in the Yamanashi Prefecture, converts electricity generated from renewable energy into hydrogen.

## 3. Yamanashi's Environmental Issues

### 3−1. The diffusion of renewable energy

Developing and utilizing renewable energies is paramount for societies that strive to minimize their impact on climate: Each country is responsible for developing and adopting individual solutions according to their needs. Yamanashi is a landlocked prefecture; therefore, there are few suitable sites for wind power generation; however, solar power generation is highly advantageous in Yamanashi Prefecture due to its increased annual sunshine duration. The Yamanashi 'Local Production for Local Consumption' energy strategy, formulated by the Yamanashi Prefectural Energy Bureau in 2013, sets goals for the promotion of renewable energy, as shown in Table 1. The largest proportion of renewable energy is residential solar power of less than 10 kWh. Yamanashi Prefecture's goal is to have installed solar power in 50% of all detached houses by 2050, thereby ensuring 1.16 million kWh of clean electricity. In 2011, residential solar power amounted to 45,000 kWh; from 2011 to 2014, production increased by approximately 14,666 kWh per year (Table 2) . Assuming that this rate remains constant, approximately 45 % of all detached houses will be producing solar power by 2050. Thus far, the installation costs of solar panels are a burden to the households; financial support could alleviate these costs and further the use of solar panels.

According to the Japan Chemical Industry Association, thermal power generation using fossil fuels results in the emission of approximately 690 g $CO_2$ per 1 kWh; this amount of $CO_2$ can be spared from the atmosphere if solar power generation is used instead, considering that it involves no

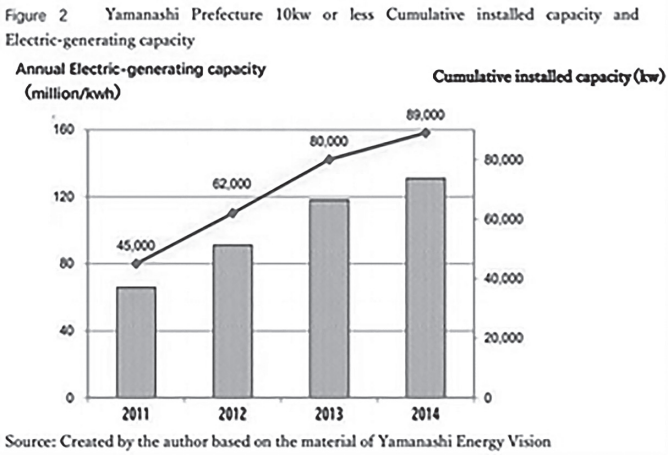


**Figure 2: Yamanashi Prefecture 10kw or less Cumulative installed capacity and Electric-generating capacity**

$CO_2$ emissions. The solar power target for businesses is 600,000 kWh; following Table 1, an additional 362,000 kWh solar power is necessary. This amount of energy equals about 254 t $CO_2$ reduction over 36 years[12] (assuming that the number of operating facilities increases at the same rate as domestic adoption, as shown in Table 2) ; alternatively, it means 1.18 million kWh of solar power in 2050, which implies that the long-term goal of 600,000 kWh renewable energy by 2050 is achievable.

However, there are also some concerns. Table 2 shows the total number of operating 10 kWh solar power businesses; when compared with the issued licenses by the government, the only part is in operation. This is due to 'feed-in tariff', i.e., the purchase price of renewable energy is expected to decline and therefore businesses are wary to invest, implying that estimates of future energy production targets may be unreliable.

If future energy production targets are to be met, corporate installation needs to be promoted while being mindful of the impact of such infrastructure, for it is necessary to also reduce the burden on residential solar energy. Local communities need to collaborate via establishing partnerships to achieve decarbonization.

### 3−2. Reduction of plastic waste

Plastic waste is recognized as a major issue in Yamanashi Prefecture. According to the Ministry of the Environment, more than 8.3 billion t of plastic have been produced since 1950, of which 6.3 billion t have been disposed of as waste; if this continues, it is reported that more than 12 billion t of plastic will be in landfills or discarded in the environment by 2050. In Japan, according to the "Environmental Bureau of the Tokyo Metropolitan Government"[13], Japan's plastic waste in 2018 was 8.91 million and had an adverse effect on the rivers in the Yamanashi Prefecture, which received a considerable amount. According to the "River Scattered Waste Composition Survey of the Yamanashi Prefecture Energy Division"[14], 76　% of the scattered waste in rivers is plastic, with dire implications for natural ecosystems and the environment.

$CO_2$ emissions from the incineration of plastic waste are currently unavoidable, and plastic waste that cannot be incinerated or recycled is disposed in nature or in landfills.

**Table 2　$CO_2$ emissions from the incineration of plastic waste in Kofu City in 2014.**

| | 2014 | | 2015 | | 2016 | |
|---|---|---|---|---|---|---|
| | Recovery amount (t) | CO2 conversion (t-CO2) | Recovery amount (t) | CO2 conversion (t-CO2) | Recovery amount (t) | CO2 conversion (t-CO2) |
| Total amount of plastic | 15,732.70 | 43,500.50 | 15,239.10 | 42,135.30 | 12,433.31 | 34,378.10 |
| Incineration amount | 15,375.60 | 42,513.50 | 14,896.00 | 41,187.00 | 11,943.40 | 33,024.00 |

Source：Created from materials provided by Kofu City Environmental Center

Table 3 shows the $CO_2$ emissions from the incineration of plastic in Kofu City from 2014 (Heisei 26) to 2016 (Heisei 28) : while the amount of $CO_2$ emissions during this period is gradually decreasing, it remains high, with approximately 34378 t emitted in just the first four months of 2016[15]. In December 2016, Kofu City began collecting plastic containers and packaging separately in an attempt to increase recycling; this equated to 624.18 t (1725.9 t $CO_2$) in 2017, while in 2018 it increased to 678.41 t (1875.5 t $CO_2$) , i.e., 8.7% increase. With regard to these figures, it is difficult to achieve reduction of plastic waste without governmental intervention, and it is especially important to promote it with the cooperation of businesses and citizens in the prefecture.

## 4. Overcoming Challenges: A Proposal for Building a Carbon Neutral Regional Economy

### 4−1. Employing the Unique Yamanashi 'Mujin' Culture

In addition to protecting the global environment, addressing environmental issues can have an impact locally by creating job opportunities and enhancing development. By employing the traditional Yamanashi cultural practice of 'Mujin', a carbon-neutral society is possible.

'Mujin' is a remnant of the private financial system of a bygone era when financial institutions were not widespread throughout Japan; it is a mutual aid system for social security, whereby a small amount of money is collected from members to be used in times of hardship, illness, or sudden loss. In this way, Mujin promoted communication, deepened relationships, and improved well-being. Today, with established social welfare and private insurance, Mujin's role has diminished, financing community events, social activities, and parties instead. For this reason, restaurants and izakaya-typical Japanese bars-in the Yamanashi Prefecture often carry a sign saying: "We host Mujin meetings". This is not the case in other regions in Japan.

The "Yamanashi Decarbonization Partnership" proposed here is a system that utilizes this traditional custom through reappropriation of funds: by lending with little or no interest a small percentage of the Mujin funds spent at these restaurants to local companies working on decarbonization activities in the prefecture, environmentally friendly activities and production are supported by the local communities, thereby helping to create a sustainable society.

The proposed system operates in the following way: first, bars and restaurants that agree with the initiative are registered in the system. Subsequently, a small percentage of the money spent by Mujin parties at

the registered establishments is used to support decarbonization projects. When a local business wishes to obtain a loan by the initiative, a proposal is submitted and evaluated under environmentally conscious criteria, such as the purpose and feasibility of the project, and the timeframe and amount of anticipated $CO_2$ reduction, among other factors. During the implementation of the project, progress reports are mandatory, while being disclosed for transparency. An operating entity responsible for the examination, financing, and management is required; the entity is ideally composed of experts, financial institutions, prefectural representatives, and local companies and government officials, while the operation costs are part of the procured funds. A portion of the interest or profit produced by loans from this partnership will be returned to the restaurants in the form of goods or vouchers in order to honor the good will of the initial investment, while distributed proportionally to incentivize participants, thereby aiding further engagement in the initiative. If the proposed initiative is successful at raising money for sustainable investments, it could transition from loans into a donation program in the future.

## 4−2. Detailed Mechanisms of Yamanashi Decarbonization Partnership

### 4−2.1. Structure of the Yamanashi Decarbonization Partnership

Figure 3 illustrates the Yamanashi Decarbonization Partnership: 1) Mujin customers use a store part of the decarbonization partnership and pay the total price plus 1%, e.g., if 10 people attend a Mujin event that costs 5000 yen per person, 500 yen in total will be additionally charged as a partnership fee. 2) The funds raised in this way are managed by an operating entity. 3) Establishments are given points according to the amount of funds raised as a method of tracking contributions. 4) Companies or local governments that wish to obtain a loan from the initiative

submit a proposal (including the target $CO_2$ reduction and timeframe). 5) The proposal is

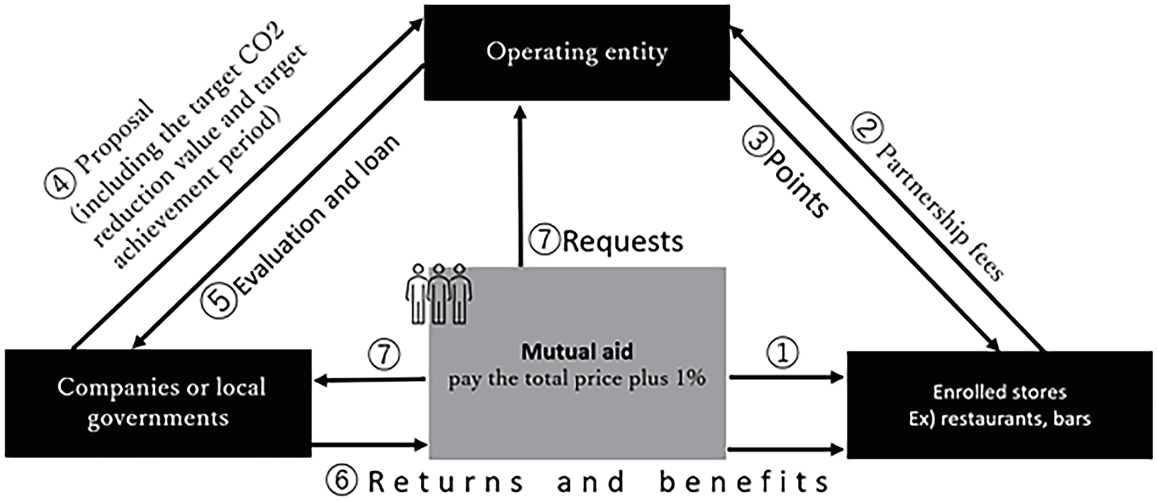


**Figure3 Structure of the Yamanashi Decarbonization Partnership**

examined by a committee that considers the loan amount and repayments; in the ideal case, the loan is approved. 6) The business operator who receives the loan returns a portion of the benefits that $CO_2$ reduction has afforded them to affiliated establishments that are the funders in the form of rewards, according to decarbonization results. 7) The public is able to make suggestions for changes via the project website to which companies can respond.

As mentioned earlier, the Yamanashi Decarbonization Partnership is a mechanism that raises financial resources from traditional economic activities in the prefecture in order to support economic activities that contribute to decarbonization. The economic benefits of environmentally friendly practices are, in part, returned to the local economy.

The Yamanashi Tourism Organization conducted a campaign for the registration of Mujin establishments in May 2020 and ended up with a total of 8460 registered prefectural establishments; if all these Mujin establishments were to participate in the initiative, and if the earlier example of 500 yen per Mujin event were to be raised every month, it would result in 50.76 million yen raised in one year[16] .

Establishments are incentivized to join the initiative with exposure and promotional opportunities both in store with promotional branding in the form of stickers, online on a dedicated site, and through social networking. This enables establishments to differentiate themselves as positively impacting the environment and encouraging consumer activity; therefore, a starting fee of 1000 yen per establishment is proposed. The marketing benefits of this proposal make this cost prohibitive and can generate several million yen to assist initial start-up costs.

### 4−2. 2. Mujin Points Reward System

Registered establishments receive points proportional to the money collected from the Mujin events. Points allow establishments to select items from an inventory managed by the oversight committee. The items on the inventory highlight prefectural products or ingredients that are sustainable or environmentally friendly from companies that have achieved climate goals or standards.

Companies that use Mujin loans must achieve their set climate goals outlined in their loan proposals to be promoted within their community. Once these goals are achieved, these items can be acquired by participating restaurants in exchange for points. While directly supporting their businesses, this also enables participating establishments to advertise local ingredients to Mujin customers, the use of which further reinforces the businesses' reputation as dependable, eco-friendly companies.

### 4−3. Estimating the reduction of $CO_2$ emissions

When a company or local prefectural governing body wants to receive backing from the Mujin fund, a proposal is submitted, and a business plan to realize decarbonization is implemented. Here, we provide three hypothetical examples, and the reduction of $CO_2$ emissions by each business plan is estimated.

### 4−3. 1. Promotion of Local Plastic Production

This proposal aims to install local products in Yamanashi prefectural grocery stores, promoting plastic-free local production. According to the Toyotomi Roadside Station Market's agricultural product

sales posted on the Yamanashi Prefecture website in 2013, approximately 1,000 people per day made purchases at the store. As an estimate, if each person purchased on average five products packaged in plastic bags, approximately 1.8 million bags were consumed annually. If the amount of plastic per plastic bag is 2.86 g per sheet, this becomes equivalent to approximately 5.15 t of plastic or approximately 14.2 t $CO_2$, which can be reduced or eliminated[17]. According to Shimokawa et al.（2013）, there were 121 direct sales stores in Yamanashi Prefecture in 2010, and the average annual sales were 52.14 million. If 50％ of the direct sales stores in the prefecture agree to implement this plastic reduction policy, these plastic-free stores can reduce $CO_2$ emissions by approximately 85 t $CO_2$ per year and save about 540,000 yen[18].

### 4−3. 2. Promotion of Residential Solar Power Installation

Supporting solar panel installation at residential units is important for creating a carbon-free society. Most solar panels are durable and often last for 20 years. Even if maintenance costs are incurred, costs can be recovered through electricity sold and reduced electricity usage over the first ten years of the solar panel's operation. Additionally, according to the Agency for Natural Resources and Energy, the initial cost required for installing photovoltaic power generation systems producing 10 kWh or less is steadily decreasing each year owing to the progress of renewable energy technologies.

Nevertheless, there are issues regarding the cost, installation, and supply of equipment that are prohibitive for the general consumer. By supporting both consumer and local private-sector research and development, these challenges can be partly mitigated; therefore, this partnership can provide financial support by lowering the cost of installing solar power generation and/or by providing a package that guarantees maintenance costs.

In this simulation, the standard installation cost required for a household solar panel with a power generation capacity of 5 kWh is 1.88 million yen[19]. The electricity usage fee for the above-mentioned three-person household is estimated to be approximately 11,116 yen per month, or about 133,300 yen per year.

$$\frac{\textit{Total domestic power usage in kWh (2016)}}{\textit{Total number of households (2016)}} = \textit{Annual power consumption per household,}$$

$$\frac{269{,}166{,}700{,}000}{55{,}364{,}100} = 4{,}861 \text{ kWh,}$$

$$\frac{4{,}861}{12} = 405 \text{ kWh per month.}$$

Based on data of the New Energy and Industrial Technology Development Organization（NEDO）[20], the average amount of power generated per square meter of solar panel per day is 4.44 kW/ ㎡ /per day in Hokuto City（H）with a loss coefficient of 0.73（K）[21]. Therefore, the estimated annual power generation and investment recuperation can be calculated:

*Annual expected power generation expressed in kWh (E) = daily power generated (H) × loss (K) × system capacity of 5 kWh × 365 × solar intensity under standard conditions (r), 1 kWh.*

Therefore, the following can then be calculated:

$$\frac{\text{Hokuto average solar kWh per day generated by a 5 kWh system} \times 365}{\text{months}} = \text{Average monthly output in kWh,}$$

$$\frac{44.4 \times 0.73 \times 1 \times 5 \times 365}{12} = 493,$$

493 – 405 = 88 kWh surplus energy generated per month,

88 × 11 yen per kWh (predicted surplus energy rate) = 968 yen,

88 × 12 × 10 = 116,160.

When this is added to the savings generated by no longer paying an electrical bill, 77 % of the installation cost would be compensated in 10 years, while the remaining 430,000 yen is compensated in the 13th year. With maintenance, solar panels have a 20-year lifespan; over this period, they provide approximately 900,000 yen in profits.

As the equations show, the installation cost of the photovoltaic system is the main obstacle preventing people from installing solar panels; however, by supporting people financially, the partnership assists those who wish to invest in a photovoltaic system but cannot afford the installation. If (from the 116,000-household target by 2050, as seen in Table 2, above), 50,000 use the loan of this proposal by 2050, it will be possible to reduce $CO_2$ equivalent by 140,486 t $CO_2$ per year (5,915.2 kWh per unit × 50,000 units; Eko Memo).

### 4−3. 3. Zero Carbon Campus Plan

Universities worldwide understand the importance of creating a sustainable, carbon-free society. In Japan, more than 100 universities participate in the Carbon-Neutral University Coalition, scheduled to be launched in 2021 to eliminate $CO_2$ emissions by their campuses. Based on this movement, we consider $CO_2$ emissions at Yamanashi Prefectural University (YPU):

In 2019, the YPU Iida Campus used 672,286 kWh, equating 319,336 kg of $CO_2$ emissions. For the YPU Iida Campus to reach the same $CO_2$ reduction target as the Yamanashi Energy Vision, a reduction of 81,431 kg (25.5 %) by 2030 is necessary. This amounts to 171,432 kWh of power. The initial investment to achieve this goal through a photovoltaic system would be 37,950,000 yen; however, it would save the university 3,730,000 yen per year when considering current power usage. Thus, after 10 years, the initial investment would be compensated.

### Summary and Future Prospects

The Yamanashi Decarbonization Partnership proposal envisions a sustainable society for future generations through reducing $CO_2$ emissions and environmental waste. Based on the culture of mutual aid called Mujin-unique to the Yamanashi region-our proposal utilizes social capital to develop and promote sustainable practices within the community and provides focus and accountability for communities that contribute to achieving their climate goals and social responsibilities. By creating incentives for participation, it ensures that the $CO_2$ reduction and sustainable practices with the support of the partnership benefit not only the contributors, but also the wider community. This will improve the understanding of global environmental issues and encourage sustainable living, with less environmental impact.

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1）Faculty of Glocal Policy Management and Communications, Yamanashi Prefectural University Ninomiya Seminar

2）See The Japan Meteorological Agency website of the ministry of land, infrastructure, transport, and tourism.

3）CDIAC (Carbon Dioxide Information Analysis Center) is a research institute in the United States_

4）See McGrath, M 2015.

5）See page 51, Ministry of the Environment, 2018,

6）As a guideline, energy measures that contribute to the revitalization of the prefecture's economy and the safe and secure life of citizens are expected; such measures should aim at incorporating various clean energies in a well-balanced manner and introducing independent distributed energy systems that are environmentally friendly and disaster resistant by 2030.

7）From 2009 to present, the amount of $CO_2$, electricity, gas, gasoline, etc. emitted by more than 3,500 households in the prefecture can be aggregated, analyzed, and converted into data. See

Yamanashi Prefecture 2020.

8) See the information on the Otsuki City Woody Biomass Power Plant, Obayashi Group Otsuki Biomass Power Co., Ltd. 2018.

9) Approximately 85% of the total power generation in 2017 was used by government buildings; surplus electricity was sold.

10) See the information about "Solar Panels in Hokuto City", Hokuto City, n.d.

11) Yamanashi Prefecture aims also to create a brand for "environmentally friendly agricultural products", which are made by the 4 per 1,000 initiative. See Yamanashi Prefecture n.d.a.

12) $CO_2$ emissions from thermal power using fossil fuels are calculated at approximately 690 g per 1 kWh; hence, 690 g * (600,000 - 232,000 kW) / 100,000 = 254 t. Find detail in Yamanashi Prefecture 2016.

13) See Ministry of the Environment n.d..

14) See Yamanashi Prefecture n.d..

15) The $CO_2$ emission factor for plastic incineration is 2.674.

16) Calculated as 500 yen x 12 months x 8460 cases.

17) Calculated with a $CO_2$ emission factor of 2.764 due to plastic cancellation based on the material provided by the Environmental Administration of the Environment Department of Kofu City in 2019.

18) Calculated as 14.2 t $CO_2$ x 0.1 x 121 x 0.5. See Lee 2011, p.56..

19) 5 x 1 kW solar panels for existing houses at 376,000 yen each.

20) Includes solar panels, power conditioners, mounts, and construction costs. See NEDO 2020.

21) The loss coefficient considers mainly the loss caused by power conditioners and cables, and is 0.73 in the NEDO Technology Development Organization Photovoltaic Power Generation Introduction Guidebook. In addition, 1 kW / ㎡ is the solar radiation intensity in the standard state, and since it is equal to unity, it does not affect the calculation. See NEDO 2020.