1.3. Private-public partnership model for developing SHP in a remote mountainous community of Japan

CATEGORY:
SHP FOR SOCIAL AND COMMUNITY DEVELOPMENT

COUNTRY:
JAPAN

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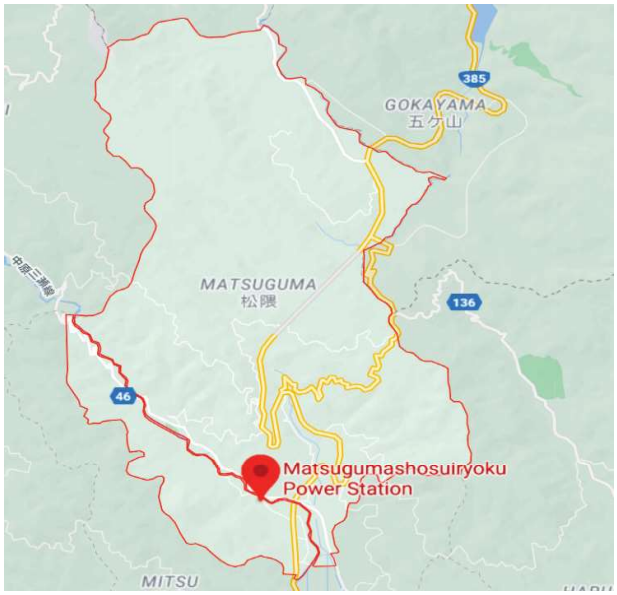
Figure 1. Location of the Matsuguma SHP plant



Source: Google Maps

Table 1. Project Overview

SHP plant name: Matsugumashosuiryoku / Matsuguma SHP
Location: Matsuguma Village, Yoshinogari Town, Saga Prefecture, Japan
Installed capacity: 30 kW
Water source: Pre-existing irrigation channel for agricultural use
Developers: A public–private partnership. Key actors: Saga prefectural government and the community company, Matsuguma Community Development Co., Ltd.
Construction cost: USD 600,000 (in the form of loan, taken by the community for 20 years).
Support schemes/incentives: A cheap financial loan and high FIT prices.
Ownership: 100% by the local community.
Status of the SHP project: The construction was completed in 2020.

Benefits

Economic:

- Economic independence of the community: electricity generation for local needs and for sale.

Environmental:

- Renewable energy generation
- Reduction of 18 tons of CO_2 per year (estimation)
- Maintenance of the irrigation channel and regeneration of the land and mountain landscape

Social:

- Training and employment of local inhabitants linked to maintenance of the SHP plant for a minimum of 20 years
- Community empowerment: a joint project that unites all households of the village

Potential: This model can be further adopted in Japan and abroad in mountainous areas with available irrigation channels.

1. INTRODUCTION

The Matsuguma community is located in the northern part of Saga Prefecture. Its total area is approximately 2.7 km^2. In 2015, the community comprised 43 households (136 people). Almost all of them were small-scale family farmers.

In the past, the community had a 36 kW SHP plant, which was in operation from 1945 to 1967. But the plant stopped functioning due to the lack of appropriate management and maintenance.

Over the years, the community faced the growing pressure of an ageing population, emigration due to the lack of economic opportunities for the younger generation and degradation of farmlands, roads, irrigation systems and waterways. The remaining households were seeking a way to revive the life in the village and socioeconomic activities in the area and increase social welfare and sustainability.

"Matsuguma village is suffering from damage due to declining birthrate and an ageing population. Everyone in the village was worried about how to develop the community for the future, how to regenerate the agricultural fields and mountains and how to connect the community to the next generation. We will emulate our predecessors and think about what we should protect and pass on to the next generation", said Mr Masahiro Tara**,** the ex-mayor of this community and the chief of Matsuguma SHP.

A good opportunity appeared in 2016, when the government of the Saga Prefecture identified the Matsuguma village and its pre-existing irrigation channel used for agricultural purposes and characterized by a rich water flow throughout the year as an appropriate location for constructing a new 30 kW SHP plant that could supply stable power to the Kyushu Electric Power grid. The local government approached the community to discuss the benefits of the project. The local community agreed to collaborate with the government and for the SHP plant to be installed "by the local community and for the local community". This project became the first case of the public-private partnership model implementation for the construction of an SHP plant in the Saga Prefecture with the aim of community development. *"The mountainous areas with a high ageing rate should survive without relying on subsidies. As residents, we are responsible for the future of the prefecture. Our actions and ideas should lead towards sustainability of the community"* – said Governor of Saga Prefecture Mr. Yoshinori Yamaguchi.

Table 2. Project Stakeholders

1. Concept design of compact hydropower: Nakayama Iron Works Co. Ltd (Japan) and Seiko Service and Engineering Co. Ltd (Japan)

2. Civil Engineering: Masakoumuten Co. Ltd (Japan)

3. Management and consulting: River Village Co. Ltd (Japan)

4. Owner: Matsuguma community development Co. ltd.

5. Saga Prefecture government: initial study of the project's viability / feasibility study.

A feasibility study showed that the plant would supply enough electricity to meet the community's needs as well as for sale, thus, generating revenues that could make the community economically independent.

In November 2020, the community of the Matsuguma Village, in Yoshinogari Town, successfully finalized the construction and inaugurated the local SHP plant.

2. TECHNICAL CHARACTERISTICS OF THE PLANT

Table 3. Key Technical Characteristics of the Matsuguma SHP

Item	Value
Turbine	Cross-flow
Total output	30 kW
Electricity generation per year	212 MWh (est.)
Site condition and parameters of the plants	Source of water – Ichinose izeki sabo dam Effective head – 20.4 m Design discharge – 0.22 m^3/s
Turbine	Cross-flow T14 (D225, B270) from Asosiasi Hidro Bandung (Indonesia) Efficiency of the turbine – 76%
Type of generator	IPM generator from Yasukawa Electronics (Fukuoka, Japan) Generator spec – 850 rpm, 45 kW Generator/GD/DC efficiency = ~95/95/95%

Figure 2. 10f container-based powerhouse of the Matsuguma SHP plant

The Matsuguma SHP plant represents a compact system that uses water from a pre-existing irrigation channel. The key benefit of such a system is that it is easy to install, monitor and manage, as outlined below.

2.1 Compact SHP system

The 30 kW Matsuguma SHP uses an old (second-hand) 10f shipping container as a powerhouse (Figure 2), with all mechanical, electrical and control equipment pre-installed in a factory. Such a compact system significantly reduced the costs and the length of time needed for project implementation. It took only a few hours to install the container powerhouse at the site. Moreover, such a powerhouse could be moved out to another location, when needed.

The container has an extended pipe of approximately 30 cm in length that is exposed outside the container and was connected with the penstock pipe during the installation.

2.2 Intake and forebay tank

This SHP plant utilizes the existing agricultural aqueduct. It draws water from the Ichinose dam on the Tade River that flows through Yoshinogari Town. A head tank was constructed in the middle of the waterway. A 400 mm pipe under the road guides the water to the powerhouse. The management of the water intake from the Ichinose dam, which had been a problem for the village for many years, has been improved with the new water intake facilities.

The water from the pre-existing irrigation channel was diverted by making a small weir and a desilting tank as an intake for the SHP plant. The diverted water passes over a meshing screen and the garbage gets strained and flown out. The usable water for the SHP plant falls to pass through the screen and goes to the forebay tank (Figure 3).

Figure 3. Forebay tank and desilting tank

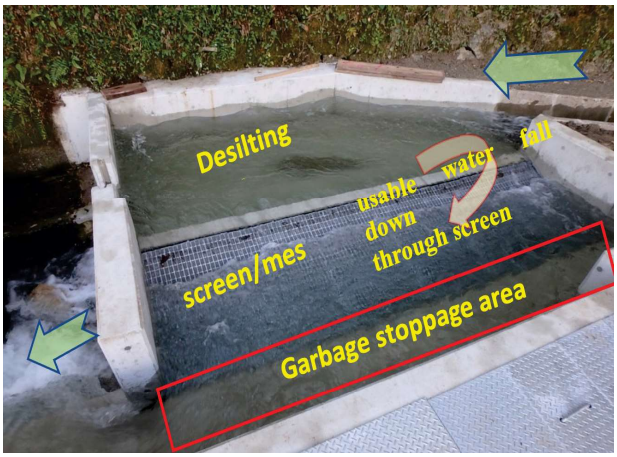


Figure 4. Newly made intake at Tade River

Figure 5. Newly made forebay tank on the existing water channel

2.3. Remote control and IoT functions

The Matsuguma SHP plant is equipped with an intelligent Internet of things (IoT) and control system. The many sensors log different data such as net head, output, total generation, bearings temperature, guide vane control, etc. The monitoring of the powerhouse is fully automatic. The guide vane of the turbine opens and closes automatically in case of an increase or decrease in the water level. The plant can be monitored and controlled remotely from anywhere in the world. In case of emergency (failure of the grid), the plant shuts down within 20 seconds and can re-start automatically once the grid is available.

3. BENEFITS

The SHP plant is a significant community project that provides many relevant socio-economic benefits. In terms of specific United Nations Sustainable Development Goals (SDG), the Matsuguma SHP supports the targets of SDGs 7, 8 and 13.

Economic benefits

The project has a substantial economic interest. It enables the community to generate the electricity for its own needs and become financially independent by selling excess electricity with high FIT prices. This business supports community development and brings financial security to households.

Social benefits

This SHP project has empowered the community by boosting a local business and setting clear community goals.

The local community company, created by the local households, gained valuable technical expertise during the construction of the SHP plant. Now the community company is the owner of the plant, fully responsible for the facilities. The project created local employment linked to the maintenance and management of the SHP plant for a minimum of 20 years.

The profit generated from selling the electricity has been used by the stakeholders to maintain the village, its roads, water systems as well as other facilities and to protect the local infrastructure from degradation. The additional income has increased the welfare and quality of life in the community.

The older generation believes that this SHP plant is a tribute to the previous generations and a valuable asset for the younger generations that will help the village to survive in the future.

Figure 6. Community members at the inauguration ceremony of the Matsuguma SHP plant

At the opening ceremony on 22 November 2020 (Figure 6), Masahiro Tara, President of Matsuguma Community Development Co., Ltd., said, *"We kept the teachings of our predecessors and the residents came together to accomplish this business. We want to create a community where people can continue to live with a smile and a rich heart."*

Mr. Yoshinori Yamaguchi, Governor of Saga Prefecture (Figure 7), shared his big hope: *"The direction of valuing the energy derived from nature is wonderful and I hope it will spread to various places as a model."*

Environmental benefits

The Matsuguma SHP initiative contributes to the Government's efforts to promote renewable energy generation by converting unused available water into a useful product without consuming or affecting it.

In terms of reducing CO_2 emissions, based on the estimation that each kWh of electricity generated from a renewable energy source is equivalent of 0.555 kg CO2, the 212 MWh of electricity generated annually by the Matsuguma SHP plant will result in an estimated reduction of 118 tons of CO2 per year.

The income generated by the community will also help maintain the farmlands from degradation.

Figure 7. The Governor of Saga Prefecture at the powerhouse and intake

4. BUSINESS FIGURES

4.1 Key calculations

The plant construction cost approximately JPY 60 million (USD 600,000). Local farmers would not be able to mobilize and invest such a considerable amount of money without certain guarantees and favourable conditions. A critical incentive for planning and realizing this project was offered by the feed-in tariff, a governmental policy that supports the development of renewable energy sources by providing a

guaranteed, above-market price for producers. The official price offered by the Government of Japan for electricity generated from the Matsuguma SHP was 34 JPY/kWh (0.34 USD/kWh; under 200 kW). The community estimated that the SHP plant would generate approximately 212 MWh of electricity per year, implying an income of approximately JPY 7 million (USD 70,000) per year.

If the conditions stay the same, a break-even on the project investment will be achieved in nine years. It is expected that profit earning will be possible over the 20-year lifespan of this SHP project.

Table 4. Key Business Figures of the Matsuguma SHP

Total investment	Appr. JPY 60 million (USD 600,000)
FIT	34 JPY/kWh (0.34 USD/kWh)
Estimated generation of electricity per year	212 MWh
Expected income per year	Appr. JPY 7 million (USD 70,000)
Break-even	9 years
Lifespan	20 years

4.2 Community business

The Saga Prefecture government conducted and financed the initial study.

To realize the project, the local community established a company, Matsuguma Community Development Co., Ltd., with all the households as its shareholders. Positions and responsibilities were distributed among the community members. To start this small business, each household member contributed JPY 5,000 (appr. USD 50). In total, the company collected JPY 20,0000 (USD 2,000).

Matsuguma Community Development Co., Ltd took a loan from a prefecture financial corporation at the interest rate of 1 per cent for 20 years to pay the total construction costs. The community did not receive any subsidies or financial support from other institutions.

The company, run by the local community, is the owner of the SHP plant: the community members participated in the installation of the plant, and now they are fully responsible for managing and maintaining it.

As per estimation, the plant will allow generating approximately USD 70,000 of income annually by selling electricity to the national electrical company. The community company plans to pay USD 50,000 to the financial corporation as loan repayment and use the remaining USD 20,000 to maintain the SHP plant and develop local facilities, such as roads, irrigations, waterways, etc.

5. LESSONS LEARNED AND CONCLUSIONS

For the prosperity and sustainability of rural communities, it is very important to ensure their self-sufficiency, supporting local people to work together, develop their skills and motivations, uniting them by clear goals and letting them efficiently use available resources.

Some lessons could be highlighted:

1. **In different countries, there are many fresh water streams flowing from the mountains. These streams have an abundance of water which can be used to develop SHP locally.** For example, in Japan these streams were used in the past for the irrigation of rice and tea fields. These streams have an abundance of water which can be used to develop SHP locally. This is an effective way to develop and support local communities. This business model applied for the Matsuguma plant development has shown its viability and can be used in other mountain communities of the country.
2. **Such SHP projects represent a win-win situation for the local communities as well as for the Government.** For example, in this particular case study, SHP helped the local community to stop migration, to become economically independent, at the same time contributing to the governmental goals to reduce the carbon footprint and achieve SDG.
3. **It is important to develop such projects that create value for local communities, involving them in the decision-making process and making them key stakeholders.** When the local communities are integrated in the business model, they have a greater motivation to maintain and manage the plant well, since the plant becomes the "motor" of their welfare, sustainability and security for the future. For example, in this Japanese case, the slogan "By the community, from the community and for the community" is a good demonstration of how local people see the mission of the project.
4. **The transparency and justice are important elements of a business model.** In the case of the Matsuguma community all of the households have become equal stakeholders of the created community company, with equal rights and responsibilities.
5. **The success of such projects very much depends on the local policies, incentives and the governmental support.** In the case of the Matsuguma project, a reasonable break-even (in 9 years) could be achieved only thanks to the high FIT proposed by the Government and to the low interest rate provided by the local financial institution. The initial study was also supported and financed by the prefecture government, which made the project planning easier.
6. **A compact SHP system, which can be easily installed, maintained and controlled, can make the whole project more efficient and secure.** The Matsuguma case shows that smart solutions can be found to reduce the costs of installation and operation.