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DEVELOPMENT OF A DIGITAL COMMUNITY CURRENCY SYSTEM TO PROMOTE THE USE OF WOODY BIOMASS THERMAL ENERGY: A CASE STUDY OF MOGAMI, JAPAN

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ABSTRACT

This study investigates community currencies (CCs) for forest resource utilization, focusing on the design of a digital CC system (digital CCS) in Mogami, Yamagata, Japan. The aim is to boost woody biomass (WB) thermal energy use and local economic and mutual aid activities. Building on Japan's "Ki-no-Eki" scheme, which has promoted self-employment forestry since 2003, this research examines its effectiveness and challenges. The designed digital CCS addresses two key areas: expanding involvement in local forestry by including thermal energy users, volunteers, and government service users as CC recipients, and diversifying funding through subsidies, donations, and decarbonization credits. We designed a circulation experiment in Mogami using the "Géné" digital CC, designed to promote local energy production/consumption, mutual aid, economic circulation, and healthy lifestyles. Géné features health stamp rewards, CO₂ emission reduction feedback, and certified firewood from common forests. This digital CCS aimed to enhance the value of local forest resources and further local economic development and mutual aid. Future steps involve sharing survey results with residents and ongoing stakeholder discussions for Géné's development. This research offers insights into digital CCS as a tool for sustainable forest resource use, local economic circulation, and community engagement, providing valuable information for similar initiatives elsewhere.

KEYWORDS

Digital Community Currency, Sustainability, Currency Design, Decarbonization, Woody Biomass.

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1 INTRODUCTION

This study examines the issues surrounding the use of community currencies (CCs) for the utilization of forest resources, and reports on the design of a digital community currency system (digital CCS) that can promote the use of woody biomass (WB) thermal energy and local economic and mutual aid activities, as well as the activities and specific digital CC designs that led to a circulation experiment in Mogami, Yamagata Prefecture, based on this design.

In Japan, a CCS has been issued and used since 2003 to promote self-employment, self-harvesting forestry, and revitalize local economies. Since 2009, this initiative has spread nationwide through the “Ki-no-Eki (Wood Station)” scheme and, as of 2019, projects using community currency were underway at 55 locations in Japan (Izumi and Nakazato 2021).

Our study aims to examine the effectiveness of the Ki-no-Eki scheme and the challenges it raises, and to design a digital CCS scheme that considers the following two points. The first point is to increase the number and variety of people involved in local forestry. In addition to the existing woody biomass resource (WBR) haulers at “Wood Stations” and local shops that cooperate with this scheme, we propose increasing the number and variety of recipients of digital CC within the community, e.g., the thermal energy users of WBRs, volunteers who chop wood for firewood, and those who use government services. Thus, we developed a currency circulation design that can be used by a wide range of people, from those actively involved in local forestry to those who are not.

The second point is to diversify funding sources for development and operating expenses. Our project is financially supported not only through subsidies (e.g., the Forest Environment Transfer Tax to encourage the use of Japanese forests) and donations from outside the local community, but also by credits granted as decarbonization benefits associated with WB usage. Japan employs a J-credit system that provides a market system for selling decarbonization benefits. In this study, we propose a method to calculate the decarbonization benefits associated with WB usage based on the transaction history of digital community currency.

Based on the results of this research, we designed the digital CC “Géné”. This paper introduces Géné’s objectives and details and based on insights gained from the initial distribution test conducted from October 2024 to January 2025, outlines future challenges to be addressed.

2 CHALLENGES OF WB UTILIZATION USING CCS IN JAPAN

The latest version of The Forest and Forestry Basic Plan, which the Forestry Agency reviews every five years to determine the policy direction of Japan’s forests and forestry industry, identifies ‘green growth’ through forests, forestry, and the lumber industry as a major policy direction for the future (Forestry Agency 2021). Green growth refers to the proper management of forests and the growth and development of the forestry and timber industries while enhancing their sustainability. The Forestry Agency has established the following five measures to achieve this goal: (1) Appropriate management and use of forest resources through conservation and management of natural interest while promoting reforestation; (2) Development of “new forestry” initiatives to achieve profitability, ranging from harvesting to reforestation and nursery; (3) Strengthening the competitiveness of the timber industry to improve both the international and local competitiveness of domestic timber; (4) Creating “second forests” in urban areas to capture new demand for timber in medium- and high-rise buildings, to store carbon in cities and contribute to tackling global warming; (5) Developing forest service industries in mountainous and rural areas; and (6) Creation of new mountain village values that promote cooperative activities for the maintenance of villages (Ibid.).

Approximately 70% of Japan’s land area is forested, and under this policy, WB energy is attracting attention as a renewable energy source. As Yoshida and Toyota (2024) have shown, WB accounts for only 30% of the energy stored in trees when used solely for power generation, and it is most vital that it be used as thermal energy. However, in Japan, biomass fuels account for only a tiny share of heating and cooling, and WB is required for thermal energy. For WB energy to be used efficiently for heating, a small-scale, decentralized energy system that uses local forest resources would be effective. By utilizing firewood, pellets, and chips, the use of WBRs not only has a positive effect on the circulation of the local economy, including forestry, the wood processing industry, and energy supply companies, but also strengthens local resilience by building social capital related to the use of forest resources and constructing small-scale distributed energy systems (Yoshida and Toyota 2024).

Nevertheless, several issues must be resolved before forest resources can be utilized—the first concerns human resources. Human resources are indispensable for managing forests; however, in Japan, there is a persistent shortage of personnel. This is the first issue to be resolved to build a system that utilizes WB. In Japan, Tosa-no-Mori Kyuentai (Forest Resources Rescue Team in Tosa) has begun activities to develop human resources to manage

forests and address this problem. As part of this activity, the Kyuentai issued a CC, the Mori-Ken (Forest Ticket), in 2003.

The Mori-Ken were given as a reward to volunteers for forest maintenance work and could be used at local stores. The stores that received the Mori-Ken could exchange them for yen at Kochi Shizen-mura (Kochi Nature Village). The unit of a Mori-Ken is a Mori (Forest), and one Mori ticket can be used to purchase items worth approximately 1,000 yen or less. According to Miyazaki and Kurita (2018), approximately 2,500–3,000 Mori-Ken are distributed annually. This initiative was implemented in 14 locations in Kochi Prefecture between 2009 and 2013. The “Ki-no-Eki (Wood Station)” scheme is based on an initiative in one of these areas and simplifies the mechanism to facilitate introduction. The Ki-no-Eki (Wood Station) is a collection point for thinned timber gathered from local forests (see Figure 1). Under this scheme, various volunteers load thinned timber generated during forest maintenance onto their own trucks and transport it to this station, receiving CCs based on the volume transported.

According to Izumi and Nakazato (2021), by the end of 2019, this scheme had been adopted at 74 locations throughout Japan, 55 of which use CCs.

Figure 1: The Ki-no-Eki (Wood Station) in Oguni



Source: <https://manabiyanosato.or.jp/kinoeki/>

The Ki-no-Eki scheme is that each regional wood station pays CCs for each shipment of thinned wood. The thinned wood collected at the wood station can be sold to buyers, and the Ki-no-Eki office can use it as a source of funds for issuing CCs. Issued CCs can be used to purchase goods at cooperating stores in the region, and stores may subsequently exchange these tickets for yen at the Ki-no-Eki office. According to a survey of the status of the Ki-no-Eki scheme (Izumi and Nakazato 2021), the largest and smallest shipments of lumber were 1,099 and 18 tons per organization, respectively, for a total volume of 1.17 million tons per year. The total amount of CCs issued was approximately 65-million yen-equivalent (range 30,000 to 6,493,000 yen-equivalent; median 1,110,000). The average turnover of issued CCs was 1.24.

Yamazaki et al. (2022) used a questionnaire survey to analyze the attitudes of people involved in shipping thinned wood as members of this Ki-no-Eki scheme, as well as local stores that received CCs. The study found that active members of Ki-no-Eki feel that the activities influence individual participants by helping them gain new friends, affect the CC by increasing its circulation, and contribute to a recycling-oriented society. Furthermore, the cooperating stores are aware that, by receiving CCs, they are contributing to the conservation and utilization of local forest resources, such as mitigating the effects of flooding and sequestering carbon dioxide.

Viewed from this perspective, the CC-based Ki-no-Eki scheme has positive outcomes for its participants and stakeholders, including participation in local community networks and contributions to the conservation of local forest resources. However, this scheme also faces several challenges, which Izumi and Nakazato (2021) summarized as follows: the first is the negative spread that occurs when thinned wood is purchased at a high price and sold to

contractors at a low price. To address this problem, many Ki-no-Eki offices rely on subsidies from local governments and other sources. The second is the lack of secondary circulation. The average turnover rate of 1.24 indicates that, in effect, CCs used in stores are immediately converted into yen. “To raise awareness of the problem of converting them into cash immediately, it is necessary to devise measures such as charging a fee when converting them into cash if they have not been used a certain number of times or more, and conversely, offering rewards if they have been used a certain number of times or more” (Izumi and Nakazato 2021, 162). The third is the lack of number and variety of CC recipients. Izumi and Nakazato (2021) found that relatively few local people engage in shipping thinned wood to the Ki-no-Eki (averaging approximately 22 per organization), and Yamazaki et al. (2022) reported that more than 80% of these individuals are in their 60s or older. This indicates that the stakeholders for this scheme are limited in scope, as they are primarily older individuals interested in using forest resources.

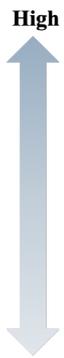
As these studies have shown, there is a strong affinity between establishing a small-scale, decentralized energy system using WB and building a small-scale, decentralized social network using CCS. Although the use of CCS as a platform for forest resource use has certain benefits, the number and variety of users are low, turnover of CCs is low, and the benefits of CCS are not fully exploited. We therefore developed a digital CCS as a platform to broaden the base of people involved in forest resources. This approach aims to build a sustainable socio-economic system centered on local forest resources by increasing the number and diversity of people involved in managing these resources. It achieves this by integrating other local resources—namely economic resources, human resources, and social capital.

3 DEVELOPING A SCHEME FOR THE SUSTAINABLE USE OF WBRs USING DIGITAL CCS

In developing a digital CCS to utilize WBRs, we pursued two key objectives. One is to broaden the base of people involved in forest resources, and the other is to establish a stable funding procurement method. As we saw in the previous section, the existing Ki-no-Eki scheme involved transporters of WBRs (closely related to forest resources) receiving CCs and then using them at local stores. As we have already seen, this system made local stores aware of the philosophy behind CC issuance. However, it also limited the number and variety of CC users and reduced the number of times tokens were used before being converted into legal tender.

We believe it is crucial to raise awareness among residents that the forest resources in their area have value; therefore, we have created a digital CCS that can be used not only by people who are deeply involved in forest resources, such as those who work at the Ki-no-Eki, but also by people who are less closely involved. Table 1 shows the anticipated users of the newly devised digital CCS. As shown, in addition to users of the conventional CCS at the Ki-no-Eki, we also consider users of WB heat energy, i.e., users of heat energy from wood stoves, pellet stoves, and chip boilers. Furthermore, we included residents as users to support mutual aid and local government as providers of administrative services. In addition, we established a scheme that allows residents in other regions to receive CCs in return for their donations.

Table 1: Various ways of obtaining a digital CC according to the degree of involvement with forest resources

Degree of involvement in local forest resources	Local forest resource stakeholders	How to obtain/receive a digital CC
 High	WB Providers*	Obtained according to time worked, the weight of forest resources provided, the weight of residual wood processed into chips or firewood, etc.
	WB Users	Obtain a certain percentage (e.g. 10%) of the purchased electricity from firewood, chips or WB heat
	Local Stores*	Received as compensation for goods and services sold
	Local Government	Received as compensation for services provided by local government
	Residents	Obtained through mutual aid and events.
	Low	Non-Local Residents

*Bold text indicates stakeholders in conventional *Ki-no-Eki* scheme

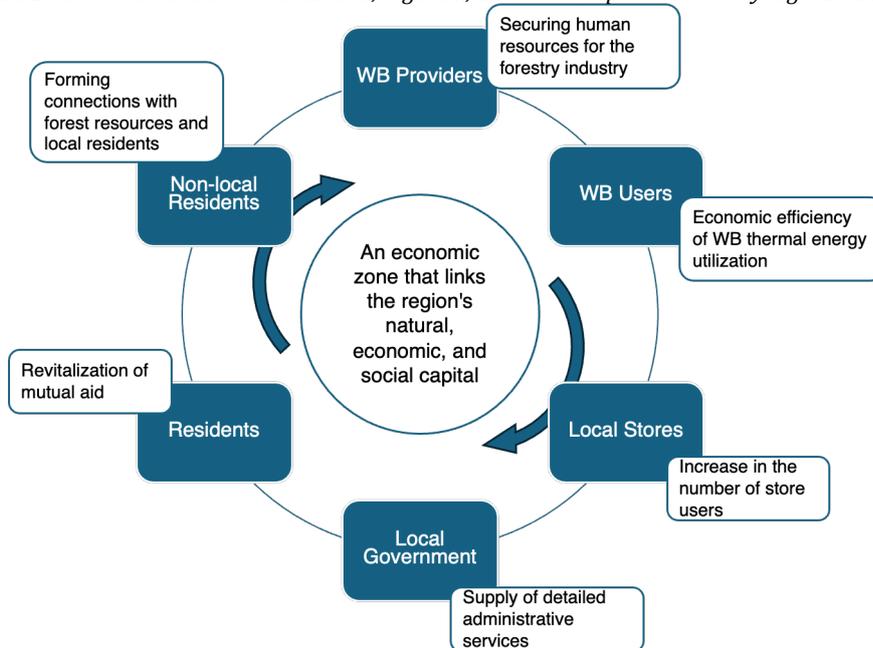
Making this digital CCS available for use by such a diverse range of entities will promote the recognition of forest products as a valuable regional resource, not just among the community involved in forest resources, but also by forming links with the local economy and other forms of social capital. Figure 2 shows the benefits each entity can

enjoy when using a digital CC. As this shows, as with the conventional Ki-no-Eki scheme, the use of this CC enables WB suppliers to secure human resources involved in local forestry. In addition, from the perspective of local stores, the supply of WB is expected to increase the number and variety of store users.

One feature of this digital CCS is that it incorporates WB thermal energy users into this scheme. This was not included in the conventional Ki-no-Eki scheme, but in Japan, relatively few households use firewood or pellet stoves, and even fewer facilities use chip boilers. By enabling participating households and facilities to use the digital CC to procure WBRs, it is expected that they will enjoy greater economic benefits from reduced reliance on kerosene or heavy oil.

Even for residents who are not directly involved in WBR use, their mutual aid activities are expected to be further enhanced by incorporating them as users of this digital CCS. Additionally, by incorporating local governments, which provide various public services within the region, as users of this scheme, it will be possible to provide more detailed administrative services aligned with CC use history. Furthermore, there are also significant benefits to incorporating non-local residents as users of the digital CC. Although non-local residents are likely to use digital CC less frequently than local residents, giving them digital CC as a token of appreciation for their donations to the region will make them more aware of the connections with the region's forest resources and residents.

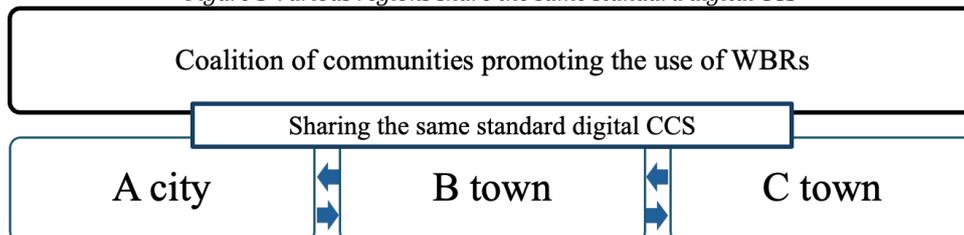
Figure 2 The connection between natural, regional, and social capital created by digital CCS



In this way, by incorporating various entities as users, this scheme can serve as a framework to connect the three types of regional resources: natural resources (forest resources), regional economic resources, and social capital.

Furthermore, by sharing digital CCS standards that leverage each region's resources, multiple regions can expect synergies in the use of WBRs (see Figure 3).

Figure 3 Various regions share the same standard digital CCS



The first benefit of having multiple communities using a common digital CCS is that it allows them to supplement the resources they lack. Not all regions have sufficient natural, economic, or social capital. Being able to procure the

capital they lack from other communities with which they have a partnership is a significant benefit of sharing the same digital CCS. The second advantage is that using a common digital CCS across multiple communities allows the development and operating costs to be shared. Unlike analog CCS, the development of digital CCS is expensive. This is one reason why many digital CCSs in Japan utilize the same digital payment systems developed by specific vendors; however, it is also one of the reasons why some regions have introduced a digital CCS that does not match the local situation.

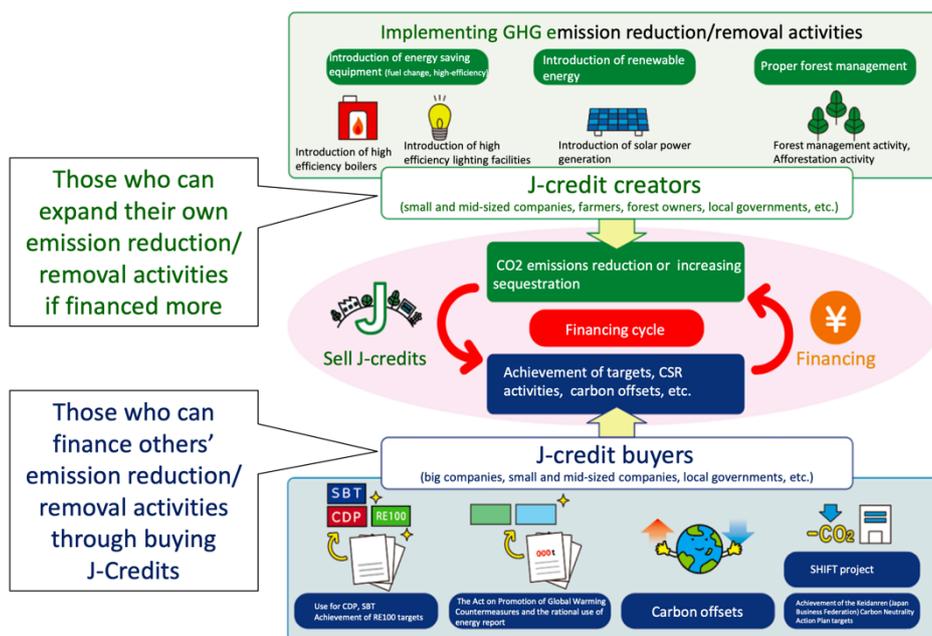
Another measure considered when planning the digital CCS centered on the use of WBRs was the method of procuring operating funds. As seen in the previous section, there is a problem of reverse spread because the selling price to vendors is lower than the purchase price of the WB, and this reverse spread is compensated for by subsidies from the local government, etc., as seen in many cases of Ki-no-Ekiiv. In addition to compensating for these backlogs, the management and operation of the digital CCS also entails costs, including server management, system updates, data management, and public relations activities. In addition, the issuing organization must be prepared to pay the cost of converting the CC received by cooperating stores into legal tender, which is usually the largest cost.

Table 2 Potential funding sources to continue issuing and operating a digital CCS

Durability	External funding methods	Features
 <p>High</p> <p>Low</p>	Carbon Credit	<ul style="list-style-type: none"> • Credits for CO₂ emission reductions using transaction history. • Currently, there are J-credits, etc
	Donation	<ul style="list-style-type: none"> • Donations from residents outside the region and support for activities such as conservation of forest resources
	Forest Environment Transfer Tax	<ul style="list-style-type: none"> • Distributed by the Government to the municipalities based on the three factors of private forest plantations, number of forestry workers, and population, prorated 55:20:25 respectively • Used for thinning, human resource development, promotion and education of timber use, etc.
	Subsidies	<ul style="list-style-type: none"> • Subsidies related to forestry support, local economic stimulation, and mutual aid • Useful in the start-up phase of the organization

We envisioned a range of funding sources beyond subsidies to cover the costs of managing and operating the proposed digital CCS model, as shown in Table 2. We first focus on the carbon credit crediting of decarbonization and procurement. In Japan, the Ministry of the Environment (MOE), Ministry of Economy, Trade, and Industry (METI), Ministry of Agriculture, Forestry, and Fisheries (MAFF), and the Forestry Agency have established the J-Credit System^v, which certifies credits for CO₂ emissions reduced through the introduction of energy-saving equipment and the use of renewable energy, as well as the amount of CO₂ absorbed through proper forest management. Under this system, companies and local governments can purchase credits for reducing their emissions of CO₂ and other greenhouse gases, and use these to offset their emissions, meet CSR targets, and achieve other goals (See Figure 4). In our digital CCS scheme, we calculate the amount of CO₂ emissions reduced by using WB, based on the transaction history of the digital CC, and sell credits based on that calculation to provide the source of funds used by local companies to convert CC to yen.

Figure 4 Outline of J-Credit scheme



Source: METI (2023)

Secondly, in our scheme, donations are positioned as a method of external fundraising. In Japan, there is a system called “Furusato Nozei” (Hometown tax donation program), which allows people to make donations to the local government of their choice and have the amount over 2,000 yen deducted from their income tax and residential tax. Using this system, donations from residents outside the region help cover the costs incurred when local stores convert the CC to yen.

Thirdly, our scheme also envisages the use of a Forest Environment Transfer Tax Systemvii. In Japan, municipalities collect a Forest Environment Tax of 1,000 yen per person per year as a national tax. The tax revenue is incorporated into the Special Account for the Distribution of National Taxes and is transferred to municipalities as a Forest Environment Transfer Tax. The transfer is apportioned according to the area of private and artificial forests, the number of forestry workers, and the population of the relevant municipality at a ratio of 55:20:25. Each municipality uses the Forest Environment Tax for forest thinning, human resource development in the forestry industry, promoting the use of timber, and educational activities. The purpose of our scheme is to promote the use of WB thermal energy. Therefore, we considered using this tax system to fund these activities.

These methods of raising external funds, such as carbon credit, donations, and Forest Environment Transfer Taxes, are not only a means of covering the operating and management costs of the digital CCS but also serve as a way of forging links with various companies, local governments, and individuals through credit purchases, donations, and the payment of Forest Environment Taxes. By visualizing the situations in which the digital CCS is maintained by various entities within and outside the region, it becomes clear that the maintenance and use of regional forest resources, including WBRs, are supported by a wide range of entities.

As with analog CCS, to ensure the sustainable circulation of digital CCS, the scheme must incorporate the principles and values that the issuing organization prioritizes. The digital CCS that we are envisioning aims to promote the utilization of WB thermal energy, as well as to promote regional economic circulation and mutual aid in society, based on the philosophy of realizing a society that can make better use of the diverse resources of the region’s natural, economic, and social relationships. The diversification of related entities and funding methods presented in this section is incorporated into the scheme from this perspective.

4 INTRODUCTION PROCESS AND SCHEME DESIGN OF THE ‘GÉNÉ’ DIGITAL CCS IN MOGAMI, YAMAGATA PREFECTURE, JAPAN

Mogami is in northeastern Yamagata Prefecture, with a population of 7,431 and 2,765 households (as of August 31, 2024). Mogami Town is promoting its policy of placing facilities utilizing WB energy and its forests, which account for approximately 84% of the town, as resources. Currently, wood-chip boilers are installed to supply heating, cooling, and hot water to general medical and welfare facilities and specific residential areas. The town declared itself a Zero Carbon City in 2021 and aims to achieve virtually zero CO2 emissions by 2050.

Figure 5 Location of Mogami, Yamagata Prefecture, Japan



Mogami Local Production for Local Consumption Energy LLC (also known as Mocchieviii) also operates a Ki-no-Eki using WBRs (currently on hiatus), a solar-powered electricity retail business, and a community development business using local resources.

Since June 2023, we have been working with the town and Mocchie to build a system for conducting experiments in digital CCS circulation. Table 3 shows the schedule for these experiments.

Table 3 Schedule for digital CCS circulation experiments in Mogami

2023.6	2023.9	2023.11	2023.12 - 2024.8	2024.9	2024.10 - 12
<ul style="list-style-type: none"> Explanation of research objectives Tour of WB utilization facilities 	<ul style="list-style-type: none"> Experiencing the use of digital CC through gaming simulation 	<ul style="list-style-type: none"> Experiencing the use of digital CC through gaming simulation 	<ul style="list-style-type: none"> Development of digital CC Development of distribution experiment design Coordination of cooperation with various organizations in Mogami Town Naming of the digital CC 	<ul style="list-style-type: none"> Briefing for residents Registration of experiment collaborators 	<ul style="list-style-type: none"> Period of circulation experiment
2025.1	2025.2	2025.3			
<ul style="list-style-type: none"> Result Analysis 	<ul style="list-style-type: none"> Explanation for residents of the analysis of distribution experiment results 				

The first action, in September 2023, was to hold a gaming simulation involving the researchers, the Mogami Town Hall staff, Mocchie's executive staff, and people from other related organizations, to share a common vision of digital CCS^{ix}. After that, in November 2023, we held a workshop to conduct a thought experiment on where digital CCS could be used in Mogami, and based on the results, we developed a digital CC and circulation experiment for digital CCS called "Géné". The name "Géné" has the following meanings: a generator that produces energy and empowers local communities, and a green gene that will be passed on to the next generation.

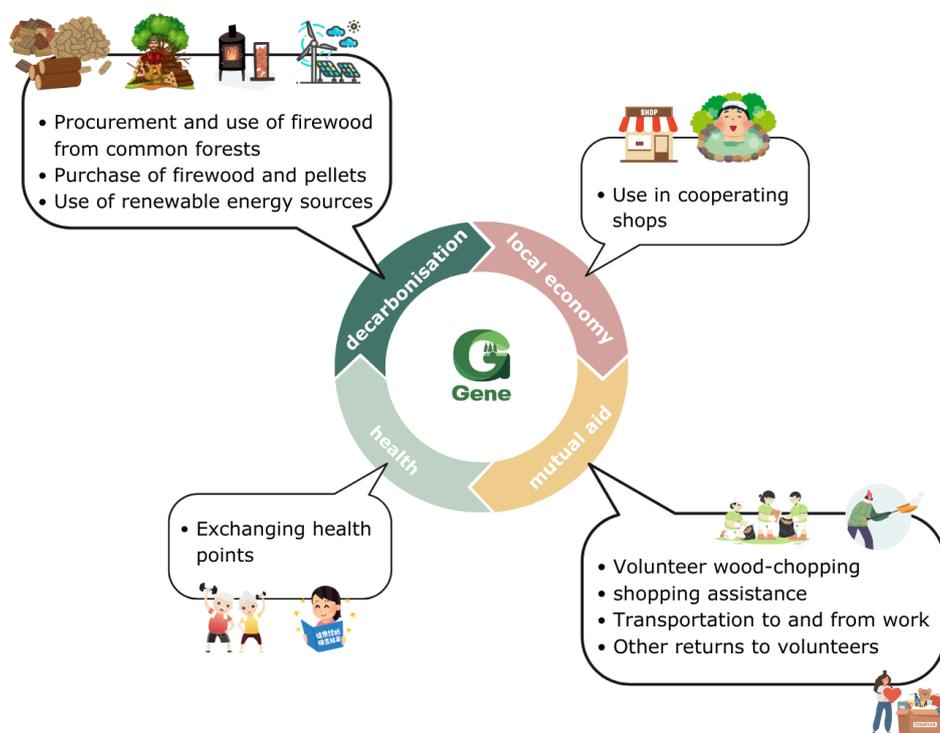
In this circulation experiment, we were unable to incorporate all the schemes we originally planned; therefore, we conducted the following experiments (see Table 4). First, we excluded non-local residents from the main users. Second, we limited the study area to Mogami only. As for the method of raising funds, we did not implement it in this circulation experiment and incorporated it only into the digital CCS to determine the impact on users if carbon credits were adopted (see Figure 7 below).

We decided to design Gén  with the promotion of activities in four areas at the heart of the scheme: the promotion of local production for local consumption of energy, such as the purchase and usage of firewood and wood pellets, and volunteering to cut logs and split firewood; the promotion of mutual aid, such as looking after children, caring for the elderly in the community, and snow removal, etc.; the promotion of local economic circulation by encouraging consumption within the community; and promoting the habit of healthy lifestyles by exchanging points gained through health activities for Genes (see Figure 6).

Table 4 Differences between the scheme conceived and the circulation experiment in Mogami

	The scheme described in Section 3	Circulation experiment in Mogami
Main users	WB providers, WB users, Local stores, Local government, Residents, non-local residents (Figure 1)	WB providers, WB users, Local stores, Local government, Residents
Areas where DCC is being introduced	Coalition of communities promoting the use of WBRs (Figure 2)	Area of one municipality that utilizes WBRs
Methods of raising funds	Carbon credit, Donation, Forest Environment Transfer Tax, Subsidies (Table 2)	Only the effects on DCC users when using carbon credits are verified.

Figure 6 The scheme of Gén 



When paying with Gén , the user scans the recipient's QR code, enters the amount of Gén  to be paid, the type of transaction, and, in the case of decarbonization, the amount of firewood or pellets to be purchased, and then makes the payment (see Figure 7). After payment, users can earn stamps depending on the type of transaction (see Figure 8). When users have collected five stamps, they can earn Gén s depending on the number of types of stamps they have collected. Specifically, the system is set up such that if users collect five stamps of one type, they receive 500

Génés; if they collect two types, they receive 700 Génés; and if they collect three types, they receive 1000 Génés. The aim of introducing this type of system is to encourage more types of transactions.

Figure 7 Payment method

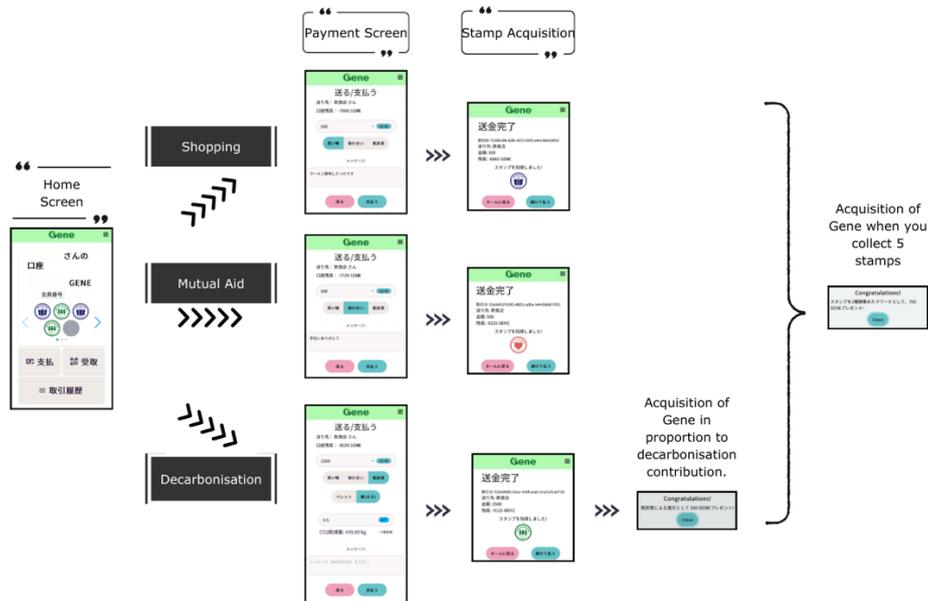
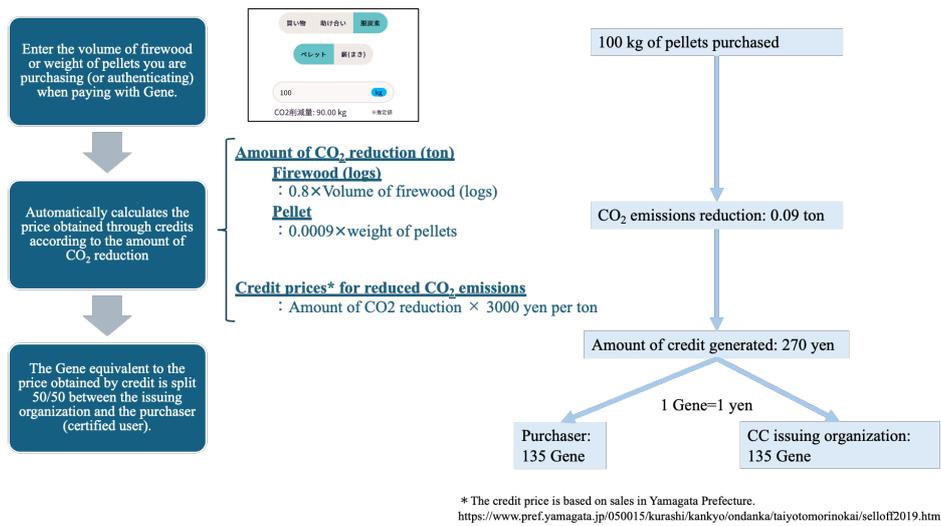


Figure 8 Three types of stamps



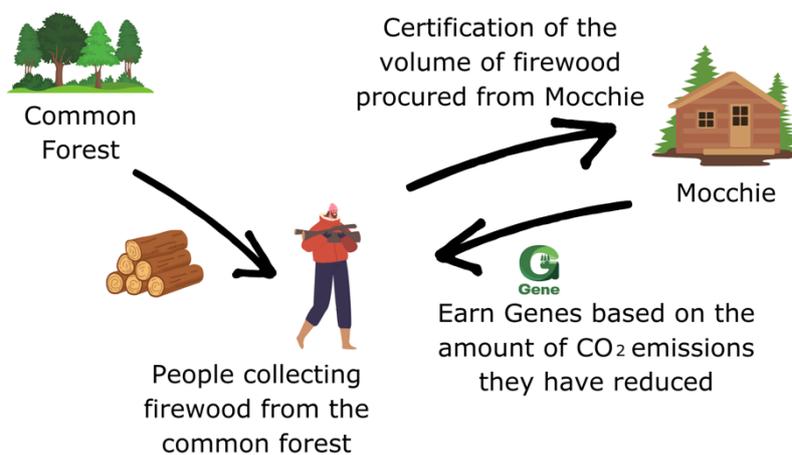
The aim of Géné is to add value to local forest resources and to use this to further promote local economies and mutual aid. To achieve this, when users purchase WBRs through Géné, the amount of CO2 emissions reduced by doing so is shown to the purchaser, and the amount of emissions reduced is converted into credits to raise funds, half of which is returned to the purchaser, whereas the other half is received by the issuing organization and used as a fund in the event that cooperating local stores need to convert Géné into yen (see Figure 9). In this experiment, the amount of CO2 emissions reduced was not actually sold as credits, but the purchaser still received the corresponding Géné, as shown in Figure 9.

Figure 9 System for providing feedback to purchasers on the decarbonization effect of using WBRs



In addition, in 2023, more than 200 households in Mogami use wood- or pellet-stoves, and most procured firewood or logs from designated locations in each village's common forest. Consequently, these people have almost no opportunity to purchase firewood, yet they are important people who can use WBRs reliably. Therefore, we introduced a system in which Mocchie certifies the volume of firewood and logs procured from the common forest by paying a fee of approximately 100 Génés; they then receive Génés corresponding to the amount of CO2 emissions reduced (see Figure 10).

Figure 10 Certification system for firewood and logs procured from common forests



5 FUTURE WORKS: PLAN FOR FULL-SCALE DISTRIBUTION IN MOGAMI

To examine the effects of the digital CCS design, this study focuses on three aspects: digital CC trading behavior, changes in user awareness, and the usability of digital CCS. In analyzing the trading behavior of digital CC, we will first focus on the structure of the trading relationships among all users. Specifically, we will identify the roles of the four areas in the design of Géné (see Figure 6) within the currency's overall circulation network and identify the key entities within it. In addition, we will conduct a questionnaire survey of users before and after the circulation experiment to consider the kinds of changes in awareness that occurred as a result of using Géné, and the causes of these changes. We will then examine Géné's usability through questionnaire surveys and interviews, and clarify issues such as its interface and circulation channels.

We have a plan to conduct multiple distribution trials before full-scale distribution. The primary objective of this distribution trial was to gather feedback from residents on the usability of the Gén  we designed. Over approximately 100 days from October 2024 to January 2025, 43 residents, 9 stores, and 2 organizations registered to participate in the experiment. Of these, 21 residents, 7 stores, and 1 organization actually used the service. Gene's total number of transactions was 164 (transaction amount: 59,876 G n ), of which 69 (27,986 G n ) were related to the regional economy, 95 (31,890 G n ) were classified as mutual aid, and none were related to decarbonization. The primary reason no decarbonization transactions occurred was that firewood and other materials for the current period had already been procured before the experimental period, making it inappropriate to purchase them. While the objective this time was to gather opinions on G n  usage, it became clear that organizational design is necessary to promote WBR utilization under the scheme we designed. The results of this experiment have been shared with the residents of Mogami, and we plan to continue discussions with the residents, the municipality, Mochie, and others on the future development of G n .

Moving forward, as we conduct circulation experiments, we must advance the development of a viable digital CCS while addressing the following challenges:

1. Improving the usability of the application.
Japan has a high aging rate, and in local communities, especially, many residents who benefit from the local economy and mutual support are elderly. Therefore, it is necessary to enhance the convenience of applications so that residents of various ages can use them.
2. Validating of funding acquisition methods to reduce development and operational costs for digital CC.
It is necessary to examine, from various perspectives, the challenges and solutions involved in implementing the funding method proposed in this paper.
3. Verification of management structure for utilizing the value of forest resources in regional economies and societies.

In this experiment, no examples of WBR utilization were observed. However, at the results briefing held on March 10, 2025, residents who use WBR for thermal energy expressed strong praise for G n 's concept. The challenge lies in establishing the organizational structure necessary to operate the digital CCS in a way that enables the value of forest resources to be utilized within the local economy and society. It will be essential to examine, through future distribution experiments, what kind of members are required for this purpose.

NOTES

ⁱ According to MOE (2012), the utilization of thermal energy from wood-based residuals (WBRs) involves the health and atmospheric environmental impacts of exhaust gases generated during wood biomass combustion. These exhaust gases contain harmful components such as carbon monoxide, volatile organic compounds, polycyclic aromatic hydrocarbons, particulate matter, and other harmful components. Furthermore, when inappropriate fuels are used, nitrogen oxides, sulfur oxides, dioxins, and other substances may be generated, potentially causing health impacts. Therefore, recognizing the need to establish exhaust gas control, equipment and fuel standards, installation criteria, etc., MOE created the "Environmental Guidelines for the Promotion of Wood Biomass Stoves" in 2012. For details, refer to MOE (2021).

ⁱⁱ According to Biomass Industrial Social Network (2024), of the 14.418 million bone dry tons of woody biomass used as energy in 2022, wood chips accounted for 10.621 million bone dry tons, wood pellets for 2.290 million bone dry tons, and firewood for 0.047 million bone dry tons.

ⁱⁱⁱ Seyfang and Longhurst (2013), who systematically analyzed various CCS cases, point out that, across multiple cases introducing CCSs, those that focused primarily on social inclusion and economic regional circulation have been numerous, while those that focused mainly on environmental objectives have been few. Furthermore, through a systematic review of papers on CCS, Michel and Hudon (2015) demonstrate that CCS strengthens social capital, such as trust and solidarity. While their economic impact is limited, they demonstrate effectiveness in providing workers with fair recognition and in supporting livelihoods. On the other hand, they also highlight minor environmental benefits, such as promoting local consumption and revitalizing recycling. Kobayashi, Miyazaki, and Yoshida (2000), who investigated various cases in Japan, also reported that a certain number of CCs aimed at environmental protection and resource recycling have been issued.

As these cases demonstrate, CCS has been widely reported to yield significant effects on regional economies, social solidarity, and social inclusion. While its environmental sustainability effects—such as recycling and local consumption—have not been verified, cases have been reported. The concept presented in this paper aims to link the decarbonization effects generated by utilizing regional forest resources to activities that foster regional economic circulation, the formation of human networks, and, through these, social solidarity and inclusion.

^{iv} As Izumi and Nakazato (2021) indicate, in the case of Ina City, thinned timber is sold for approximately ¥3,000 per ton, while

volunteers are paid about ¥6,000 per ton in community currency.

^v For details, see METI (2023).

^{vi} For details, see MIC (2015).

^{vii} For details, see MAFF (2019).

^{viii} *Mocchie* is an abbreviation of *Mogami Chisan-Chisho (Local Production for Local Consumption) Energy LLC*.

^{ix} For details of the method, see *Yoshida and Kobayashi (2018)* and *Yoshida and Toyota (2024)*.

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