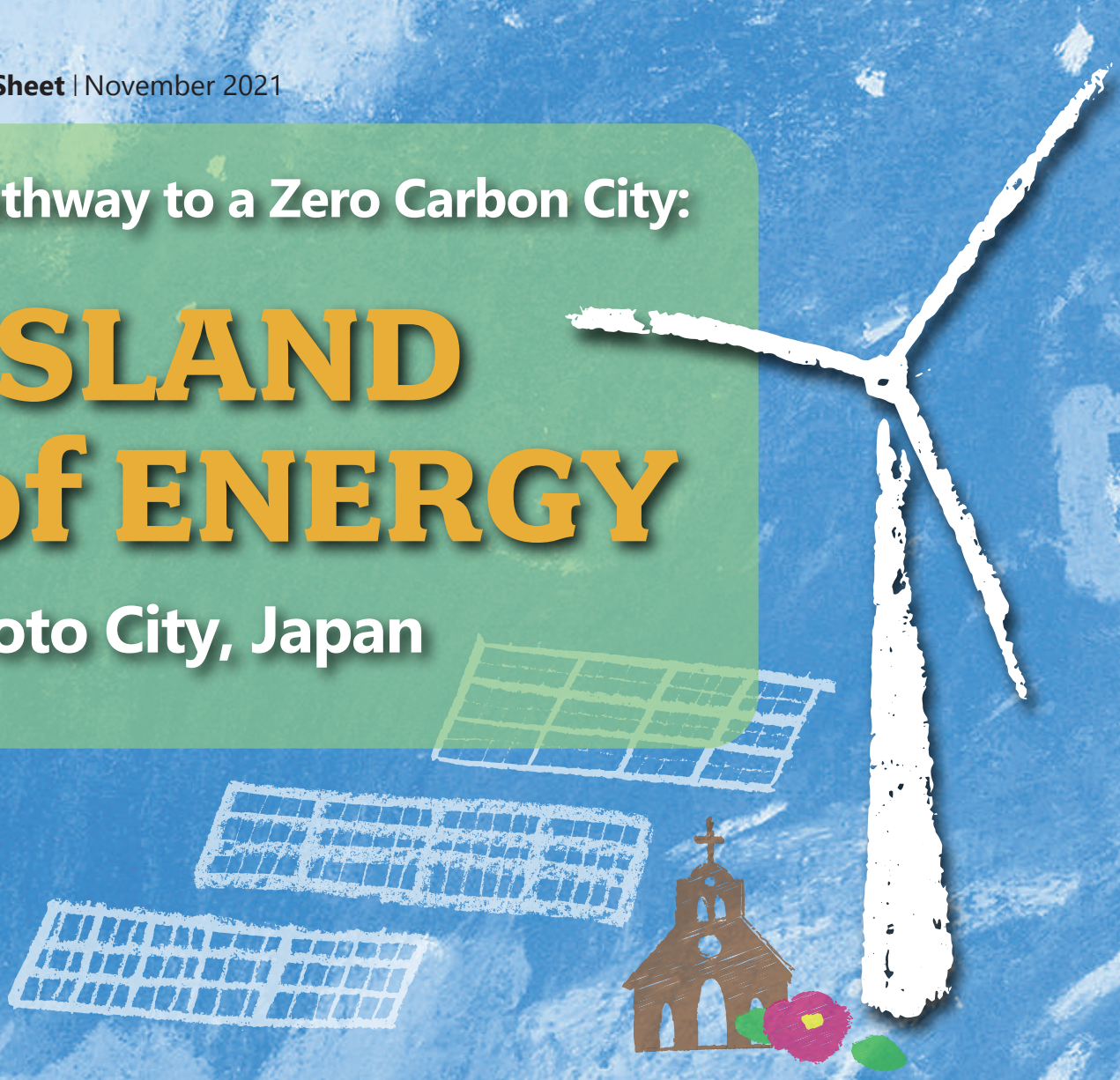
Pathway to a Zero Carbon City:

ISLAND of ENERGY

Goto City, Japan



Main Messages

▼In Japan, over 460 municipalities, so-called "Zero Carbon Cities" along with the national government have committed to reduce carbon dioxide emissions to net zero by 2050. It aims to create " domino effect" , in which the best performing Zero Carbon Cities knock down other municipalities to turn the whole country to be carbon neutral. Goto City, a Zero Carbon City in Nagasaki Prefecture could be one of the initiators of domino effect.

▼Goto City, a remote island municipality in Kyushu region, southwest of Japan, has been advancing its vision of "Island of Energy" by increasing its renewable energy supply ratio over electricity demand in the city to 56% (as of 2020), which is outstanding achievement where the national average renewable supply ratio is about 20%.

▼Goto City has been a pioneering site of the floating offshore wind power generation and a notable case of fruitful multi-stakeholder cooperation including fishery. The city has created unique stakeholders engagement systems, involving local community to maximize benefits for the local area.

Fedor Myasoedov | Intern at IGES, Kitakyushu Urban Centre (April to October 2021);
PhD Student, Graduate School of Advanced Integrated Studies in Human Survivability (GSAIS), Kyoto University,
myasoedov.fedor.62r@st.kyoto-u.ac.jp

Junko Ota | Policy Researcher at IGES, Kitakyushu Urban Centre
j-ota@iges.or.jp

IGES Institute for Global Environmental Strategies

1. City Profile

1.1. Background

Goto City in Nagasaki Prefecture encompass 11 inhabited and 52 uninhabited islands on the southern half of the Goto Archipelago, approximately 100km off the west coast of Kyushu, Japan (Figure 1). Goto has population of 36,443 (as of June 2020) with the majority residing on the main island of Fukue.

The economy is comprised mainly of agriculture, livestock (cattle), fishing, construction and third sector industries (including tourism and retail). The area attracts visitors due to its lush nature, beautiful beaches and UNESCO World Heritage Hidden Christian Sites in the Nagasaki Region.

The major challenge for the city is its ageing and decreasing population coupled with associated economic decline. The population has been falling steadily from its peak in 1955 (91,973 people) and is projected to drop further to 20,000 by 2050 (Figure 2). To counteract this trend, Goto City has been proactively developing various initiatives towards revitalisation.

Favourable natural conditions and the open-minded enthusiasm of the former mayor led Goto to host a pilot project for Japan's first floating-type offshore wind power generation.

With its vision of "Island of Energy", the city is aiming for island-wide carbon neutrality, and eventually wants to export renewable energy beyond city boundaries, while at the same time, realising benefits for the local economy, society and environment.

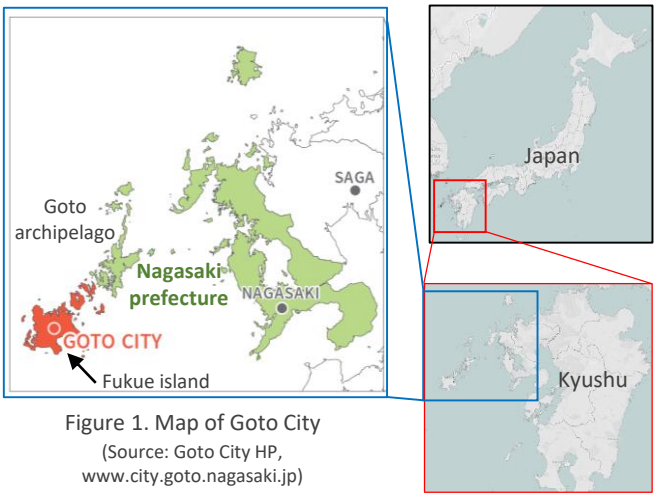


Figure 1. Map of Goto City
(Source: Goto City HP, www.city.goto.nagasaki.jp)

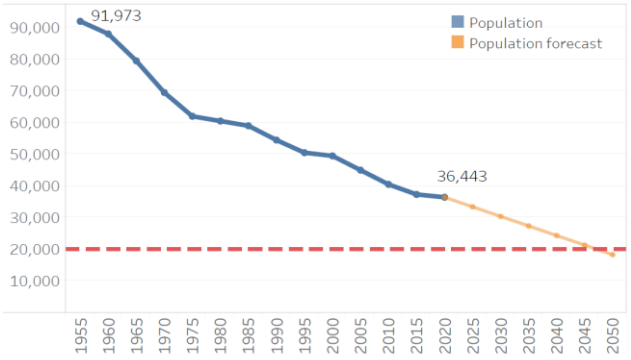


Figure 2. Population transition of Goto City
(1955-2020: actual, 2020-2050: forecast)
(Source: Created by authors based on Goto City Profile Book 2021[1])

1.2. Climate related policy plans

I) Renewable Energy Basic Plan[2]

The Renewable Energy Basic Plan of Goto City was formulated in 2014, in alignment with energy strategies set out by both the Government of Japan[3] and Nagasaki Prefecture[4]. The plan firmly set the direction on advancing renewable energy (RE) production. In particular, the assessment of potential RE types identified floating offshore wind power and tidal power as the most promising type for Goto City to develop[5].

The plan promotes the "Island of Energy" vision that depicts building an independent and decentralised energy society, yielding a variety of co-benefits for the region.

Specific targets include achieving an RE self-sufficiency ratio[6] of 62.7% by 2022 and 132.4% by 2030, thus becoming an exporter of clean energy (Figure 3).

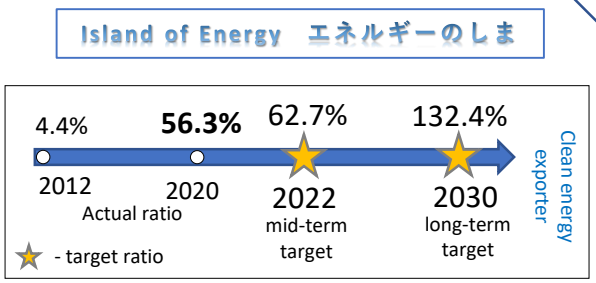


Figure 3. Renewable energy self-sufficiency ratio of Goto City
(Source: Created by authors from Renewable Energy Basic Plan of Goto City, 2014)

Expected co-benefits

- Creating new jobs and business in local industries
- Mitigating population decline, attracting new settlers
- Acquiring new sources of tax revenue from RE operations
- Increasing resilience and local autonomy
- Producing & consuming clean energy locally
- Reducing CO_2 emissions

II) Climate and Energy Action Plan[7]

As one of Japan's first signatories to the Global Covenant of Mayors for Climate and Energy[8] in 2018, Goto City pledged to contribute to the Paris Agreement with local actions.

In July 2020, the city formulated the "Climate and Energy Action Plan" including an inventory of CO_2 emissions and measures for climate mitigation and adaptation.

CO_2 emissions in the city declined steadily since 2013 (base year) to 2018, resulting in a total reduction of 21% (Figure 4).

The city set its 2030 mid-term CO_2 reduction target at 33% compared to 2013 levels, which exceeded the national target at the time (Figure 5).

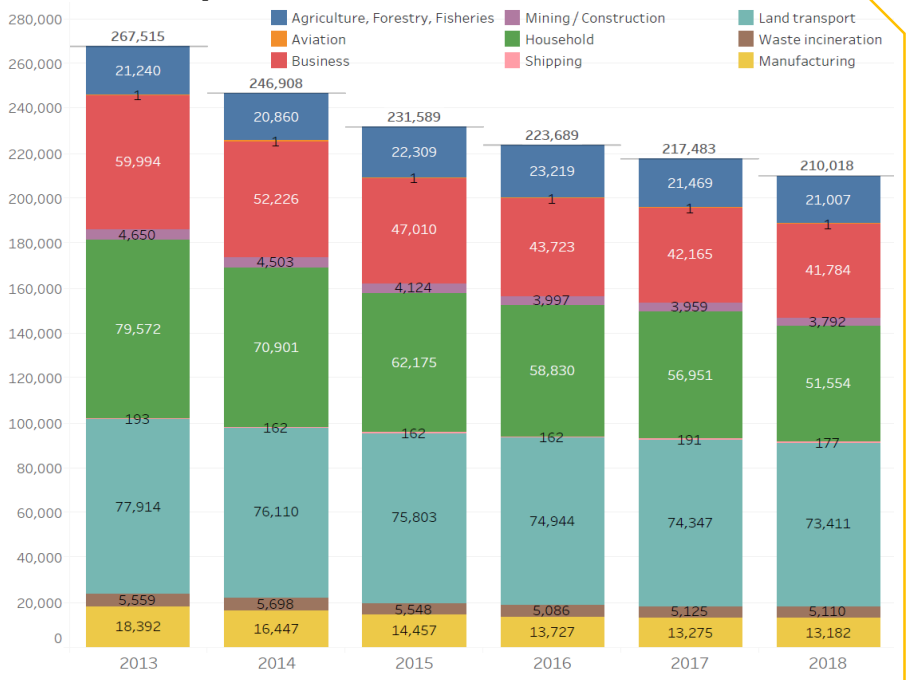


Figure 4. CO_2 emissions by sector in Goto City (2013-2018)

(Source: Graph created by authors from Renewable Energy Basic Plan of Goto City, 2014)

III) Declaration of Zero Carbon City by 2050

In December 2020, Goto City declared its commitment as a Zero Carbon City to achieve net-zero[9] CO_2 emissions by 2050[10]. Such announcements by municipalities are promoted and registered under the Zero Carbon City framework by the Ministry of the Environment, Japan (MOEJ).

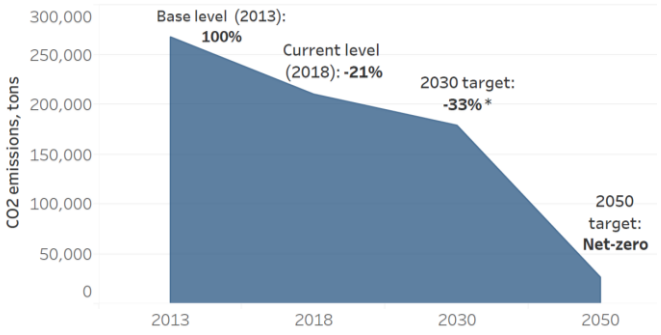


Figure 5. Reduction targets of CO_2 emissions of Goto City

(Source: Graph created by the authors from Climate and Energy Action Plan of Goto City, 2020)

*Currently Goto City is carrying out a series of discussions with the city's stakeholders to raise the 2030 mid-term target[12].

環境省 Ministry of the Environment

2050年 二酸化炭素排出実質ゼロ表明 自治体

Announcement by municipalities on net-zero CO_2 emissions by 2050 "Zero Carbon Cities"

This national framework for Zero Carbon City encourages municipalities (prefectures, cities, towns, villages) to commit to net-zero CO_2 emissions by 2050. As of September 2021, the number of Zero Carbon Cities reached 464[10]. In addition, the Roadmap for Decarbonization of All Local Governments by 2050, was developed to catalyse a *decarbonization domino effect*[11] across all municipalities in Japan by initiating 100 model decarbonised regions by 2030. Further, the Japan's Act on Promotion of Global Warming Countermeasures was revised in May 2021, which added the legal statement of carbon neutrality by 2050.

2. Distinctive Initiatives toward a Zero Carbon City

2.1. Framework for stakeholder engagement and capacity building in Goto City

To facilitate dialogue and nurture knowledge in the new field of RE, Goto City created multi-stakeholder engagement platforms for industry, academia, government and citizens (Figure 6)[13]. In addition, the city worked to raise awareness and strengthen civic pride to realise its "Island of Energy" vision. Since the city's energy strategy has been focusing on the development of cutting-edge marine RE (e.g. floating offshore wind power and tidal power), it was particularly important to foster understanding between locals that depend on the sea for their livelihoods (e.g. fishermen), and other related stakeholders such as energy companies, developers, etc.[13]

These stakeholder engagement and capacity building platforms have not only created a productive base for further expansion of floating offshore wind power, but have also given rise to new initiatives, such as the creation of the local energy company (*see section 2.2*).

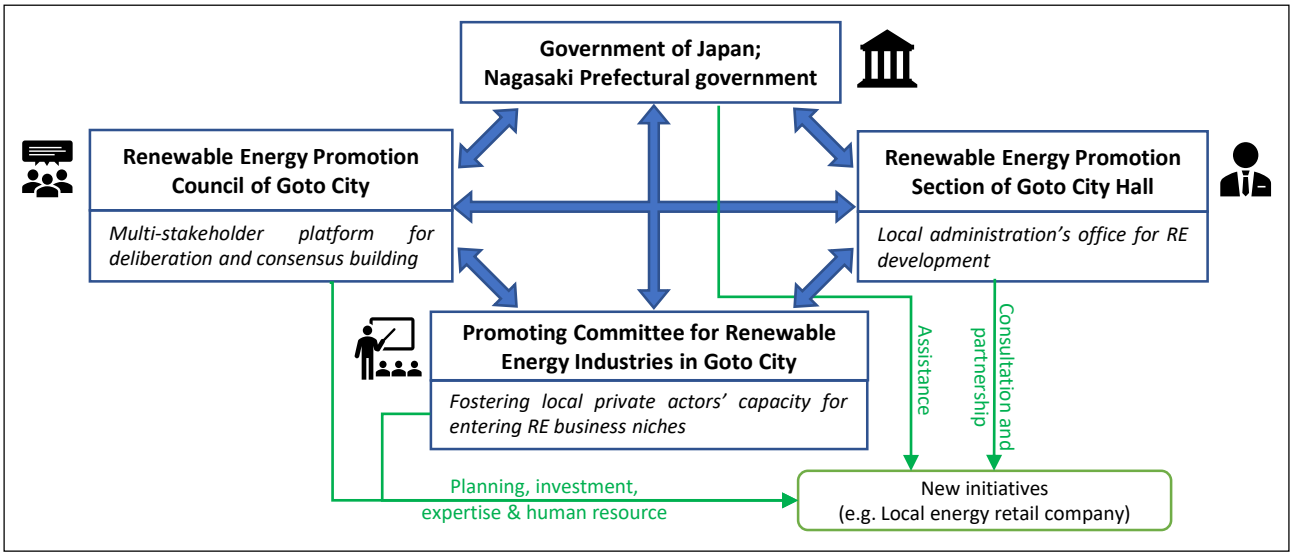


Figure 6. Stakeholder cooperation framework for the development of RE in Goto City.
Source: Created by authors based on "Renewable Energy Basic Plan of Goto City, 2014" and personal communication with Goto City Renewable Energy Promotion Office, on 24 June, 2021

Renewable Energy Promotion Council of Goto City

Established in January 2014, the council comprises 29 organisations including representatives from industry (e.g. fishery and agriculture associations, energy businesses), academia (Nagasaki University, Kyushu University), government (national, prefectural, and city), and community groups.

It is chaired by the head of the Chamber of Commerce of Fukue island, with the Fukue Fishery Cooperative director and the Mayor of Goto City as vice-chairs[14].

The aim of the council is to promote renewable energy in the city through building consensus and realising co-benefits among different stakeholders.

It is notable that the city government does not steer the council in a top-down manner, rather it facilitates horizontal and multilateral dialogue among stakeholders[12].

Promoting Committee for Renewable Energy Industries in Goto City

Established in June 2015, the committee comprises 26 local business members aiming to discuss and study new business potentials related to renewable energy (especially offshore wind and tidal power).

Making use of such new businesses will result in the city's socio-economic revitalisation. Thus, it is vital to provide local private stakeholders with opportunities for learning, awareness-raising, business matching and other capacity-building activities.

The committee investigated the potential for new business opportunities such as manufacturing of the concrete structures for offshore wind power facilities, maintenance and monitoring of wind turbines, and creation of local energy retail company[12][15].

Renewable Energy Promotion Section Goto City Hall

A new section was established in April 2014 in the city hall to promote renewable energy. The section aims to coordinate with the national and prefectural governments as well as local stakeholders related to renewable energy.

Offshore wind power operations often involve issues that cannot be handled only by the local government. For example, permission of utilisation of sea area requires consultation with the national government. Increasing the capacity of underwater cable to transmit the electricity between the mainland of Nagasaki Prefecture and Goto islands necessarily involves the prefectural government.

The number and complexity of renewable energy projects are growing. Lack of human resources and insufficient technical expertise of local staff are typical challenges in Japanese municipalities, including Goto City[12].

2.2. Local Energy Retail Company: Goto Citizens' Electric Power

Goto Shimin Denryoku (Goto Citizens' Electric Power) is a local energy retail business established in 2018 in Goto City, after Japan's electric power market was fully liberalized[16]. The company buys electricity, mainly from locally-generated renewable energy, and sells it to consumers in the Kyushu region, thereby generating and circulating profit within the region (Figure 7).

The idea of establishing this company arose from the city's stakeholder engagement platforms (*see section 2.1*). Members of the Renewable Energy Promotion Council of Goto City, and the Promoting Committee for Renewable Energy Industries in Goto City jointly applied for a subsidy from the Ministry of Agriculture, Forestry and Fisheries[17], and conducted a feasibility study between 2016 and 2018 on a new business model for a local electric power company[18]. As a result, Goto Citizens' Electric Power was launched in May 2018 with joint capital from 52 private entities and individuals. The company contrived a unique win-win partnership with the city government and local business sectors, including the utilisation of existing service agents as '*toritsugi-ten*' to serve as intermediaries for customer sales[18].

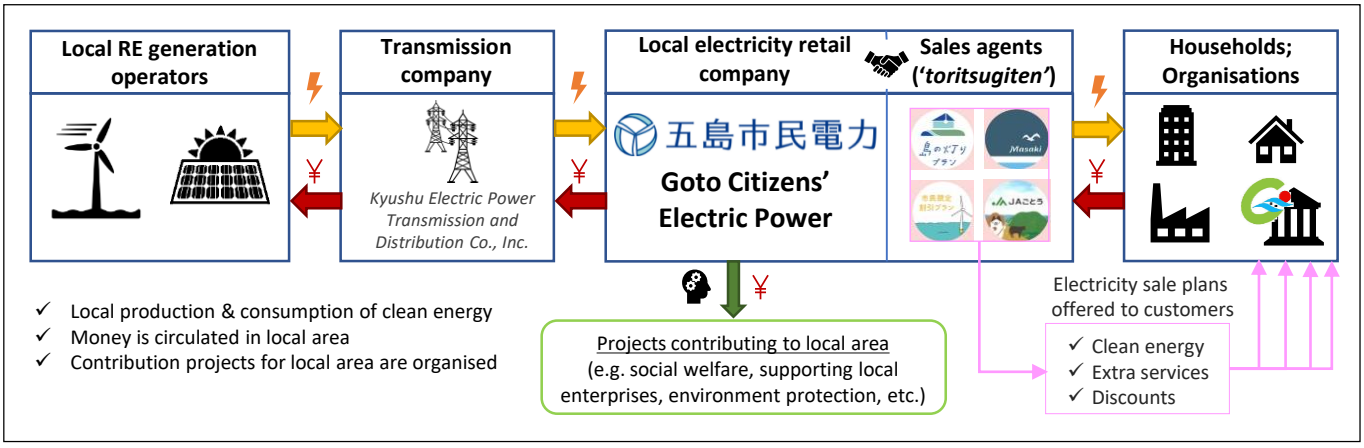


Figure 7. Business model for Goto Citizens' Electric Power

Source: Created by authors based on company's HP (www.510power.com) and personal communication with the company's director on 24 June, 2021;

Mutual benefits to the energy company, the city and local community

Goto Citizens' Electric Power and the city government came to an agreement on electricity supply and purchase for the majority of public facilities in the city. This brings co-benefits: the company gains business stability and predictability, while the city benefits from the company's social programmes for the local community .

Such programmes include the preservation of Goto's renowned "*tsubaki*", camellia flower groves, and subsidised travel (e.g. ferry fare) for school students to participate in sports and culture activities outside the city[19].

"Tsubaki" flower

Source: Goto City HP

Business model with locally existing sales agents '*toritsugi-ten*'

Goto Citizens' Electric Power utilises the existing local service-sector businesses and agricultural cooperative as sales agents that serve as intermediaries for electricity contract transactions with consumers. This business model generates co-benefits including:

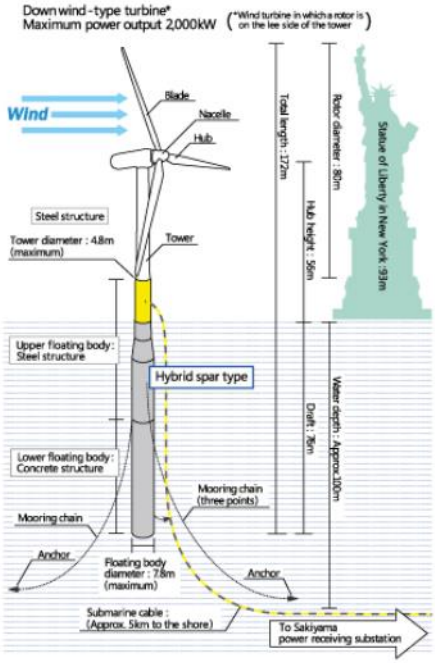
- Goto Citizens' Electric Power can benefit from acquiring extensive client networks and sales expertise by outsourcing the sales tasks to local agents, while saving the cost of hiring its own sales staff and opening new shops.
- Local '*toritsugi-ten*' shops can benefit from expanding their business items to electricity handling. They can operate the service under the license of electricity handling held by Goto Citizens' Electric Power.
- Customers can benefit from having a choice of various electricity plans, which include social and environmental returns in the community, and assurance of 100% renewable energy generated in Goto City.
- Goto City can benefit from the promotion of locally generated and consumed renewable energy through local business agents, which retains both flows of economy and renewable energy within the region.

(Source: Based on Goto Citizen's Energy HP (www.510power.com); Personal communication with the company's director, on 24 June, 2021)

2.3. Floating offshore wind power development

Photo 1. Floating offshore wind turbine in Goto City ('Haenkaze'). Taken by authors on 24 June, 2021

2.3.1. Background



Although Japan has huge potential for harnessing offshore wind energy, its coastal waters are primarily too deep (i.e. over 50m) for installing the 'fixed type' turbine[20][21]. A large part of this potential is in ocean depths between 50 and 200 meters, making the 'floating type' turbine — not fixing the main pillar on the seabed (Figure 8) — particularly promising[20][21]. The Strategic Energy Plan[3] and Japan's Revitalization Strategy[22] envisioned the creation of offshore wind industry in Japan, including the floating type turbine.

Goto City was chosen as the location for the first pilot project of Floating Offshore Wind Turbine (FOWT) in Japan due to the suitability of its natural conditions[23], the availability of transmission infrastructure[24], and also thanks to the former mayor's enthusiasm[12][21]. The project was implemented by a consortium led by the construction company Toda Corporation, along with universities, manufacturers, developers, etc. with funding from MOEJ between 2010 to 2015[25]. The project envisaged the manufacture, installation, grid-connection and pilot operation of the 2MW hybrid spar-type [26] FOWT, including the half-scale model (100kW) prior to installation of the full-size model[21].

Figure 8. Floating type offshore wind turbine in Goto City (Source: Toda Corporation, https://haenkaze.com/en/)

2.3.2. Demonstration project (2010-2015)

The small-scale 100kW pre-model was installed in 2012, becoming the first grid-connected FOWT in Japan[21][25]. Shortly after the installation, a severe category-5 typhoon swept through the region damaging infrastructure on land, but virtually no damage was inflicted on the FOWT, thereby demonstrating its physical durability in extreme weather conditions, which was the major concern in Japan[21].

Subsequently, a full-scale model, known as '*Haenkaze*', featuring a 2MW HITACHI turbine[27] , was installed, connected to grid and began its first pilot commercial operation in 2013. After two years of testing and monitoring, the pilot stage was successfully concluded with no significant trouble, proclaiming the technology suitable for further scaling up and commercial use[21].

After the completion of the pilot project, the *Haenkaze* facility remained in Goto City, and was stepped up to be the first fully commercial FOWT in Japan[21][25]. At its maximum power output, the wind turbine can supply electricity to about 1,800 households[25].

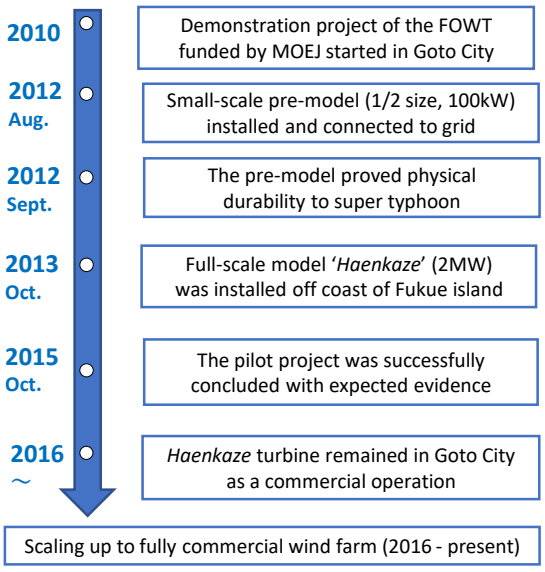


Figure 9. Timeline of *Haenkaze* FOWT project

2.3.3. Scaling up to a fully commercialised offshore wind farm (Present)

Following the success of the first FOWT demonstration, the city is now hosting a full commercial offshore wind farm project developed by a consortium led by Toda Corporation. The project is underway to install eight new FOWTs with similar specifications (2MW) to *Haenkaze*[12]. The new FOWTs are currently under construction using a special submerged boat called the 'Float Raiser' to carry parts to the construction sites (Photo 2).

When this project is completed, a total of nine FOWTs will be operated in Goto City, which is estimated to reduce CO_2 emissions by about 8% from 2013 levels[7] and to increase the city's renewable energy self-sufficiency ratio to approximately 80%[12]. In addition, the project is expected to benefit the local area with new jobs in the manufacturing sector[29], as well as for the assembly, maintenance and monitoring of the FOWT facilities[12].

Photo 2. A special boat for offshore wind farm construction, 'Float Raiser' carries FOWT parts to the installation sites off the coast of Fukue Island, Goto City.

Taken by authors on June 24, 2021

2.3.4. Benefits and concerns of local community

The benefits of local renewable energy generation include direct effects such as an increase in clean energy, reduction of CO_2 emissions, and additional tax revenue for the local government, as well as indirect effects such as creation of new businesses and employment, cleaner impression of the host city, awareness-raising for the environment and others. Although these benefits are laudable, local communities often have concerns about the risks of negative impacts from the facility on their quality of life (e.g. noise), deterioration of the local environment, encroachment by new people (e.g. new industry, visitors), loss of fishing areas in ocean, etc.

Local fishery associations may oppose the development of offshore wind power operations, especially when the pilot project is then scaled up to larger wind farms, with concerns on the possible decrease in the fishing area and catch, and unknown environmental impacts on the marine ecosystem[12].

Opposition to large infrastructure projects (e.g. airports, dams, nuclear power plants) has a long and tumultuous history in many countries, including Japan, with fierce protests, practices of land expropriation by the state, legal disputes and so forth. Such opposition has resulted in additional costs for developers, significant delays and even total abandonment of plans[30]. Thus, it is indispensable to foster a harmonious relationship that involves the city, its local community and developers in a win-win fashion, by carefully considering the needs and concerns of different stakeholders, particularly in offshore wind power development.

City government plans[2][13] mentioned the importance of involving local stakeholders, and ministry guidelines[15] outline the necessary measures for engaging stakeholders and building consensus with the local community when planning for wind power development. These include the creation of new multi-stakeholder platforms (see section 2.1), information dissemination, conducting explanatory and opinion-exchange sessions[2][13][15].

In addition to community involvement, a multi-faceted environmental assessment should be carried out, including assessing the impact on wildlife habitat (birds, fish, seaweed/corals), as well as on the visual attractiveness of the landscape[15]. Furthermore, any plans should be aligned with all other relevant legislation and policies effective in the area (e.g. World Heritage Candidate Assets, Important Marine Bird and Biodiversity Areas, existing freight and ferry routes, and so forth)[15]. By conducting such work and establishing relevant mechanisms, Goto City became a pioneering case in the development of floating offshore wind farm in Japan. Goto City serves as a good showcase for other municipalities, private companies and other stakeholders from Japan and abroad who are interested in learning about best practices of offshore wind power operation.

2.3.5. Co-existence with marine ecosystem

One of the most remarkable scientific observations from the *Haenkaze* FOWT was the positive impact on the marine environment. The lower structure consisting of a floating pillar submersed underwater turned out to be an excellent environment for marine microorganisms to use for nesting (Photo 3). Marine plants, algae and small organisms are attracted to the lower structure, which then forms a rich environment for larger fish, thereby fostering a food chain[31][32].

Underwater monitoring was conducted by the Marine Renewable Energy and Fisheries[33] together with local fishermen, and it was revealed that fishing in the vicinity of the FOWT yielded a bigger catch compared to areas with artificial reefs and natural reefs (Photo 4)[31].

Degradation of the marine forest environment is a serious problem in Japan (e.g. bleaching of corals and seaweed). This unexpected benefit of FOWT could play a positive role in revitalising both the marine environment and fishermen's livelihoods[32].

The Marine Renewable Energy and Fisheries is further investigating the optimum design for an artificial reef that could be integrated with FOWT to create a stable environment for increasing seaweed seedlings in the future (Figure 10)[32]. Importantly, this type of design requires multiple perspectives from all users of the sea, scientists, marine experts, developers and other stakeholders, and uniting them to establish common values.

Such considerations must be taken into account when trying to win the hearts of hesitant local communities and gain their support for the development of FOWT in their area. Fishery associations may initially voice their objections against FOWT development. However, after learning about actual positive impacts and benefits for the local environment and people, they may change their opinion[31]. Nonetheless, further research is required to fully assess all the various impacts and conditions.

During the pilot operation, people with different interests met many times to exchange views and accommodate each others' needs and concerns in the local community. Goto City is now a showcase for outstanding practices of cooperation among stakeholders as well as exhibiting a harmonious relationship between the FOWT and the marine environment. Various study tours have been organised by local tourist agencies, and visitors are increasingly learning about the potential of FOWT for local revitalisation[34]. Goto City will definitely be the start of the decarbonisation domino effect across other regions in Japan and even overseas.

Photo 3. Lower pillar of FOWT attracting marine organisms

(Source: Shibuya Masanobu, SDI Shibuya Diving Industry Group. www.shibuya-diving.co.jp/)

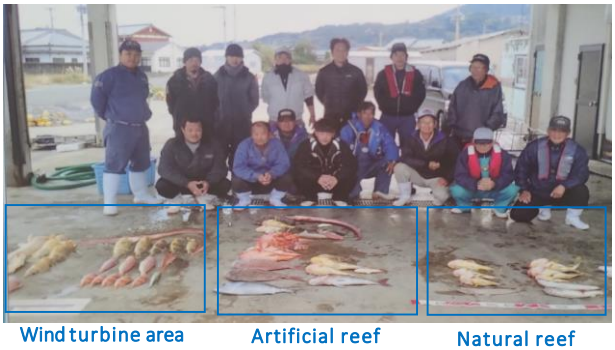


Photo 4. Fish catch in three different sea areas (FOWT, artificial reef, natural reef) from the experiment by Marine Renewable Energy and Fisheries and local fishermen

(Source: Shibuya M. (2021). 地域や漁業と共存共栄する洋上風力発電づくり. Longsellers publishing.)

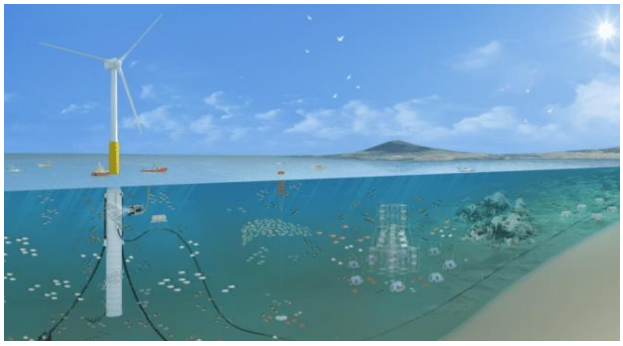


Figure 10. Visionary design of FOWT that co-exists and co-prospers with fishery

(Source: Shibuya Masanobu, SDI Shibuya Diving Industry Group. http://www.shibuya-diving.co.jp/publics/index/35/)

Notes and References

1. Goto City (2021), City's HP: Goto City Profile Book 2021
   https://www.city.goto.nagasaki.jp/s014/020/020/020/2021/20190912101403.html
2. Goto City (2014), Renewable Energy Basic Plan of Goto City (五島市再生可能エネルギー基本構想)
   https://www.city.goto.nagasaki.jp/energy/010/010/20190118212254.html
3. Japan's 4th Strategic Energy Plan (Apr. 2014) emphasised that the "introduction of offshore wind power is indispensable for Japan where the potential of onshore wind power is limited". In addition, it called for the full commercialisation of floating offshore wind power technology by 2018.
   (Government of Japan (Apr. 2014), Strategic Energy Plan, p.43
   https://www.enecho.meti.go.jp/en/category/others/basic_plan/pdf/4th_strategic_energy_plan.pdf)
4. Nagasaki Prefecture's Energy Plan envisioned an increase in RE production from 6% (as of 2013) to 25% by 2030 and emphasises the region's unique potential for marine energy (offshore wind power and tidal power) development
   (Nagasaki prefecture (Jun. 2019), Renewable Energy Introduction Promotion Vision of Nagasaki Prefecture (長崎県再生可能エネルギー導入促進ビジョン), p.18
   https://www.pref.nagasaki.jp/bunrui/kurashi-kankyo/kankyohozen-ondankataisaku/saiseiene/saienevision/)
5. In the plan, potential generation in Goto City was estimated at 3,706,800 MWh/year for floating offshore wind, and 917,700 MWh/year for tidal energy.
   (Goto City (2014), Renewable Energy Basic Plan of Goto City, p.44)
6. RE self-sufficiency is defined as the proportion of annual RE production in the city over annual electricity consumption in the city.
   (Goto City Hall, Renewable Energy Promotion Section, Section chief, personal communication on October 14, 2021)
7. Goto City (2020), Climate and Energy Action Plan of Goto City (五島市気候エネルギー行動計画)
   https://www.city.goto.nagasaki.jp/energy/010/040/20200917144118.html
8. Global Covenant of Mayors for Climate and Energy (GCoM) is a global coalition of city leaders addressing climate change by pledging to cut GHG emissions and prepare for the future impacts of climate change. The coalition's regional branch (CoM Japan) was set up in Japan in August 2018.
   https://covenantofmayors-japan.jp/
9. Achieving equilibrium between anthropogenic GHG emissions from sources and removals by sinks, such as forests.
10. Ministry of the Environment, Japan web page on '2050 Zero Carbon Cities in Japan' (Access Aug. 2021)
    http://www.env.go.jp/en/earth/cc/2050_zero_carbon_cities_in_japan.html
11. *Decarbonization domino effect* is a term coined by the Ministry of the Environment, Japan to spread Zero Carbon Cities across the country with an initial 100 decarbonised regions disseminating their good practices to others.
12. Goto City Hall, Renewable Energy Promotion Section (五島市再生可能エネルギー推進室) , Section chief, personal communication on June 24, 2021.
13. Goto City (2013), Renewable Energy Preliminary Basic Plan (五島市再生可能エネルギー前期基本計画)
    https://www.city.goto.nagasaki.jp/energy/010/010/20190118212254.html
14. Goto City Renewable Energy Information, homepage (Access Sep. 2021)
    https://www.city.goto.nagasaki.jp/energy/010/020/20190121192900.html
15. Ministry of Environment (Jul. 13, 2017), press release on publication of the 「Guide for regional-led selection of suitable sites for wind power generation ～ Consensus building and environmental survey for selection of suitable sites by local governments ～」 <attachment> Case 3_Goto City, Nagasaki Prefecture" (「風力発電に係る地域主導による適地抽出手法に関するガイド～地方公共団体による適地抽出のための合意形成と環境調査～」の公表について ＜別添＞事例3_長崎県五島市), (Access Sep. 2021)
    https://www.env.go.jp/press/104259.html
16. Full liberalisation of electricity in Japan was enacted in April 2016, allowing new businesses to enter competition on the electricity retail market (i.e. electricity provision for households and enterprises).
17. Subsidy name: '*Support funding for the business project in local production & local consumption of renewable energy in rural districts*' (農山漁村再生可能エネルギー地産地消支援事業)
18. Goto Citizens' Electric Power Co., Ltd.(五島市民電力株式会社), Director, personal communication on 24 June, 2021.
19. Other examples of local contribution projects can be found on the company website: https://510power.com/contribution
20. Ministry of Environment of Japan (2011), 2010 Renewable Energy Introduction Potential Survey Report (平成２２年度　再生可能エネルギー導入ポテンシャル調査報告書)
    https://www.env.go.jp/earth/report/h23-03/

Notes and References

21. Utsunomiya, T., Sato, I., Shiraishi, T. (2016). Floating offshore wind power generation in Kabashima, Goto City. *System / Control / Information Vol. 60, No. 9, pp 402-40* (In Japanese). doi.org/10.11509/isciesci.60.9_402
22. The plan *"Japan Revitalization Strategy -JAPAN is BACK-"* was initially formed in 2013 and contains the *"2030 roadmap for strategic market creation",* which envisioned the creation of a global market for FOWT by Japan, with a concrete target of commercialising the first FOWT by 2018.
(Prime Minister's Office of Japan (2013), Japan Revitalization Strategy -JAPAN is BACK-, 2030 Roadmap for Strategic Market Creation https://www.kantei.go.jp/jp/singi/keizaisaisei/pdf/rm_en.pdf)
23. Required natural conditions and actual conditions near Kabashima (initial testing site): average wind speed over 6.5m/s at 60m height (actual: 7.5 m/s); average wave height 4 - 10m (actual: 7.7m).
(Utsunomiya, T., Sato, I., Shiraishi, T. (2016). Floating offshore wind power generation in Kabashima, Goto City, p.40)
24. Goto City islands are connected to the mainland Nagasaki city by underwater electric cable.
(Goto City Hall, Renewable Energy Promotion Section, Section chief, personal communication on June 24, 2021).
25. Toda Corporation, Goto-Floating Wind Power LLC., Goto City. Pamphlet: "Sakiyama 2 MW Floating Offshore Wind Turbine in Japan" (崎山2MW浮体式洋上風力発電所), 2017.
https://www.toda.co.jp/business/ecology/special/pdf/sakiyama2mw_e.pdf
26. Spar-type FOWT: upper part of the floating structure is made of steel; lower part is made of reinforced concrete in the form of a hollow cylinder. Using concrete brings down costs and is suitable for underwater use. Spar-type FOWT is anchored with 3 chains to the seabed.
(Goto City Hall, Renewable Energy Promotion Section, Section chief, personal communication on June 24, 2021)
27. Wind turbine generator HTW 2.0-80 (Hitachi, Ltd. 2MW class): downwind type, rotor diameter 80m.
(Toda Corporation, Goto-Floating Wind Power LLC., Goto City. Pamphlet: "Sakiyama 2 MW Floating Offshore Wind Turbine in Japan", p.4)
28. Ministry of Environment of Japan, About the selection of offshore wind power generation company off the coast of Goto City, Nagasaki Prefecture (長崎県五島市沖における洋上風力発電事業者の選定について) (Access Oct. 2021)
https://www.meti.go.jp/press/2021/06/20210611004/20210611004.html
29. Reinforced concrete section of the FOWT is produced locally in Goto City. The steel section is manufactured in Nagasaki City.
(Goto City Hall, Renewable Energy Promotion Section, Section chief, personal communication on June 24, 2021)
30. Aldrich, A. (2010). Site Flights: Divisive Facilities and Civil Society in Japan and West. Cornell University Press
31. Shibuya, M. (2021). Creating offshore wind power generation that coexists and co-prospers with the region and fisheries (地域や漁業と共存共栄する洋上風力発電づくり), Longsellers publishing
32. Marine Renewable Energy and Fisheries Inc, Director, personal communication on 24 June, 2021.
33. Marine Renewable Energy and Fisheries is a general incorporated association, centered in Goto City, that investigates the model of co-existence and co-prosperity among marine renewable energy, fisheries, and the marine ecosystem. HP:
http://www.sdi-marine-energy.com/
34. Goto Marine Energy Tour (五島海洋エネルギーツアー)
https://www.goto-energy.jp/contents/course
Goto Archipalego Tourism Convention Bureau (五島列島観光コンベンションビューロー)
https://gcvb.jp/page/tour/detail.php?number=3

Acknowledgements

The authors would like to express sincere gratitude to Mr. Taichi Yanawaki, Section Chief at the Renewable Energy Promotion Section, Goto City Hall, Mr. Masanobu Shibuya, director of Marine Renewable Energy and Fisheries Inc., and Mr. Taketoshi Hashimoto, director at Goto Citizens' Electric Power Co., Ltd. who kindly cooperated with the interviews. We would also like to express our deep appreciation to Mr. Hiroyuki Okada from Goto Tourism Association for arranging site visits and interviews, Mr. Seiya Tominaga, visiting researcher at Kitakyushu Urban Centre for his valuable consultations, and all relevant colleagues at IGES for insightful advice and comments. We express additional gratitude to Mr. Masanobu Shibuya for giving permission to use his research images (ph. 3,4, fig.10).

IGES Institute for Global Environmental Strategies

IGES Kitakyushu Urban Centre

International Village Center 3F, 1-1-1,
Hirano, Yahatahigashi-ku, Kitakyushu,
Fukuoka, 805-0062, Japan
Tel: +81-93-681-1563
Fax: +81-93-681-1564
E-mail: kitakyushu-info@iges.or.jp