The potential for carbon neutrality in Hokkaido

12 May 2023

MUFG

Hokkaido carbon neutrality:

Outline

Executive Summary (1/3)

- **In June 2021, MUFG announced its ambition to become carbon neutral. It also joined NZBA,** the flagship climate initiative under the Principles for Responsible Banking. MUFG committed to achieving net-zero emissions in its finance portfolio by 2050. Financial institutions that are members of NZBA are required to set "interim targets for 2030 or earlier" through a science-based approach.
- **MUFG is committed to: achieving net zero emissions in its finance portfolio by 2050; supporting a smooth transition to a decarbonized society through business; and, proactively contributing to creating a sustainable society by fostering a virtuous circle between the environment and economy.** We recognize that the process for achieving these goals will vary depending on regional and business characteristics, which will impacted by geopolitical risks and other factors. For that reason, we are seeking to resolve issues through engagement and dialogue with our customers.
- **MUFG aims to responsibly support our customers' journey toward carbon neutrality**. Beyond reducing emissions on our own balance sheet, we will work closely with our customers to **engage rather than divest**, thereby achieving the twin targets of revitalizing the economy and reducing emissions.
- **MUFG participates in international initiatives** such as the Asia Transition Finance Study Group. We are also involved in the development of guidelines and policies, and will continue to contribute through advocacy activities. In addition, we continually strive to connect the efforts of various stakeholders by **understanding the content, passion, and intentions of global discussions, connecting them to customers**, and feeding back our customers' and Japan's situation into **global discussions**.
- **As part of this initiative, we published "MUFG Transition Whitepaper 1.0" in October 2022.**
  Whitepaper 1.0 highlights **three key messages** through objective information-based comparisons of regional characteristics in considering climate change issues. We consider four drivers (sources of energy and emissions, connectivity, energy security, and socio-political factors), and compare the characteristics of Japan and the West. Key messages:

  1. The starting point, direction, and trajectory of carbon neutrality differ depending on **the characteristics of the region**.
  2. Carbon neutrality should not be focused on individual sectors, but rather should focus on identifying levers based on the **close vertical and horizontal linkages (interdependency) between industries**.
  3. **In Japan**, achieving carbon neutrality of **electricity and heat** will play an important role.

- The **managed phase-out of fossil fuel power generation is premised on the fact that the** world shares an ultimate target, that a variety of approaches are required according to the characteristics of each region, and that **the implementation of new technologies such as co-firing and mono-firing power plants, in addition to early retirement, will be important in achieving renewable energy on a global scale**.

Executive Summary (2/3)

- **After the publication of Whitepaper 1.0**, we **confirmed the following issues through face-to-face** discussions with Western administrative authorities and related stakeholders:
  1. Continuing to show that the direction of travel on carbon neutrality promoted by Japan is credible.
  2. Highlighting the importance of regularly publishing reports on progress.
- At present, we are working with partner companies and administrative authorities to formulate Whitepaper 2.0, **scheduled to be published in October 2023**.
- Based on analyses of policies in Europe, the US, China, and ASEAN, Whitepaper 2.0 highlights the need to **compile a list of technologies and supply chains that play an important role in promoting carbon neutrality in Japan's electricity and heat sectors**, as well as the need to widely promote financial support. The whitepaper will **discuss the potential** of various technologies, and the background and intentions of their implementation. It will provide **narrative explanations in Western rhetoric**.
- By summarizing the efforts of the Japanese government and leading Japanese companies and disseminating them in an English-language white paper, we aim to **improve Japan's investment predictability in global finance**. Among the technologies set forth in Japan's basic policy for realizing green transformation (GX), we plan to focus on **six, relating to the pursuit of carbon neutrality in the electricity and heat sectors**.

Six technologies covered in Whitepaper 2.0

1. Next-generation fuel
2. CCUS
3. Renewable energy (solar & offshore wind)
4. Transmission & distribution
5. Nuclear
6. Heat pumps

Electricity storage

Attracting demand (Semiconductors & data centers)

Executive Summary (3/3)

- In conjunction with the Whitepaper 2.0 initiatives, it is important to promote Japan's GX efforts and strengthen financial support for the early deployment of carbon-neutral technologies in areas with high potential. **Hokkaido will be one such strategic priority area for accelerating GX in Japan**.

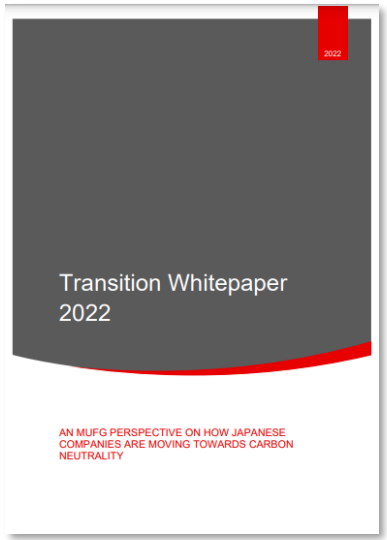
Hokkaido's potential

Offshore wind	**Has the greatest potential in Japan**. The national offshore wind implementation target is 45 GW (by 2040), and Hokkaido accounts for one third (15 GW) of that target.
Transmission & distribution	**The largest investment plan in the country**. Of the 6-7 trillion yen to be invested in increasing power transmission and distribution nationwide, 4.5 trillion yen will be assigned to Hokkaido.
Heat pumps	**Community-integrated thermoelectric management in the industrial, agricultural, and household sectors** is expected for **Hokkaido**.
Data centers	**Hokkaido has potential for data centers:** Basic infrastructure is already in place. Opportunity for carbon neutrality/cost reduction benefits
Semiconductors	**Japan's semiconductor & electronic devices industry is concentrated in western Hokkaido**. The scale of the industry has been expanding over the past 10 years, and Rapidus Corporation plans to build its first factory.
Next-generation fuel	**Largest scale of renewable energy + bioresource**. Synthetic and biofuel supply chains can also be built.
CCS	**Muroran and Tomakomai in Hokkaido are the most promising CCS locations in Japan.** Also adjacent to CO2 emission areas.
Forest	**Hokkaido ranks first in Japan in terms of forest area, artificial forest area, and timber production value.** The quality of the forests is the highest in Japan.
Agriculture	**Best agricultural output in Japan.** Leads the way in introducing biochar and building a recycling-based dairy farming model.
Carbon credit	**Hokkaido J-Credit has expanded by nearly fourfold in the past three years.** High potential for afforestation and reforestation credits.

From the perspective of carbon neutrality for electricity and heat, Hokkaido is one of the regions with the greatest potential in Japan

- Through its collaborations with the national government, provincial governments, local governments, investors, local financial institutions, industries, and educational institutions, MUFG will **provide financial support for the integrated flow of efforts for carbon neutrality in Hokkaido through; [i] developing the investment environment → [ii] facilitating flow of funds → [iii] industrial development/promotion and → [iv] human resource development**. MUFG will also balance economic factors and carbon neutrality, and will proceed with the construction of role models for regional economic revitalization.

MUFG Transition Whitepaper 1.0: Review of Initiatives



- Apr-Jul 2022 : Discussions with Whitepaper partner companies
- Aug 2022 : MUFG forum
- Aug-Sep 2022 : Discussion with Western administrative authorities
- Oct 2022 : MUFG Transition Whitepaper 1.0 publication
- Nov 2022 : COP27 publication

Source: MUFG

Key takeaways from Whitepaper 1.0

1 Regional characteristics

- Different starting point and direction for carbon neutrality in the region
- Regional analysis of sources of energy and emissions, connectivity, energy security, socio-political factors

2 Inter-industry relations (interdependency)

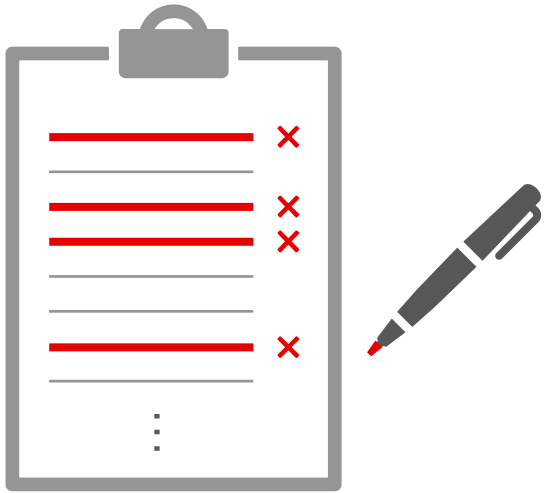
- Carbon neutrality by individual sector may not be fully effective
- Industries are closely linked, both horizontally and vertically, so identify effective levers with consideration of interdependency
- In Japan, carbon neutrality of electricity and heat is an important lever

3 Japanese version of managed phase out

- The direction of managed phase out for Japan and the West is similar, but the approach is different. Early retirement of coal power plants in Europe, while co-firing in the short-term, mono-firing in the medium/long-term in Japan.
- Japan embodies the concept of retrofit/repurpose for managed phase out

MUFG Transition Whitepaper 2.0: Purpose of Initiative

Divestment-oriented



Engagement-oriented (positive technology list)

Construct a program that fits the framework of foreign policy (taxonomy etc.) and create a technology list that summarizes Japan's efforts in a Western framework

Source: MUFG

Taxonomies of Major Economies Analysis Approach

1 Overview of carbon neutral technology **(long list)**

What technologies can be deployed?

List of carbon neutral technologies around the world that are expected to be deployed around 2030-2035.

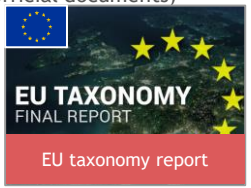
Industry	Technology category	Technology sub-category
Renewable energy	Renewable energy devices	Renewable energy devices manufacturing
	Solar	Solar generation
	Solar heat	Solar heat generation
	Wind	Onshore
		Offshore fixed-bottom
		Offshore floating
	Biomass	Biomass generation
	Water	Water
		Pumped-water
	Geothermal	Geothermal
	Tidal	Tidal generation
	Ocean	Ocean generation
	Space solar power	Space solar power generation

Number of technologies: 167

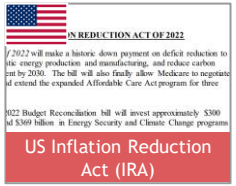
2 Taxonomy target technology **(middle list)**

Which technologies are acceptable?

List of technologies permitted by country and region (carbon neutral technologies described in official documents)



EU taxonomy report



US Inflation Reduction Act (IRA)


China green bond support project catalog

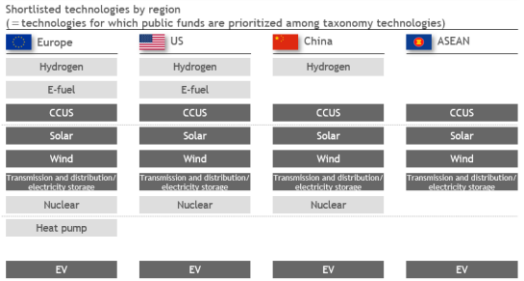
ASEAN taxonomy report

Number of technologies: 99 (EU), 52 (US), 62 (ASEAN), 71 (China)

3 Technologies eligible for economic support **(short list)**

Which technologies will receive deployment support?

List of technologies supported by national and regional policies



Number of technologies: 101[1] (EU), 8 (US), 5 (ASEAN), 7 (China)

These taxonomies are top-down and comprised of structured lists, which makes it easier to understand the context and intention

1. Includes transition technology nuclear power and gas

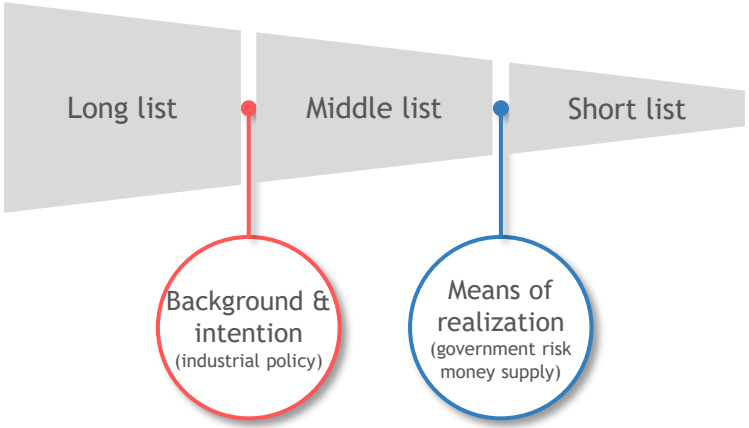
Source: Official taxonomy documents of each country and expert interviews with persons involved in taxonomy formulation

In the major economies, background/intention and means of realization are transmitted from the long lists to the middle and short lists. In Japan, we need to reinforce the narrative in the middle (means of realization based on background and intention), connecting the long and short lists.

Implications for Japan from overseas taxonomy analysis

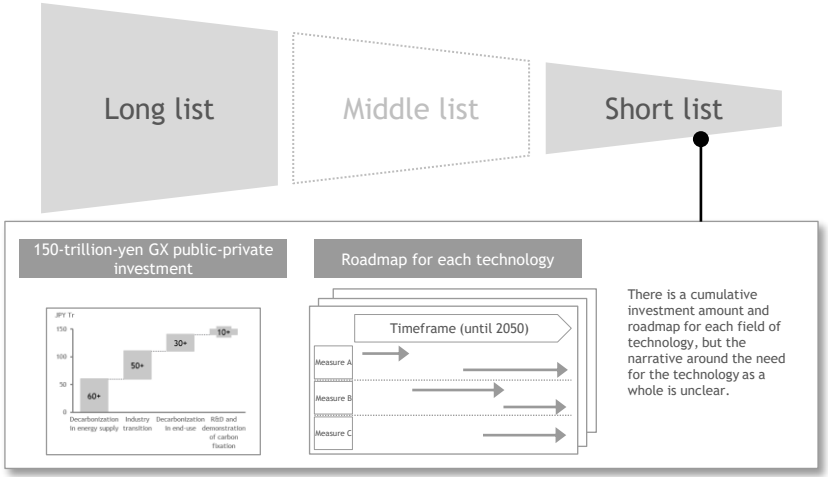
Taxonomies of major economies approach — Top-down

Select technologies based on top-down industrial policies and select priority technologies based on government risk money supply policies.



Japan's GX policy approach — Bottom-up (current)

GX public-private investment policy was formulated in the Green Growth Strategy, but the middle part connecting long list and short list is unclear



As an engagement-oriented project, rather than a divestment-oriented project,
Whitepaper 2.0 aims to clearly convey the necessity (background and intention) of Japan's short list technologies
by incorporating industrial policies from the top down and the government's risk money supply policy

Source: Expert interviews with people involved in the formulation of each country's official taxonomy documents and taxonomies; the Ministry of Economy, Trade and Industry

Technologies Listed in the Basic Policy for Realizing GX: From the Perspective of Analyzing Taxonomy by Region

: Technologies that have been shortlisted in all regions　: Technologies that have been shortlisted in some regions

Overseas

Shortlisted technologies by region
(technologies for which public funds are prioritized among taxonomy technologies)

	Europe	US	China	ASEAN
Fuel	Hydrogen	Hydrogen	Hydrogen	
	e-fuel	e-fuel		
	CCUS	CCUS	CCUS	CCUS
Electricity	Solar	Solar	Solar	Solar
	Wind	Wind	Wind	Wind
	Transmission and distribution/ electricity storage	Transmission and distribution/ electricity storage	Transmission and distribution/ electricity storage	Transmission and distribution/ electricity storage
	Nuclear	Nuclear	Nuclear	
Energy use	Heat pump			
	EV	EV	EV	EV

Japan

Technical elements listed in the basic policy for realizing GX

1. Next-generation fuel (e-fuels such as hydrogen, ammonia, SAF/e-methane)
2. CCUS
3. Solar
4. Wind
5. Transmission and distribution/ electricity storage
6. Nuclear
7. Heat pump
8. Digital investment for GX
9. EV

Priority carbon neutral technologies (short list technologies) in four overseas regions and the technological elements set forth in Japan's basic policy for realizing GX are similar = Publish the story in Whitepaper 2.0.

Source: Each region's taxonomy analysis results

Hokkaido's Affinity for the Technologies in Japan's Basic Policy for Realizing GX

Japan		Hokkaido	
Technologies listed in the basic policy for realizing GX		Evaluation of Hokkaido's technology utilization potential	Hokkaido's key technologies
Fuel	1 Next-generation fuel (e-fuels such as hydrogen, ammonia, SAF/e-methane)	• In Hokkaido, it is possible to produce e-fuels such as SAF using green hydrogen derived from renewable energy and CO2 from inside and outside Hokkaido. Also to produce biofuels using forest, agriculture, and livestock resources.	✓ Next-generation fuel (e-fuel/bio fuel)
	2 CCUS	• Hokkaido is one of the most suitable CCS locations in Japan, along with Niigata and Kyushu. • It has the largest forest area in Japan, which absorbs CO2, and has significant carbon storage potential (biochar no-till) due to large areas of farmland.	✓ CCS/forest/ agriculture
Electricity	3 Solar	• Prefectures such as Yamanashi, Kochi, Miyazaki, and Gifu have the longest daylight hours in Japan, at around 2,100 hours/year.	
	4 Wind	• Hokkaido will have the largest offshore wind capacity in Japan by 2040 (15GW) • The scale of floating offshore wind is currently the largest in Japan, and offshore wind is expected to expand into other parts of Asia	✓ Offshore wind
	5 Transmission and distribution/storage	• Hokkaido is planning the largest grid expansion in Japan under its master plan (up to 1.1 trillion yen) • In addition, investment in the Hokkaido-Tohoku-Tokyo regional interconnection is the largest in Japan (up to 3.4 trillion yen)	✓ Transmission & distribution
	6 Nuclear	• The specific restart date for the Tomari Nuclear Power Plant, the only nuclear power plant in Hokkaido, has not been decided.	
Energy use	7 Heat pump	• Hokkaido, which is a suitable location for offshore wind-focused renewable energy, is one of the most promising locations for the integrated regional operation of clear power + heat using heat pumps.	✓ Heat pumps
	8 Digital investment for GX (semiconductors, data centers)	• Clean electricity is important for the carbon neutrality of digital industries such as semiconductors (e.g., Rapidus) and data centers, and Hokkaido's abundance of renewable energy is both attractive and growing.	✓ Semiconductors Data centers
	9 EV	• In terms of automobile production value, areas where automobile-related companies are concentrated,, such as Aichi, Fukuoka, Kanagawa, Shizuoka, and Hiroshima, occupy the top positions in Japan.	

Hokkaido has the biggest potential in such technologies as next-gen fuel, CCS, forests, agriculture, offshore wind power, power transmission and distribution, heat pumps, semiconductors, and data centers which are set out by Japan in its basic policy for realizing GX.
It also plays a key role in early implementation of these technologies.

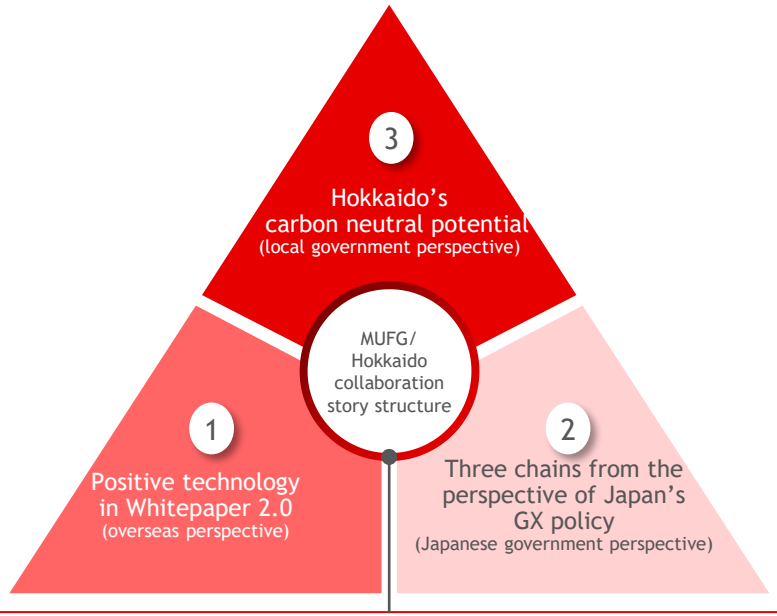
Source: MUFG analysis

MUFG/Hokkaido Carbon neutrality Collaboration Framework

Technologies with high priority/potential in each region

①	②	③
Hydrogen & e-fuel	Next-generation fuel	Next-generation fuel (e-fuel/biofuel)
CCUS	CCUS	CCS/ forest/agriculture
Solar	Solar	–
Wind	Wind	Offshore wind
Transmission and distribution/storage	Transmission and distribution/storage	Transmission and distribution
Nuclear	Nuclear	–
Heat pump	Heat pump	Heat pump
–	Digital investment for GX (semiconductors, data centers)	Digital investment for GX (semiconductors, data centers)
EV	EV	–

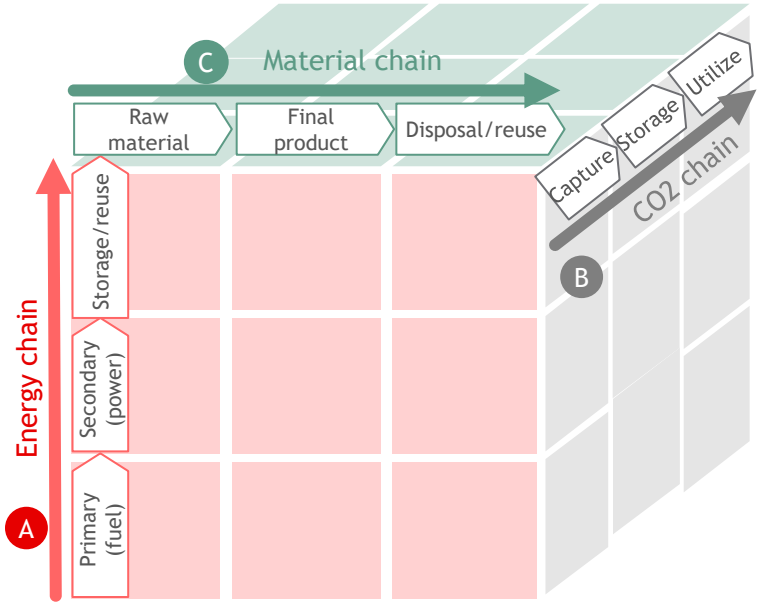
MUFG/Intersection of three perspectives on Hokkaido's carbon-neutrality collaboration



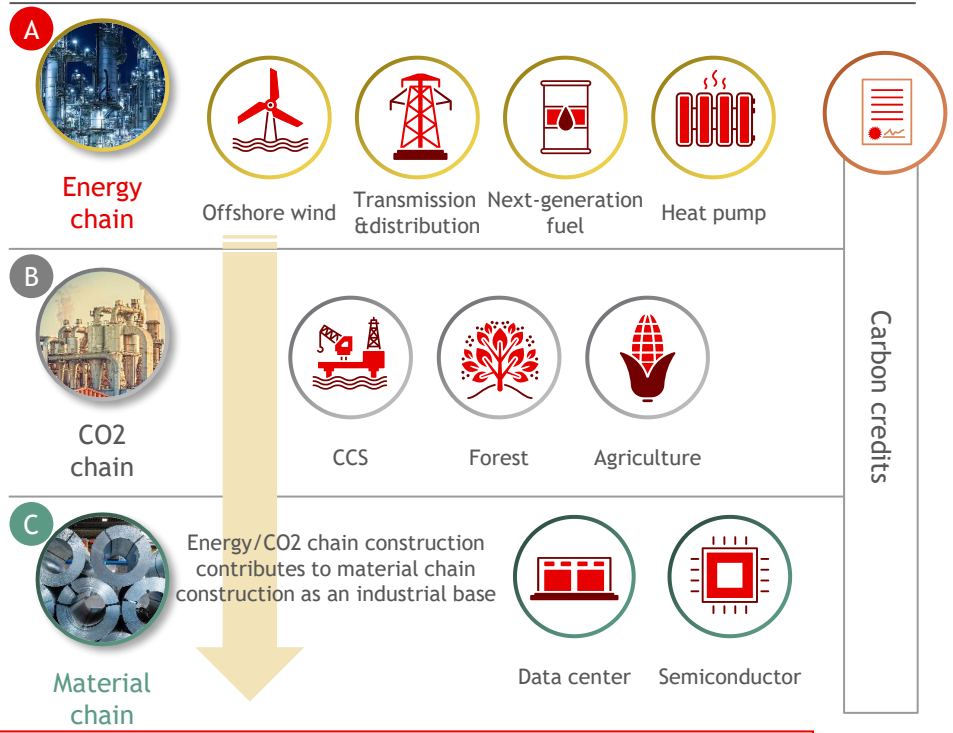
Carbon neutrality in Hokkaido is at the intersection of three points; local governments, overseas entities, and the Japanese government. MUFG is promoting support as part of its regional effort for carbon neutrality.

Perspective on GX Policy Review: Overview of Key Chains in Industrial Structure Analysis

Three chain frameworks in GX policy review



Hokkaido carbon neutrality potential across three chains



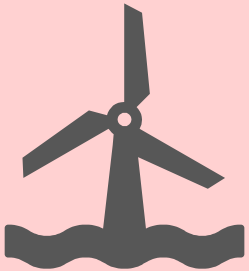
Stakeholders in Hokkaido's carbon neutrality potential can create three framework chains; energy, CO2, and materials - highlighted by the Ministry of Economy, Trade and Industry in its GX policy review

Source: MUFG analysis

Hokkaido carbon neutrality: potential

Hokkaido carbon neutrality potential

Offshore Wind



One of the largest wind installations in Japan

About 45 GW of offshore wind is scheduled to be installed nationwide (as of 2040), with Hokkaido expected to generate **15 GW** that is equivalent to one third of the total

- At present (2023), 3.9 GW capacity has been confirmed in five preparation areas within Hokkaido.

Japan's largest demonstration experiment of floating offshore wind power generation (as of March 2023) is also being conducted in Ishikari Bay, Hokkaido, and it is expected that the port will be further developed, and that the offshore wind power project will be expanded not only in Japan, but also to Asia in the future.

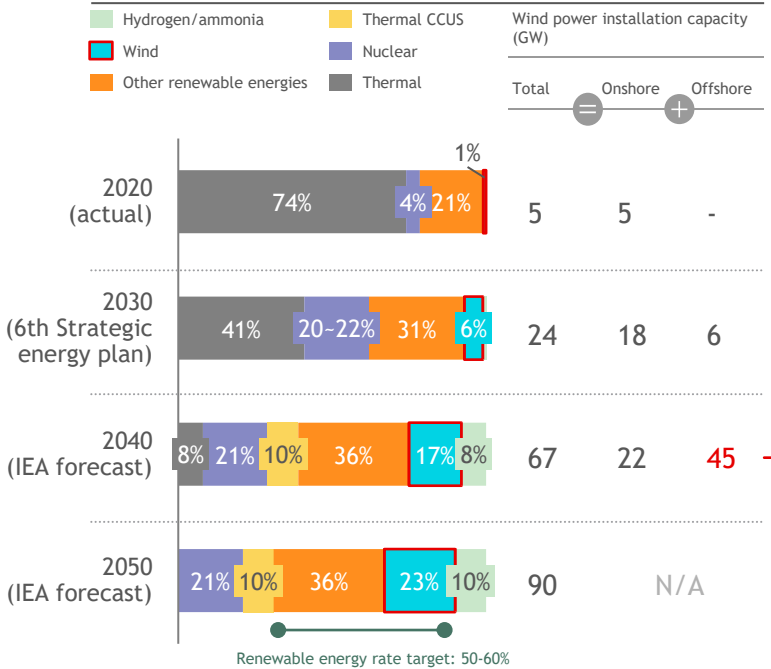
- In Ishikari Bay, Hokkaido, the Green Innovation Fund is demonstrating Japan's largest floating offshore wind (15 MW/turbine) as of March 2023.
- Offshore wind development requires nearby ports. Four bays in Hokkaido are candidates to become bases for offshore wind power development.

Similar to the automotive industry, **the offshore wind industry significantly impacts regional economic revitalization, due to the involvement of many different actors.**

- Offshore wind power equipment consists of about 20,000 parts, which is equivalent to the 10,000-30,000 parts needed for automobiles. The offshore wind industry will help promote domestic industries in Japan, including small- and medium-sized enterprises, like Japan's automobile industry does.

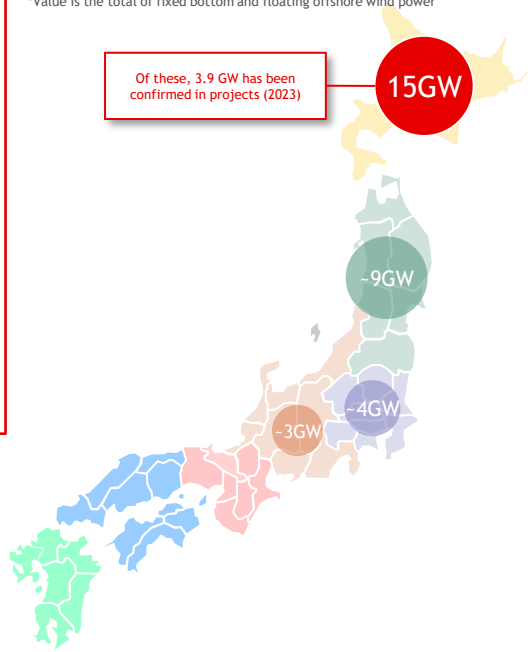
Potential for Offshore Wind in Hokkaido

Japan: Power generation energy mix (current and future)

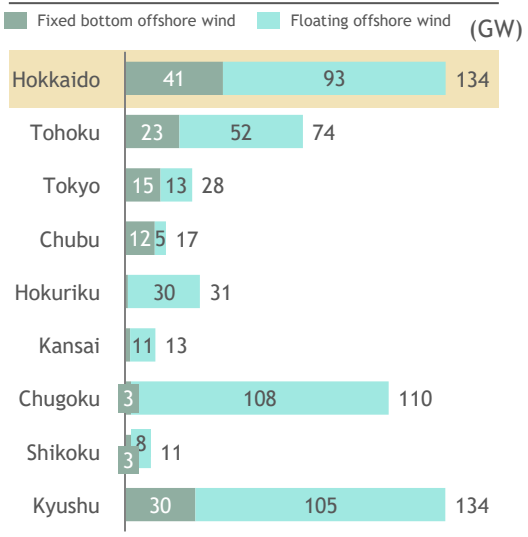


Offshore wind by region (2040)

*Value is the total of fixed bottom and floating offshore wind power



Maximum potential for offshore wind



Total: 553 GW (largest potential in Japan)

However, there are restrictions on developments of 45 GW or higher

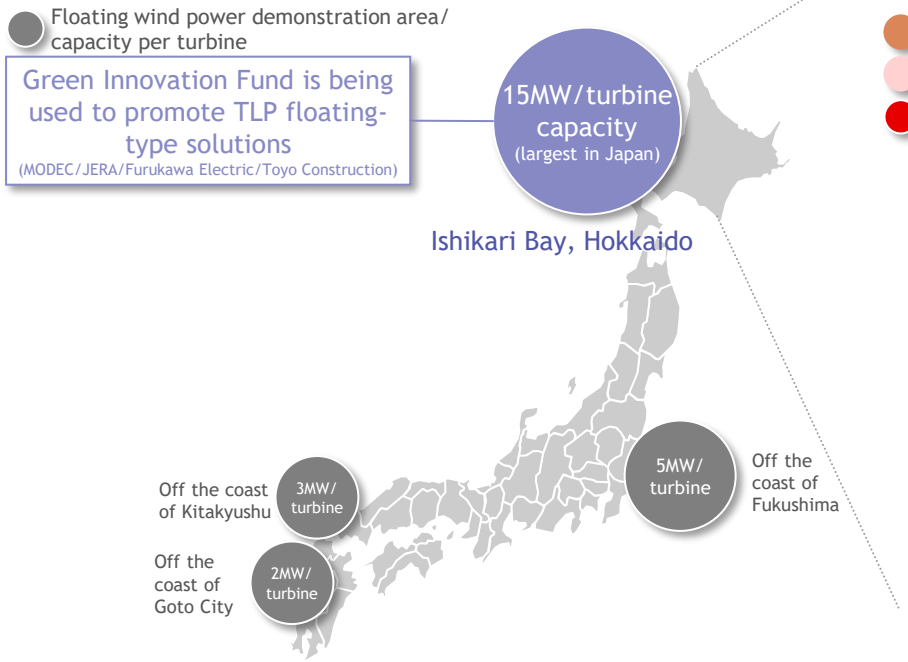
- Transmission grid capacity constraints
- Lack of resources such as manpower and ships to develop projects simultaneously etc.

Of the 45 GW of offshore wind to be installed in Japan by 2040, Hokkaido will be home to the largest share with 15 GW

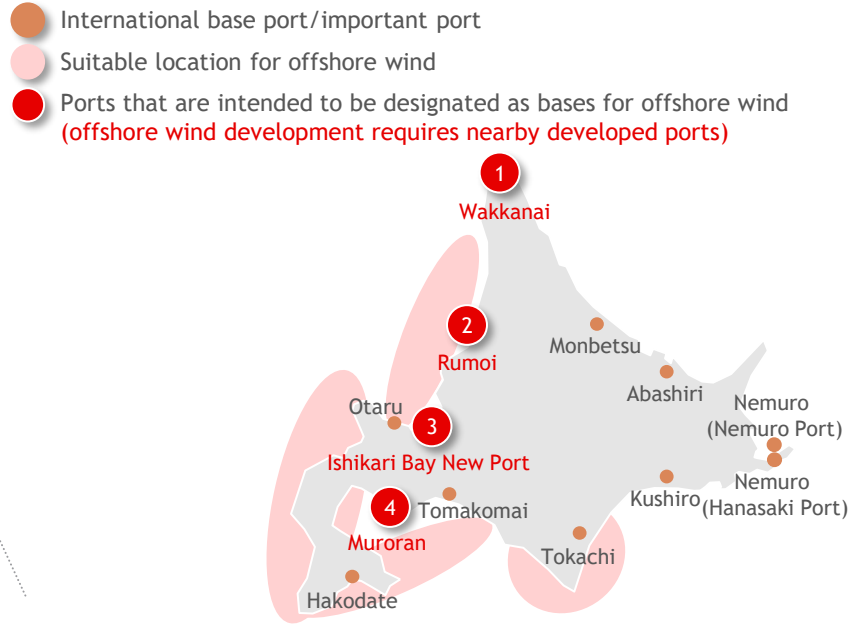
Note: The IEA's APS (Announced Pledges Scenario) is when all of the government's announced commitments, including those that have not yet been implemented, are implemented.
Source: Japan Wind Power Association; OCCTO; Materials released by the Agency for Natural Resources and Energy; The Minister of Economy, Trade and Industry's opinion on each assessment consideration statement; Article search; MUFG analysis

Floating Offshore Wind Development Trends in Hokkaido

Floating offshore wind demonstration trends (as of March 2023)[1]



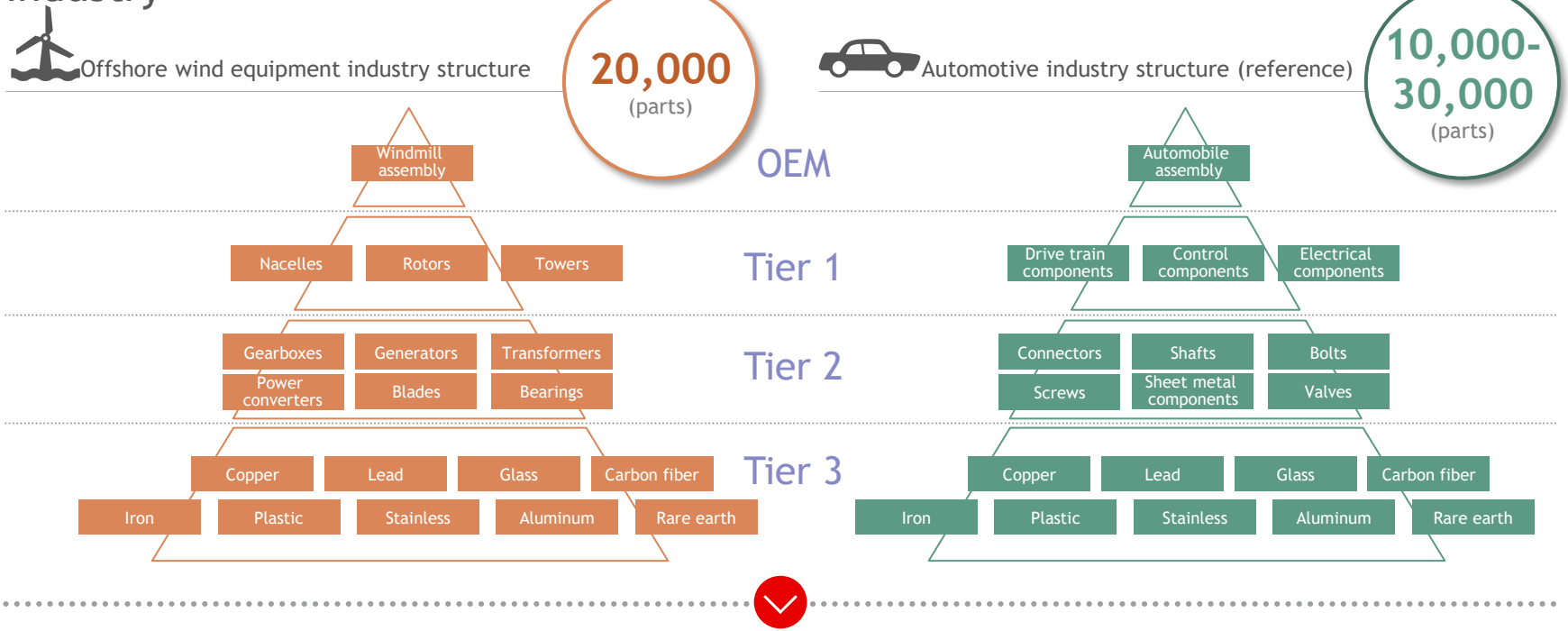
Candidate ports to become bases for domestic & international offshore wind development



In Hokkaido, efforts are currently underway to demonstrate Japan's largest (15 MW/platform) floating offshore wind capacity. In addition, four ports in Hokkaido are candidates to become bases for offshore wind.

1. Green Innovation Fund started research in August 2022 in collaboration with MODEC, Toyo Construction, Furukawa Electric, and JERA.
Source: Materials published by NEDO; HP of each company/consortium; Article search; Ministry of Land, Infrastructure, Transport and Tourism, Port Authority, Sept. 2022; Hokkaido; MUFG analysis.

Economic & Employment Ripple Effects in the Offshore Wind Manufacturing Industry

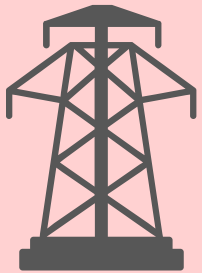


The formation of an offshore wind industry bases is expected to revitalize the local economy, including small and medium-sized enterprises on a scale similar to the automobile industry.

Source: MUFG analysis based on various information available to the public

Hokkaido carbon neutrality potential

Transmission & Distribution



Japan's largest planned investment in power transmission

Japan plans to invest 6-7 trillion yen in expanding renewable energy infrastructure, of which **Hokkaido is expected to account for 60% (4.5 trillion yen).**

- The 4.5-trillion-yen investment includes two initiatives: **(1) Developing power transmission and distribution in the Hokkaido region, and (2) developing inter-regional transmission networks around Hokkaido**.

Developing power transmission and distribution in the Hokkaido region: Up to 1.1 trillion yen (the largest amount in Japan) will be invested to connect coastal renewable energy/offshore wind to demand sites in Hokkaido.

- Three new 275 kV transmissions will be added, in addition to the current single 275 kV transmission.

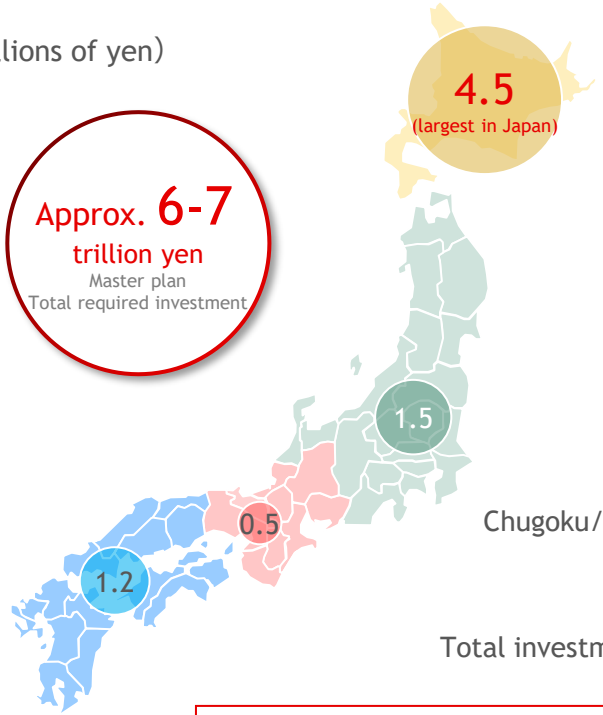
Developing inter-regional transmission networks around Hokkaido: Up to 3.4 trillion yen (the largest amount in Japan) will be invested to supply Hokkaido's renewable energy to Honshu and Tokyo.

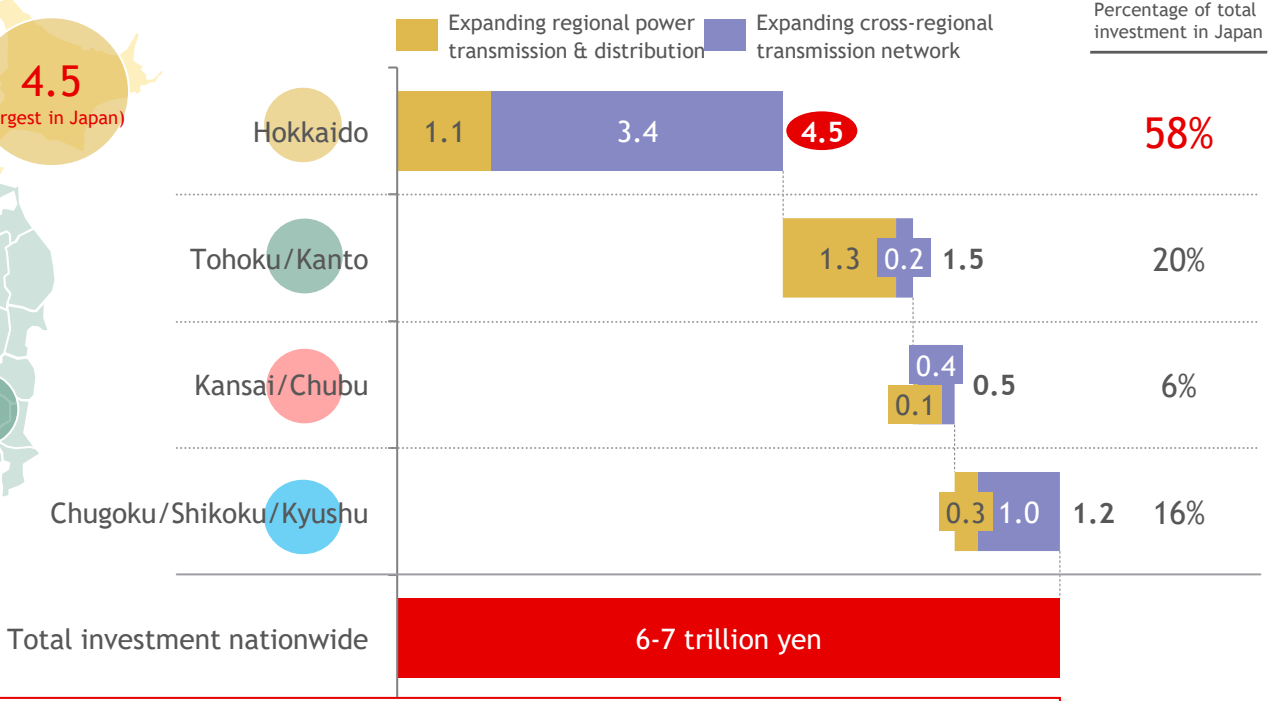
- As a transmission network connecting Hokkaido and Tohoku, up to 1.8 trillion yen will be invested to expand 600 km/4 GW line and 300 km/2 GW line.
- As a transmission network connecting Tohoku and Tokyo, up to 1.6 trillion yen will be invested to expand 400 km/4 GW line and 500 km/4 GW line.

Master Plan for Enhancing Transmission & Distribution in Japan

(Trillions of yen)

Approx. 6-7 trillion yen
Master plan
Total required investment



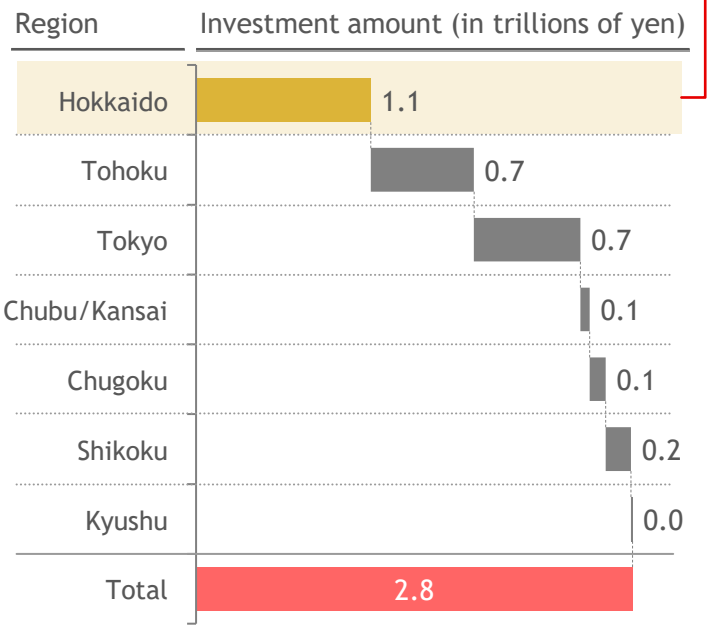


The investment in transmission and distribution in Hokkaido under the master plan will be the largest in Japan (4.5 trillion yen), accounting for about 60% of the total.

Source: Ministry of Economy, Trade and Industry "Status of Consideration for Formulating Master Plan (Long-Term Outlook (Draft)" (Dec. 2022)

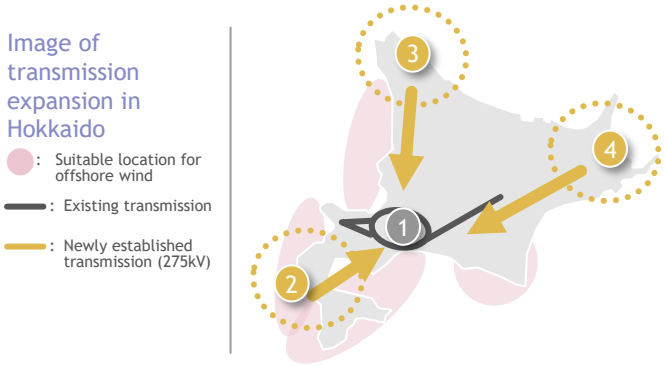
Plan for Expanding Transmission & Distribution in the Hokkaido Region

Master plan for transmission: Invest to expand transmission & distribution in the region



Within Hokkaido: Plan for expanding transmission & distribution

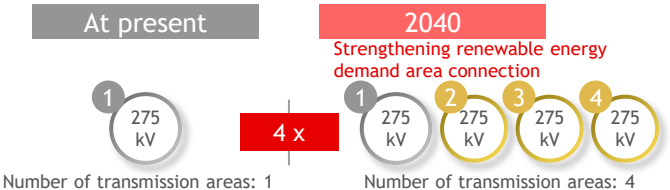
Image of transmission expansion in Hokkaido



Using newly established transmissions to connect locations in Hokkaido suitable for offshore wind with existing transmissions (demand areas)

⇒ Promote renewable energy

Scale of transmission



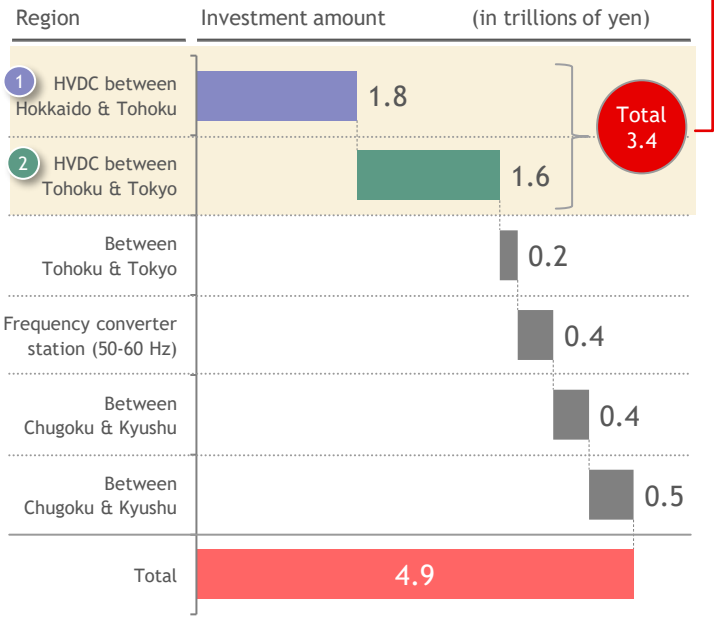
Offshore wind capacity

Invest up to 1.1 trillion yen to expand transmission and distribution in the region, connecting Hokkaido's renewable energy/offshore wind to areas of demand.

Source: OCCTO's published materials; Agency for Natural Resources and Energy's published materials; Hokkaido Electric Power Network's published materials; MUFG analysis

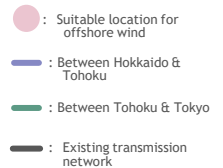
Plan for Expanding the Cross-Regional Transmission Network for Transmission & Distribution to Areas Around Hokkaido

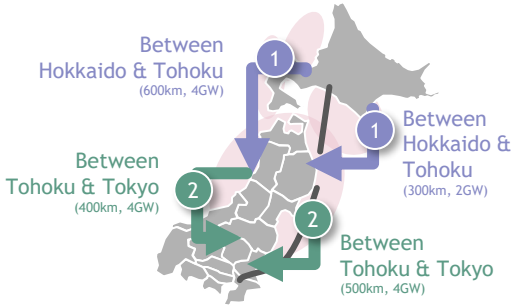
Master plan for transmission: Invest to expand transmission network for transmission & distribution



Transmission network for areas around Hokkaido: Plan for expanding transmission & distribution

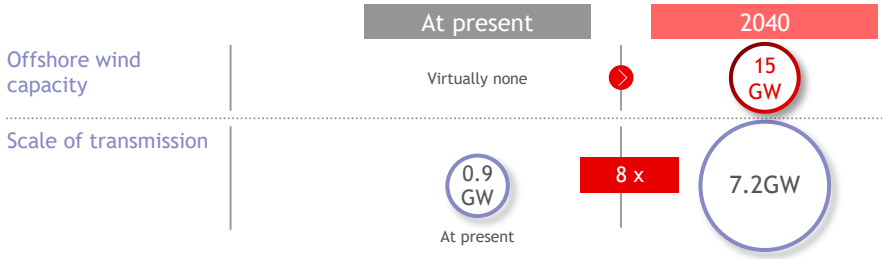
Image of transmission network expansion to areas around Hokkaido





Using transmission network to connect offshore wind in Hokkaido to Honshu/Tohoku & Tokyo

⇒ Promote renewable energy



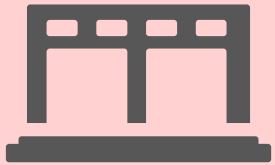
Invest up to 3.4 trillion yen to expand the transmission network to supply Hokkaido's renewable energy to Honshu & Tokyo

1. Potential as of 2040

Source: OCCTO's published materials; Agency for Natural Resources and Energy's published materials; Hokkaido Electric Power Network's published materials; MUFG analysis

Hokkaido carbon neutrality potential

Data Centers



Potential to become a hub for data centers

Hokkaido ranks 10th in Japan's data center area ranking, with 41 data centers.

- A certain level of basic infrastructure has already been established, mainly in Sapporo City. Future utilization of this infrastructure has the potential to attract new data center construction.
  - Further enhancement of basic infrastructure, such as telecommunications networks, is a prerequisite.

Hokkaido's **abundant renewable energy and cool climate are potential advantages in terms of carbon neutrality and cost reduction for data centers**.

- There is a strong need for carbon neutral electricity in data centers, which consume enormous amounts of electricity. Hokkaido has abundant renewable energy resources, especially offshore wind.
- Since 50% of data center OPEX is electricity costs, of which air conditioning accounts for 30%, it is possible to reduce costs by saving energy through Hokkaido's outdoor air conditioning solutions.
  - Telecommunication costs will increase compared to the Tokyo metropolitan area, but if these costs can be controlled by measures such as clustering, total costs may also be reduced.

Data Center Location Trends in Hokkaido

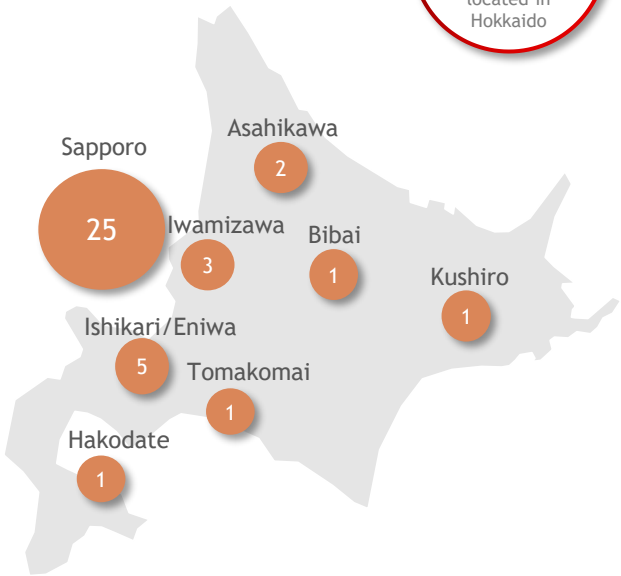
Ranking of data center area by prefecture (1-20)

#	Prefecture	Data center area (m^2)
1	Tokyo	560,550
2	Osaka	298,080
3	Kanagawa	150,000
4	Chiba	118,340
5	Hyogo	55,000
6	Gunma	44,000
7	Fukuoka	36,000
8	Saitama	29,000
9	Aichi	28,400
10	Hokkaido	17,290
11	Kyoto	16,400
12	Fukushima	15,940
13	Okayama	14,000
14	Tochigi	7,000
15	Hiroshima	6,200
16	Toyama	6,100
17	Nagano	5,750
18	Kagawa	5,700
19	Okinawa	5,700
20	Niigata	5,500

Many are located in city centers, due to recovery response & data response speed

Distribution of data centers in Hokkaido

Total: 41 locations
Data centers located in Hokkaido



Hokkaido (ranked 10th nationally) already has a certain level of basic infrastructure (telecommunication network, etc.) for data centers, especially in Sapporo, and this can serve as a basis for attracting new data centers.

Source: Fuji Chimera Research Institute "Data Center Business Market Research Overview 2022 Version, Market Edition"; MUFG analysis

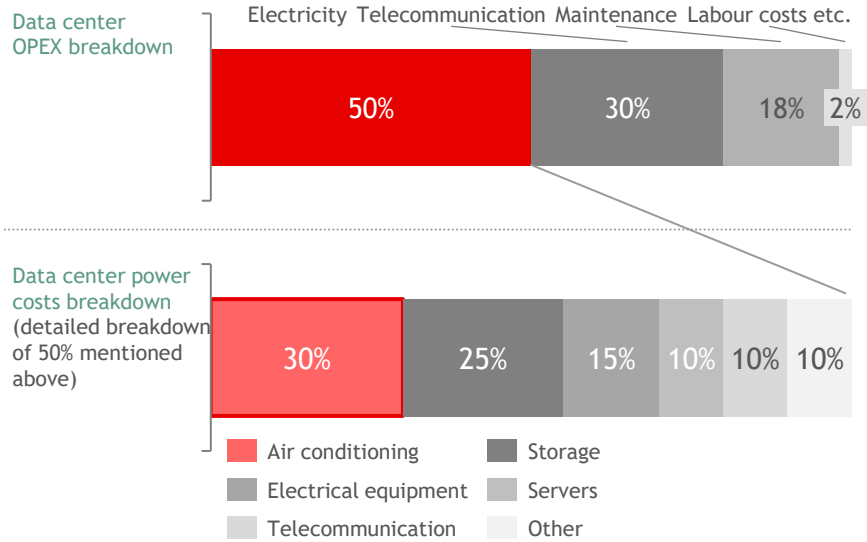
Hokkaido's Advantages as a Location for Data Centers

Hokkaido's advantages as a location for data centers

: Items whose needs are growing due to carbon neutrality

1. Suitable location for renewable energy
   Abundant renewable energy resources to generate the power used in data centers.
2. Cool climate
   Energy-saving data centers can be achieved because of cool conditions
3. Risk diversification
   Geographically separate from the Tokyo metropolitan area, so a low risk of simultaneous disasters.

Data center cost structure (Nation average[1])



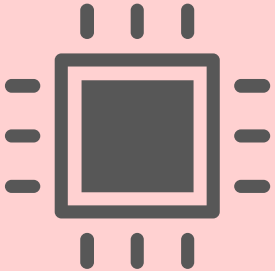
Hokkaido's suitable locations for renewable energy and its cool climate can be an advantage in terms of both carbon neutrality & cost reduction[2]

1. There are some areas, such as Inzai City, Chiba Prefecture, where electricity accounts for a low percentage of the data center. In addition, it is assumed that there are costs (communication costs, maintenance costs, etc.) that are unique to Hokkaido.
2. Telecommunication costs will increase compared to the Tokyo metropolitan area, but if these costs can be controlled through integration, etc., total costs may also be reduced.

Source: Fuji Chimera Research Institute "Data Center Business Market Research Overview 2022 Version, Market Edition"; MUFG analysis

Hokkaido carbon neutrality potential

Semiconductors



Semiconductor/electronic device-related industries are concentrated & there is a base of engineering talent

Hokkaido meets the requirements as a location for semiconductor factories, and since **semiconductor-related industries are already present, mainly in the western part of Hokkaido**, future expansion is expected:

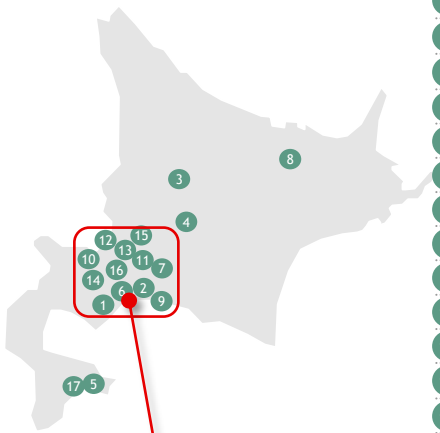
- The main requirements for the location of semiconductor factories include having sustainable energy supplies, abundant high-quality water, clean air, and low vibration/noise. Hokkaido meets all of these conditions.
- There are 17 semiconductor/electronic device related factories located in western Hokkaido, and the trend toward electrification and digitalization is expected to continue.

The scale of Hokkaido's semiconductor industry is expanding, and **there is a base of engineering talent. The construction of the Rapidus Corporation's first Hokkaido factory** is a tailwind for further expansion

- The number of semiconductor-related employees and the shipment value of manufactured products in Hokkaido have risen by 20-30% over the past decade.
- There are approximately 10,000 engineering students in Hokkaido, who could support the semiconductor industry in future.
- Rapidus, a leading semiconductor manufacturer, announced the construction of a new plant in Hokkaido that will start mass production in the late 2020s. Peripheral industries are also expected to expand.

Status of Semiconductor Industry Clusters in Hokkaido

Hokkaido: Status of semiconductor-related industry clusters



#	Name of company	Manufactured items
1	EPSON	TFT LCD panels
2	Denso	Sensors
3	Toshiba Hokuto Electronic Devices	Thermal printheads
4	Nidec SVTCL	Probe cards
5	Hakodate Electronics	Board mounts
6	Hokushin Metal Industries	Thermistors
7	FJ Composite	Heat sinks
8	Kyocera Corporation	Communication modules for automobiles
9	Minebea Mitsumi	Transistors
10	Amkor	Contract manufacturing of back-end processes
11	KYOSEMI	Optical semiconductor devices
12	Umezawa Musen	Industrial computers
13	Ueno Electric Industrial	PC board patterns
14	Daikoku Electronics	Semiconductors
15	DENCOM	Various sensor devices
16	Fuji Electric	Various sensor devices
17	Medec	Semiconductor manufacturing equipment

Semiconductor-related industries are concentrated in the western part of Hokkaido and are expected to expand.

Location conditions required for semiconductor manufacturing plants

Stable energy supply

Manufacturing consumes large amounts of power. Stable power is important because the slightest voltage drop can lead to significant losses

Abundance of high-quality water

High-quality water is important because the semiconductor manufacturing process, which hinges on precision machinery, uses a large amount of ultrapure water.

Cool air/Low vibration/Low noise

Maintaining cleanliness of the clean room and reducing vibration are important to maintain a highly accurate process.

Renewable energy supply (offshore wind)

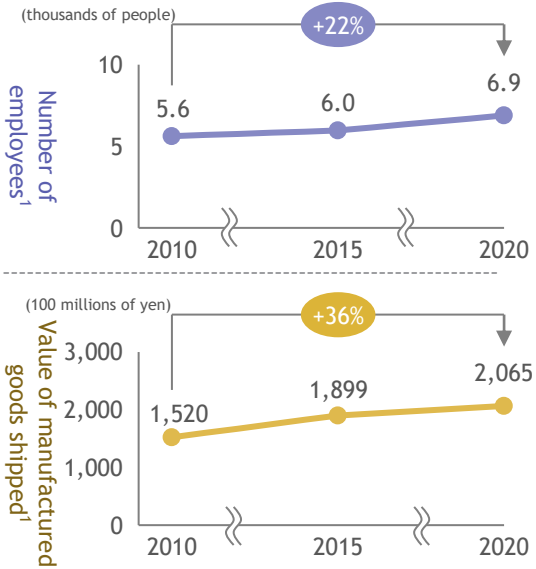
Clean electricity used in the manufacturing process (supply of renewable energy) is important.

Hokkaido meets all conditions, making it an attractive location for semiconductor operators.

Source: Article search; MUFG analysis

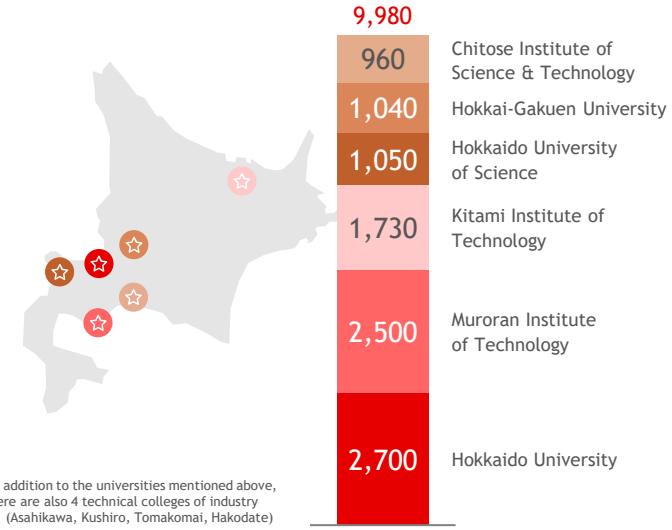
Semiconductor Industry Trends in Hokkaido

Overview of semiconductor-related industries in Hokkaido



The number of semiconductor-related employees and the value of product shipments have increased by 20-30% in the past 10 years

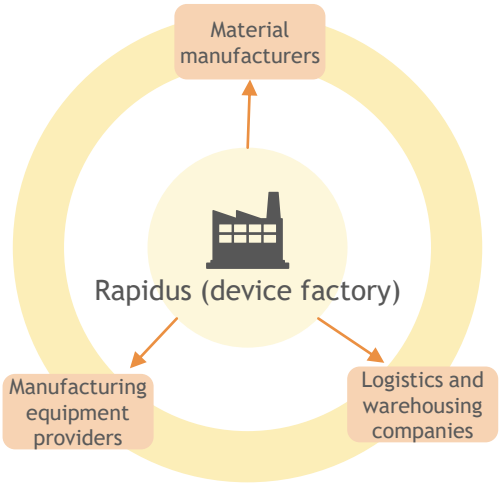
Estimated number of engineering students in Hokkaido



*In addition to the universities mentioned above, there are also 4 technical colleges of industry (Asahikawa, Kushiro, Tomakomai, Hakodate)

There are around 10,000 engineering students in Hokkaido, who could support the semiconductor industry in the future

Rapidus Corporation: Expanding the development of semiconductor factories in Hokkaido



With Rapidus constructing its first plants, the semiconductor industry in Hokkaido is expected to grow.

1. Among the manufacturing industry classifications, “food,” “beverages/tobacco/feed,” “printing,” and “others” are excluded.
Source: Hokkaido industrial statistics survey; Hokkaido University; Cabinet Office; Desktop research; MUFG analysis

Hokkaido carbon neutrality potential

Heat Pump

Renewable-energy based thermoelectric management in the industrial, agricultural, and household sectors can be expected for the region as a whole

Heat pump is a carbon-neutral technology that can shift heat generation from fuel combustion to **heat electrification.**

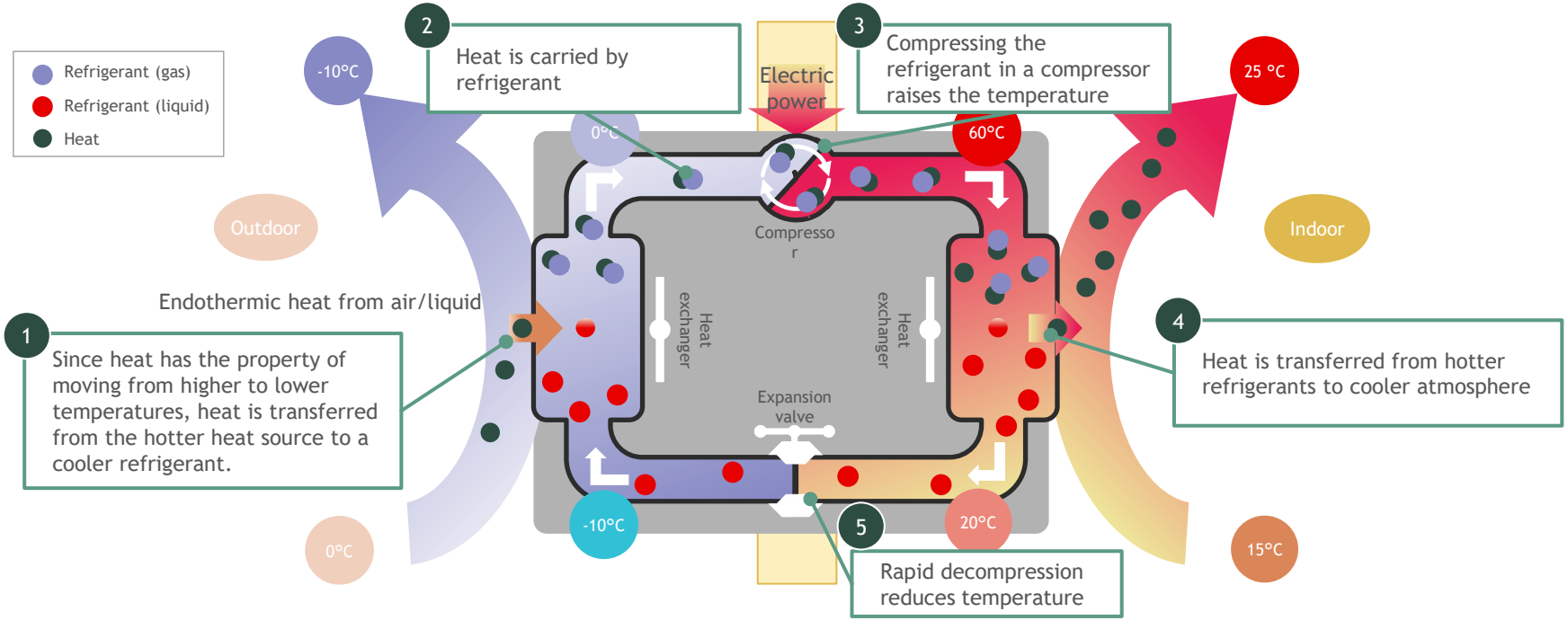
- Heat pumps collect heat from the atmosphere and produce more energy through a compression and decompression process that uses refrigerants, which are fluids that carry heat.

While there are multiple options for carbon neutrality in heat depending on the temperature range, **heat pumps are assumed to produce temperatures mainly below 200 degrees Celsius**, while alternative fuel conversion technologies are assumed to be for higher temperatures.

- Europe, which is capable of procuring large amounts of cheap renewable energy, is promoting full electrification.

Electrification technologies, including heat pumps, are expected to have a **positive economic effect of 2.9-5.0 trillion yen, and a positive employment effect on 104,000-183,000 people in Japan as of 2030**.

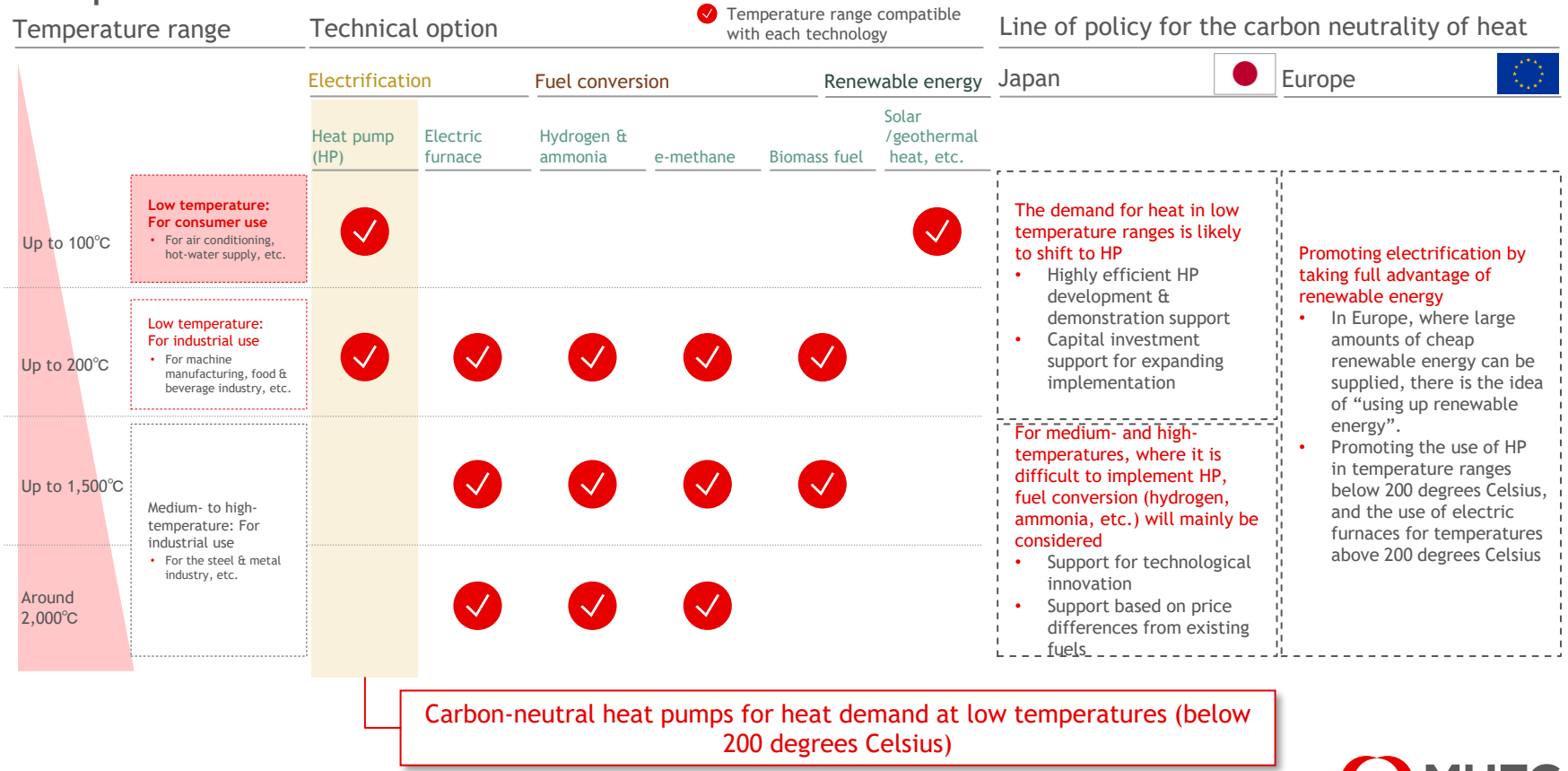
How Heat Pumps Work



Since heat pumps produce heat through electrical power rather than fuel combustion, heat pumps enable a process called “heat electrification”

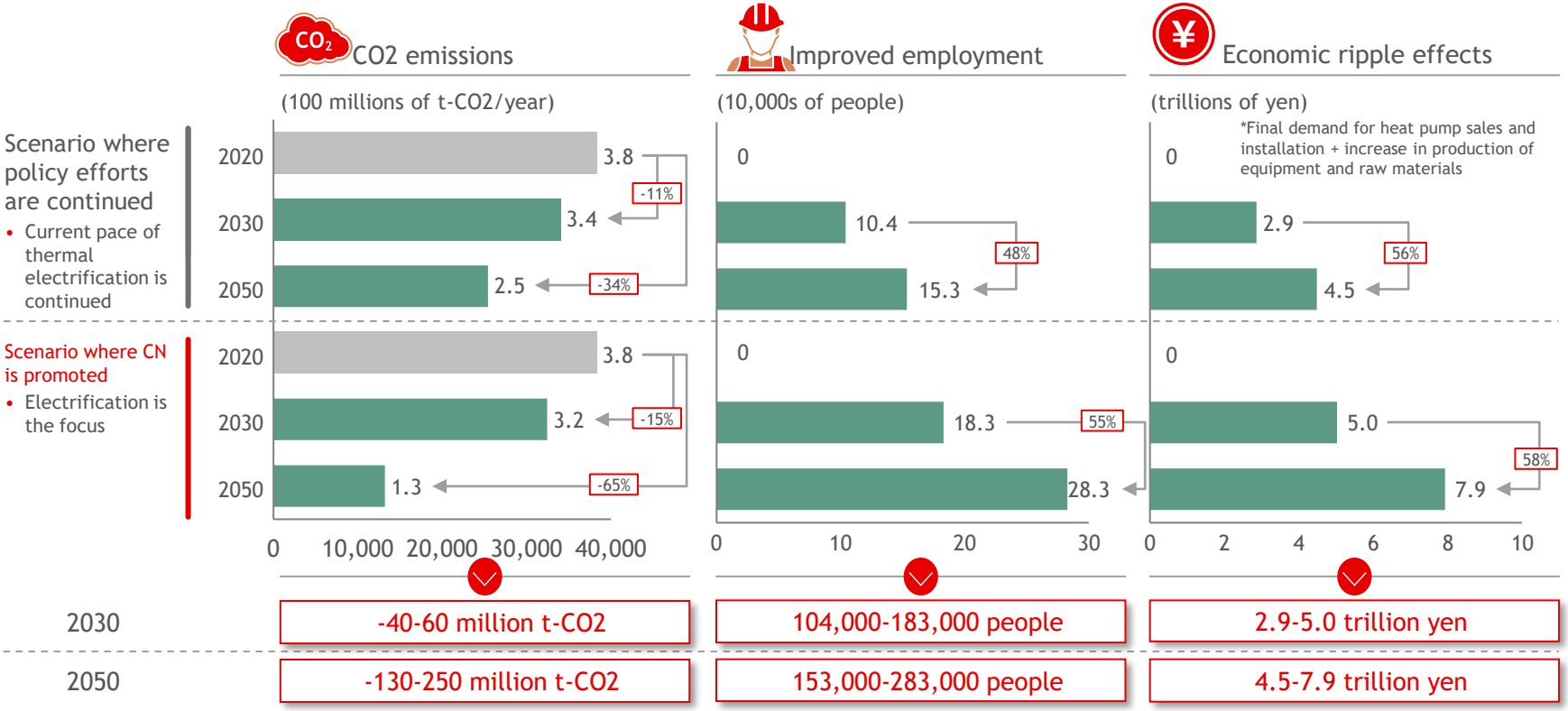
Source: Heat Pump & Thermal Storage Technology Center of Japan

Technical Options & Line of Policy for Carbon Neutrality of Heat Sources by Temperature Zone



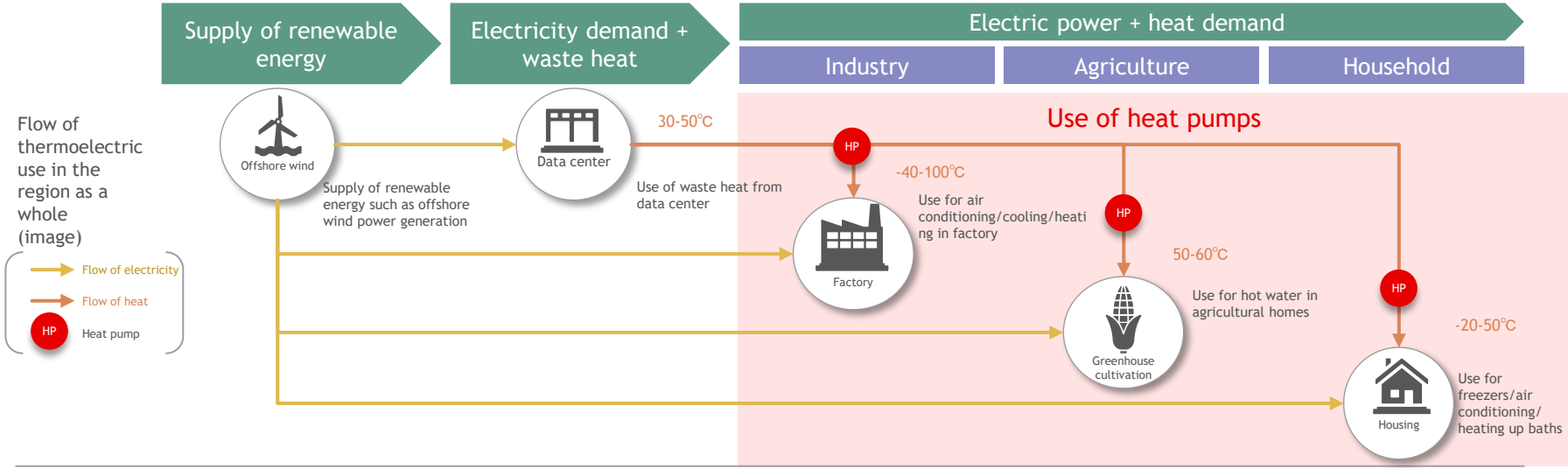
Source: Ministry of Economy, Trade and Industry “Clean Energy Strategy: Interim Strategy” (May 13, 2022); Various published information; MUFG analysis

CO2 Emissions Reductions, Improved Employment, & Economic Ripple Effects Through Thermal Electrification in Japan



Source: Heat Pump & Thermal Storage Technology Center of Japan/Japan Electro-Heat Center "Electrification Dissemination Outlook Survey Report" (Sept. 2022); MUFG analysis

Thermoelectric Management for Hokkaido



Hokkaido's advantages

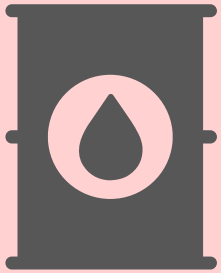
- Largest offshore wind installed in Japan (15 GW, 2040)
- Hyperscale data center of the future Optimal location
- Semiconductor employees/shipment value are on an upward trend (+20-30% in the past 10 years)
- Agricultural output Number 1 in Japan/ 1.2 trillion yen
- Heating needs in winter are extremely high due to Hokkaido's cold climate

In Hokkaido, it would be possible to use heat generated from renewable-energy-based heat pumps, enabling integrated thermoelectricity management to the industrial, agricultural, and household sectors.

Source: Article search; MUFG analysis

Hokkaido carbon neutrality potential

Next-generation fuels



Largest renewable energy & bio resources

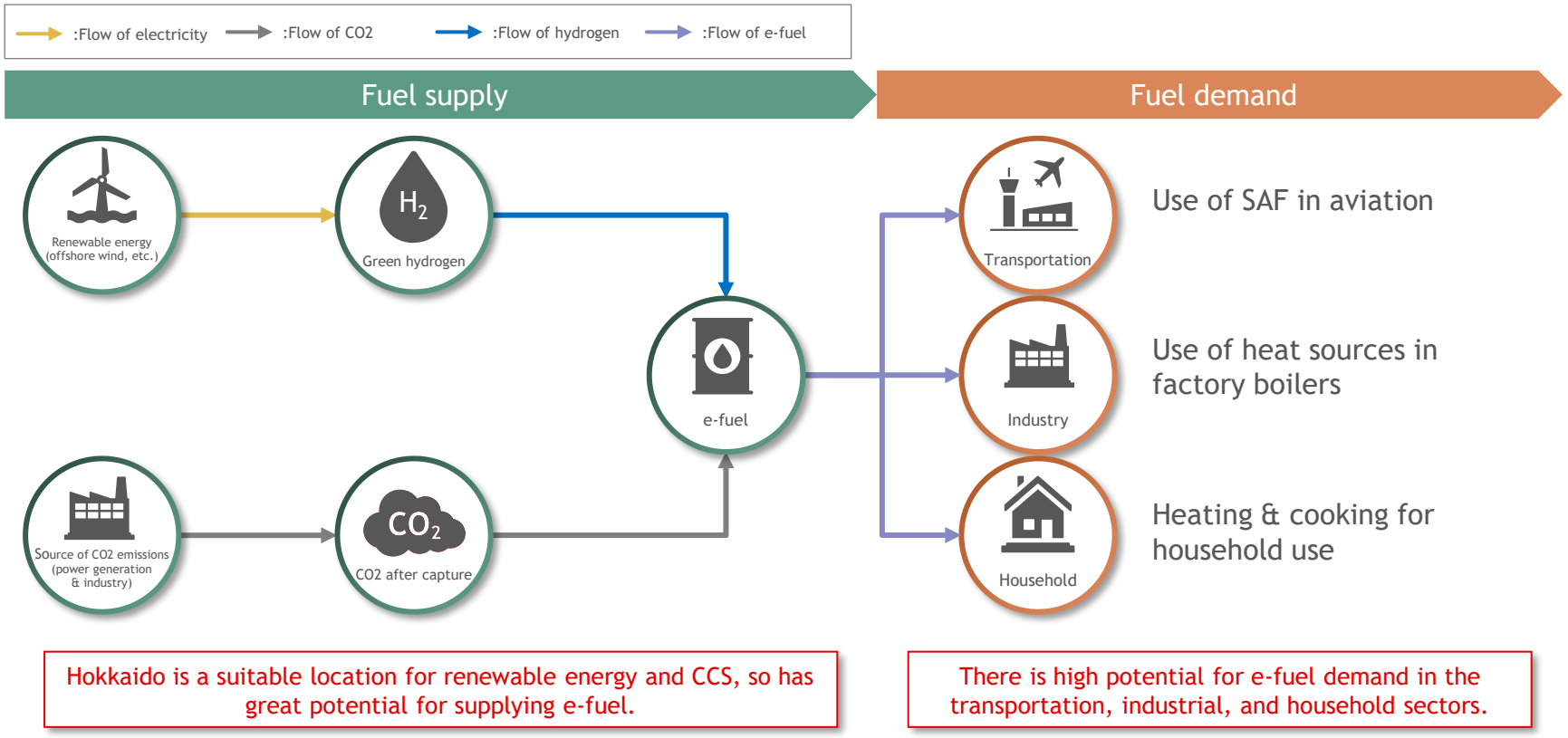
In Hokkaido, **an e-fuel supply chain based on a local-production-for-local-consumption model will be built** by connecting demand with an e-fuel supply network that utilizes resources in the region

- Hokkaido is the largest renewable energy/offshore wind power source (2040: 15 GW), for hydrogen production, required for e-fuel in Japan and is the most suitable location in the country for carbon capture and storage (CCS), which can supply CO2, a raw material for e-fuel.
- In terms of demand, e-fuel will be supplied to New Chitose Airport as sustainable aviation fuel (SAF), CO2-emitting industrial areas in Tomakomai and Muroran, and urban residential areas such as Sapporo.

In addition to e-fuel, new **biofuel supply chains** in Hokkaido are expected to be constructed:

- Okoppe Town, Hokkaido, aims to collaborate with local companies to realize a carbon neutral recycling-based dairy farming system that converts biogas into a liquid fuels such as methanol for use as an energy source in the region.

Hokkaido's Advantages for an e-fuel Supply Chain



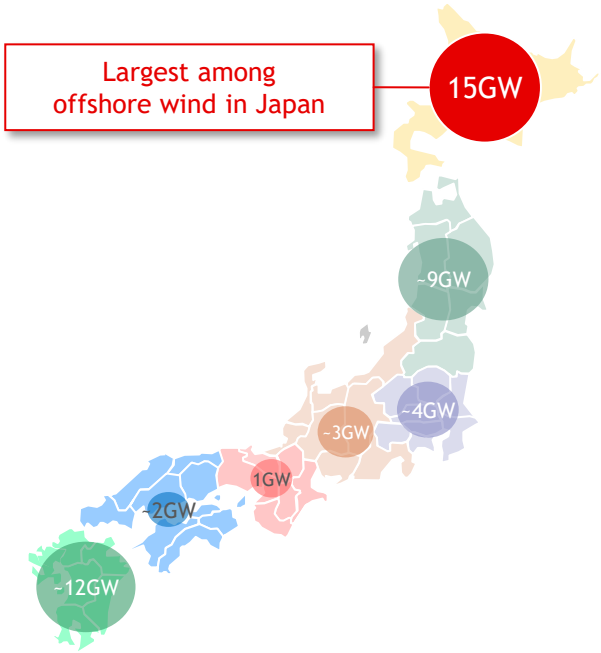
Hokkaido is a suitable location for renewable energy and CCS, so has great potential for supplying e-fuel.

There is high potential for e-fuel demand in the transportation, industrial, and household sectors.

Source: MUFG analysis

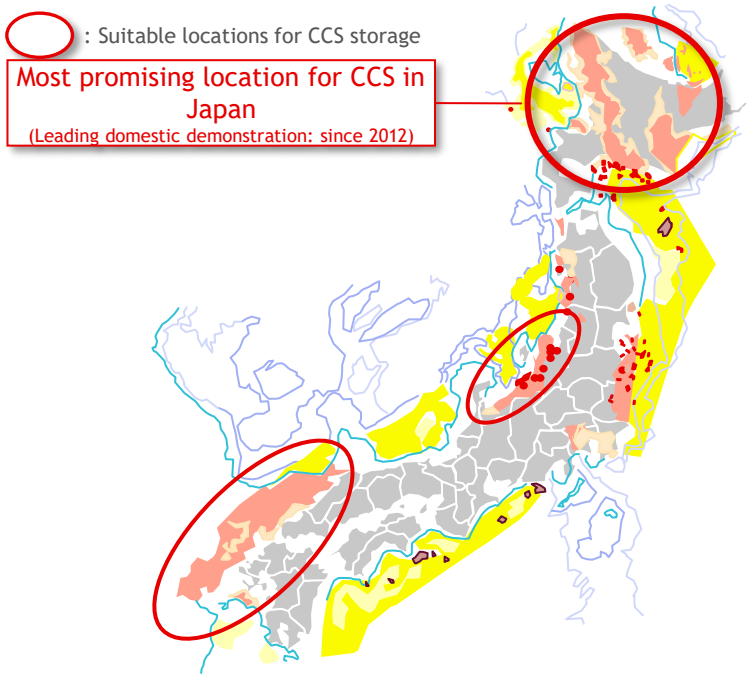
Hokkaido's Potential for Supplying e-fuel

Japan: Expected offshore wind installations by region (2040)



Renewable energy/offshore wind power, which is the energy source to produce hydrogen required for e-fuel, is expected to be the largest in Japan.

Japan: CO2 storage potential area (current)



The most promising CCS location in Japan, which can supply the CO2 required for e-fuel.

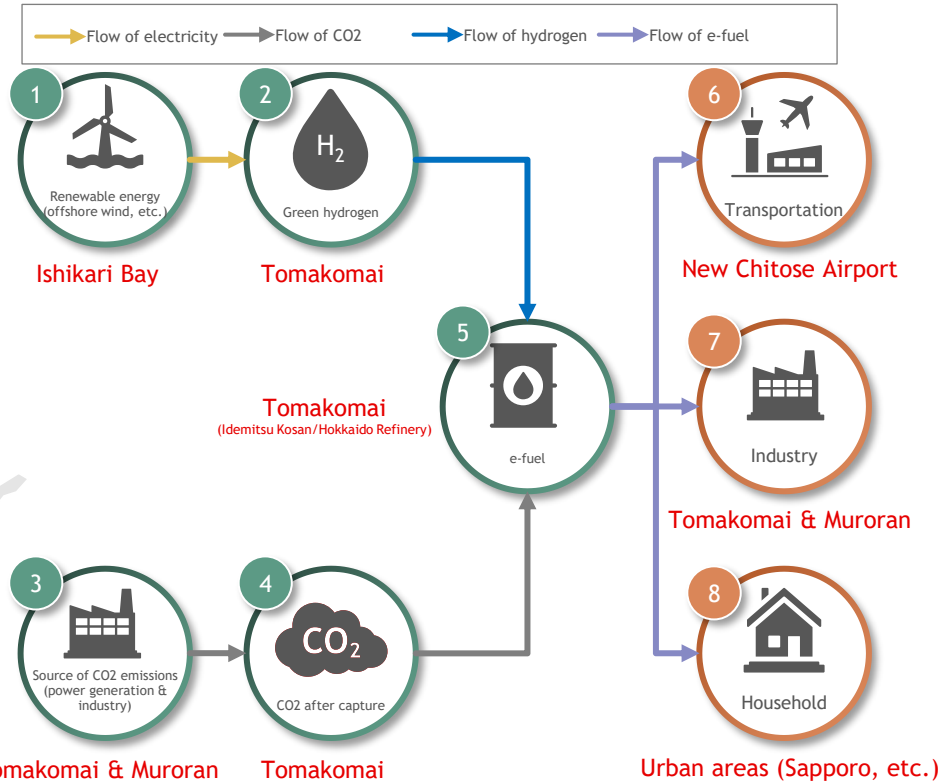
Source: OCCTO; Agency for Natural Resources and Energy's published materials; MUFG analysis

Future of e-fuel Supply Chain in Hokkaido

: e-fuel supply

: e-fuel demand

Local production for local consumption e-fuel supply chain

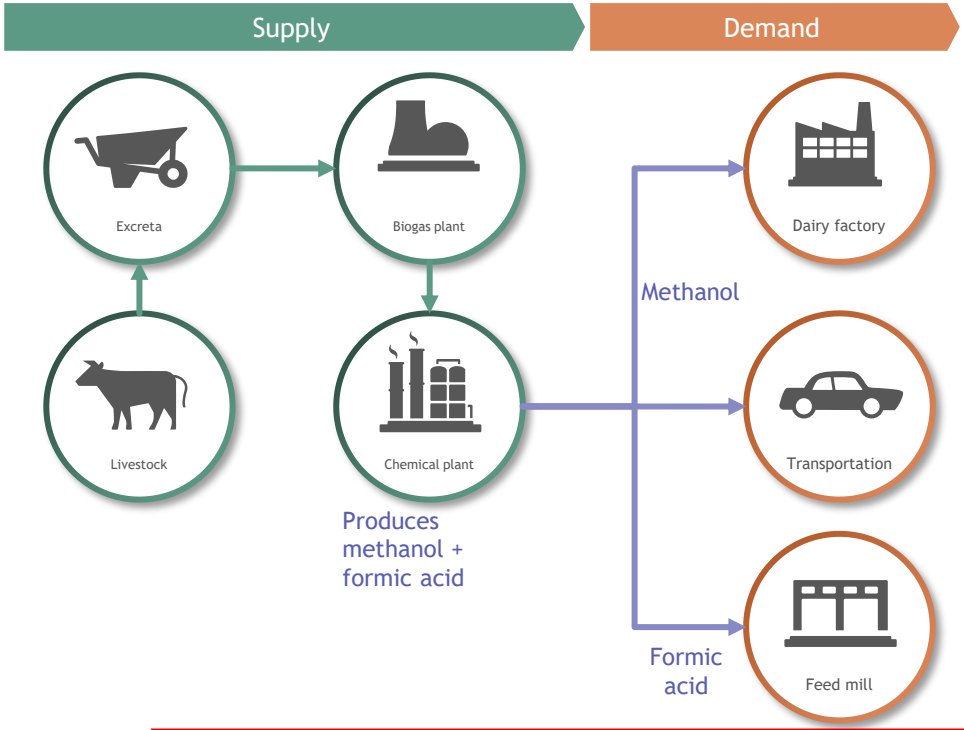


In Hokkaido, it is expected that an e-fuel supply chain based on a local-production-for-local-consumption model will be built by connecting demand with an e-fuel supply network that utilizes resources in the region.

Source: Various media reports; MUFG analysis

Biofuel: Initiatives Using Biogas in Okoppe Town, Hokkaido

Building a biogas-derived fuel supply chain in Hokkaido



Outline of initiatives

Implementation details

Produce biogas using excreta derived from livestock, and use that biogas to produce methanol etc.

- Generate methanol + formic acid derived from methane fermentation gas produced in the process of treating livestock excreta, and use it for transportation and industrial applications.

Implementing companies

Okoppe Town, University of Osaka, Air Water Hokkaido, Iwata Chizaki

Timing

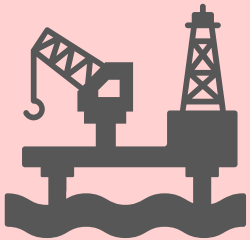
- 2019: Start of research & development by Osaka University and Okoppe Town
- 2021: Participation of two Hokkaido companies
- FY2030 and beyond: Practical application targets

Okoppe Town, Hokkaido, aims to collaborate with local companies to realize a carbon neutral recycling-based dairy farming system that converts biogas into liquid fuel methanol etc., for use as an energy source in the region.

Source: Various published information; MUFG analysis

Hokkaido carbon neutrality potential

CCS



Muroran and Tomakomai are the most promising locations for carbon capture and storage (CCS) in Japan

Tomakomai, where the CCS investigation is most advanced, **is the most promising location for CCS in Japan** and is expected to be capable of storing **500 million t-CO2**.

- The CCS potential for all of Japan is 15 billion t-CO2
- The estimated amount of CO2 storage capacity is still being investigated, but the investigation in Tomakomai, Hokkaido is the most advanced.

Hokkaido's main sectors of CO2 emissions, namely the electricity and industrial sectors, are concentrated in Muroran and Tomakomai, which are also suitable locations for CCS storage. Thus, it is possible to build **a CCS model in the Hokkaido region**.

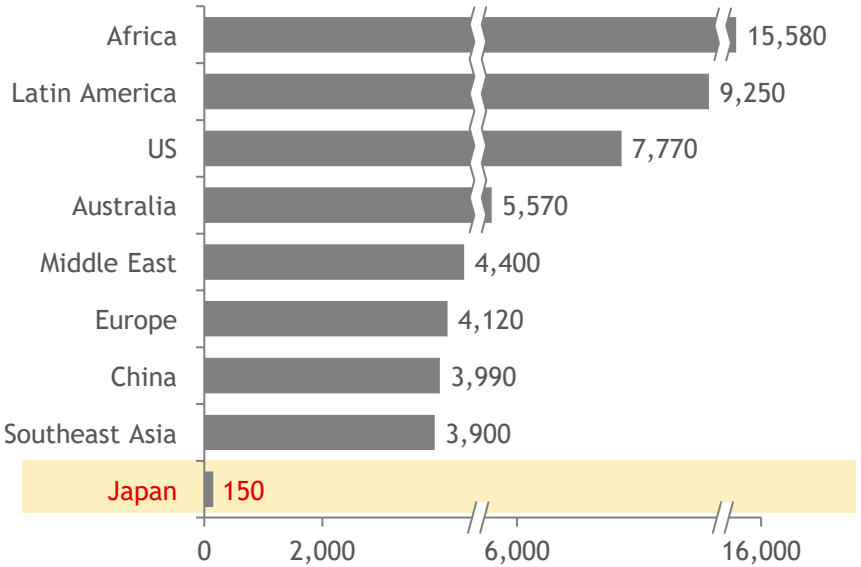
- Among the major cities in Hokkaido (Sapporo/Ishikari, Kushiro, Hakodate/Chinai, Muroran and Tomakomai), the industrial and power generation sectors of Muroran and Tomakomai have the largest CO2 emissions at 4,273,000 CO2 t/year.

In Tomakomai, where CCS experiments have been underway since 2012, efforts are currently being made to promote a system for **liquefying, transporting, and storing CO2** emitted in Kyoto.

- 10,000 t-CO2/year of CO2 will be collected and transported from a power plant owned by Kansai Electric Power in Kyoto, and stored at a site suitable for CCS in Tomakomai (expected to be completed in 2024).

CCS Potential in Hokkaido

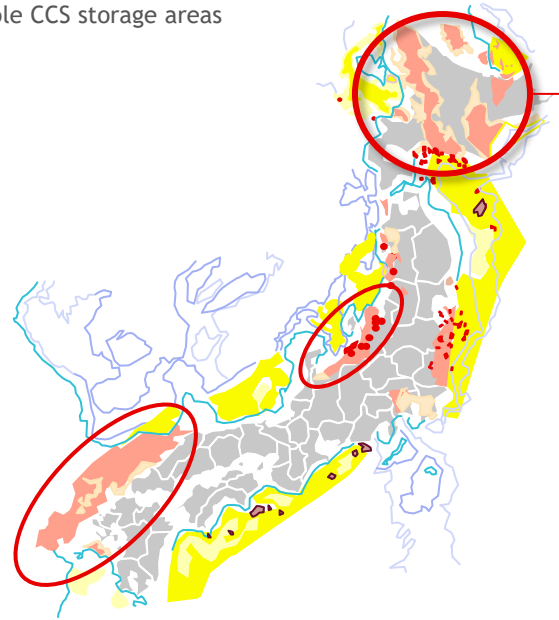
Global: CCS potential [1] (100 millions of t-CO2)



The CCS potential for all of Japan is 15 billion t-CO2

Japan: Areas where CO2 can be stored (current)

: Suitable CCS storage areas



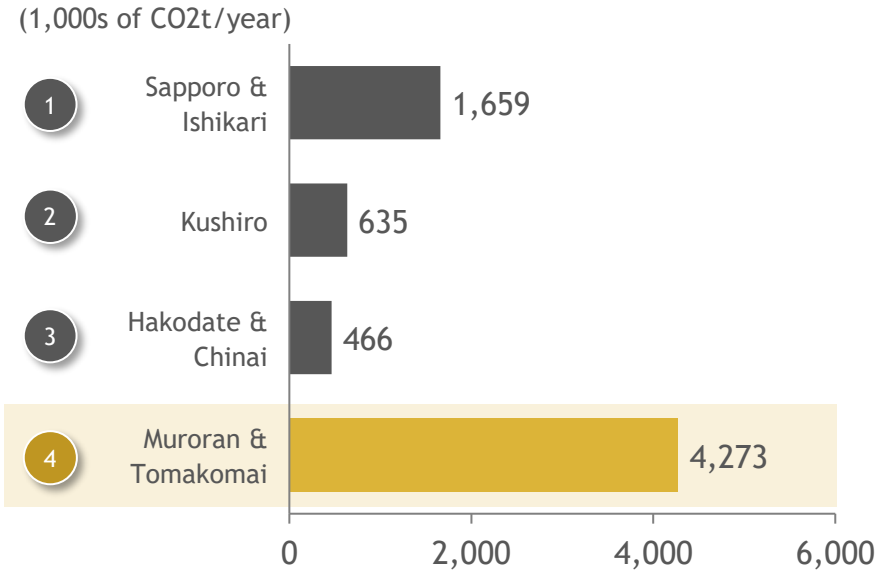
In Tomakomai, Hokkaido, where the CCS investigation is most advanced, a storage capacity of 500 million t-CO2 is confirmed.

1. The IEA estimates realistically storable values for marine storage potential, targeting depths within 300 m and coastal areas within 300 km worldwide.

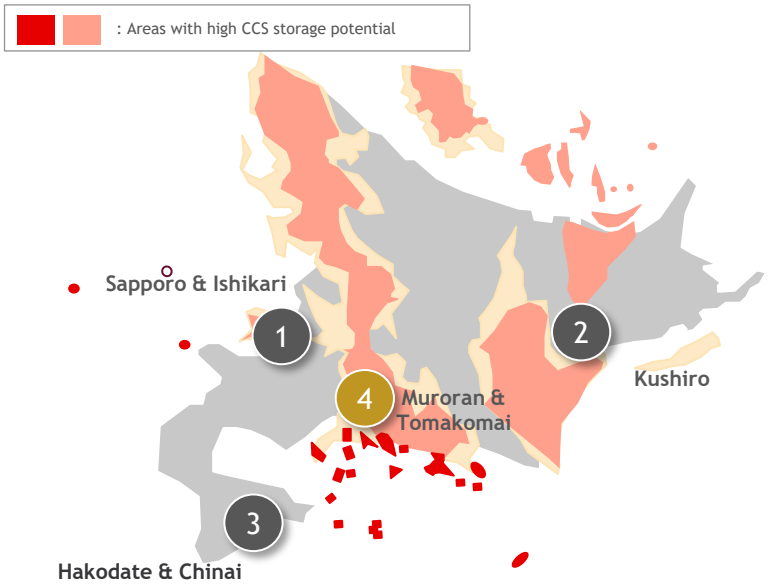
Source: IEA; Ministry of the Environment's estimation of current CO2 emissions by sector; RITE; Japan CCS investigation; Ministry of Economy, Trade and Industry; IEA; MUFG analysis

Model of CO2 Emission Areas & Regional CCS in Major Cities in Hokkaido

The CO2 emissions of the industrial & power generation sectors in major cities in Hokkaido



CO2 storage potential in Hokkaido



The largest CO2 emission areas in Hokkaido are Muroran & Tomakomai

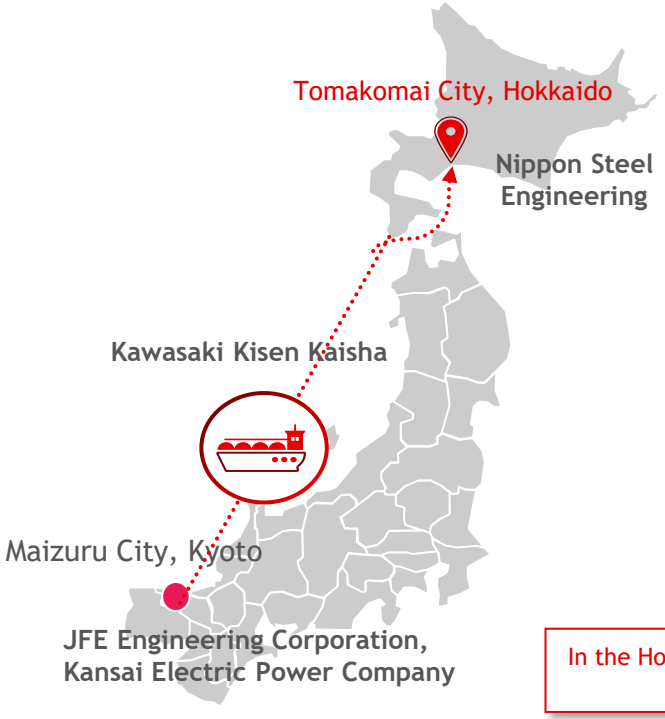
Muroran & Tomakomai are the most suitable locations for CCS in Hokkaido

CCS model in Hokkaido

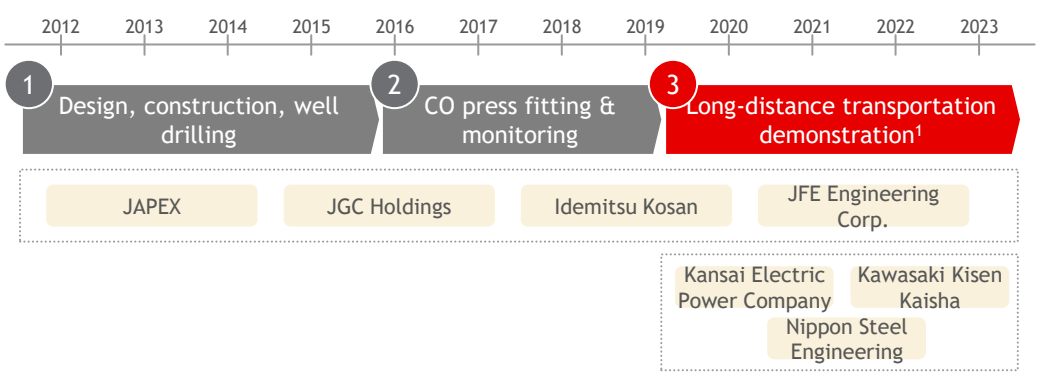
1. Emissions of the power generation sector after transfer to each sector 2. Of the main power plants, Naie, Sunagawa, and Date are excluded due to suspension. Ishikari Bay New Port Warf 2 is accounted for
Source: Ministry of the Environment's estimation of current CO2 emissions by sector; RITE; Japan CCS investigation; Ministry of Economy, Trade and Industry; IEA; MUFG analysis

CCS Demonstration in Hokkaido & Future Plans

CO2 liquefaction transportation project in Japan



CCS demonstration trends in Tomakomai



Checking of construction costs (24 billion yen at 1,000,000 CO2t/year)

Estimated storage capacity of approx. 500 million t

Transporting CO2 emitted in Kyoto and storing it in Tomakomai (10,000 t-CO2/year, expected to be completed in 2024)

In the Hokkaido Tomakomai case, efforts have been made to confirm costs, storage capacities, and, in recent years, long-distance transportation potential.

1. project by a four-company consortium consisting of Japan CCS Study (JCCS), Engineering National Association of Japan (ENAA), ITOCHU, and Nippon Steel Corporation

Source: Ministry of Economy, Trade and Industry; NEDO; Article search; MUFG analysis

Hokkaido carbon neutrality potential

Forests

Hokkaido ranks first in Japan in terms of forest area, artificial forest area, and lumber production value.

Hokkaido ranks first in Japan in terms of forest area, artificial forest area, and lumber production value and also takes steps such as using ICT to maximize the use of forest resources.

- Hokkaido has a forest area of 554 ha, of which 149 ha is artificial forest. It has a lumber production value of 35.8 billion yen. These metrics are the highest in Japan.

Hokkaido formulates forest management plans and acquires forest certifications at a high rate, and is very aware of forest management and environmental considerations **(= high-quality forests)**

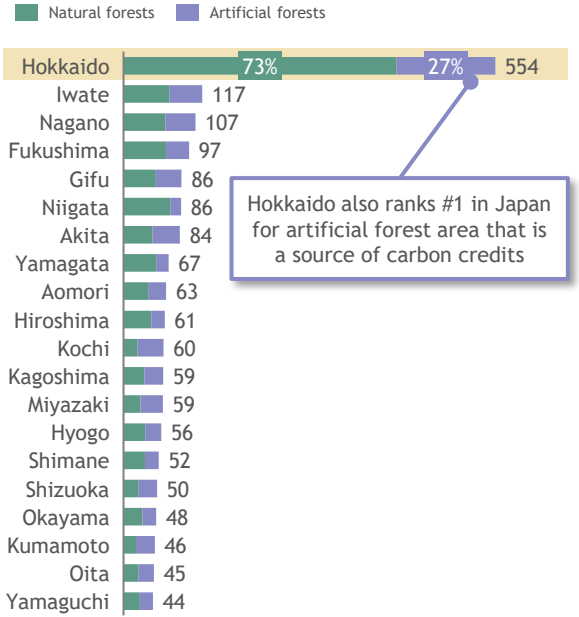
- Forest management plan formulation rate: 29% nationwide, 72% in Hokkaido
- Forest certification acquisition rate: 9% nationwide, 26% in Hokkaido

Hokkaido has set **a target of 8.5 million t-CO2/year for CO2 absorption through forests** and is striving to improve its afforestation rate and carbon fixation volume.

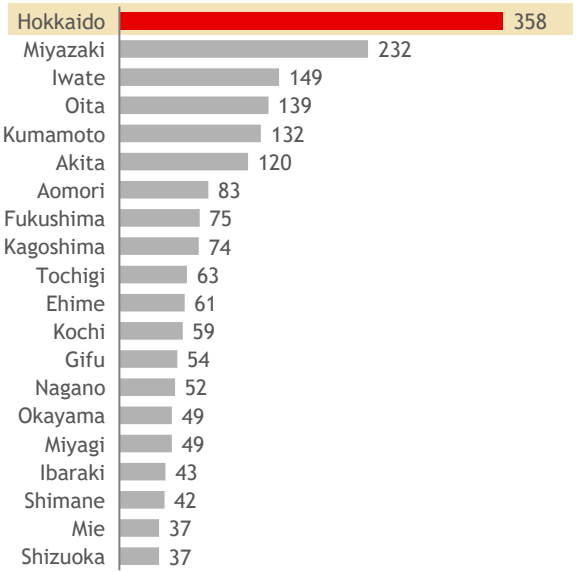
- Afforestation rate is 31% nationwide, but 87% in Hokkaido.
- Hokkaido has increased forest carbon fixation by 15% through: (1) shortening harvest times, and (2) reducing planting density.
- Hokkaido boasts the third largest abundance of unused materials in Japan & uses them in biomass power generation

Status of Forest & Lumber Industry in Hokkaido

Forest area by prefecture[1] (unit: 10,000s of ha)



Lumber production value by prefecture[2] (unit: 100 millions of yen)



Hokkaido: The largest initiative to utilize forest resources

1	Increase production of excellent seedlings	Forming an artificial forest mainly of larch/abies sachalinensis from excellent seedlings called clean larch
2	ICT utilization	Establishing & fixating smart forestry using ICT etc.
3	Credit generation	Generating large amounts of forest-derived credits
4	Education on the quality of wood products & the importance of their use, corporate collaboration	Collaborating with companies to implement forest development & education on the quality of wood products & the importance of their use

Hokkaido ranks first in Japan for forest area, artificial forest area, and lumber production value.

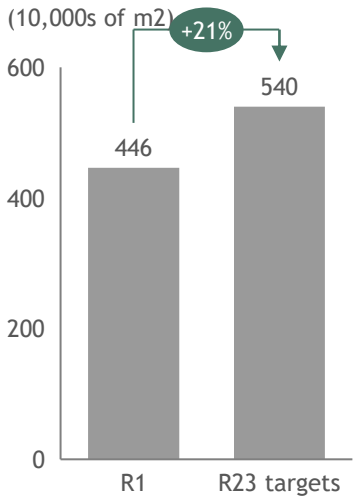
Hokkaido has implemented various measures to expand the use of forest resources

1. Only the top 20 prefectures are listed; 2. Only the top 20 prefectures are listed
Source: Forestry Agency; Ministry of Agriculture; MUFG analysis

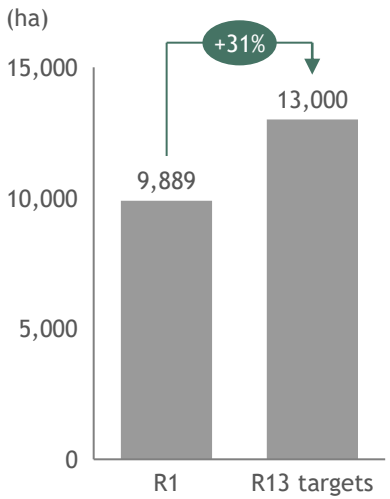
Current Status of Forestry in Hokkaido

Hokkaido: Change in lumber use & afforestation area

Wood utilization



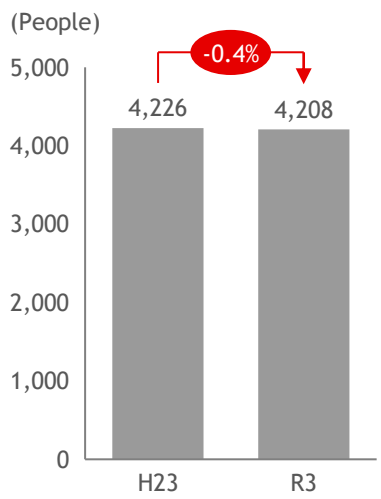
Afforestation area



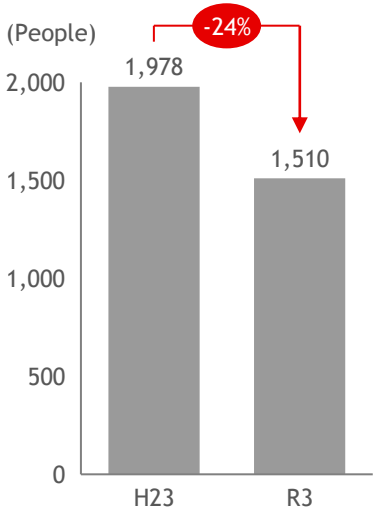
Hokkaido forestry is expanding, but…

Hokkaido: Change in number of employees

Number of forestry workers



Of which, number of employees engaged in afforestation



… the number of forestry workers is declining, so there is a need to promote ICT.

Source: Hokkaido Government Office

Potential Utilization of ICT in Hokkaido Forestry

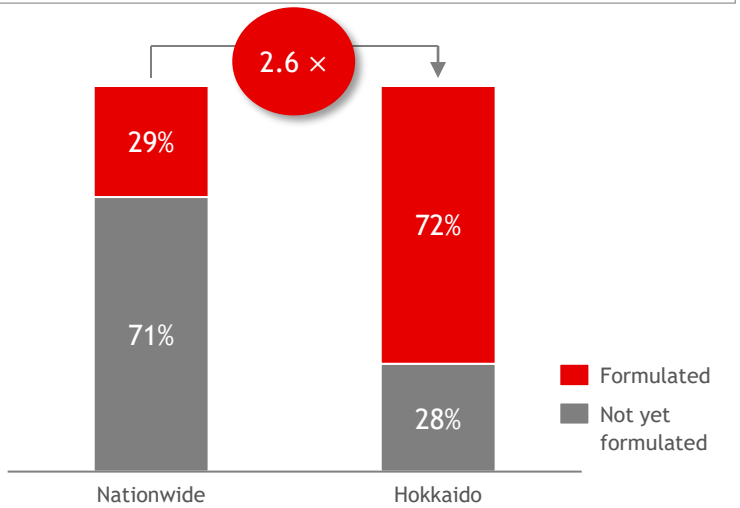
Classification	Conventional method	Smart forestry methods & their effects	
Forest survey	Human surveys 	Surveys using aerial & terrestrial lasers and drones for forest surveys, etc. 	Reduced man hours
Tree cutting & accumulation	Felling with chainsaws & accumulation with forestry machinery 	Production with high-performance forestry machinery 	Increased productivity
Confirmation of log production volume	Manual detection (through the use of human resources) 	Forestry machinery (ICT harvester) data management & log detection using tablet devices etc. 	Reduced man hours
Improvement of log selling price	Scoring based on operator experience 	Sampling using ICT harvesters 	Increase in high value-add logs
Factory acceptance & inventory management	Manual detection (through the use of human resources) 	Detection using tablet devices etc. 	Reduced man hours

Source: Hokkaido Government Office

Hokkaido's Excellent Forest Management System

Area rate formulated in forest management plan

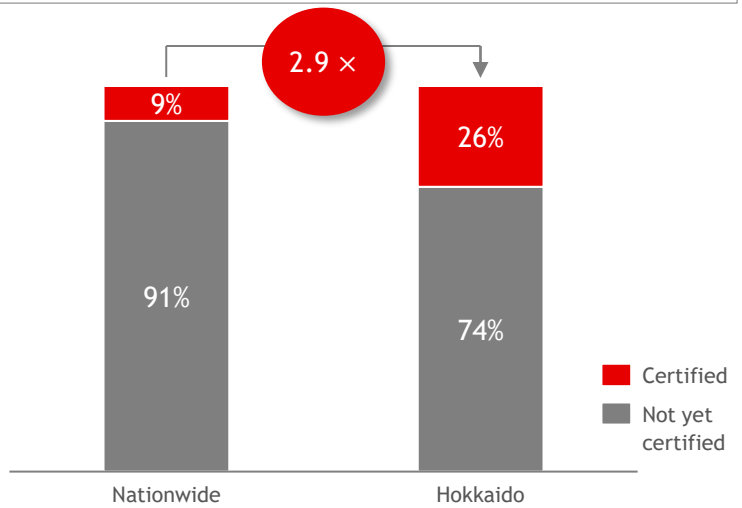
Forest management plan:
Forest owners/consignors can receive subsidies, tax exemptions for land, and other forms of support with a five-year plan for forest management and protection.



Hokkaido systematically cultivates forests and improves their added value

Area rate for which forest certification has been acquired

Forest certification:
A system in which a third-party organization certifies forests that meet certain standards, including forest management sustainability and environmental considerations, and encourages consumers to purchase certified materials.

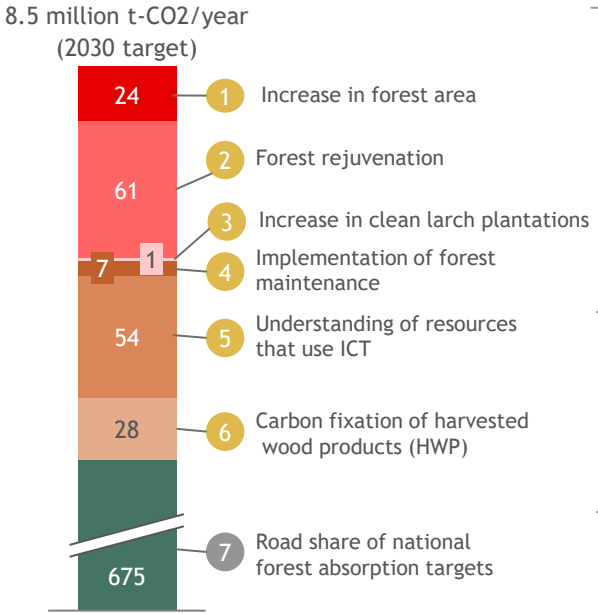


Hokkaido excels in providing environmentally-friendly, high-value-add certified materials

Source: Ministry of Land, Infrastructure, Transport and Tourism, Hokkaido Bureau, Agriculture, Forestry and Fisheries Division "Forests and Forestry in Hokkaido 2020"; MUFG analysis

Outline of the Plan to Promote Forest Sink Measures in Hokkaido

Hokkaido: 2030 forest absorption target



Specific measures for achieving target

Type of measure	Outline	Indicators	2019	2030
Creating vibrant forests	Systematic forest maintenance	Afforestation area	10,000 ha	13,000 ha (1.3×)
	Clean larch seedlings	Number of used & produced clean larch	160,000	1.2 million (7.5×)
	Calculation of forest absorption Securing of target forests	Percentage of forests subject to calculation	70%	75%
Promoting the use of Hokkaido lumber	Long-term carbon fixation Promoting the use of lumber	Ratio of Hokkaido-made lumber in demand for lumber, plywood etc.	69%	75%
	Promoting the use of wood biomass	Amount of wood biomass used	1.38 million m3	1.95 million m3 (1.4×)
Creating forests in collaboration with companies	Promoting corporate tree education activities	Number of tree education activities in collaboration with companies etc., and woodworking experts.	81 times	141 times (1.7×)

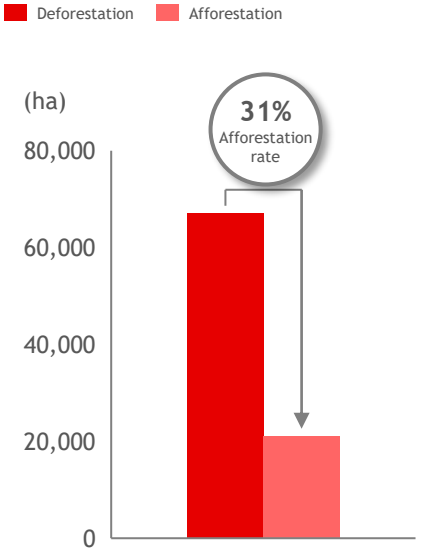
Manage progress by setting specific measures, evaluation indicators, and target values in order to move toward a target of 8.5 million tons of forest CO2 absorption by 2030.

Source: Plan to promote forest sink measures in Hokkaido; MUFG analysis

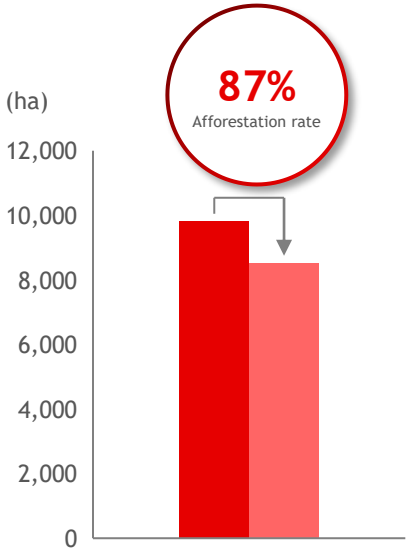
Afforestation Management & Improvement of Carbon Fixation in Hokkaido

Cutting area & afforestation area (2016)

Nationwide

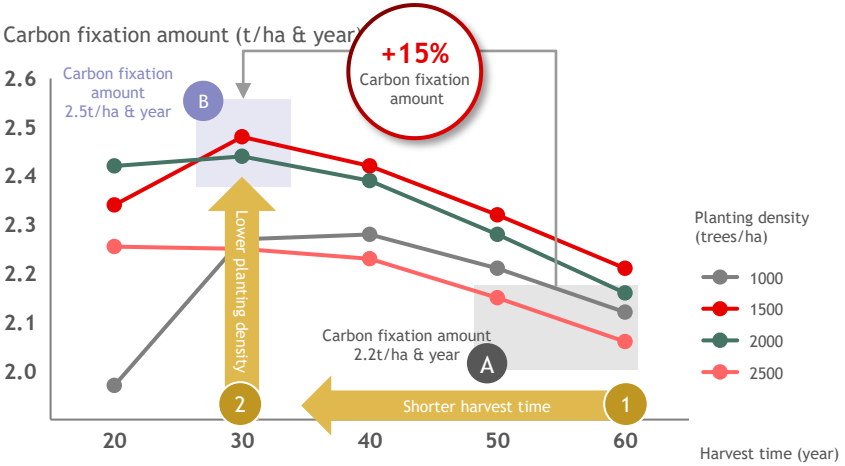


Hokkaido



Planting density & harvest time

	Until now A	After improvement B
1 Harvest time (year)	50 – 60	30 – 40
2 Planting density (trees/ha)	2,500	1,500 – 2,000



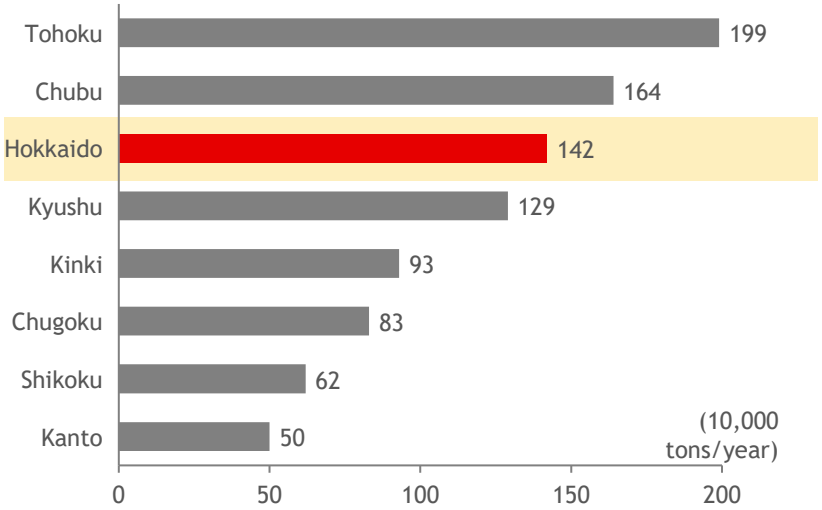
Hokkaido has a high afforestation rate (which means it has an excellent circulation cycle of forest resources). It improves carbon fixation by managing the density of afforestation efforts and harvesting times.

Source: Hokkaido; Hokkaido Research Organization; MUFG analysis

Current Volume of Unused Wood in Japan & Use in Hokkaido

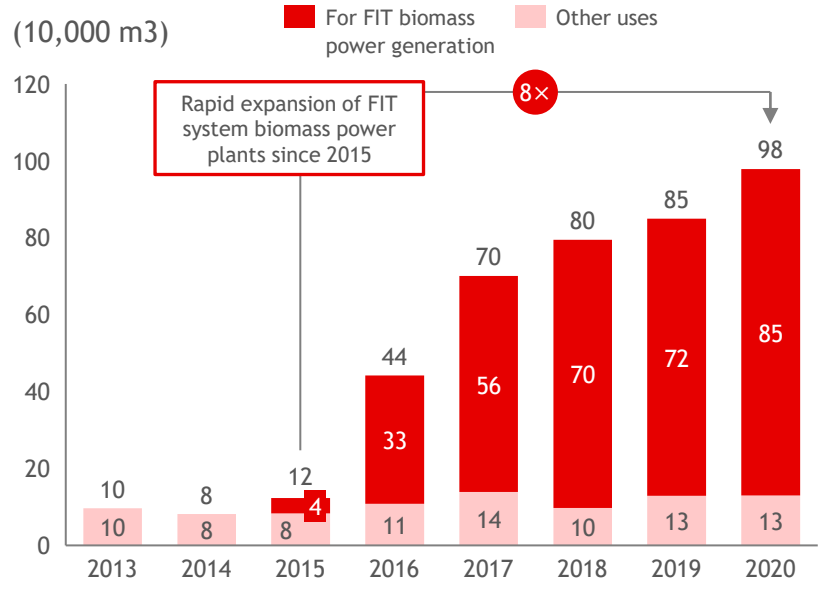
Current volume of unused wood[1]

Unused wood: Thinned wood that cannot be used in lumber, etc., branches at the base of trees etc., which accumulate during harvesting



Hokkaido has the third largest abundance of unused woody materials in Japan

Biomass applications derived from unused wood in Hokkaido



Hokkaido uses its abundance of unused materials for FIT biomass power generation

1. Estimates from FY2008 state-owned forest & FY2006 privately owned forest data

Source: Hokkaido Government Office materials; White Paper on forestry; Report on wood supply & demand; NEDO; Norinchukin Research Institute; Article search; Japan Woody Bioenergy Association; MUFG analysis

Hokkaido carbon neutrality potential

Agriculture

Highest agricultural output in Japan

Hokkaido's **agricultural output value is the highest in Japan at 1.2 trillion yen**

- Hokkaido accounts for 14% of Japan's total agricultural output of about 9 trillion yen

When it comes to **agricultural crops, which account for about 40%** of agricultural output, Hokkaido's arable land area **is also the largest** and best managed, and Hokkaido's carbon storage potential through biochar and no-till farming is high.

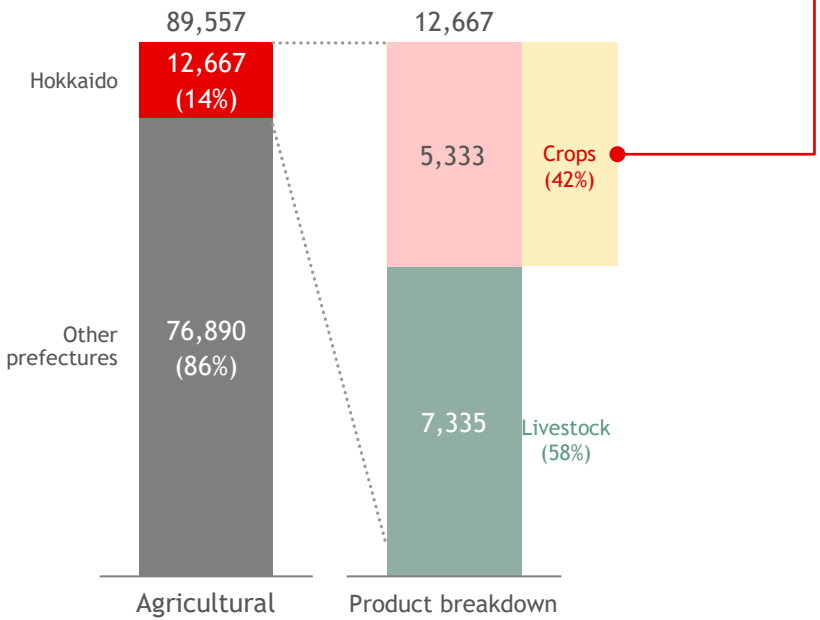
- Hokkaido's agricultural output is 500 billion yen
- Hokkaido ranks first in Japan in terms of arable land area (921,400 ha) and arable land area per manager (30.2 ha), making it suitable for the cultivation of biochar, which can store CO2, and no-till farming.

Livestock accounts for about 60% of agricultural output. Efforts are being made to promote a **recycling-based dairy farming model** that contributes to carbon neutrality by absorbing and circulating methane and CO2 emissions into forests and soil.

- Hokkaido's livestock output is worth about 700 billion yen.
- Utopia Agriculture, Sony, and Hokkaido University are jointly promoting a model that absorbs and recycles methane emissions from the livestock sector in forests and soil.

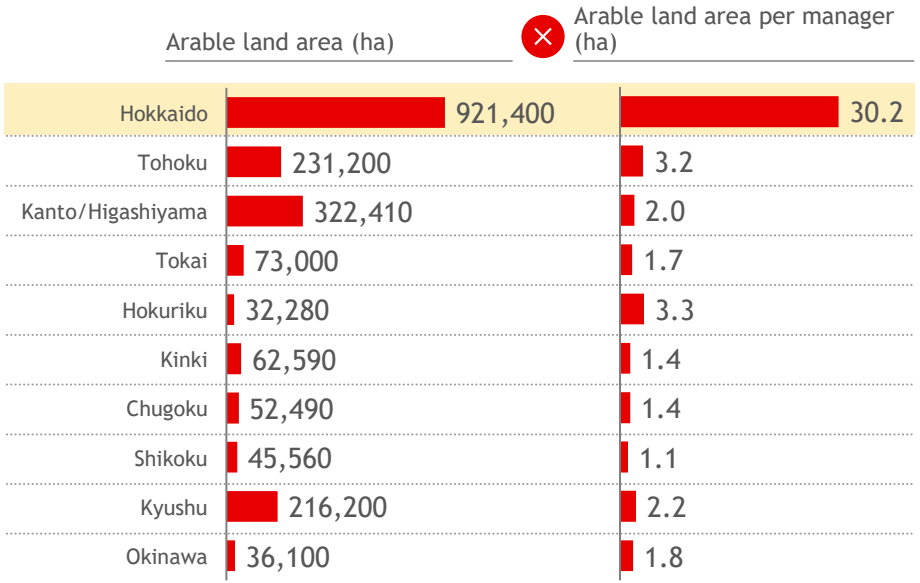
Carbon Storage Potential for Hokkaido's Agriculture Sector

Agricultural output & breakdown of items (unit: 100 millions of yen)



Hokkaido's agricultural output is the highest in Japan at 1.2 trillion yen

Actual state of arable land & carbon storage potential in Hokkaido



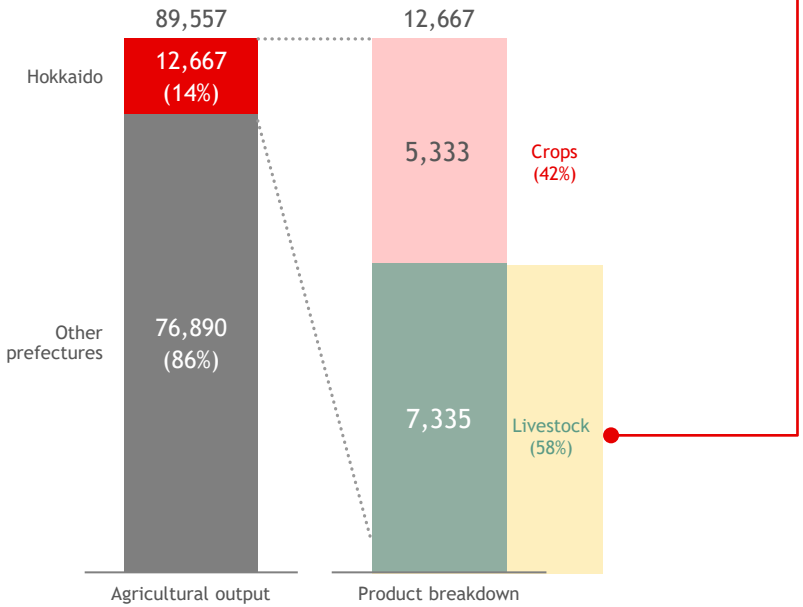
Hokkaido has the largest arable land area in Japan, which is well managed. It also has high potential for biochar, which can store CO2, and no-till farming.

No-till farming: Enhancing the carbon storage function of soil by using cultivation methods that do not till farmland.

Source: Ministry of Agriculture, Forestry and Fisheries; Japan Cool Vege Association; MUFG analysis

Hokkaido's Recycling-Based Dairy Farming Model

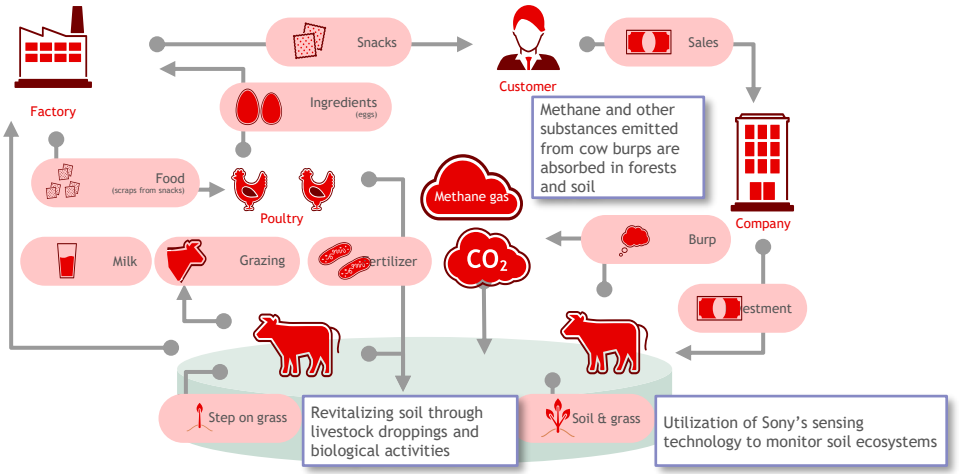
Agricultural output & breakdown of items (unit: 100 millions of yen)



Hokkaido's recycling-based dairy farming model

Participants: Utopian Agriculture, Sony, Hokkaido University

Purpose To absorb & circulate methane emissions from the livestock sector using forests and soil

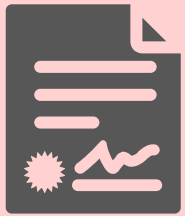


Promote a dairy farming model that contributes to carbon neutrality by absorbing and circulating emitted methane and CO2 emissions into forests and soil.

Source: Ministry of Agriculture, Forestry and Fisheries; HOKUREN Federation of Agricultural Cooperatives; Published information from Utopian Agriculture's; MUFG analysis

Hokkaido carbon neutrality potential

Carbon Credits



Hokkaido J-credits have expanded by around fourfold in the past three years

Hokkaido J-credits have expanded by around fourfold in the past three years. The main focus is the creation of carbon credits in **biomass (about 60%) and forest formation (about 40%).**

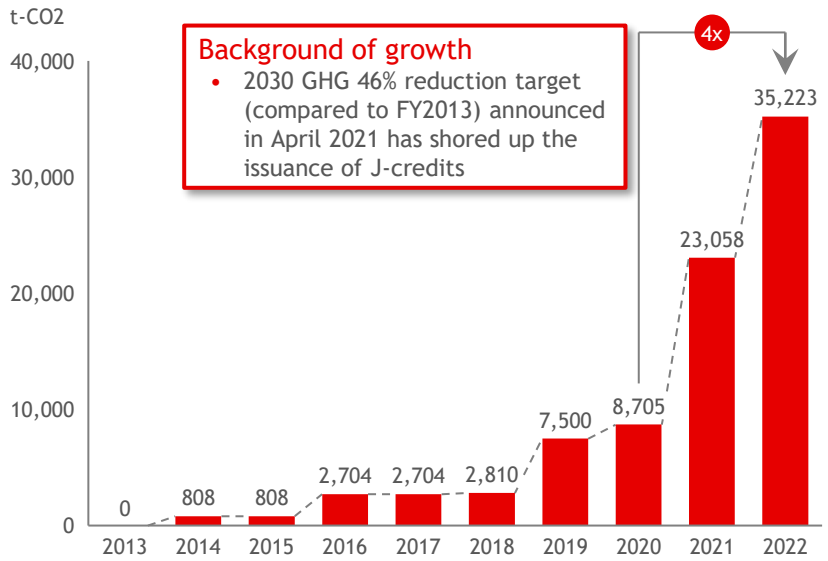
- The target of reducing GHG by 46% by FY2030 (compared to FY2013 levels), announced in April 2021, has shored up issuance of J-credits.

The global **voluntary carbon credit market is expected to grow, and afforestation and reforestation, which are the mainstay methods for natural removal and will account for about 30%** of the market in the future**, have high potential in Hokkaido.**

- The global voluntary carbon credit (VCC) market is expected to expand fivefold from 2020 to 2030.
- As of 2030, natural removal will account for about 30% of the global VCC market, and about 80% of natural removal will be afforestation and reforestation.
- Artificial forests will for the basis for afforestation and reforestation, and since Hokkaido's artificial forest area spans 1.48 million ha., which overwhelmingly ranks first in Japan, there are high hopes that voluntary carbon credits will be generated from Hokkaido.

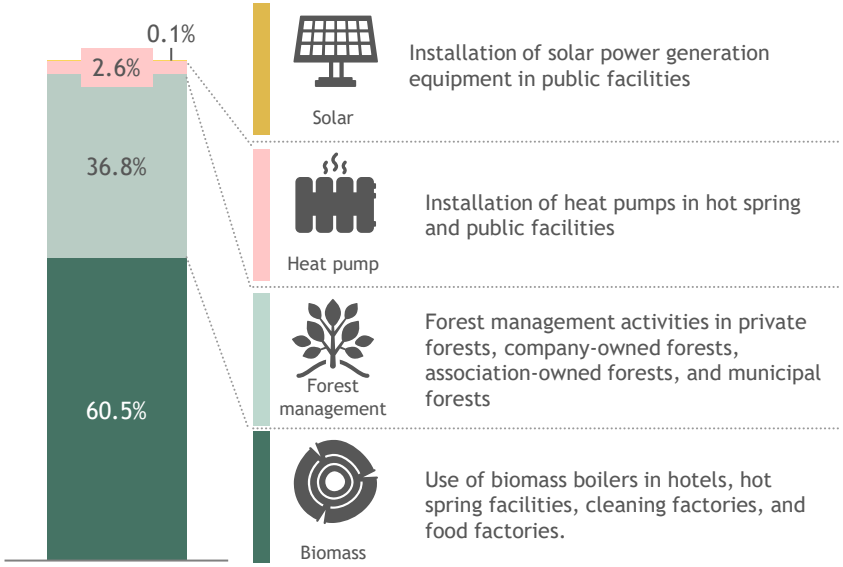
Carbon Credit Trends in Hokkaido

Hokkaido: Cumulative J-credits issued[1]



Hokkaido's J-credits have increased about fourfold in the past three years

Breakdown of J-credits issued by Hokkaido

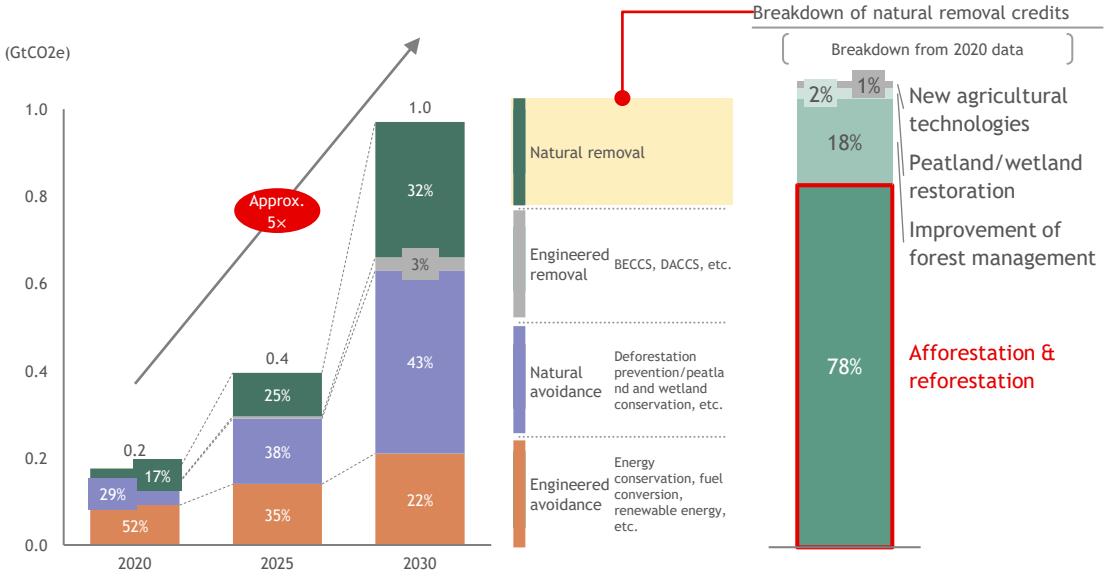


Biomass and forest management are major sources of J-credits

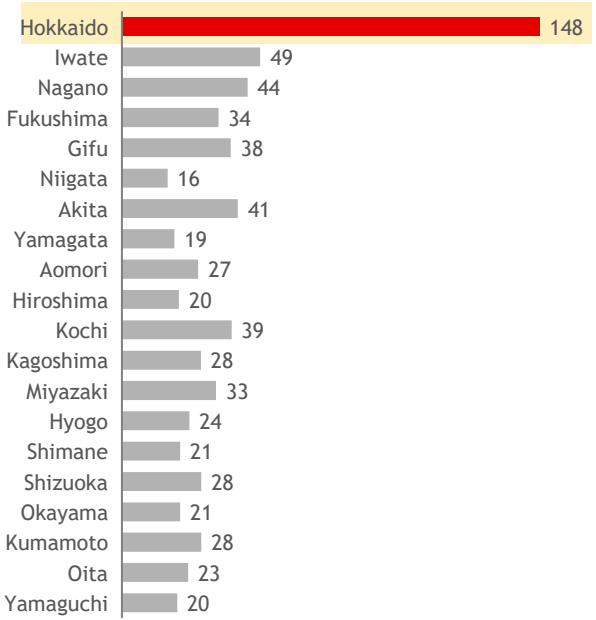
1. Does not include credit generated from solar power generation facilities installed under subsidized projects of the Ministry of Economy, Trade and Industry
Source: J-credit system homepage; MUFG analysis

Global Voluntary Carbon Credit Trends & Hokkaido's Potential

Global: Voluntary carbon credits (VCC) trends



Artificial forest area by prefecture[1] (unit: 10,000s of ha)



The global carbon credit market is growing, and afforestation and reforestation will be the mainstay of natural removal, which will account for about 30% of that market in future.

In terms of artificial forest area, which forms the basis of afforestation and reforestation, Hokkaido ranks first in Japan.

1. Only the top 20 prefectures in terms of natural forest + artificial forest size are listed
Note: 2020 data are actual values, and figures for 2021 and beyond are estimated values. Credits across multiple domains are distributed equally (e.g., Increased Forest Management)
Source: Voluntary Carbon Market Dashboard (Climate Focus) ;Registries (Verra, Gold Standard, ACR, CAR); CORSIA; IMO; IEA; CDP; Company commitments; ICAP; Fraunhofer ISI; MUFG analysis

Hokkaido sector-specific potential: Recap

Hokkaido Carbon neutral Technology Potential: Assessment Summary

	Environmental and economic contributions in Hokkaido	Value provided to areas outside Hokkaido
Offshore wind	45 GW of offshore wind power is scheduled to be installed nationwide across Japan by 2040. Hokkaido is expected to be home to the largest proportion of that installed amount, at 15 GW. In addition, 3.9 GW of capacity has already been confirmed in five preparation areas in Hokkaido (2023).	In Ishikari Bay in March 2023, Hokkaido, the Green Innovation Fund is conducting a study for the demonstration of one of Japan's largest TLP-type floating offshore wind power sites (15 MW/unit), and is expected to develop the offshore wind power business in Japan and Asia while promoting port development.
Transmission & distribution	Approximately 1.1 trillion yen is being invested in strengthening regional power transmission and distribution in Hokkaido. By expanding the current single 275 kV transmission area to four areas, it is expected that offshore wind power across multiple coastal areas of Hokkaido will be suppliable to urban areas in Hokkaido.	Up to 3.4 trillion yen is being invested in strengthening the transmission network between Hokkaido, Tohoku, and Tokyo. Increasing the scale eightfold from the current 0.9 GW to 7.2 GW will help expand the supply of offshore wind power produced in Hokkaido to Honshu (the largest of the four main islands of Japan).
Heat pump	Hokkaido has an abundance of renewable energy (offshore wind 15 GW (2040), etc.), which will promote the use of electric heat pumps that generate heat below 200 degrees Celsius in the industrial, business, household, and agricultural sectors. Waste heat from data centers in Hokkaido can supply heat to neighboring areas. A regional heat circulation model using a community-wide heat pump can be built.	
Next-generation fuel	Realizing the production of SAF and the promotion of cleaner energy sources in Hokkaido by generating e-fuel using green hydrogen and CO2 produced in Hokkaido, derived from the prefecture's abundant surplus of renewable energy, as well as bio-raw materials from wood etc., obtained from Hokkaido's abundant forestry resources.	By using some of the CO2 for CCS transported from outside Hokkaido as a raw material for e-fuel, the added value of CO2 can be improved and recycling efforts promoted (CCU). it may be possible to provide clean mobility fuel, mainly SAF, to areas outside Hokkaido.
CCS	The industrial sector, which is the primary CO2 emitter in Hokkaido, is concentrated in the areas of Muroran and Tomakomai. Tomakomai has a site suitable for CCS (area with a sedimentary layer thickness of over 1,000 m, and a water depth of less than 200 m), which would allow for CO2 capture/storage.	There is room for domestic collaboration to store CO2 emitted outside Hokkaido in suitable locations in Hokkaido. A project has been launched to liquefy, transport, and store 10,000 CO2t/year emitted by Kansai Electric Power Company/Maizuru Power Station (Kyoto) (to be completed in 2024).
Forest	Hokkaido boasts the largest forest area in Japan (554 ha), and has an excellent forest management plan, forest certification acquisition, afforestation rate, and forest carbon fixation. It has set a forest absorption target of 8.5 million t-CO2/year by 2030.	Hokkaido, which boasts the largest timber production value in Japan (35.8 billion yen), is using ICT to cover the labor shortage in the forestry industry, provide more productive and high value-added lumber, and effectively use unutilized wood with large amounts of reserves as biomass fuel in Hokkaido.
Agriculture	Hokkaido boasts the largest arable land area in Japan (1,143 ha, about 30% of the total in Japan), and has high carbon storage potential through techniques such as biochar and no-till farming. It is expected to expand the use of negative emissions technologies (NETs) in agriculture.	Hokkaido's agricultural output is about 1.2 trillion yen (about 15% of Japan's total), and the 500-billion-yen agricultural produce sector and the 700-billion-yen livestock sector are Hokkaido's basic industries. In addition, there is room for nationwide development of the recycling-based dairy farming model developed by Hokkaido University.
Data center	Hokkaido's cool climate is suitable for data centers, and it has land suitable for renewable energy and users' risk diversification. About 50% of data center OPEX is electricity, which can be lowered by utilizing outdoor air conditioning	Hokkaido offers data center services for business continuity planning or backup, leveraging renewable energy and the cool climate, from the perspective of risk diversification
Semiconductor	Hokkaido can provide stable electricity supply, an abundant supply of high-quality water, cool air, as well as low-vibration and low-noise environments that are necessary for semiconductor factory locations. There is interest in concentrating the development of semiconductor-related industries in Hokkaido. Renewable energy supply is also attractive.	The number of semiconductor-related employees and the value of product shipments in Hokkaido increased by 20-30% between 2010-2020, and the value of semiconductor-related shipments is expected to rise even further as engineering students in Hokkaido (about 10,000) play active roles in the future.
Carbon credit	J-Credit in Hokkaido was issued 35,000 t-CO2 (60% for biomass use, 40% for forest management) in the 10-year period between 2013-2022, and the amount issued has expanded fourfold from 2020 to 2022 and is expected to expand even further in future.	The market for VCC (Voluntary Carbon Credit) is expanding around the world, and since nature-based carbon removal credits are mainly derived from afforestation and regenerated forests, there is room for credit from Hokkaido's abundant artificial forests to be circulated in the market.

Carbon Neutral Economic Zone Concept in Hokkaido (Draft)

Building a regional economic zone through carbon neutrality in Hokkaido

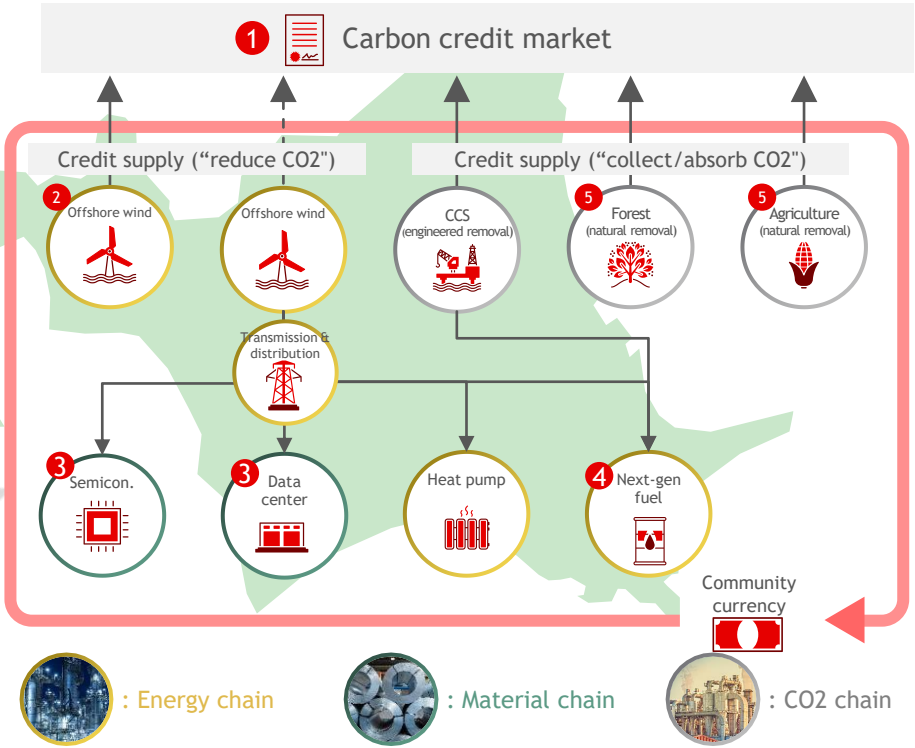
Utilize abundant resources such as renewable energy, forests/agriculture, and CO2 storage to promote early carbon neutrality in Hokkaido, and issue a community currency linked to Hokkaido's sustainability projects to build a regional economic zone.

Value supplied to locations outside Hokkaido

1. Credit
2. Renewable energy (transmission network between regions)
3. Digital-related goods & services
4. Next-generation fuel
5. Timber & agricultural products

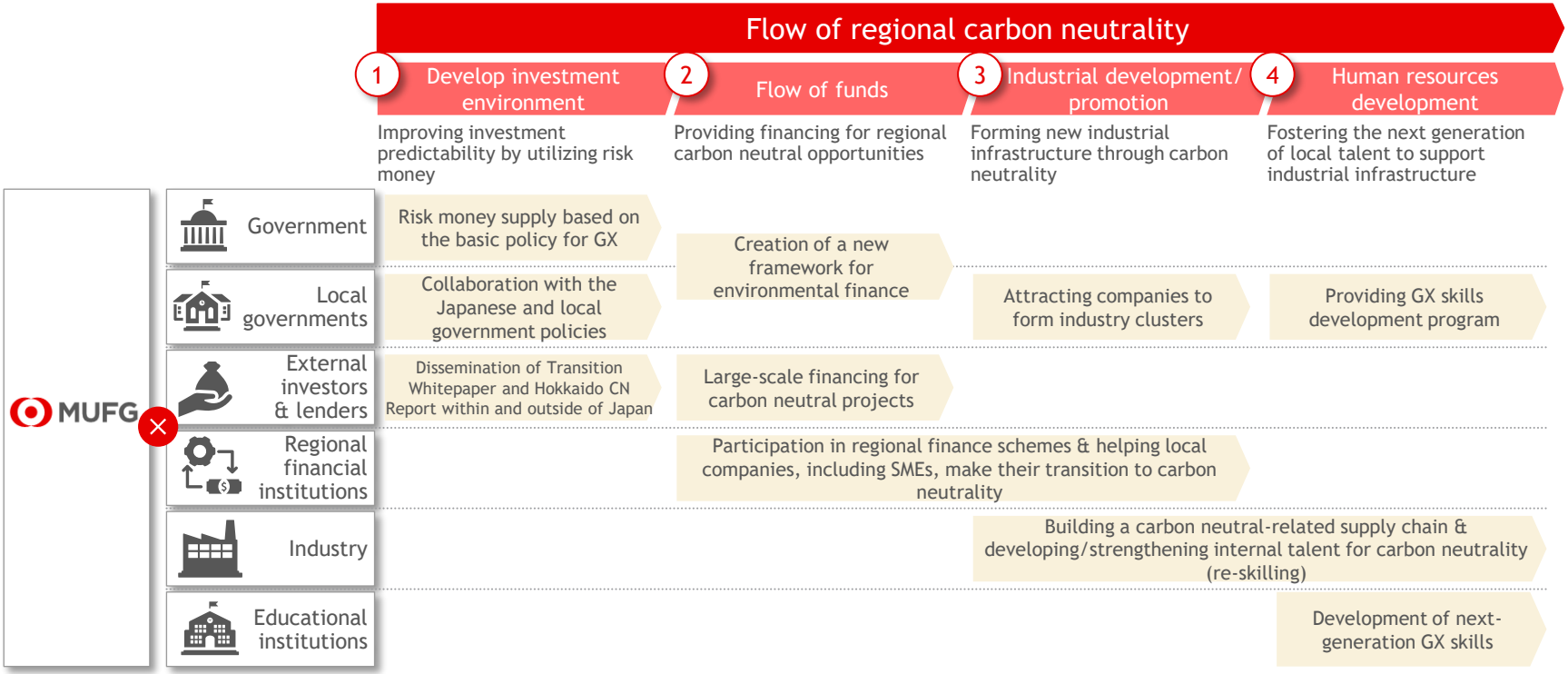
GDP expansion through the supply of sustainable goods and services to locations outside Hokkaido

Contribute to environmental sustainability and raise Hokkaido's GDP by expanding the supply of sustainable goods and services (credits, offshore wind power, clean semiconductors/data centers, next-generation fuels, lumber/agricultural products, etc.) to areas outside Hokkaido



Promoting carbon neutrality in Hokkaido would create a regional carbon neutral model that both supports a regional economic zone & boosts GDP by supplying sustainable goods and services to locations outside Hokkaido

MUFG's Role in Hokkaido's carbon neutrality



MUFG will be an intermediary for stakeholders and provide integrated support for carbon neutral activities

Disclaimer

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