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► Enabling small and medium-sized enterprises towards a low-carbon future

A study of the decarbonization experience of six Japanese SMEs



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► **Foreword**

The urgency of climate action is clear, and the transition to a low-carbon economy is no longer a matter of choice but an imperative. Achieving global and national decarbonization goals requires the participation of all economic actors, including small and medium-sized enterprises (SMEs). While large corporations often take the lead in making climate commitments, SMEs play an equally crucial role. They form the backbone of economies worldwide, accounting for a significant share of employment, innovation and economic output.

Yet, SMEs face distinct challenges in adopting low-carbon technologies and integrating sustainability into their operations. Many of these enterprises struggle with financial constraints, technical barriers and uncertainty about the long-term implications of decarbonization on their business models. Limited access to capital, information and expertise can hinder their ability to transition effectively. At the same time, the shift to greener business practices has significant implications for a firm's human resources, requiring investments in skills development, social protection and just transition policies to ensure that the transformation leaves no one behind.

This report, *Enabling Small- and Medium-Sized Enterprises towards a Low-Carbon Future: A Study of the Decarbonization Experience of Six Japanese SMEs*, examines how SMEs in Japan are navigating the decarbonization process. It draws insights from six enterprises that participated in the Model SME Project for Decarbonization, an initiative of the Ministry of the Environment (MOE) from 2020–2022. Through in-depth case studies, the research identifies key enablers, barriers and lessons learned that can inform policies and support mechanisms for SMEs undergoing similar transitions.

A just transition is essential to maximizing the social and economic opportunities of climate and environmental action, while minimizing and carefully managing the challenges. As outlined in the 2023 ILO Resolution concerning a just transition towards environmentally sustainable economies and societies for all, a just transition is based on effective social dialogue, respect for fundamental principles and rights at work and compliance with international labour standards. The findings of this study highlight the importance of skills development, access to technical assistance and stronger social dialogue in supporting SMEs and their workers in this transition. While the companies studied have taken proactive steps to reduce their carbon footprint, broader efforts are needed to bridge knowledge gaps, facilitate financing and create an enabling environment for more SMEs to embark on the same path.

This report was prepared by Ms Gabrielle Iglesias, Dr Jenny D. Balboa and Emi Mitani, Green SME Policy Development Officer of the Enterprises Department, ILO. ILO technical backstopping was provided by Sandra Yu, SME Enabling Environment Specialist of the Enterprise Department and Mette Grangaard Lund, Technical Officer, Green Jobs, Enterprise Department. Camilla Roman, Senior Technical Specialist, Priority Action Programme on Just Transition, provided valuable input. Mr Atsushi Inoue provided valuable support, particularly in translating interviews and focus group discussions. This report further benefited from comments received from Eléonore D'Achon, Sara Andersson, Michihiro Tanabe and Carlotta Osti.

The insights presented in this report aim to contribute to the ongoing discussions on SME decarbonization and just transition policies. It is our hope that policymakers, social partners and industry leaders will use these findings to develop stronger policies and programmes that empower SMEs to adopt sustainable practices. By ensuring that SMEs receive the necessary support, we can accelerate the transition to a resilient, sustainable and inclusive economy.

**Dragan Radic**

Chief, MSME Branch
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► **List of acronyms and abbreviations**

CO ₂	Carbon dioxide
GHG	Greenhouse gas
GX	Green transformation
ILO	International Labour Organization
LED	Light emitting diode
LPG	Liquefied petroleum gas
JTUC-RENGO	Japanese Trade Union Confederation
METI	Ministry of Economy, Trade and Industry
MHLW	Ministry of Health, Labour and Welfare
MOE	Ministry of the Environment
MSME	Micro, small and medium-sized enterprises
OSH	Occupational safety and health
SBT	Science-based target
SDG	Sustainable Development Goal
SME	Small and medium-sized enterprise
SMEA	Small and Medium Enterprise Agency
t-CO ₂	Tons of carbon dioxide

► Executive summary

On 12 May 2023, the Diet passed the GX Promotion Act (An Act on the Promotion of Smooth Transition to a Decarbonized, Growth-Oriented Economic Structure). This legislation provides the framework to implement Japan's Green Growth Strategy of 2021 through the GX Basic Policy, which outlines the country's transition toward a carbon-neutral and sustainable economy. The Act promotes technological innovation, regulatory incentives and industrial transformation, ensuring that Japan remains competitive in the global economy while addressing climate change.

Small and medium-sized enterprises (SMEs) are the backbone of the Japanese economy and the GX Promotion Act recognizes that green transition cannot be achieved without the cooperation of SMEs. Although Japanese SMEs account for only 10–20 per cent of total CO₂ emissions, a big part of the Japanese economy relies on SMEs as it employs almost 70 per cent of workers in the country. The industrial structure of Japan is heavily supported by SMEs that are linked to large companies as subcontractors, suppliers and customers. At this time, decarbonization is still not a widespread effort among Japanese SMEs due to knowledge gaps, financial constraints and uncertainty about its impact on their workforce. The fragmented nature of SME operations, coupled with limited access to capital and technical expertise, makes transitioning to low-carbon business models a challenge.

The main purpose of this research is to examine the factors that enable the Japanese SMEs to pursue decarbonization efforts and the extent to which these efforts support decent work objectives. Six SMEs participating in the Ministry of Environment's (MOE) Model SME Project for Decarbonization (2020–23) were selected to analyse their decarbonization strategies and their climate actions. Using a case study approach, the research identifies key factors that enable SMEs to transition towards greener business practices while considering the principles of a just transition, ensuring that economic shifts are inclusive and that they minimize disruptions to workers. The study also explores policy implications and best practices to foster a more sustainable business environment.

Key findings and insights

The research showed that the six SMEs that participated in the study are actively engaged in decarbonization. Being early adopters and pioneers, they are also not the average SMEs. The definition of SMEs in Japan also includes firms that are sizeable. Yet, through their intensive efforts, these companies provide a rich landscape for understanding decarbonization experiences and the types of support needed. To achieve their decarbonization goals, these companies changed production processes and equipment, introduced policies to save energy and created new green products. They recognized the important role of MOE's technical support, especially in the calculation of their carbon emissions and in the development of decarbonization roadmaps. Organizational leadership and company culture were key factors in driving engagement in decarbonization. Other key factors include government support, influence of business networks, disasters and global risks. Technical knowledge and financing were the main forms of assistance that the SMEs received. It should be noted that these companies belong to industries known for high emission and hence were prioritized by government for decarbonization.

The companies cited several challenges in their decarbonization efforts. They mentioned the high cost of green technologies, insufficient client demand for low carbon products, inadequate human resources to manage decarbonization, the limited availability of technical experts to guide companies in calculating emissions and in determining needed action. They called for government support to influence consumer demand, to make it simpler for SMEs to access government programmes and subsidies and to expand private sector financing decarbonization investments.

Regarding the just transition aspects of their decarbonization efforts, the companies reported that decent work and occupational safety and health measures are part of the company culture. The most widely recognized measures were skills development for workers, employee participation and the

assignment of environmental focal persons and teams to sustain decarbonization initiatives. However, based on this research, there is not yet an explicit recognition for just transition planning to mitigate negative impacts on workers and to support positive impacts and opportunities.

Recommendations

The SMEs studied are early adopters of decarbonization, committed to taking action and to supporting the country's Net-Zero goal for 2050. Surveys, however, still reveal a large proportion of SMEs that remain undecided or lack awareness of how to move forward. The company cases in this study provide a rich picture of what SMEs may face as they decarbonize. The companies recommended greater awareness raising and capacity building for SMEs, workers and consumers, on decarbonization. Given the importance of a just transition, moving forward would involve initiatives to raise awareness of a just transition, especially on the importance of social dialogue and just transition planning. Further research may involve covering other decarbonizing SMEs and learning from their experience with various types of policy support. It is also critical that future research efforts gather workers' perspectives more comprehensively.



► Introduction

Overview: Paris Agreement and a just transition

One of the greatest threats to the planet now is climate change. Addressing this problem has become a priority for many countries. A total of 193 States and the European Union have committed, through the Paris Agreement, to keep global warming to well below 2°C above pre-industrial levels, and limiting it to 1.5°C is the global benchmark for climate action. It is the goal and intention of the countries under the Paris Agreement to reduce the amount of greenhouse gases they emit to limit the increase in global average temperatures. The 194 Parties that signed the Agreement began to submit their action plans or Nationally Determined Contributions (NDCs) to reduce their emissions. To achieve this goal, countries must reach net zero greenhouse gas (GHG) emissions by 2050 by reducing the emissions at the source and increasing the carbon sinks¹ that absorb and store carbon.

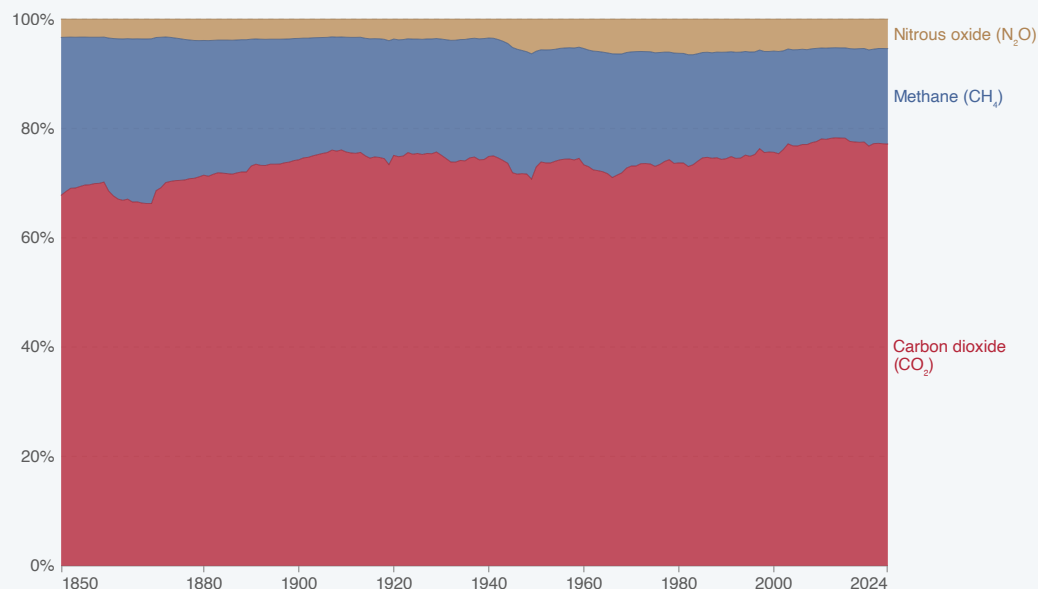
Figure 1 shows that carbon dioxide is the predominant greenhouse gas, followed by methane and nitrous oxide. Hence, one approach to reducing GHG emissions is to reduce the amount of carbon dioxide emissions generated by society through decarbonization.

► Figure 1: The breakdown of global emissions by gas, 1850 to 2023

Greenhouse gas emissions by gas, World, 1850 to 2024

Our World
in Data

Greenhouse gas emissions¹ from all sources, including agriculture and land-use change². They are measured in tonnes of carbon dioxide-equivalents³ over a 100-year timescale.



Source: Jones et al. (2024) – with major processing by Our World in Data

¹ A carbon sink is anything that absorbs more carbon from the atmosphere than it releases; examples are forests, oceans and soils.

The Paris Agreement of 2015 placed technology as fundamental to accelerating climate actions and enabling a sustainable future, together with financing measures to increase renewable energy capacity and establishing a technology implementation programme. The NDCs and Long-Term Strategies of countries for climate action were also identified as key documents that should integrate plans for the development and deployment of low-emission, climate-resilient technology.

While changing to low-emission energy sources, products, services and methods is important, the international community underlines that the process could have negative impacts upon workers if not anticipated and guided accordingly. To address these challenges, the ILO adopted in 2015 the Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All (ILO Guidelines). This document serves as a policy framework and a practical tool to help countries manage the transition to low-carbon economies and to help them achieve their NDCs. The guidelines recognize that greening of economies presents opportunities for environmental sustainability with economic growth, while affirming that the four pillars of the Decent Work Agenda² are also required to ensure that development is both sustainable and inclusive (ILO 2015). The 2023 International Labour Conference Resolution Concerning a Just Transition towards Environmentally Sustainable Economies and Societies for All endorsed the ILO Guidelines as the central reference for policy making and a basis for action (ILO 2023).

► Box 1: Key concepts

Green economy: an economy that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.

Green transition: the process through which an economy becomes a green economy. In this process, economies reduce their reliance on GHG emissions (become “low carbon”) and become resource efficient.

Just transition: promotes environmentally sustainable economies in a way that is inclusive, by creating decent work opportunities, reducing inequality and by leaving no one behind.

Source: ILO 2022c; ILC 2023

The private sector’s cooperation is vital to achieving the target of the Paris Agreement since it is an important source of emissions. While large corporations have been seen as the biggest emitters of greenhouse gases, it has been estimated that 80 per cent of their emissions are derived from their supply chains, which would include SMEs (Bove and Swarz 2016). Although SMEs individually are not large carbon emitters, their collective numbers, estimated at 90 per cent of firms in most countries, means that they are critical to achieving global decarbonization targets. However, not all SMEs will be ready to absorb the new green technologies and participate in the opportunities opened by decarbonization, and their workers may be disproportionately affected. The ILO Guidelines note that micro, small and medium-sized enterprises (MSMEs) need special attention from governments as they are making the transition. They are vulnerable to disruption and may be hampered by limited resources to understand and adapt to policy- and market-driven changes of a greening economy (ILO 2022a).

² The four pillars are: social dialogue, social protection, rights at work and employment.

Decarbonization

Decarbonization may be approached by reducing absolute emissions (of carbon dioxide or CO₂ in metric tons) or by reducing the intensity of emissions per unit of economic activity (per capita, per employee, per product, per million US dollars in sales). Actions that may be taken to decarbonize include (Pathak et al. 2022):

- reducing energy consumption and usage;
- using renewable energy (solar, wind, water) instead of fossil fuels (oil, gas, coal);
- replacing fossil fuel transportation with electric vehicles;
- adopting sustainable farming and land practices (including reducing chemical fertilizers);
- replacing inputs and raw materials with more sustainable alternatives;
- value chain efficiency optimization and supply chain sustainability improvements;
- improved circularity, reuse, recycling and end-of-life treatment for finished and discarded goods and products;
- carbon capture, tree planting and other methods to sequester CO₂ from the air.

There is a standard for measuring emissions called the Greenhouse Gas Protocol (GHG Protocol). It has accounting standards and tools for measuring six GHGs (CO₂, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride), as well as calculating the company's carbon footprint.³ The protocol categorizes GHG emissions into Scopes 1, 2 and 3:

- Scope 1: direct emissions from controlled and company-owned resources, resulting from a company's own set of activities. Examples are on-site combustion, organization-owned fossil-fuel power plants or the emissions from company vehicles.
- Scope 2: indirect emissions from the generation of purchased energy (electricity, steam, cooling and heat) from a utility provider.
- Scope 3: all indirect emissions that occur in a company's upstream and downstream supply chain. Examples include emissions from business travel, waste disposal, raw materials, purchased goods and services and end-of-life treatment of products.

Once the sources of GHGs are identified and the emissions are measured, companies can voluntarily set so-called Science-Based Targets (SBTs) for reducing them. The Science Based Targets initiative, an international non-profit organization, has set up a process for SMEs and other organizations to establish their emission reduction targets in line with the goal of the Paris Agreement.⁴ In Japan, for example, the government created a fund in 2019 administered through the MOE to support companies with a low-carbon innovation to set their SBTs (Aden 2019). After the SBTs are validated by expert reviews, these firms or organizations publish their targets and the results of yearly emissions monitoring. This process can be quite technical depending on the industry, enterprise, product and production process.

³ Greenhouse Gas Protocol <https://ghgprotocol.org/>

⁴ Science-Based Targets initiative <https://sciencebasedtargets.org/>

► Box 2: Science-based targets

To keep global emissions within 1.5°C of pre-industrial levels, global emissions need to be reduced by half by 2030 and then reach net zero by 2050. Because of the urgent and drastic reduction required, private sector cooperation is critical to meet the ambitious goals of their respective sectors.

Science-based targets are emissions-reduction targets aligned with climate science. They translate the level of decarbonization required to meet the goals of the Paris Agreement into achievable pathways for organizations, enabling them to calculate emissions reductions consistent with their sector's contribution to limiting global warming.

Source: Science Based Targets initiative <https://sciencebasedtargets.org/>

Just transition

The push for renewable energy and decarbonization is only part of the overall efforts for a green and sustainable development. Equally important is the need to ensure that the effort is fair and inclusive, especially since the changes must happen rapidly in order to meet the target of the Paris Agreement. The Agreement recognizes this in its Preamble, which notes “the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities.” This was further supported by the 2023 United Nations Climate Change Conference (COP 28), which created a work programme (Decision 1/CMA.5) to include workforce considerations within transition pathways, as well as social protection measures to mitigate the possible negative impacts during transition.

► Box 3: Key documents

Resolution concerning a just transition towards environmentally sustainable economies and societies for all (ILC.111/Resolution V)

Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy (MNE Declaration)

Guidelines for a just transition towards environmentally sustainable economies and societies for all (ILO 2015)

How MSMEs can contribute to and benefit from a just transition. Just Transition Policy Brief. (ILO 2022a)

Greening Enterprises: Transforming Processes and Workplaces (ILO 2022c)

World Benchmarking Alliance Just Transition Methodology (WBA 2021a)

The ILO describes a just transition as “promoting a green economy in a way that is as fair and inclusive as possible to everyone concerned — workers, enterprises and communities — by creating decent work opportunities and leaving no one behind” (ILO 2023). The ILO's approach not only takes advantage of opportunities from climate and environmental actions to create decent work, promote inclusive growth and reduce poverty, but also proactively anticipates and mitigates potential impacts on employment, such as job losses and worker displacement. The ILO underscores the need for decent jobs in a green economy.

The ILO 2015 Guidelines cover nine policy areas to simultaneously address environmental, economic and social sustainability (ILO 2022b, ILO 2023); namely:

- Macroeconomic and growth policies
- Industrial and sectoral policies
- Enterprise policies
- Skills development
- Occupational safety and health
- Social protection
- Active labour market policies
- Rights
- Social dialogue and tripartism.

The just transition framework underlines the opportunities for the private sector to take climate action that, at the same time, generates growth and decent jobs. The transition to environmentally sustainable economies can be an engine for job creation, job upgrading, social justice and poverty eradication. Furthermore, ensuring that the transition is just will keep the process respectful of the rights and welfare of the workers in the greening industries.

SMEs' growth and stability are important ingredients for sustainable development. As more domestic and international value chains undergo decarbonization, the SMEs that supply them with products and services will need to adjust to new requirements. These SMEs and their workforce will need to change skills, resource inputs and production processes to those that emit lower carbon emissions (ILO 2022a). They stand to benefit from the guidance on how to join the green economy in a just manner.

Research description, methodology and limitations

Objective

This research project examines decarbonization efforts in Japan following the country's commitment to a comprehensive green transition. The government announced in October 2020 its Green Growth Strategy of 2021, which established the framework for Japan's GX (Green Transformation) transition. The intention is to achieve carbon neutrality or "to transition from a fossil fuel-centered industrial structure and social structure to a clean-energy (zero CO₂ emissions)-centered one".

In April 2021, Japan set a target to reduce greenhouse gas emissions by year 2030 (against 2013 levels of 46 per cent) and to reach net-zero emissions by 2050, as reflected in its first submission to the Paris Agreement. To support the strategy, the Japanese Cabinet approved the Basic Policy for the Realization of GX of 2023 (a ten-year roadmap for industrial transformation). This was later formalized by the Diet through the GX Promotion Act of 2023. SME decarbonization was deemed essential to successfully achieve these national goals. Although Japanese SMEs account for only 10–20 per cent of total CO₂ emissions, they are a key part of the economy, employing almost 70 per cent of the workforce in the country and serving as vital subcontractors and suppliers to larger companies.

The objective of this research is to understand the factors that may influence SME adoption of green business practices and to draw lessons for policy support. The study achieves this by documenting the experiences of SMEs that have received the Japanese government's technical assistance on decarbonization. It focuses, as a case in point, on the MOE's Model SME Project for Decarbonization, implemented from 2020 to 2022. The project provided participating SMEs with financial assistance and in-depth technical advice to support their decarbonization efforts. Specifically, this study seeks to:

- 1) document the decarbonization experience of the SMEs, including the technical assistance they received from the Japanese government and other organizations, as well as the green and just transition experiences throughout their decarbonization efforts;
- 2) identify firm-level needs that can support decarbonization and a just transition, the policies and strategies that meet those needs and the gaps where additional support is required;
- 3) highlight good practices and lessons learned from the SMEs' decarbonization efforts and develop case studies on decarbonization.

In examining the SMEs' experience, various factors were analysed to determine whether they facilitated the decarbonization process. The analysis specifically accounts for the technical and financial support extended by the Model SME Project, alongside organizational dynamics and elements of the just transition framework.

Scope

The research focused on 22 SMEs that received technical assistance through the MOE's Model SME Project (2020–22). The research team interviewed six of these enterprises to understand their decision-making processes, key considerations, perceived benefits and impacts. Data was gathered primarily through these interviews and a focus group discussion with company representatives.

This research specifically examines decarbonization as a method for greening existing enterprises. It does not cover climate change mitigation efforts external to the firm's value chain, such as purchase of carbon offsets or participation in reforestation initiatives.

Research design

In close consultation with ILO and MOE, SMEs were selected from the list of 22 firms that participated in MOE's Model SME Project for Decarbonization. The SMEs were purposively sampled to collectively meet the following criteria: two medium-sized and three small-sized enterprises; at least three in the manufacturing sector; at least one from any of the growth sectors identified in Japan's Green Growth Strategy; at least one with Science-Based Targets certification; and at least one offering a green service or product. The selection further ensured that the SMEs interviewed had made substantial progress in their decarbonization efforts, allowing for richer insights. Alternative firms were also identified in case some declined to participate in the study. Eventually, the SMEs that agreed to participate in the study were: Kato Light Metal Industry Co Ltd; Kyohatsu Industry Co Ltd; NiKKi Fron Co Ltd; Rai Hatome Kogyo Co Ltd; Tamamura Delica Co Ltd; and Tsuyakin Co Ltd.

At the outset, it is important to acknowledge the limitations of this exploratory study. Due to time and resource constraints, the researchers interviewed only six SMEs; therefore, the findings are preliminary and cannot be generalized to all Japanese SMEs. All interviews were conducted online. Each SME was unique, with a distinct starting point and pathway for decarbonization, even among the three manufacturers working with the same input material (aluminum). While research on corporate climate action is often complicated by the risk of greenwashing (unsubstantiated claims on environmental action), the SMEs' participation in MOE's Model Project suggests they are reputable firms with verified track records. These enterprises are likely early adopters of green practices with stronger intrinsic motivations than the average SME. Furthermore, because the interviews were limited to owners and managers, workers' perspectives were not fully captured. References to specific firms, commercial products or processes do not imply endorsement by the International Labour Office, and any omission is not a sign of disapproval.

Methodology

Nine key informant interviews were conducted across six companies, involving five owners or presidents and four managers. These primary accounts were supplemented by background data from company websites, publications and internal documents. Respondents were asked to describe their decarbonization experiences, explain their motivations, share best practices and evaluate the effectiveness of the Japanese government's assistance programmes.

A focus group discussion was held with six participants to gain a deeper understanding of the organizational and workforce impacts of these changes. This group included previously interviewed executives and managers, alongside human resource leads (see Annex 3 for the participant list).⁵ The discussion aimed to further examine the drivers of decarbonization and to explore dimensions of a just transition. In addition, an interview with two representatives from the Japanese Trade Union Confederation (JTUC-RENGO) provided additional insight into Japan's broader just transition landscape.

The interview responses, discussion points and secondary data are analysed and summarized in this section. Note that the definition of an SME in Japan varies by industry, and these firms often remain sizeable enterprises (see box 4 for further detail).⁶

► Box 4: Definition of SMEs in Japan

	Manufacturing and others	Wholesale	Retail
Capital	300 million JPY or less (US\$1.8 million)	100 million JPY or less (US\$632,000)	50 million JPY or less (US\$316,000)
Number of employees	300 or less	100 or less	50 or less

Source: Japan, Small and Medium Enterprise Basic Act of 1999 (Act No. 154 of 1963: amended 3 December 1999)

This report is organized into the following major sections:

Review of related literature. This section summarizes existing studies on how enterprises, specifically SMEs, experience decarbonization and similar transitions. A technology adoption lens is used to identify factors influencing the uptake of green technologies in production processes or the development of new green products and services.

Overview of Japanese experience and policy on decarbonization. This section details the laws, regulations and programmes promoting a green economy, a just transition and SME growth. It includes insights from interviews with MOE and Ministry of Economy, Trade and Industry (METI) regarding policy objectives, the role of government in supporting SME decarbonization and coordination of inter-ministerial efforts in advancing a green and just transition.

⁵ Data on the SMEs examined was obtained in 2023 through interviews and focus group discussions conducted at that time.

⁶ While SMEs are considered a broad category in Japan, small enterprises are explicitly defined as those with a regular workforce of not more than 20 persons (or five persons in the case of enterprises which are principally engaged in commerce or the service industry).

Summary of findings and key insights. This section presents findings from the interviews with six Japanese SMEs that participated in the MOE's 2020–22 technical assistance project. SME experiences are categorized into four areas: 1) decarbonization efforts; 2) just transition elements; 3) organizational enabling factors; and 4) government support accessed to advance decarbonization goals.

Conclusion and recommendations. This section synthesizes the identified decarbonization and just transition efforts to offer policy recommendations. It proposes avenues for future research to support these policy directions.

Annex 1: Case Studies. The decarbonization experiences of the SMEs are presented as case studies to contextualize their efforts and provide a more holistic narrative.

Annexes 2 to 5. These annexes include the guide questions used in the interview and the focus group discussion, as well as the lists of respondents and participants.

► Review of related literature

This section summarizes research on SME decarbonization, identifying the factors that enable or encourage firms to initiate and sustain greening efforts and the key considerations for promoting a just transition. The conceptual framework presented at the end of this section is derived from the literature reviewed.

SMEs and decarbonization

Enterprises depend on a stable natural environment to operate effectively. However, climate change is increasingly destabilizing the foundations of business activity. A green transition is therefore essential to secure a sustainable future for the private sector. As significant contributors to global emissions, businesses play an indispensable role in attaining carbon neutrality (ILO 2022c).

Earlier discussions on climate change solutions focused on large corporations due to their high-visibility greenhouse gas emissions. ILO (2022c) found that firms in the European Union adopting green practices tend to be larger, have higher annual revenue, supply goods and services to public administrations and operate in specific sectors, such as manufacturing, energy and hospitality.

However, some studies show that 80 per cent of emissions originate from small companies embedded in global value chains that supply goods and services to large companies. While SMEs may have a modest carbon footprint individually, their collective environmental impact is substantial (WTO 2022). Conversely, climate change directly threatens SME resilience, productivity and profitability. Enabling SMEs to decarbonize is therefore important for both business sustainability and the promotion of decent jobs (ILO 2022a).

Meta's Global State of Small Business survey, conducted between July and August 2021 and again from 3 to 17 January 2022, gathered responses from more than 35,000 MSMEs across multiple countries and territories to understand their perception and attitudes towards climate change. The results showed that MSMEs are aware of climate change and recognize the need to reduce their carbon footprints to remain competitive and sustainable (WTO 2022). Similarly, the SME Competitiveness Outlook 2021 reported that 68 per cent of SMEs in Sub-Saharan Africa and 54 per cent in developed countries view environmental risks as significant threats to their operations (ITC 2021).

Transitioning towards environmentally sustainable societies and economies requires systemic change to mitigate environmental harm (Hatch et al. 2017). The ILO (2022c) proposed a typology that categorizes enterprises into four types based on their adoption of greening actions: 1) firms implementing resource-efficiency action (greening processes); 2) firms offering green products or services (greening outputs); 3) firms implementing resource efficiency action and offering green products or services (greening processes and greening outputs); and 4) firms not engaging in the green transition.

This typology is based on self-reported responses to a 2021 survey of over 17,500 European firms of all sizes from 27 EU Member States regarding their environmental actions (EU 2022). The survey showed that 89 per cent of SMEs reported some level of greening, either of their processes or their products. The most common resource-efficiency measures among SMEs were minimizing waste (64 per cent), saving energy (61 per cent) and saving materials (57 per cent). However, most SMEs (72 per cent) reported that they lacked a concrete strategy to reduce their carbon footprint and become climate-neutral or climate-negative.

European SMEs also reported facing several barriers to deeper engagement: complex administrative or legal procedures (34 per cent), the high costs of environmental actions (24 per cent) and supply chain shortages (24 per cent). Among the SMEs attempting to green their processes, 24 per cent required

external support, specifically in the form of technical advice (39 per cent), public funding (36 per cent) and private funding (28 per cent). Similarly, among those offering green products or services, 24 per cent needed external support, such as advice (35 per cent), public funding (20 per cent) and private funding (20 per cent) (EU 2022).

OECD has conducted several studies on SMEs, green entrepreneurship and eco-innovation practices (OECD 2023; OECD 2022; OECD 2021). Green practices can be categorized into three types: incremental, disruptive and radical, as explained below.

- Radical innovation introduces new solutions leading to fundamental changes in work processes or technological systems. Examples are digitalizing operations and transitioning to renewable energy sources, such as solar, wind or geothermal power.
- Disruptive innovation entails significant alterations to organizational practices or business models.
- Incremental innovation involves technological modifications to conserve resources and improve energy efficiency.

These innovations correspond to “shades of green”, ranging from limited, proactive, to transformative approaches (Castillo 2023). These involve varying extents to which technologies, products and business practices are engaged to reduce carbon footprints (table 1). Within each category, measures range from limited approaches at the top (for example, fuel-efficient vehicles) to transformative approaches at the bottom (for example, systemic changes in land use policies).

► **Table 1: Shades of green: Examples of pro-environmental measures in major segments of the economy**

Segment	Pro-environment measures (listed within each category in the order of limited to transformative measures)
Energy supply	Integrated gasification/carbon sequestration
	Co-generation (combined heat and power)
	Renewables (wind, solar, biofuels, geothermal, small-scale hydro); fuel cells
Transport	More fuel-efficient vehicles
	Hybrid-electric, electric and fuel-cell vehicles
	Car sharing
	Public transit
	Non-motorized transport (biking, walking); changes in land use policies, settlements
Manufacturing	Pollution control (scrubbers and other tailpipe technologies)
	Energy and materials efficiency
	Clean production techniques (toxic avoidance)
	Cradle-to-cradle (closed loop systems)
Buildings	Lighting, energy-efficient appliances and office equipment
	Solar heating/cooling solar panels
	Retrofitting
	Green buildings (energy-efficient windows, insulation, building materials, HVAC)
	Passive-solar houses, zero emissions buildings

► **Table 1: Shades of green: Examples of pro-environmental measures in major segments of the economy (Cont.)**

Segment	Pro-environment measures (listed within each category in the order of limited to transformative measures)
Materials management	Recycling
	Extended producer/responsibility/product take-back and remanufacturing
	De-materialization
	Durability and repairability of products
Retail	Promotion of efficient products/eco-labels
	Store locations closer to residential areas
	Minimization of shipping distances (from origin of products to store location)
	New service economy (selling services, not products)
Agriculture	Soil conservation
	Water efficiency
	Organic growing methods
	Reducing farm-to-market distance
Forestry	Reforestation and afforestation projects
	Agroforestry
	Sustainable forestry management and certification schemes
	Halting deforestation

Source: Author's own elaboration.

Factors relevant to adopting decarbonization technology

The development and utilization of green technology are crucial to meeting the targets of the Paris Agreement. In the context of this report, the adoption of decarbonization technologies is an important green business practice. These technologies offer multifaceted benefits, including reduced energy costs, improved resource efficiency through circular practices and mitigation of health risks by lowering worker exposure to carbon emissions and pollutants. Despite these expected advantages, SMEs often face varying levels of readiness or capacity to adopt such innovations.

In this study, “technology” is defined broadly as the application of knowledge to solve problems. It extends beyond physical equipment to encompass three interdependent dimensions:

- Hardware – physical tools, equipment and materials required for decarbonization;
- Software – technical knowledge and skills necessary to operate technology effectively, including competencies required to calculate and monitor carbon emissions;
- Orgware – institutional and policy frameworks — ranging from the firm-level to the national-level regulations — that support the implementation and maintenance of technology.

This study employs a technology adoption approach to identify enabling factors and obstacles from the perspective of SME decisionmakers, namely, the owners and managers. This approach goes beyond the decision to invest in technologies, considering broader elements, such as skills training, safety protocols and human resource needs. When applied to study small and medium-sized companies,

research indicates that technology adoption is primarily driven by three clusters of factors: individual characteristics of the owner-manager, organizational characteristics and external factors (see table 2).

► **Table 2: Factors influencing adoption of technology by small- and medium-scale enterprises**

SME owner-managers' characteristics	Organizational characteristics	External factors
Knowledge	Teamwork or structure	Network and social partners
Skills	Staff competencies & skills	Government support
Qualifications	Company culture	Government regulations
Character	Investors' expectations	Market demand
Leadership style	Employee/Union initiatives	Infrastructure
Technology know-how	Profitability and productivity	Disaster and climate risks
–	–	Global risks

Source: Based on the literature review

Factors influencing technology adoption

SME owner-manager characteristics. Given their scale, SMEs are typically under the direct supervision of their owner-managers. Consequently, decisions related to technology adoption and just transition measures rest largely with these individuals (Abdullah et al. 2012; ILO 2022c). Factors such as attitudes, technical expertise, leadership style, and personal commitment to sustainability significantly influence a firm's technology adoption. For example, a survey of 268 SMEs in Spain showed that owner-managers who have higher education levels and stronger business acumen are more likely to adopt new technologies (Romero and Martínez-Román 2015).

Organizational characteristics. The internal environment of a firm — including nature of work, its organizational structure, staff education levels and a corporate culture that prioritizes technological use for efficiency and productivity – is a critical determinant of technological readiness (Abdullah et al. 2012). Workplaces that foster a culture of creativity and innovation are better equipped to absorb new technologies. Furthermore, environments that prioritize cooperation and dialogue can ease the transition, as engaged employees are more likely to support organizational change. SMEs that uphold principles of fair treatment are also better positioned to safeguard worker welfare during periods of transformation.

External factors. External networks, social partners, market demand, customer expectations and government support play pivotal roles in encouraging technology adoption. Firms integrated into environmentally conscious value chains or those catering to pro-environment customers often adopt green technologies to protect their reputation and market share. Social partners also act as catalysts; Spanish SMEs linked to business networks and those engaged in employee training initiatives show a higher inclination toward innovation (Romero and Martínez-Román 2015).

Government's incentives and subsidies are important for raising awareness among SMEs managers about renewable energy solutions, green inputs, resource-efficiency equipment. These financial instruments are also crucial for the practical integration of technology into production processes.

Challenges to technology adoption

One of the most important constraints to technology adoption is finance. Given their smaller scale and vulnerability, SMEs often lack the capital to invest beyond short-term needs (WEF 2020). When seeking to upgrade, these firms encounter restricted access to credit, as banks often perceive SMEs as higher-risk borrowers compared to large corporations.

Other barriers include a lack of specialized skills, weak infrastructure (such as slow internet connectivity) and limited access to data, particularly in rural areas. Furthermore, external shocks such as global conflicts can affect the price and availability of materials and energy (WEF 2020; WEF 2022).

Employment impacts

The employment effects of technological adoption are uneven. While automation is often feared as a threat to job security, it also presents opportunities for job creation and protection through reskilling. Research suggests that 35 per cent of firms introducing technologies in the last five years such as artificial intelligence and automation have created or retained jobs by investing in their workforce (CIPD 2020).

However, the benefits of learning and role expansion are not automatic; they require deliberate support. As employers reorganize production, revise tasks and work processes, employees face increased expectations to manage changes in the workload and job content (Beer and Mulder 2020). Employees are expected to be flexible in taking on complex tasks. Adjustments in work roles come with new technology and hence the need for retraining and learning. While automation reduces manual labor, it may increase mental workload through computation tasks and intensified monitoring of machines. Workload and workflow interruptions increase due to adjustment to new tools and workload pressure. These changes can negatively affect worker autonomy, task meaningfulness and career opportunities.

Drivers of green technology adoption

Both internal and external factors can facilitate green technology adoption. Most SMEs view cost reduction as their primary motivation for decarbonization. In some cases, customer demand for environmentally friendly services drives firms to adopt green technologies. In others, employee initiatives or investor expectations play a key role. Government policies, subsidies and incentives are strong drivers for greening products and services (OECD 2021).

Specifically in the Japanese context, a survey of over 6,000 SMEs revealed that while these firms recognize the importance of greening, they are unlikely to implement green policies unless they lead to tangible profits or new business opportunities. This highlights the need to link decarbonization to business growth strategies such as human resource development, de-risking investments and product innovation (Shibamoto 2022).

Just Transition Approach and Process

While employers may benefit from technological advancements through increased efficiency and market expansion, the adoption of new technologies can significantly impact workers. As previously noted, these shifts alter both workload and job content. Studies indicate a widening skills gap: demand for high- and low-skilled workers is expected to rise, while middle-skilled roles are increasingly vulnerable to replacement by ICT, automation and artificial intelligence. Around 14 per cent of existing jobs may disappear in the next 15–20 years, while another 32 per cent of existing jobs will undergo radical transformation (OECD 2019). Sectoral shifts are already evident. For example, manufacturing employment has declined by 20 per cent in recent decades, while employment in the services sector has grown by 27 per cent (WEF 2021).

These dramatic shifts threaten not just job quantity but also job quality. A study conducted from 2018 to 2020 by the UC Berkeley Labour Center found that technology adoption across five industries — trucking, warehousing, healthcare, retail and food delivery — often compromised wages and working conditions. In many cases, technology was used to enforce stricter monitoring and accelerate work pace (Hammerling 2022). The same study showed that unionized sectors — healthcare, trucking and grocery — experienced fewer adverse impacts, since workers possess collective bargaining power to negotiate better conditions. The study concluded that proper regulation, policy and institutional changes are needed to maintain job quality and equality in the labour market. In the absence of regulation, employees in SMEs remain highly vulnerable to job insecurity during the transition phase since SMEs may have less capacity and knowledge to manage transition. SMEs need full support for decarbonization in order to make the transition just.

Greening encompasses more than the adoption of technology; it requires strategic policy interventions that enable economies, enterprises and workplaces to transform accordingly (ILO 2018). This process involves ‘greening the workplace’ and the creation of green jobs. Greening of the workplace occurs when employers and employees collaborate to reduce greenhouse gas emissions, implement pro-environmental practices, protect the health and safety of the workers and commit to making changes in their personal and community consumption patterns (ILO and UNEP, 2008). Within this framework, green jobs are defined as decent jobs that contribute directly to the protection and preservation of the environment. To achieve a just transition, a planned decarbonization strategy is crucial to maximize climate action and social benefits, while minimizing social hardship.

The ILO Just Transition Guidelines, adopted in 2015, provide a systemic, multi-faceted framework centered on social dialogue. These guidelines are designed for governments, as well as workers’ and employers’ organizations, offering tailored actions based on their respective roles and capacities. A just transition must specifically address the unique needs of MSMEs to ensure they are not left behind. Key principles of the framework include social consensus, gender dimensions and responsiveness to countries’ contexts. While these principles provide a vital policy framework for achieving carbon-neutral and climate-resilient economies, they are primarily aimed at institutional levels and do not always outline specific, direct actions for individual corporations.

The World Benchmarking Alliance developed six indicators to assess companies’ just transition efforts (WBA 2021a). These were developed in consultation with workers’ and employers’ organizations and align with the ILO Guidelines:

- 1) social dialogue and stakeholder engagement;
- 2) just transition planning to mitigate impacts on workers and affected stakeholders;
- 3) creation and support of green and decent jobs;
- 4) retention and reskilling/upskilling to facilitate redeployment;

- 5) social protection and social impact management; and
- 6) advocacy for supportive policies and regulations.

The Alliance used the indicators to benchmark 180 companies and rate their performance. This benchmark study revealed that while the companies performed relatively well in job creation and reskilling, they scored significantly lower on the remaining indicators (WBA 2021b).

While the World Benchmarking Alliance indicators apply to large companies, the SME segment faces a distinct set of challenges in their decarbonization and just transition efforts. ILO (2022a) identifies three key drivers to SME-led just transition: market-driven factors, such as cost reduction and increasing business opportunities and markets; compliance-driven factors, including avoidance of penalties under carbon tax policies and environmental laws; and resilience-driven factors, such as mitigating the negative impacts of climate change on business.

Conversely, SMEs are hindered by systemic barriers, including a lack of market access due to government policies or infrastructure, limited technical information, skill gaps, restricted access to finance and low productivity which reduces profitability of businesses during the transition.

As the ILO (2022a) noted, achieving a just transition requires that government, employers' and workers' organizations, downstream companies, training and education providers and financial service providers provide a comprehensive enabling environment. SMEs need partners that will provide tools and information to help them understand the importance of climate change actions, comply with the environmental standards and decarbonize their business operations, while helping them increase their productivity, resilience and capacity to absorb the new technology. Collaboration, linkages and constant dialogue between key stakeholders, particularly government agencies and social partners, such as employers' and workers' organizations, are critical.

Government agencies hold a foundational role by establishing a policy landscape that assists SMEs in reaching their green goals. This involves providing targeted incentives and subsidies, implementing a transparent public procurement strategy that upholds decent work standards, introducing tax reforms aligned with environmental objectives. Furthermore, government-backed risk guarantees are essential to help SMEs transition into new sectors or de-risk the investments required to protect worker welfare during decarbonization.

Social partners further bridge the gap between policy and practice. Employers' organizations can build organizational capacity by promoting climate literacy, advising on sustainable workplace practices, exposing SMEs to best practice and connecting SMEs with other partners. In a similar vein, workers' organizations contribute to the development of sustainable policies by fostering social dialogue and integrating decarbonization practices into collective bargaining agreements. These organizations are also vital in facilitating dialogues to enhance occupational safety and health (OSH), particularly for jobs most vulnerable to climate change and environmental risks.

The technical and human dimensions of the transition are supported by training, education, and employment service providers. These institutions assist SMEs in upgrading workforce skills, facilitating technology transfer, and providing critical information on financial resources and green networks. Employment service providers specifically help match workers with emerging green job opportunities while offering upskilling and reskilling services.

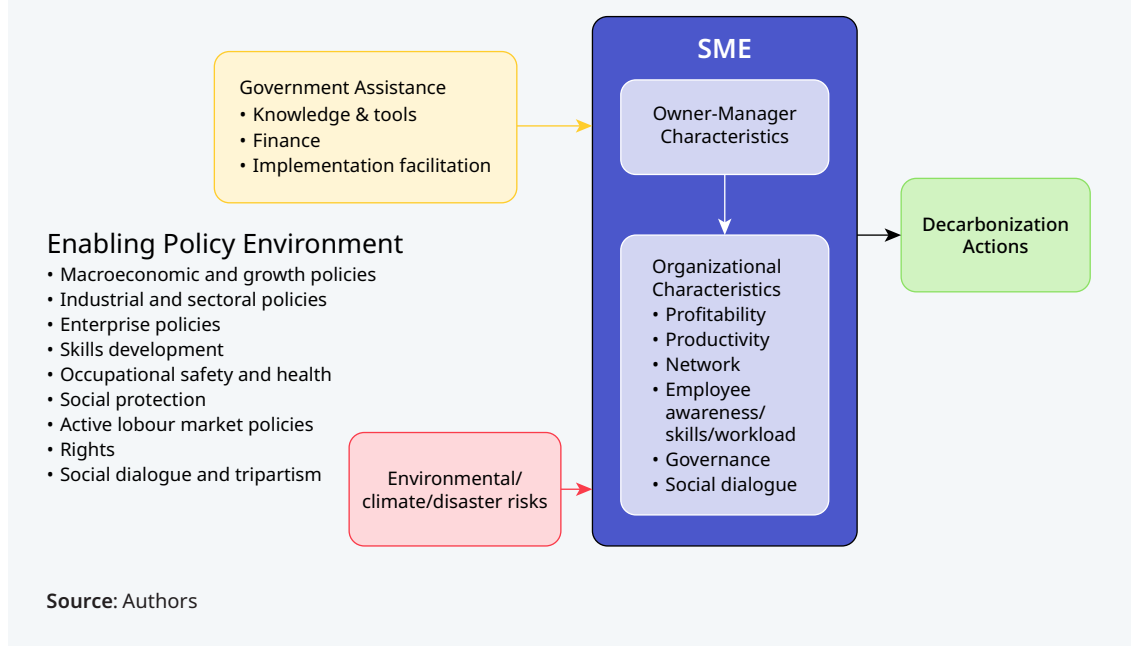
Finally, the private sector and financial institutions provide the practical means for implementation. Downstream partner companies can leverage their buying power and sustainability standards to influence SME decarbonization, providing the necessary investment or modern equipment for supply chain alignment. Complementing these efforts, financial service providers supply capital designed to support SMEs in greening their operations and maintaining long-term viability.

Conceptual framework

The following framework was developed to analyse the experiences of the SMEs interviewed for this report. It aims to discern the drivers and enablers at play as these enterprises undertook their decarbonization and just transition actions.

The framework categorizes the factors influencing an SME's decision to implement green business practices into three essential clusters, as identified in the literature: (1) characteristics of the owner-manager, (2) organizational characteristics, and (3) external factors comprising government support and regulations and professional network, as well as risks associated with disasters, conflicts and climate change. These variables, detailed in table 2 and illustrated in figure 2, provide a lens through which we can understand why and how certain SMEs choose to adopt new technologies.

► **Figure 2: Conceptual framework**



What distinguishes a just transition to a green economy from standard greening actions is the integration of decent work and social justice. A just transition framework should anticipate and mitigate the potential impacts on workers, including job displacement and role changes; involve skills development required to transition workers toward green technologies and jobs; promote businesses that are fair, inclusive and protect the rights of workers; and, formalize social dialogue to enhance transition planning.

This report argues that just transition measures do not only offer additional benefits to society, economy and the environment; they are also critical enablers of successful decarbonization. By fostering broad-based ownership of the transition through active engagement of both workers and employers, these measures ensure that climate actions are sustainable and effective. The companies studied in this report illustrate how decarbonization processes rely on these just transition enablers. Ultimately, these findings aim to inform policy mixes that will empower countries to meet their national decarbonization commitments through a more inclusive and resilient private sector.

► Overview of Japanese policy on decarbonization

This section provides an overview of Japan's decarbonization policy landscape. It outlines the strategic framework for green growth, policies on greening SMEs, survey findings on SMEs' actions and perceptions on decarbonization. Furthermore, it defines the components of a just transition within the context of Japanese SMEs.

Japan's interest in climate change is relatively recent (Kameyama, n.d.). While many country leaders and climate change experts have been discussing the climate change problem since the 1980s, Japan at that time was only mildly interested in the issue. Nuclear power was the favored energy source by the business community for its cost-efficiency and low emissions. This paradigm shifted following the Tohoku earthquake and tsunami in March 2011. The subsequent disaster at the Fukushima Daiichi nuclear power plant led to the temporary closure of Japan's nuclear fleet for safety inspections and maintenance (Batty et al. 2012), forcing the nation to increase its reliance on imported fossil fuels, particularly coal and liquefied natural gas.

In response, the government accelerated its transition to renewable energy. By 2012, Japan introduced new policies following the passage of the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Source by Electric Utilities (Act No. 108 of 2011). Under this law, electric companies were obliged to purchase all power generated by wind and solar energy. In the same year, the government implemented a carbon tax to fund research and development of clean energy technologies (MOE, n.d.). These policies were followed by the Global Warming Countermeasures Plan of 2016, which described the policies that will be undertaken to achieve emission reduction targets by 2030, and the Long-term Strategy Under the Paris Agreement of 2019, which prioritized innovations in hydrogen energy and utilization and carbon capture and storage technologies.

Japan experienced significant challenges that shaped its current position regarding energy consumption and generation. Its economy weathered two global oil crises in the 1970s. The country had already converted much of its energy generation in the 1960s from coal-fired to oil-fired plants, relying heavily on petroleum imports from the Middle East (Kobori 2010; as cited in Yago 2020). In 1979, the Diet passed the Law Concerning the Rational Use of Energy (Energy Conservation Act). This landmark piece of legislation successfully reduced national energy consumption. To align with the 2050 carbon neutrality goal, this Act was amended in 2023 to expand its scope to non-fossil energy, as outlined in the METI's Basic Policy for the Realization of GX: A Roadmap for the Next 10 Years. The amendment requires large-scale businesses to: 1) install in-house non-fossil energy generation equipment and storage batteries; 2) procure heat and energy from providers using non-fossil fuels; and 3) utilize energy-efficient equipment (METI 2023).

Japan's geographic location makes it prone to climate-related disasters. In 2019, strong typhoons destroyed thousands of houses and buildings in the country. The General Insurance Association of Japan (2024) reported that the typhoons Faxai and Hagibis caused over 1048.2 billion yen (\$9.64 billion) in insured losses, fundamentally altering public and corporate perceptions of climate risk. These scenarios gave Japan a new impetus to take climate action seriously (Kameyama, n.d.).

Japan has furthermore witnessed changes in its climate lately; both land and sea temperatures are rising. Rainfall patterns have changed as well, leading to devastating floods. Extreme weather events will affect Japan in many ways in the future because a large portion of its population and industrial activities are along the coastlines and are highly vulnerable to sea-level rise and other climate change effects (IPCC 2022: 2169-71). To address these vulnerabilities, the Cabinet issued the Basic Policy for Realization of Green Transformation (GX) in February 2023. The GX strategy focuses on decarbonizing energy production through a mix of nuclear and renewable power. It also identifies the key growth sectors where decarbonization is essential, targeting them for future policy support. In February 2025, Japan submitted an updated NDC, setting ambitious targets to reduce GHG emissions by 60 per cent by 2035

and 73 per cent by 2040 relative to 2013 levels (of 1,408 million tons of carbon dioxide equivalents), with the goal of achieving carbon neutrality by 2050. Japan aims to advance policies that promote growth with net zero at the core, in alignment with the GX policy, which seeks to simultaneously ensure stable energy supplies, economic growth and decarbonization.

Japan's Green Growth Strategy

Since the beginning of Prime Minister Fumio Kishida's term in 2021, climate action in Japan has gained significant momentum. The Green Growth Strategy serves as the primary industrial framework for achieving carbon neutrality by 2050, supported by an interim target to reduce GHG emissions by 46 per cent by 2030. Under this policy, the green transition is no longer considered a cost or a constraint to growth; rather, it is positioned as an opportunity for sustained growth and prosperity.

The Green Growth Strategy of 2021 is an industrial policy that combines economic growth with environmental protection, designed to foster a "virtuous cycle of the economy and the environment". It provides the private sector with a clear roadmap toward carbon neutrality by 2050. This strategy uses five cross-sectoral policy tools or support measures and action plans for 14 growth sectors (see table 3), providing direction, policy actions and goals and most of all, an environment that will encourage businesses to decarbonize their operations and services. The five policy tools for the Green Growth Strategy include grant funding, tax incentives, guidance policy on finance, regulatory reform and international collaboration.

► **Table 3: Japan's 14 growth sectors under the Green Growth Strategy**

Energy	Transport/Manufacturing	Home/Office
Offshore wind power Wind turbines, parts, floating wind turbine	Mobility and battery EV (electric vehicle), FCEV (fuel cell vehicle), next generation batteries	Housing and building, and next generation power management (Perovskite solar cell)
Hydrogen and fuel ammonia Combustion burner (as fuel in transition period to hydrogen-powered society) Turbines for power generation, hydrogen reduction steel-making, carrier ships, water electrolysis	Semiconductors and ICT Data centers, energy-saving semiconductors (demand-side efficiency)	Resource circulation Biomaterials, waste, recycled materials, power generation
Next-generation thermal energy	Maritime Fuel-cell ships, electric propulsion ships, gas-fueled ships	Lifestyle-related industry Local decarbonization business
Nuclear power SMR (Small Modular Reactor), nuclear power for hydrogen production	Logistics, people flow and infrastructure Smart transportation, drones for logistics, fuel-cell construction machinery	
	Foods, agriculture, forestry and fisheries Smart agriculture, wooden skyscrapers, blue carbon	

► Table 3: Japan's 14 growth sectors under the Green Growth Strategy (Cont.)

Energy	Transport/Manufacturing	Home/Office
	Aviation Hybrid electric, hydrogen-powered aircraft	
	Carbon Recycling Concrete, biofuel, plastic material	

Source: METI 2020

The GX Basic Policy approved by the Cabinet in February 2023 outlines the plan to increase the production and use of renewable energy. It sets priorities for each growth sector, provides incentives for investment in these sectors and describes an emissions trading system. This policy recognizes that SMEs require support for skills development, including assistance in calculating their emissions, and access to local financing. It also contains a section on a just transition to support the smooth movement of the workforce away from fossil fuel industries and towards low-carbon industries. It seeks to promote a just transition through the acquisition of new skills and the smooth transition of the labour market to green and emerging industries, supported by measures such as career advancement assistance for workers seeking to change jobs.

Japanese policies on greening of SMEs

As the backbone of the Japanese economy, SMEs are indispensable to the success of the national green transition. Comprising 99.7 per cent of all enterprises, SMEs employ 68.8 per cent of the workforce and contribute 53 per cent of the economy's total value added (SMEA 2019). Environmentally, their impact is equally significant. According to METI, SMEs emit an estimated 120 million to 250 million tons of GHG annually, representing 10–20 per cent of the country's total carbon emissions (Yamashita 2023). Consequently, achieving carbon neutrality by 2050 is impossible without their active participation.

Like many businesses worldwide, Japanese SMEs continue to face the dual challenges of the COVID-19 pandemic recovery and a volatile economic landscape marked by inflation and labour shortages. The *2023 White Paper on Small and Medium Enterprises in Japan* published by the Japanese government emphasized that overcoming these hurdles requires a fundamental shift in business strategy (SMEA 2023). The Green Growth Strategy offers a framework for such restructuring.

While national and local governments maintain net-zero targets, detailed medium-to-long-term roadmaps specifically tailored for the SME segment are still evolving (FSA 2023, 46–47). Nonetheless, several government agencies have issued pronouncements related to SMEs and decarbonization. METI and MOE provide tools and subsidies to help SMEs through the process of “knowing, measuring and reducing” their carbon footprints. Other agencies are using government data to help individual firms map physical risks and develop transition scenarios. The challenge is how to convey this information to SMEs and make it useful for their transition (FSA 2023, 45–46).

The Japanese government supports SME restructuring and has allocated 2.4 trillion JPY for programmes to boost SMEs growth (EIPB 2023). These funds are directed toward building resilient companies, including startups and SMEs that create new value and innovative products and services. Attention will also be given to the development of human resources and growth industries that can attract skilled workers from around the world, which is especially important considering labour shortages and Japan's ageing society (EIPB 2023).

Just transition in Japan and the SMEs

Decarbonization is not yet a widespread practice among Japanese SMEs. Research indicates that these enterprises have limited technical knowledge regarding decarbonization measures and a low awareness of how such changes might affect their workforce. The Japan Financial Services Agency (FSA) recently reviewed the status and perception of SMEs regarding decarbonization as part of its effort to develop guidelines for local financial institutions (FSA 2023). Synthesizing surveys from the Japan Chamber of Commerce and Industry (n.d.), Shinkin Economic Research Institute (n.d.) and Shoko Chukin Bank (2021), the FSA identified several critical trends:

- 1) Only 6–17 per cent of SMEs are currently engaged in decarbonization, with 10–28 per cent in the planning stages.
- 2) Between 58 per cent and 80 per cent of SMEs report a lack of interest or awareness regarding government green transition plans.
- 3) Roughly 31 per cent cited a lack of technical and financial support as the primary barrier.
- 4) Nearly half (46 per cent) were unaware of available green subsidies and loans from regional financial institutions.
- 5) While these figures suggest a significant implementation gap, there is latent potential: 31 per cent of SMEs expressed a willingness to act if provided with robust government support and financial incentives.

These findings are further supported by a January 2021 Daido Life Insurance Company survey of over 6,000 SMEs. The results highlighted a significant gap between current practice and future aspirations. While 67 per cent of SMEs were not taking any greening actions and only 6 per cent were actively engaged, 28 per cent considered the transition important and intended to act in the future. Notably, when asked about long-term goals, more than 70 per cent of SMEs expressed a willingness to address environmental issues, with only 27 per cent of SMEs stating they had no plans to do so (Daido Life Insurance Survey, as cited in Shibamoto, 2022).

In contrast, more recent survey results published by the SMEA in 2023 reflect a shift toward more positive views. The findings show that 43.7 per cent of SMEs now consider it necessary to pursue carbon neutrality, though 56.3 per cent remain uninterested — a figure that underscores the urgent need for targeted outreach to these enterprises (SMEA 2023, 1–59).

Synthesizing these various surveys, it can be inferred that while only a minority of Japanese SMEs are currently decarbonizing, a lack of intent is not always the primary obstacle. Instead, a sizeable proportion of firms — ranging from 18 per cent to 48 per cent — remain inactive largely because they lack the practical knowledge to proceed. Therefore, addressing this significant knowledge gap remains one of the most effective ways to encourage broader participation in greening efforts.

Furthermore, the concept of a just transition has yet to fully take root in Japan, with references in national climate change plans remaining relatively sparse and lacking in depth. Some initial groundwork has been laid in Japan's submission under the Paris Agreement,⁷ which highlights the importance of minimizing job losses and fostering an inclusive, locally based transition to net-zero. Building on these objectives, the Sixth Basic Environment Plan, adopted by Cabinet decision on 21 May 2024, emphasizes the necessity of decent work, social safety nets, green reskilling and community-wide energy management systems. However, despite these high-level inclusions, many specific policies remain ill-defined. This lack of clarity has been noted by environmental NGOs; for instance, the Kiko Network analysed the just transition specifically in the context of phasing out coal power plants. Their research highlights the

⁷ Government of Japan: The Long-Term Strategy under the Paris Agreement, Cabinet Decision 11 June 2019

need for well-planned interventions to protect worker livelihoods and ensure robust social protection throughout the industrial shift (Mabon et al. 2022).

An interview with JTUC-RENGO, a confederation of 46 trade unions representing seven million members, yielded a few comments that address these policy ambiguities (on just transition) from the perspective of organized labor. The confederation noted that while the green transition is essential, it will fundamentally reshape the landscape for industries and workers. High-emission sectors, such as energy, chemicals and steel, are expected to face the most acute disruptions. In response to these challenges, JTUC-RENGO advocates for a robust just transition framework designed to create green jobs and facilitate labour mobility without the risk of unemployment. Their vision for this transition includes comprehensive skills development and vocational training, the establishment of multi-layered safety nets, and targeted support for local economies affected by industrial relocation. Central to this approach is the development of a formal roadmap backed by budget allocations to minimise negative impacts on local economies and employment. Furthermore, JTUC-RENGO argues for intensified government support for SMEs, emphasizing that these enterprises underpin local economies and remain the primary source of employment opportunities for the Japanese workforce.

Broadly, while it remains difficult to forecast the precise impacts on workers at this stage of GX implementation, there is a clear consensus that employment policy must be implemented in sync with industrial and climate change policies. To be effective, these protections must be proactive; implementing employment safeguards only after negative impacts emerge would be too late. For many SMEs, carbon neutrality and a just transition remain novel concepts, and these firms have yet to fully experience the structural shifts brought by the green economy.

JTUC-RENGO has consistently emphasized that social dialogue between governments, employers, and workers is the essential mechanism for navigating this uncertainty. By securing a seat in the GX Implementation Council, represented by its president Tomoko Yoshino, the confederation successfully advocated for labor interests alongside leaders from industry and academia. This advocacy was instrumental during the 2023 legislative process.⁸ As a result, the subsequent law includes a dedicated section on the just transition and a five-year investment package exceeding one trillion JPY to facilitate the smooth migration of the workforce into low-carbon industries (Section 5.1, just transition). JTUC-RENGO cites this legislative victory as a prime example of how social dialogue can shape national policy. Looking forward, the confederation stresses that this dialogue must now penetrate the enterprise level. JTUC-RENGO continues to promote these principles at industry and regional scales. Since the bill was enacted by the Diet, it has been engaged in discussions on more concrete GX policies.

⁸ Based on interview with JTUC-RENGO; see also their statement on the GX Promotion Act at: <http://www.jtuc-rengo.org/updates/index.cgi?mode=view&no=416&dir=2023/05>

Key government agencies for decarbonization

The Ministry of Economy, Trade and Industry (METI)

As the primary architect of Japan's industrial strategy, METI is the lead agency for SME decarbonization, working in close coordination with the MOE. On 10 February 2023, the government adopted the Basic Policy for the Realization of GX (METI 2023) and METI hosted the GX event⁹ attended by all ministries. METI has spearheaded a support package for SMEs unaware of how to decarbonize their business and practices. This includes consultancy services, measurement of CO₂ emissions, a decarbonization plan and financial assistance in the form of subsidies.¹⁰

To streamline national efforts, METI and MOE collaborate on promotional materials, ensuring SMEs receive a unified message on the benefits of decarbonization. Because the path to net-zero can be complex, the government has established multiple channels for support. For instance, to help SMEs access affordable renewable energy, METI provides hands-on assistance with solar panel installation and offers detailed guidance on navigating green tax incentives for renewable investments.

Beyond direct ministerial contact, METI leverages a network of semi-governmental organizations with deep local roots to act as the primary entry points for SMEs. Chief among these is SME Support Japan, which serves as a practical bridge for enterprises by providing expert consultancy, customized decarbonization roadmaps and facilitation of government financial aid.

Finally, METI recognizes that the implementation of the Japan GX will have profound implications for the workforce. The ministry is particularly focused on ensuring employment security, identifying the necessary reskilling pathways for workers and facilitating labour mobility into growth sectors. To address these human-centric challenges, METI is actively exploring collaborative initiatives with the Ministry of Health, Labour and Welfare (MHLW) to ensure that the industrial transition is accompanied by robust social and employment safeguards.

The Ministry of the Environment (MOE)

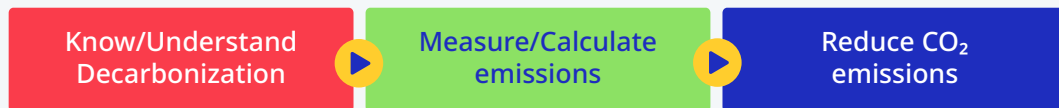
As co-lead agency, the MOE provides a dual-pillar support system categorized into hard and soft assistance. Hard assistance focuses on direct financial intervention. For example, interviewed MOE officials noted that the government can subsidize up to one-third of the investment required for facility installations. SMEs can further supplement this with green loans at lower interest rates. This financial support extends to infrastructure that addresses Scope 3 emissions, targeting energy-saving facilities and broader supply chain emissions reduction. Soft assistance, conversely, provides low-interest green loans, technical assistance, consultations and planning support.

A cornerstone of this effort was the Model SME Project for Decarbonization (2020–23), which established best practices to inspire the wider SME community. The project focused on building a three-step capacity for firms to: (1) know/understand, (2) measure and (3) reduce CO₂ emissions within their day-to-day operations, supported by combined financial and technical aid.

⁹ GX League Symposium 2023

¹⁰ See GX Dashboard, <https://dashboard.gx-league.go.jp/en/>

► Figure 3: Three main objectives of the Model SME Project for Decarbonization 2020–23



Source: Based on interviews with MOE officials

Rather than imposing punitive measures, the MOE utilizes positive incentives to drive compliance. However, transparency is maintained through a reporting requirement: SMEs emitting more than 3,000 tons of CO₂ or 1,500 kiloliters per year are formally requested to disclose their emissions and energy consumption data.

To further align Japanese firms with global standards, the MOE encourages participation in the Science-Based Targets (SBTs) initiative which validates companies' emission reduction commitments in line with the Paris Agreement.¹¹ Registered SMEs often benefit from direct linkages with MOE and exclusive access to additional resources.

The MOE's environmental initiatives are built on a long-standing foundation. More than 20 years ago, the ministry launched Eco-Action 21 as a Japanese-specific version of the Environmental Management System. While originally modeled after the ISO 14000 series used by large companies, the programme was later refined to better serve the unique needs of smaller organizations. Today, Eco-Action 21 operates as a streamlined certification and registration programme specifically adapted to help SMEs, schools and public institutions develop and sustain effective environmental initiatives.

Because SMEs typically have more visible operational impacts on the environment, Eco-Action 21 fosters a bottom-up approach to decarbonization, which is widely regarded as the most effective way for achieving decarbonization goals.

The MOE's mandate extends into worker safety and social behavior. In partnership with MHLW, the ministry manages critical climate-related health issues such as preventing heat exhaustion during Japan's humid summer months, with plans to expand this collaboration toward sustainable management and the circular economy.

Finally, MOE seeks to shift society's narrative towards deeper environmental consciousness and to encourage consumers to prefer green products. It does this through the *Decokatsu* programme,¹² a national effort to ensure all stakeholders contribute to Japan's 2050 net-zero goal.

¹¹ Japan's strategy — specifically the long-term strategy sections on industrial sector emissions mitigation and green finance — elaborates on a sector-by-sector approach, emphasizes the concept of value-chain-wide emissions and promotes the efforts of companies to set science-based targets. For more, see Nate Aden, "Japan is leading on Business Climate Commitments," Science Based Targets (blog), 18 February 2019, <https://sciencebasedtargets.org/blog/japan-is-leading-on-business-climate-engagement-will-ambitious-policies-follow>

¹² Details on this movement may be found at its website: <https://ondankataisaku.env.go.jp/decokatsu/en/>

► **Box 5: Decokatsu**

Decokatsu is a national movement designed to encourage lifestyle changes among all citizens to help achieve Japan's carbon neutrality goal by 2050 and reduce CO₂ emissions by 2030. It is a public-private partnership at all levels of government that promotes collaboration throughout society to identify necessary lifestyle changes and the policies and incentives that could encourage these.

The name *De co ka tsu* has taken the first syllables of the following actions to make the movement easy to remember:

De: Denki mo shoene dannetsu jutaku (Save electricity and promote energy-efficient, well-insulated homes.)

Co: Kodawaru tanoshisa eko guzzu (Enjoy choosing eco-friendly goods and be selective.)

Ka: Kansha no kokorowa tabenokoshi zero (Be thankful to those who produce our foods and avoid food waste.)

Tsu: Tsunagaru ofisu tere waaku (Connected offices through telework.)

► Summary of findings and key insights

This chapter synthesizes the experiences of six SMEs that participated in the MOE's Model SME Project for Decarbonization implemented from 2020 to 2023. It summarizes the cases and distills lessons regarding the enablers of a green and just transition, as well as identifies the additional support measures these firms require. Detailed case studies for each firm are provided in Annex 1.

Brief description of the SMEs' decarbonization experience

Each year, the MOE invited SMEs to apply for the Model SME Project. The selected applicants received guidance from external consultants to accelerate their decarbonization efforts. This support included:

- developing a decarbonization roadmap with identified measures and timelines;
- locating reliable renewable energy suppliers;
- preparing a financial plan for decarbonization; and
- calculating their Scope 1 and Scope 2 emissions.

The following table contains basic information about the six SMEs based on their respective websites and verification by respondents.

► **Table 4: Overview of SME Profile**

Company name	Nature of business	Year founded	Location	Number of employees
Rai Hatome Kogyo Co Ltd	Manufacture and sales of aluminum capacitor parts and other parts	1946	Yashio, Saitama	37
Kato Light Metal Industry Co Ltd	Manufacture and processing of aluminum extruded shapes, assembly and sales of products using aluminum	1994	Ama-gun, Aichi	85
Kyohatsu Industry Co Ltd	Mold design and production, press processing, welding, assembly and surface treatment for automobile parts	1966	Okazaki City, Aichi	34
Tsuyakin Co Ltd	Knitwear for fashion clothing, dyeing and processing of textiles, manufacturing and sales of clothing	1956 (as Tsuyakin) 1889 (founded by Sumiyoshio)	Ogaki City, Gifu	135
Tamamura Delica Co Ltd	Development and manufacturing of cooked noodles, snacks, prepared foods and so on. for 7-Eleven, operation of roadside stations and operation of restaurant stores	1991	Sawa-gun, Gunma	720
NIKKI Fron Co Ltd	Development and manufacturing of specialized polymer products, including fluoropolymer molding and processing, fiber-reinforced polymers for auto parts and injection molding machine assembly.	1944 (established as NIKKI Fron) 1896 (founded as Kasuga Shoten)	Nagano City, Nagano	320

Rai Hatome Kogyo, a metal-stamping and precision manufacturing company, specializes in aluminum-based components, such as capacitor casings, rivets and glass atomizer caps. While the firm serves the automotive and cosmetic industries, 98 per cent of its annual sales are derived from capacitor components. Its manufacturing process involves pressing or pulling aluminum into the required shape, followed by cleaning, sorting and packaging.

The company's journey began in 2010 when it joined the Eco-Action 21 programme. The firm appointed an Environmental Manager to plan and oversee decarbonization strategy and employee awareness. To strengthen internal expertise, the company supported this manager in obtaining a professional certification in pollution control.

In 2012, Rai Hatome Kogyo established an emissions baseline of 411.95 t-CO₂ and set an initial reduction target of 50 per cent by 2030. The primary emission sources were identified as heavy oil boilers (used for cleaning product residue) and electricity for industrial presses. The company acquired a washing machine that used significantly less hydrocarbons and did not require heavy oil boilers. It also started implementing energy-saving measures and purchasing green electricity. The switch to electric washing machines and green energy were major decisions that required the approval of the company president.

A significant portion of the company's energy-saving measures originated from the factory floor. The electricity shortages following the March 2011 Tohoku earthquake catalyzed a culture of efficiency. Through regular consultations, employees proposed several successful measures, including preventive equipment maintenance, transitioning to LED lighting and replacing paraffin heating with high-efficiency air conditioning.

By 2018, Rai Hatome Kogyo had achieved a 97 per cent reduction in emissions. Consequently, the company revised its target to full carbon neutrality by 2035.

The company joined the MOE Model SME Project for Decarbonization to learn how to further reduce their CO₂ emissions and eliminate the remaining 3 per cent of emissions. Through this collaboration, expert assessments led to technical refinements, such as installing insulation on the top panel of its washing machine and optimizing the discharge pressure of its compressor.

Kyohatsu Industry manufactures metal press products, such as washers, clamps, clips, brackets and support plates. As a supplier within Toyota Motor Corporation's supply chain, the company produces components strictly according to Toyota's specifications.

The company president became interested in supporting the SDGs after hearing Prime Minister Yoshihide Suga speak on the subject. This interest turned into a strategic necessity in June 2021 when Toyota Motor Corporation announced that its suppliers must reduce emissions by 3 per cent compared to 2020 levels. Kyohatsu Industry became the first company in the automotive industry to obtain SBT certification from MOE.

Kyohatsu Industry set a target to reduce emissions by 50 per cent by 2030 (from a 2018 baseline of 17.0 t-CO₂) and achieve full carbon neutrality by 2050. The company faced challenges, however. First, the company, as a subcontractor, cannot modify product designs or materials to reduce emissions, as these are dictated by Toyota Motor Corporation. Second, it must absorb the high cost of energy-efficient equipment, while remaining price-competitive. Third, the initial investment for large-scale solutions, such as solar panel installation and renewable energy procurement, was prohibitively high.

To overcome these hurdles, Kyohatsu Industry joined the Model SME Project for Decarbonization, gaining access to expert consultants in developing a decarbonization roadmap. This strategy balanced long-term capital investments with immediate, cost-effective efficiency gains. Initial efforts focused on operational improvements, such as switching to LED lighting, installing roof insulation to reduce summer air conditioning costs and reusing compressor heat for winter warmth. The company adopted a phased investment approach, scheduling the installation of solar panels and the switch to renewable energy in stages to manage the financial burden of its projects. Beyond technical changes, Kyohatsu

Industry introduced unique employee incentives, such as providing additional compensation for staff who choose to walk to work.

The company integrated worker health and safety into its core strategy, earning annual recognition since 2020 through METI's Outstanding Company for Health and Productivity Management award. This human-centric approach is reflected in Kyohatsu Industry's decarbonization roadmap, which prioritizes transparency by ensuring all employees remain informed of the firm's green targets and progress. To formalize this commitment, the company established a "carbon neutrality" team specifically tasked with monitoring and steering the organization towards its 2050 net-zero goal.

Kyohatsu Industry also highlights a critical challenge in the transition: the significant knowledge gap between technical specialists and the business community. To bridge this divide, the company emphasizes the importance of training and educating younger generations so that the future workforce will be equipped with the specialized knowledge and skills to sustain long-term decarbonization efforts.

Kato Light Metal Industry is a specialized manufacturer of extruded aluminum industrial components, sheets and wire, supplying critical parts to the construction, electronics and transportation sectors. The firm's manufacturing process involves heating and pressing aluminum ingots through dies (extrusion) to create precise shapes – a method that traditionally generates significant Scope 1 and Scope 2 emissions due to fuel-powered extruders and a heavy reliance on carbon-intensive virgin aluminum (aluminum extracted from bauxite and other ores).

Driven by the president's prior environmental expertise, the company adopted a proactive decarbonization management strategy. This began with a rigorous analysis of the business environment to anticipate future competition and the potential impacts of decarbonization. The analysis revealed that clients were increasingly demanding emissions disclosure as the entire industry shifted towards decarbonization. In response, Kato Light Metal Industry developed an input-output model to prioritize suppliers who are actively decarbonizing and using renewable energy. By fostering close partnerships, the company also encouraged its suppliers to innovate and reduce their own operational footprints.

Kato Light Metal Industry calculated its emissions and developed its own software to analyse and visualize its 2021 emissions data. This analysis revealed that direct operations (Scope 1) accounted for only 1 per cent (127.0 t-CO₂), while indirect energy use (Scope 2) represented 15 per cent (2371.0 t-CO₂) and the vast majority — 13706.0 t-CO₂ — fell under Scope 3. Working in consultation with industry organizations and local stakeholders, the company focused on addressing operational waste and replacing aging machinery. A key investment included an electric hybrid 2350t extruder machine, which reduced electricity consumption by 20 per cent.

The company sought further technical assistance through the Model SME Project for Decarbonization, which identified 19 potential reduction measures. Of these, 13 were prioritized as feasible within its decarbonization budget. The company also applied for METI subsidies to support the purchase of new equipment.

Finally, Kato Light Metal Industry advocates for a circular aluminum economy. By reducing its minimum order quantity from 20 kilograms to 5 kilograms, the firm has minimized waste of aluminum products and avoided emissions from overproduction. Furthermore, the company is exploring green aluminum production with various investors and advocates for government-funded aluminum recycling facilities. The rationale is both environmental and economic: recycled aluminum generates only one-thirtieth of the CO₂ emissions associated with refining virgin aluminum and provides a buffer against supply disruptions caused by the Russia-Ukraine conflict.

Despite these successes, the company president cites a human resource challenge: the firm's decarbonization knowledge remains concentrated in his leadership. He emphasizes the need for raising employee awareness and training, calling for expanded government support to develop green expertise within the SME workforce.

NiKKi Fron is a global manufacturer of custom precision parts and machinery for the semiconductor, automotive and medical equipment industries, with production plants in Japan (Nagano and Shiga prefectures) and in Thailand (Chonburi province). The company molds, sinters and shapes fluoropolymer into parts used in semiconductor manufacturing equipment; this material is ideal for the semiconductor manufacturing process because it provides low friction, can withstand extreme temperatures and does not react to chemicals. Additionally, the firm specializes in producing friction and heat insulation material from fiber-reinforced polymers, which are utilized in components, such as manual vehicle clutches and bullet train brake systems.

NiKKi Fron established an early lead in environmental stewardship by obtaining ISO 14001 accreditation for Environmental Management Systems in 2000. Since carbon measurement is a prerequisite for maintaining its accreditation, the company launched its formal decarbonization efforts in 2008. NiKKi Fron participated in the Model SME Project for Decarbonization, partnering with experts from the Industrial Technology Center to conduct precise emissions mapping across various manufacturing sub-processes. This assessment identified the sintering furnace and air conditioners as the primary sources of emissions. Consequently, the company set a target to reduce Scope 1 and Scope 2 emissions by 30 per cent by 2030 (based on a 2018 baseline of 518 t-CO₂) and developed a decarbonization roadmap that included measures to procure renewable energy, reduce energy consumption and improve operational efficiency.

Although the company now operates at the cutting edge of material science, its corporate DNA is rooted in a tradition of innovation dating back to 1896. Originally a hemp wholesaler, the company faced severe restrictions during World War II that left only low-quality hemp that would have been discarded. In a pivotal moment of adaptation, the company patented a new packing material combining hemp and silk waste. This wartime innovation birthed the company's enduring philosophy, "Utilize limited resources effectively." This commitment to resource efficiency continues today through a long-standing partnership with Shinshu University, a collaboration active since 1944 that focuses on developing new production techniques aligned with decarbonization objectives.

The vulnerability of global supply chains was brought into focus by the 2011 Tohoku earthquake and 2011 Thailand floods in the Chao Phraya River basin. Having learned from these disruptions, NiKKi Fron developed a robust business continuity plan. This foresight proved invaluable during the 2019 Typhoon Hagibis, which inundated several Nagano facilities. Because of its BCP, the firm was able to quickly shift production to its Thailand plant, maintaining operations despite the regional disaster. Furthermore, the company successfully utilized METI subsidies to cover 75 per cent of the costs for replacing damaged equipment. NiKKi Fron's experience demonstrates how financial support and strategic disaster planning are essential components of a sustainable transition.

Tamamura Delica is a food manufacturer providing freshly cooked noodles, side dishes and snacks to 7-Eleven and other convenience stores. As a supplier of 7-Eleven, the company participated in Seven & i Group's Green Challenge 2050, a campaign to reduce the environmental footprint across the store's network and supply chains, including a target to reduce 50 per cent of 2013 emissions by 2030. Alongside these environmental goals, Tamamura Delica strictly adheres to Seven & i Group's human rights policy, prioritizing employee rights and workplace wellbeing.

The food processing sector is energy-intensive, as it requires high-output heat processes like boiling or baking, alongside the constant refrigeration needed for chilling or freezing. Beyond these core functions, the automated packing of products and the rigorous, continuous disinfection of facilities further drive up energy demand. Consequently, emissions in this sector are primarily generated by the consumption of liquefied petroleum gas and heavy oils for boilers and heaters. Additionally, the industry faces significant environmental footprints from operational byproducts like waste cooking oil, the production of diverse packaging materials (such as plastic, paper, aluminum), and the complex logistics of transporting both raw ingredients and finished products.

Tamamura Delica's formal commitment to sustainability began in 2015 when it joined the MOE's Eco-Action 21 Project, launching awareness campaigns centered on local food production, waste reduction and community appreciation. Building on this momentum, the firm began publishing annual environmental management reports and consistently achieved a 1 per cent annual energy reduction in accordance with the Japanese Energy Conservation Act. These efforts culminated in 2023 with the development of an environmental management policy specifically designed to tackle food waste and carbon emissions.

The scale of this challenge is reflected in the company's emissions data. At the head office and main Gunma factory, combined Scope 1 and Scope 2 carbon emissions rose from 9,643 t-CO₂ in 2013 to 10,667 t-CO₂ by 2020. To reverse this trend and align with the Seven & i Group's Green Challenge 2050, the company established an ambitious target to reduce its 2020 levels of 4,821 t-CO₂ by 54.8 per cent by 2030. Given Tamamura Delica's production — ranging from freshly cooked noodles to various side dishes — the primary emission sources include waste cooking oil, electricity, liquefied petroleum gas and food packaging.

Through its participation in the MOE Model SME Project for Decarbonization, the company crafted a decarbonization roadmap. This plan integrates infrastructure upgrades, such as maximizing air-cooling systems and enhanced insulation with a shift towards sustainable packaging to reduce plastic consumption. The shift to greener packaging provided a dual benefit by simultaneously reducing the workload for production line workers. Furthermore, the company benefited from METI's power purchase agreement scheme, which subsidized the cost of installing solar panels across its factory roofs. Finally, the firm is exploring innovative ways to reuse waste cooking oil, aiming to significantly decrease its reliance on crude and heavy oils for boiler operations.

The success of these initiatives is rooted in a strong commitment from its upper management towards sustainability and climate action. This leadership is deeply personal; the President and Representative at the time of this research, hailing from a farming background, emphasized a first-hand awareness of how climate change impacts the agricultural sector. The company established a robust internal governance structure to operationalize this vision. The Managing Director serves as the Corporate Social Responsibility (CSR) Environment Promotion Team Leader, while the Chief Electrical Engineer and Production Technology Department-Technology Section Manager oversees energy-saving and decarbonization planning.

In February 2023, the company further formalized its commitment to environmental action by enacting an Environmental Management Policy. This policy serves as a strategic framework for the firm's transition toward a low-carbon society, specifically addressing the reduction of both food and plastic waste alongside their associated emissions. Beyond carbon management, the policy encompasses a holistic approach to environmental stewardship, including the improvement of energy efficiency, the management of water use and wastewater quality and the promotion of regional environmental improvements, all while ensuring strict compliance with evolving environmental laws and regulations.

Tsuyakin provides dyeing and finishing services for a wide range of textiles, including those used by prominent Japanese apparel brands like United Arrows. The company's history in the sector dates back to 1899, when it began using traditional methods to dye cotton and silk. Over the decades, Tsuyakin became a pioneer in the industry as the first Japanese company to introduce chemical dyeing and processing of synthetic fibers.

The textile and apparel industry is inherently carbon-intensive, with emissions spanning from thread and textile production to the incineration of unused textiles. The impacts from every part of its supply chain are amplified by rapid fashion cycles. Tsuyakin's primary environmental impact stemmed from the dyeing process, which requires heating water to high temperatures between 60°C and 135°C and maintaining that heat for 1.5 to 2 hours. Beyond the energy use, the company recognized that discharging untreated wastewater could introduce chemicals, alter the acidity (pH level) and temperature of groundwater and disrupt local ecosystems.

Tsuyakin implemented many measures to reduce its ecological footprint. The company's transition toward sustainability began as early as 1987 when it replaced its gas industrial boiler with a biomass boiler. Biomass boilers are considered to have net zero emissions because they use materials that had previously absorbed carbon. Using wood chips from demolished houses in their biomass boiler, the company achieved an estimated reduction of 12,367 t-CO₂ compared to traditional gas systems. Over time, the company introduced additional measures such as wastewater treatment systems to neutralize chemical residues, align wastewater pH levels with local groundwater and cool the water prior to discharge. It has also begun shifting to hybrid dyeing machines that significantly lower operational energy demand.

Tsuyakin's ecological initiatives extended beyond production. In 2008, the Gifu Prefectural Industrial Technology Center approached the company to collaborate on developing plant pigment dyes extracted from food processing waste. This innovation resulted in the 2011 launch of a clothing line dyed with pigments extracted from food waste. Additionally, Tsuyakin upcycles its own textile inventory to combat the large volumes of textile waste prevalent in the Japanese market.

Through its participation in the Model SME Project for Decarbonization, Tsuyakin successfully calculated its CO₂ footprint. The company subsequently received SBT certification from the MOE in August 2021. The company committed to reducing Scope 1 and 2 emissions by 50 per cent by 2030 (relative to 2018 levels) while pledging to reduce Scope 3 emissions. It became the first Japanese SME textile dyeing company to receive SBT certification. Its emissions were measured in 2021 at 424 t-CO₂, primarily driven by electricity consumption. Current implementation plans include switching to LED lighting, addressing specific equipment-related needs and procuring 10 per cent of its electricity from renewable utilities, supported by METI subsidies for the acquisition of decarbonization equipment and technology.

These decarbonization efforts are driven by the personal involvement of the company president, who formally revised the company's management philosophy to embed environmental protection and sustainability as core business principles. Beyond the factory walls, he is a public advocate for industry-wide change, calling for extended product lifecycles, increased circularity, and more sustainable inputs. The president personally engages with employees to foster a culture of environmental protection, stressing that these green practices add significant value and prestige to the company's products.

Results and analysis

The SMEs in this study were interviewed using open-ended questions designed to capture the unique nuances of their decarbonization journey (the full interview guide is available in Annex 2). To ensure a robust analysis, these firsthand accounts were substantiated with official MOE case studies, online interviews with the company owners and corporate disclosures on their websites. The synthesized findings are categorized by the specific strategic actions taken by the firms.

Decarbonization steps taken

Energy-efficient equipment. Replacing legacy machinery and equipment with high-efficiency alternatives served as a cornerstone of the companies' technical strategies.

- Rai Hatome Kogyo switched from heavy oil boiler washing machines to electric heater-based units in 2015, resulting in a 46 per cent reduction in CO₂ emissions relative to 2008 levels.
- Kato Light Metal Industry modernized its production line with energy-efficient equipment, successfully cutting energy consumption by 20 per cent.
- Tsuyakin demonstrated early leadership by switching to a biomass boiler using recycled wood chips in 1987; more recently, it adopted hybrid dyeing machines that reduce both boiling times and electricity use.

- Tamamura Delica is currently researching alternative fuel sources for noodle production, including the integration of boilers capable of utilizing waste cooking oil.
- NiKKi Fron leveraged METI subsidies following a natural disaster to invest in modern, efficient machinery that significantly lowered its CO₂ footprint.

Business practices. Operational refinements and management policies allowed these SMEs to reduce energy demand without compromising output.

- Rai Hatome Kogyo deployed monitoring equipment to manage and optimize real-time energy consumption.
- Kato Light Metal Industry standardized office temperature regulations to minimize unnecessary climate control costs.
- Kyohatsu Industry, Rai Hatome Kogyo and Tsuyakin implemented facility-wide transitions to LED lighting.
- Tamamura Delica optimized its cooling systems through a multi-pronged approach, including timer installations on refrigerators, pipe and valve insulation to prevent outside air intrusion into its freezers and the use of mist spraying on outdoor units and roof sprinkling to combat heat during Japan's humid summers.
- NiKKi Fron has maintained ISO 14001 (Environmental Management System) certification since 2000, ensuring that energy reduction policies are deeply embedded in its long-term environmental management system.

Inputs. Most companies have shifted their supply chains towards renewable energy and greener inputs.

- Rai Hatome Kogyo now procures renewable electricity from Idemitsu, a leading Japanese producer of green energy.
- Tamamura Delica installed solar panels and is finalizing plans to procure additional green energy from third-party suppliers.
- NiKKi Fron is finalizing a procurement strategy to purchase renewable energy from a local provider within the prefecture.
- Tsuyakin has advanced recycling efforts and has pioneered the use of plant dyes derived from food waste.
- NiKKi Fron has filed a patent for PTFE recycling. Similarly, Kato Light Metal Industry is exploring investments in aluminum recycling, and Tamamura Delica is investigating the conversion of waste cooking oils into boiler fuel.

Green product or service. Some of the companies have pivoted their business model to offer products that emit less CO₂ during production.

- Kato Light Metal Industry is expanding its portfolio to include low-carbon aluminum and products made with a higher percentage of recycled content.
- Tsuyakin launched two eco-friendly brands: Retricot, a clothing line made from upcycled waste cloth, and Kurakin, a textile line utilizing natural pigments.
- Tamamura Delica redesigned its 7-Eleven packaging to use less plastic by engineering new lids that eliminate the need for adhesive tapes and mixing seasonings directly into the food to remove individual plastic packets.
- NiKKi Fron is launching a PTFE recycling business and has filed for a patent for fluoropolymer recycling.

► **Table 5: Summary of decarbonization actions taken by interviewed companies**

Actions	Rai Hatome Kogyo	Kyohatsu Industry	Kato Light Metal Industry	NiKKi Fron	Tamamura Delica	Tsuyakin
Business practices	- Implemented energy-saving measures - Measured CO₂ emissions since 2012 - Reduced the number of company cars to one - Set an emissions reduction target of 50% by 2030; updated this to carbon neutrality by 2035 - Branded itself as a green company for more than 10 years - Developed worst- and best-case scenarios for decarbonization	- Cut down unnecessary energy consumption - Carefully planned and implemented SBTs to reduce CO₂ emissions by 2030 and achieve neutrality by 2050 - Improved measures to monitor and disclose CO₂ emissions	- Followed a decarbonization management approach - Conducted an energy-saving diagnosis targeting operational waste and equipment deterioration - Lowered its minimum order policy to reduce wasted aluminum - Planned the establishment of an aluminum recycling plant	- Obtained ISO 14001 certification in 2000 (covering energy-use reduction); began decarbonizing in 2008 to maintain certification - Implemented energy-saving measures - Set an emissions reduction target of 30% by 2030 - Developed a business continuity plan after the 2011 Thailand floods to allow rapid production shifts - Considered decarbonization as part of long-term business continuity	- Set an emissions reduction target of 54% by 2030 - Insulated refrigerator exteriors to improve energy use - Applied mist spraying on outdoor units and roof sprinkling in summer to reduce heat	- Believed it would be a strong company selling point to consume less energy than competitors - Obtained SBT certification from MOE in August 2021 for a 50% emissions reduction by 2030 - Measured CO₂ emissions
Energy-efficient equipment	- Upgraded washing machines from heavy oil boilers to electric-heater type - Installed equipment to monitor energy use - Switched to LED lights	Switched to LED lights for energy efficiency	- Switched equipment and facilities to a more energy-efficient electric hybrid extruder machine - Developed software to calculate Scope 1, 2 and 3 CO₂ emissions	Replaced most factory machinery after the 2019 Nagano floods with more energy- and material-efficient equipment	- Installed high-efficiency air conditioners - Installed solar panels on some factory roofs - Lowered ceilings to improve cooling efficiency	- Switched to a biomass boiler in 1987 - Switched to a hybrid dyeing machine to shorten boiling time - Replaced lights with LED bulbs
Inputs	- Switched boilers from crude oil to electric heaters in 2015 - Started purchasing green energy in 2017	n/a	Purchased materials from suppliers using renewable energy and supported greening across the business	- Planned to buy renewable energy from local providers - Studied additional renewable energy options	- Adopted greener food packaging (less plastic) - Studied the use of waste cooking oil in boilers - Planned to procure green energy	- Switched to plant dyes extracted from food waste - Upcycled unsold textiles into new textiles and clothing - Switched to renewable energy
Green product or service	n/a	n/a	Produced green (low-carbon) aluminum	Filed a patent for PTFE recycling	Produced pre-seasoned noodles in greener packaging	Created environmentally friendly brands and products with lower CO₂ emissions

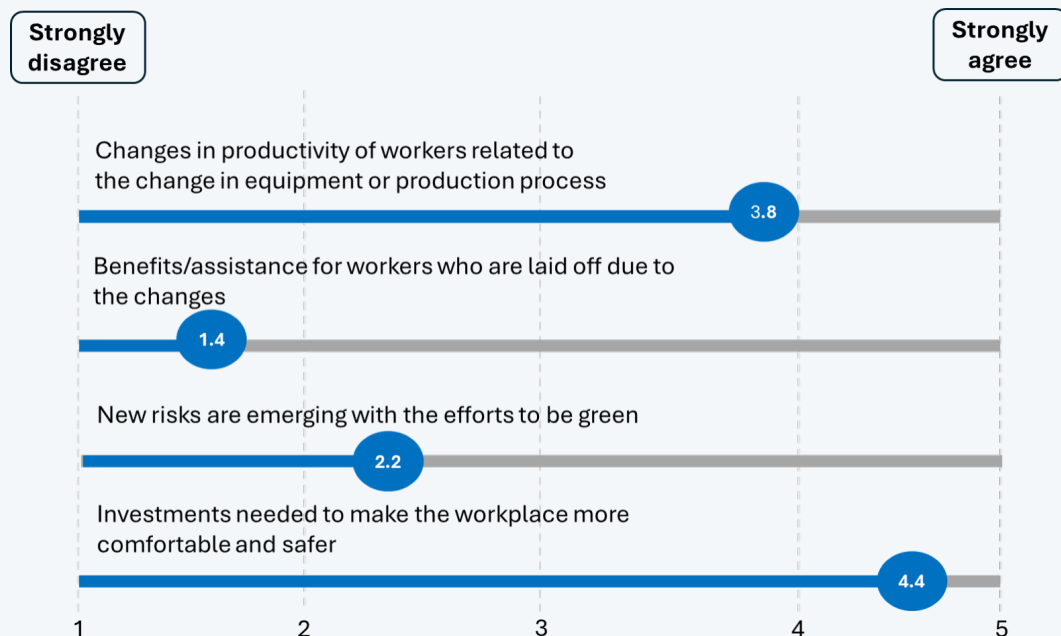
Just transition

To complement the individual interviews, a focus group discussion was conducted with business owners and human resource managers to evaluate how decarbonization affects the workforce. A recurring theme across the firms was a proactive approach to risk management: when new equipment was introduced, companies followed rigorous protocols to anticipate safety issues, mitigate risks and provide workers with comprehensive safety training. The synthesized results of these discussions are summarized in table 6.

Governance. Several SMEs integrated sustainability into their corporate governance structures, often preceding their participation in the Model SME Decarbonization Project. Kato Light Metal Industry formally incorporated decarbonization into its mission and vision statements. Tsuyakin revised its management philosophy to prioritize harmony with the environment. NiKKi Fron embedded resource efficiency in its company philosophy, aligning its operations with the SDGs. Rai Hatome Kogyo established an environmental manager position to centralize and accelerate green initiatives across the organization.

Most of the companies already maintained strong cultures of decent work and occupational safety and health measures. For example, Kyohatsu Industry had received certification and is consistently recognized for its superior OSH measures, while Tamamura Delica adheres to the stringent labour standards and human rights policies mandated by its primary client, 7-Eleven.

► **Figure 4: Main concerns during the green transition**



Source: Results of poll taken during the focus group discussion with five participants in response to the question. "What are the typical changes created by efforts of SMEs to reduce carbon emission?". Participants were asked to rank their level of agreement or disagreement with four statements indicated in the figure on a scale of 1–5.

Employee awareness / skills / workload. The transition highlighted a significant demand for specialized knowledge, particularly regarding the technical complexities of carbon accounting. All SMEs identified emissions calculation as a highly technical challenge, even for owners with engineering backgrounds. They credited the MOE with providing support in identifying sources of emissions, recommending reduction measures and crafting decarbonization roadmaps. Companies noted that the sustainability of decarbonization efforts depends on building the capacity of both managers and workers through continuous education on decarbonization and environmental protection.

During the focus group discussion, participants emphasized that employees must remain flexible, as the specific operational adjustments required to reduce emissions effectively are often difficult to predict. The firms consistently ranked environmental awareness training as their top priority, followed by the need for dedicated environmental officers and technical skills in measuring carbon footprint.

There was a consensus that transition-related risks must be anticipated and clearly communicated to employees. Key concerns included potential injuries from hazardous materials and the operation of new, unfamiliar equipment. To eliminate these risks, the SMEs reported the following standard practices:

- Conducting hazard assessments for all new equipment, materials, or processes
- Providing clear instructions and training for new machinery
- Implementing strict protocols to prevent exposure to hazardous chemicals
- Actively monitoring and protecting employees' mental health
- Ensuring total compliance with occupational safety and health laws.

Social dialogue and worker participation. Two companies explicitly engaged workers and consulted them on how to implement decarbonization measures. Kato Light Metal Industry actively solicited employee suggestions for reducing CO₂ emissions, while Rai Hatome Kogyo formalized this process by documenting worker suggestions in its annual environmental management report. Both companies also sought workers' cooperation in implementing energy-saving measures and various decarbonization actions.

In the FGD, participants successfully linked the green transition to decent work considerations. When asked to rank necessary changes accompanying decarbonization, the highest priority was investing in worker welfare to protect against emerging risks and ensure occupational safety and health (figure 4, Scoring 4.4). The second priority was enhancing worker productivity without compromising safety.

Support for laid-off workers was ranked as a low priority; every representative confirmed that no employee has been dismissed as a result of decarbonization activities.

► Table 6: Interview results: Measures and needs related to selected just transition elements

Actions	Rai Hatome Kogyo	Kyohatsu Industry	Kato Light Metal Industry	NiKKi Fron	Tamamura Delica	Tsuyakin
Governance	- Environmental manager role created under Eco-Action 21 - Annual voluntary environmental management report published	"Carbon neutrality" team created to monitor decarbonization progress - Commitment to a healthy working environment - Certification received for its strong OSH practices	Decarbonization incorporated in the company mission and vision	Company philosophy based on "Utilizing limited resources effectively"	- Eco-Action 21 programme welcomed by management - Compliance with 7-Eleven and i Holdings' Human Rights Policy expected as a key supplier	Formal management philosophy: "Pursuing business that is safe for the environment and for the future of our children"
Employee awareness / skills / workload	- Need cited for employee training on environmental protection - Employee engagement in energy saving measures - Challenges cited in sustaining decarbonization efforts when new managers and staff join - Environmental manager trained and certified in environmental management	- Employee awareness raised through involvement in the decarbonization roadmap - Concerned expressed with equipping the next generation with decarbonization skills - Identified knowledge gaps among managers on decarbonization goals and planning	Need for internal training and environmental awareness campaigns within the company	Lack of dedicated staff for R&D, cited as a key vehicle for decarbonizing production processes	- Greener packaging design reduced workload among production staff - Strong management and staff motivation to cooperate with partners towards long-term goals - Training seen as important for sustaining motivation and awareness	Need for employee awareness cited on environmental protection and decarbonization and understanding how these concepts add value to products
Social dialogue	Employee suggestions on CO ₂ reduction incorporated into annual environmental management reports	n/a	Employee ideas solicited on reducing CO ₂ emissions	n/a	n/a	n/a

To ensure a just transition, the participating companies reached a consensus on the necessity of integrated short-term and long-term plans. However, it was noted that current perceptions of a just transition remain heavily centered on climate change mitigation. To broaden this scope and secure future operations, the respondents identified the following short-term action priorities:

- Implementation of energy-saving initiatives
- Prioritization of Scope 1 and 2 CO₂ emissions
- Alignment of environmental protection with productivity
- Cultivation of workforce flexibility to help employees adapt to new processes or acquire green skills
- Training of internal specialists to support phased decarbonization (covering Scope 1, 2 and eventually 3)

The long-term plans identified by the respondents include:

- Securing specialists capable of sourcing green energy that balances environmental benefits with affordability
- Developing experts to manage new equipment and drive process efficiency
- Training leaders to oversee environmental actions and ensure stable access to green energy
- Identifying new business opportunities emerging from the global shift toward decarbonization

Enabling factors

Several factors identified in the literature review were observed and validated across the six case studies. These elements, which serve as catalysts for the green transition, are summarized below and detailed further in table 7.

Owner-manager characteristics. Company leadership emerged as a crucial factor in driving the decarbonization of the six SMEs. All case studies highlighted the importance of a champion for reform — a leader whose dynamic and sustained commitment embedded green practices into the corporate culture. The motivations of these leaders varied, ranging from a desire to strengthen business competitiveness and leave a positive legacy to address broader concerns about environmental degradation and Japan's national food security.

It is noteworthy that these SMEs acted as early adopters. They pursued decarbonization technologies well before government mandates were in place. Although three firms — Kyohatsu Industry, Tamamura Delica and Tsuyakin — face downstream procurement requirements, their leadership had initiated environmental strategies long before these external pressures materialized.

The study indicates that specific leadership traits, including technical knowledge, personal values and a strategic understanding of green benefits, are vital for a successful transition. Examples include:

- Rai Hatome Kogyo: The environmental manager facilitated company-wide dialogue, influenced key decision-making, raised employee awareness and spearheaded engagement with both government agencies and industry peers.
- Kato Light Metal Industry: The president's strong academic background in environmental science and expertise in emissions calculation enabled him to design a concrete, long-term decarbonization action plan.
- Kyohatsu Industry: The president personally led employee training and served as the primary focal point for translating complex sustainability guidelines into daily operations.
- Tsuyakin: The president integrated environmental action into the company's market strategy, viewing it as a primary tool for acquiring customers and expanding market share.

- Tamamura Delica: Drawing on his background as a farmer, the CEO integrated a deep understanding of climate change impacts on agriculture and the food supply into the company's sustainability directions.
- NiKKi Fron: The president's direct experience with the devastating impact of Typhoon Hagibis in 2019 transformed disaster resilience into a resolute commitment to pro-environment policies.

► **Table 7: Key enabling factors for SME decarbonization**

Framework dimension	Enabling factors	Examples / evidence from cases
Owner / manager characteristics	Reform "champion" within the firm	All SMEs had leaders who personally drove change
	Environmental values and long-term vision	Tsuyakin, Tamamura Delica, Kato Light Metal Industry
	Technical literacy and learning orientation	Kato Light Metal Industry, Rai Hatome Kogyo
	Risk awareness shaped by lived experience	NiKKi Fron (floods), Rai Hatome Kogyo (earthquake)
Organizational characteristics	Green company culture and identity	Rai Hatome Kogyo, Tsuyakin
	Teamwork and idea-sharing	Kato Light Metal Industry, Rai Hatome Kogyo
	Willingness to train and reskill workers	All SMEs
	Integration of OSH and decent work	Kyohatsu Industry, Tamamura Delica
	Capacity to absorb new technology	All SMEs, supported by MOE experts
Profitability and economic viability	Perceived business value of decarbonization	Rai Hatome Kogyo (branding); Tsuyakin (SBT-linked clients); Tamamura Delica (cost savings)
	Cost competitiveness of green inputs	Rai Hatome Kogyo (green electricity when cheaper); Kyohatsu (solar panels as burden)
	Market demand for low-carbon products	Tsuyakin (United Arrows); Kato Light Metal (weak demand for green aluminum)
	Productivity-linked energy savings	Kyohatsu (productivity first); Tsuyakin (hybrid machines improve output)
External factors	Supply-chain requirements	Kyohatsu Industry (Toyota), Tamamura Delica (7-Eleven)
	Business networks and partnerships	Kato Light Metal Industry, Rai Hatome Kogyo
	Disaster exposure and risk perception	NiKKi Fron, Rai Hatome Kogyo
	Government knowledge support	MOE technical assistance for all SMEs
	Financial de-risking	METI subsidies (NiKKi Fron, Tamamura Delica, Tsuyakin)
Cross-cutting enablers	Emissions measurement and road mapping	All SMEs via the Model SME Project
	Phased, feasible implementation	All SMEs
	Framing decarbonization as business value	Rai Hatome Kogyo, Kyohatsu Industry, Tsuyakin

Organizational characteristics. A firm's internal culture and organizational structure are pivotal in determining the success of its decarbonization efforts. This research indicates that attributes such as teamwork, a culture of continuous innovation, a commitment to decent work and the inherent capacity to adopt new technologies are significant drivers of the green transition.

- Rai Hatome Kogyo has fostered a green corporate culture for over a decade, and the company has solidified its commitment to sustainability. This identity is so deeply embedded that the firm continues to prioritize renewable energy even when non-renewable alternatives are more cost-effective. Employees are encouraged to practice energy-saving measures in their daily work.
- Tsuyakin's commitment to environmental protection is a core pillar of its management philosophy, driving the continuous development of low-emission processes and products.
- Kato Light Metal Industry, under a young and dynamic leader, has seen this dynamism spread throughout the company. Workers have successfully adapted to new operational processes and are actively encouraged to propose ideas for cutting CO₂ emissions.
- Kyohatsu Industry, as a supplier within the Toyota Motor Corporation network, must meet rigorous environmental and OSH standards. Its dedicated carbon neutrality team and its annual recognition as an Outstanding Company for Health and Productivity Management since 2020 reflect this high-performance culture.
- Tamamura Delica maintains high production and compliance standards necessitated by its role in the 7-Eleven & i Holdings supply chain, ensuring adherence to both environmental mandates and the group's Human Rights Policy.
- NiKKi Fron has a long-standing R&D partnership with Shinshu University, which allows the company to jointly develop new materials and processes. This collaborative approach provides the technical support needed to explore decarbonization of its production lines.

Profitability and productivity. The decision to decarbonize is heavily influenced by the demand for green services, identification of future business opportunities and the potential for cost reduction. Most SMEs interviewed reported lower production costs and expressed optimism about the long-term returns on investment.

- NiKKi Fron has yet to see a net profit increase, but the firm reported that lower energy costs, which helped offset the higher price of renewable electricity.
- Tamamura Delica also reported lower energy costs since switching from plastic to greener packaging materials.
- Kyohatsu Industry faced rising input costs and anticipated financial and technical difficulties as decarbonization progresses; yet the firm expects that these investments will secure its long-term position in the automotive supply chain.
- Rai Hatome Kogyo prioritized the procurement of green energy at competitive prices, a strategy exemplified by its 2017 switch to Idemitsu's renewable electricity when its rates became more favorable.
- Kato Light Metal Industry produces green aluminum, which, despite currently carrying a price premium over traditional aluminum, shows significant growth potential, as evidenced by a rising volume of inquiries from other firms.
- Tsuyakin leveraged its recent SBT certification to expand its market reach, specifically by fostering a green supply chain through procurement from other SBT-certified SMEs.
- Several companies noted that while low emissions are a strong selling point for business-to-business relations, consumer appreciation for green products remains relatively low.

The relationship between productivity and decarbonization was also highlighted as a dual-pathway benefit. For Tamamura Delica, improved production efficiency directly reduces manufacturing time, thereby lowering energy consumption. Similarly, Kyohatsu Industry pointed out that by prioritizing productivity, energy efficiency follows naturally as a logical outcome of a more streamlined process.

Business networks. Business networks — supply chain influence, partnerships, green energy sourcing and collaborative technical innovation — emerged as some of the most influential external drivers for SME decarbonization.

- Rai Hatome Kogyo established a strategic partnership with Idemitsu as a direct result of its search for a stable and reliable renewable energy supply.
- Kato Light Metal Industry collaborated with other SMEs to address their aluminum needs, an effort that helped clarify an industry-specific decarbonization strategy.
- Kyohatsu Industry intensified its decarbonization efforts in direct response to Toyota Motor Corporation's mandate requiring upstream suppliers to reduce emissions by 3 per cent.
- Tamamura Delica aligns its operational goals with the 7-Eleven Green Challenge 2050, ensuring its sustainability efforts reflect its buyer's climate agenda.
- Tsuyakin and NiKKi Fron began decarbonization before their respective downstream clients did; however, both firms emphasized that Tier 1 companies play a vital role in setting procurement specifications that incentivize greener production among SMEs.
- Partnerships with universities and local research institutes were instrumental in developing low-carbon products and processes, as evidenced by the successful R&D collaborations undertaken by Tsuyakin and NiKKi Fron.

Disasters and risks. The experience of natural disasters and the perception of risks significantly influenced the SME decision to adopt greener business models. Companies with direct exposure to such events tended to be more proactive in climate action and more likely to seek renewable energy as part of their energy security strategy.

- Rai Hatome Kogyo recognized the extreme vulnerability of conventional energy supplies following the 2011 Tohoku earthquake, which catalyzed its shift towards resilience.
- Kato Light Metal Industry accelerated its investment in aluminum recycling to mitigate the impact of global disruptions, such as the Russia-Ukraine War, which increased the cost and volatility of virgin aluminum imports. This reflects a broader trend among the SMEs studied, who were also motivated by the pandemic to pursue renewable energy as a means of securing their energy independence.
- Tsuyakin advocates for circularity and extended product lifecycles in the fashion industry, driven by growing environmental concerns regarding textile waste and pollution.
- Tamamura Delica, through the lens of its CEO's farming background, treats climate change as a direct risk to the stability of the food supply chain.
- NiKKi Fron leveraged its experience with the 2011 Tohoku earthquake and the Thailand floods to reinforce its business continuity planning and climate risk preparedness.

Government assistance. The SMEs studied operate within carbon-intensive sectors prioritized under Japan's GX strategy and roadmap. Consequently, these companies are strategically positioned to benefit from government interventions, being part of the automotive (Rai Hatome Kogyo, Kato Light Metal Industry, Kyohatsu Industry and NiKKi Fron), ICT (NiKKi Fron and Rai Hatome Kogyo), food production (Tamamura Delica) and lifestyle-related (Tsuyakin) industries.

Knowledge and tools. Government policies and technical assistance were pivotal in overcoming the complexity of emissions measurement, which respondents described as a significant technical hurdle even for those trained in engineering or chemistry.

- NiKKi Fron utilized expert guidance to obtain highly specific emissions data across its various production sub-processes.
- Tsuyakin received technical assistance from the MOE to measure the energy efficiency of its biomass boiler compared to its legacy equipment, a traditional boiler.
- Tamamura Delica collaborated with the MOE to develop a phased transition plan towards a renewable energy mix.
- Rai Hatome Kogyo implemented factory-specific energy recommendations following the technical assessments conducted by a government expert.
- Kato Light Metal Industry received comprehensive advice covering both manufacturing processes and emissions across its supply chain.

Participation in the Model SME Project significantly bolstered the confidence and capacity of these firms to maintain their climate action trajectories.

Financing. Financial support through government subsidies, loans and advisory services facilitated critical capital investments, though respondents noted that these schemes are often highly competitive and administratively demanding.

- Kato Light Metal Industry is currently navigating the application process for a METI subsidy to fund its decarbonization initiatives.
- Tsuyakin is pursuing METI grants to purchase ICT and high-efficiency equipment.
- Tamamura Delica successfully utilized a METI subsidy to install solar panels.
- NiKKi Fron secured METI subsidies that covered 75 per cent of its equipment replacement costs following the 2019 Typhoon Hagibis.
- Kyohatsu Industry identifies further government support as essential for the procurement of green equipment, such as solar panels
- Some companies noted that meeting the strict eligibility criteria for government programmes remains a significant barrier for many SMEs.

Complementary support. Beyond the Model SME Project on Decarbonization, broader government policies and institutional frameworks provided a foundation for environmental action.

- Rai Hatome Kogyo and Tamamura Delica utilized the Eco-Action 21 framework to institutionalize environmental management and voluntary reporting within their operations.
- Rai Hatome Kogyo adopted MOE white papers as guidance for its internal climate action strategies.
- Kyohatsu Industry cited the government's promotion of the UN SDGs and the former Prime Minister Suga's public endorsements as key drivers of its corporate sustainability shift.
- Tsuyakin leveraged MOE programmes focused on circularity in the textile and apparel sectors to align its decarbonization goals with industry-wide sustainability trends.

► Table 8: Detailed list of government assistance cited

Assistance	Rai Hatome Kogyo	Kyohatsu Industry	Kato Light Metal Industry	NiKKi Fron	Tamamura Delica	Tsuyakin
Knowledge and tools	• Participation in Eco-Action 21 • Participation in high-level seminars • MOE technical assistance to review factory layout and identify emissions-reduction measures • Access to MOE white papers on environmental action • MOE expert support on CO₂ measurement and calculation	MOE technical assistance to develop a decarbonization roadmap	• MOE technical assistance to calculate CO₂ emissions • Support to strengthen initiatives and assess supply-chain emissions	MOE technical assistance (Industrial Technology Center experts) to measure CO ₂ emissions	• MOE support to develop a decarbonization roadmap • Assistance in setting a 54% reduction target by 2030	• MOE technical assistance to calculate CO₂ emissions and set medium- and long-term targets • Support to compare energy use of biomass vs. conventional boilers
Finance	n/a	Recognition of need for government financial support, especially for solar panels	Application for METI subsidies for equipment purchase	METI subsidy covering 75% of equipment replacement after 2019 floods	METI subsidy for solar panels (power purchase agreement)	METI grant for ICT and other equipment
Previous intervention	• Government announcement of 40% CO₂ reduction target (2013) • Eco-Action 21 participation since 2010	Former Prime Minister Suga's speech and SDG policies inspired action and SBT adoption	President engaged in decarbonization prior to assuming leadership	n/a	Eco-Action 21 participation since 2015	n/a

Other notable findings

Business transparency. The transition to a green economy has acted as a catalyst for increased operational transparency among the participating SMEs. Effective decarbonization strategies require rigorous monitoring of production inputs and outputs to track carbon emissions and estimate Scope 2 emissions. Furthermore, the requirements for securing government subsidies, grants and loans have made transparent documentation and formal reporting essential. This has emerged as a positive outcome of MOE's support model: companies seeking assistance are prompted to strengthen internal data systems, reporting practices and accountability.

Decent work and just transition. Awareness of, and deliberate actions to link, decarbonization with decent work objectives and the just transition agenda remain limited. While the case studies do reveal elements of a just transition, such as reskilling, upskilling, OSH practices and worker participation, the data does not allow for a definitive assessment of whether these transitions are “just” in a comprehensive sense. A truly holistic evaluation would require direct worker interviews and on-site observations to substantiate management's perspectives.

Despite the lack of a formal framework, companies investing in decarbonization appear equally inclined to invest in their human capital to better adapt to change. Owners and managers consistently emphasized the protection of employee rights the necessity of safeguarding both physical and mental health particularly when introducing new technologies. All company representatives reported zero layoffs resulting from decarbonization efforts. Instead, they prioritized training workers to manage evolving tasks and processes.

At the same time, most SMEs acknowledged that their resources are limited. They expressed the need for government support, including from MHLW and METI, and for engagement with other social partners to provide technical assistance, strengthen institutional capacity and train workers for new equipment and roles. While these actions are positive, none of the companies articulated a systematic, management-based approach to anticipate and mitigate the potential negative impacts of the green transition on their workforce.

Current government support is largely focused on the technical and financial dimensions of decarbonization. This technical bias may partly explain why the social dimension of climate action has not yet been integrated into corporate strategies, and why the concept of a just transition is not a primary focus for SME leadership.

Although social dialogue has been used to identify environmental measures and encourage worker participation in energy-saving efforts, it has not been used as a tool for monitoring or mitigating labour-related risks. Explicit just transition planning was not mentioned as a future objective by any of the interviewed SMEs.

As noted by JTUC-RENGO, the implementation of the GX strategy is in its nascent stages, making it difficult to anticipate the challenges for SMEs. Future research should focus on longitudinal monitoring of these firms, with a specific emphasis on worker perspectives and the role of labour unions, and the emergence of mitigation mechanisms at enterprise and industry levels. Such research would help identify emerging just transition issues and inform policies that better integrate environmental objectives with social equity.

Policy development to support a just transition

The preceding analysis of the Japanese experience has illustrated the government's commitment towards accelerating decarbonization among SMEs. Central to this effort is the Green Transformation (GX) Basic Policy approved by the Cabinet in February 2023. The GX Basic Policy of 2023 is designed to achieve Japan's NDC of a 46 per cent reduction in greenhouse gas emissions by 2030 (relative to 2013 levels of 1,408 million tons of carbon dioxide equivalents) and to reach carbon neutrality by 2050. The key tenet of the policy is the recognition of SMEs as critical actors; they account for nearly 70 per cent of national employment and 20 per cent of Japan's total GHG emissions. The policy underscores the government's obligation to provide the necessary enabling environment for these firms to transition.

To operationalize this SME decarbonization support, the MOE has deployed several initiatives, including subsidies for purchasing low-CO₂ equipment, preferential interest rates for green loans and technical assistance. A cornerstone of these efforts was the Model SME Project for Decarbonization (2020–22), which provided tailored support to help participating firms align with the 2050 carbon neutrality goal.

MOE guided the SMEs through three core steps in decarbonization management:

- (1) Know/understand – assisting SMEs in reviewing their strategies for decarbonization;
- (2) Measure/calculate – supporting the calculation of CO₂ emissions and setting reduction targets; and
- (3) Reduce CO₂ – guiding SMEs in developing roadmaps to achieve those targets.

This methodology mirrors the GX Roadmap's emphasis on helping SMEs understand pathways to carbon neutrality, measure CO₂ emissions and implement concrete reduction measures.

The Model SME Project primarily engaged firms classified as early adopters. Some participants had already pursued Eco-Action 21 or SBT certification prior to joining the project. Others had developed a heightened awareness of climate vulnerabilities following direct exposure to environmental risks, such as earthquakes, floods or typhoons. Furthermore, several had successfully received financial assistance from METI.

Many SMEs are either not as aware of the need for decarbonization or remain at an early stage of adopting such practices, and they are likely to face additional challenges. As documented by a July 2021 survey by the Shoko Chukin Bank, 80 per cent of Japanese SMEs were not considering any decarbonization plans. Effectively reaching these less-engaged firms is imperative for the government to move beyond model projects and achieve carbon neutrality.

Following the completion of the Model SME Project for Decarbonization (2020–23), the MOE launched a subsequent initiative designed to scale these findings. This new project adopts a community-based approach at the prefecture level, mobilizing public and private partners to provide coordinated technical and financial support to local companies (see box 6 for a detailed description).

► **Box 6: Community-Based Decarbonization Management Support System Development Project**

Based on the lessons of the Model SME Project for Decarbonization, the MOE has launched a community-level initiative for SMEs called Community-Based Decarbonization Management Support System Development Project.

This project is designed to decentralize support, establishing localized systems that empower SMEs to execute the three critical steps of decarbonization management: (1) know/understand, (2) measure/calculate and (3) reduce. The project operates through partnerships between public and private stakeholders at the prefectural and municipality levels. By leveraging local networks, the initiative ensures that decarbonization strategies are responsive to local needs and economic conditions of the business community.

Local partners include prefectural and municipal authorities, financial institutions, chambers of commerce, universities and industry organizations with deep-rooted relationships with local SMEs. In 2023, the project supported 16 regional organizations in developing their decarbonized management support systems, followed by the inclusion of 10 organizations in 2024.

Source: MOE 2025

The case studies further illuminate the complex challenges SMEs face when promoting decarbonization. A major constraint is the significant capital requirement for green technologies and the high cost of renewable energy. Rai Hatome Kogyo noted the ongoing difficulty of procuring green electricity at rates competitive with high-emission power. Similarly, for Kyohatsu Industry, installing solar panels represented a significant financial burden. While NiKKi Fron reported that its green investments have not yet yielded higher profitability, it noted that operational efficiencies have generated savings that offset the premium costs of green energy. However, the sustainability of these actions remains under pressure; Tamamura Delica indicated that the rising cost of raw materials makes it increasingly difficult to maintain momentum in its environmental initiatives.

A lack of market demand for low-carbon products presents another significant hurdle. Several companies pointed to low consumer awareness and the limited value placed on greening efforts in purchasing decisions. Rai Hatome Kogyo found it difficult to identify clients who view low-emission manufacturing as a selling point, while NiKKi Fron observed that CO₂ footprints are rarely used as a criterion for procurement. Tsuyakin emphasized that the fashion industry must be fundamentally reshaped by sustainability and decent work considerations to ensure that manufacturers practicing decarbonization and upholding labour rights receive greater market support. In this context, government intervention was cited as a critical lever for shaping consumer demand and establishing new market norms as part of broader decarbonization and just transition efforts.

Beyond market forces, the need for a cohesive industry-wide culture remains apparent. Kato Light Metal Industry called for coordinated action across industry actors to foster collective progress and establish decarbonization as a standard sector-wide practice.

Human resource constraints also pose a threat to long-term sustainability. Rai Hatome Kogyo highlighted the difficulty of sustaining environmental management efforts as new managers and employees cycle through the company. To address these gaps, Kyohatsu Industry emphasized the necessity of government-backed training programmes to prepare younger generations and bridge the existing knowledge gap between environmental experts and shop-floor practitioners. Even among pioneers, the burden of leadership is significant; the president of Kato Light Metal Industry described the challenge of driving cultural and operational change largely in isolation and advocated for stronger government-led support systems.

Limited capacity for research and development represents yet another barrier. NiKKi Fron addressed this gap by collaborating with academic institutions to develop new materials and processes, while Tsuyakin partnered with the Gifu Prefectural Industrial Technology Center to innovate textile dyes from food waste. These examples underscore that most SMEs lack the resources and expertise required to undertake the R&D necessary for decarbonizing their inputs and manufacturing processes.

Access to government support remains a significant concern for many firms. Tamamura Delica emphasized the urgent need to streamline public subsidies and assistance programmes to make them more accessible to the SMEs. Furthermore, the company highlighted the necessity of expanding private-sector financing options to complement public funds for decarbonization investments.

The presence of experts to guide firms through emissions measurement, process redesign, equipment upgrades and workforce training provides the much-needed confidence in navigating the transition. One CEO emphasized the importance of bridging academic expertise with practical application on the shop floor.

An example of this bridging mechanism in action is the Mikata Project, launched by the METI, which deploys experts and other forms of support at the prefectural level to build the capacity of automobile-related companies (detailed in box 7).

Finally, while the primary focus of the SMEs studied has been on planning and implementation of decarbonization, this does not necessarily indicate a disregard for worker welfare. Rather, it suggests a limited explicit awareness of what a just transition entails. The current gap in anticipating and addressing social impacts through deliberate planning highlights a critical role for the government. To steer a truly equitable transition, policymakers must provide clearer guidance, articulate social expectations and embed concrete just transition strategies within decarbonization policies. This ensures that social considerations are explicitly addressed alongside environmental objectives.

► **Box 7: Mikata Project**

The Mikata Project, initiated by METI, serves as a vital model for structured, sector-specific transition. The project is specifically designed to assist SMEs in the automobile sector as they adapt to the industry shift known as CASE.

CASE is an acronym referring to four areas of mobility transformation: Connected, Automated (or Autonomous), Shared (or Services), and Electric. METI's support through the Mikata Project includes providing skills development and training for the workforce, advisory services and technical assistance, and financial subsidies for equipment upgrades.

The Mikata Project has set up regional support centers in collaboration with industry associations and SME support organizations across all 47 prefectures in Japan. It also maintains a network of more than 150 experts who provide tailored guidance to SMEs. The project demonstrates the efficacy of a coordinated, locally embedded and expert-driven support system for SMEs navigating complex industrial transitions.

Source: METI: Mikata Project, available at: https://www.meti.go.jp/policy/mono_info_service/mono/automobile/mikata_project.html

► Conclusion

This research aimed to capture the experiences of Japanese SMEs as they navigate the complexities of decarbonization, presenting these as actionable case studies for the broader business community and identifying the critical factors that shape a just transition.

The findings indicate that leadership commitment, organizational culture, government intervention, business networks and exposure to disaster and global risks are the primary drivers of SME decarbonization. These results corroborate the study's conceptual framework, suggesting that this multifaceted approach could be replicated in larger-scale research. It is hoped that the insights generated here will inform the development of more effective policies to foster innovation and sustainable growth for SMEs both in Japan and internationally.

At present, Japanese SMEs benefit from a range of government support mechanisms for decarbonization, with the MOE, METI and other agencies coordinating efforts under the national green transition agenda. These interventions include technical assistance, financial incentives and sector-specific programmes such as METI's Mikata Project, which provides the SMEs in the automobile sector with support for skills development, equipment upgrades and expert advisory services.

Beyond government intervention, this study demonstrates that long-term engagement with green practices is rooted in firm-level dynamics. The climate actions of the six SMEs illustrate how proactive organizational culture and keen perceptions of risk allow firms to initiate and sustain decarbonization even in a volatile market.

While experiences explicitly linked to a just transition were limited, several foundational elements were documented. Skills development, OSH measures and participatory decision-making have all proven essential. Technical support that bridged the gap between expert theory and business practice enhanced confidence and strengthened implementation. Employee training eased workplace adjustments, while participatory approaches influenced both production processes and everyday routines in ways that contributed to emissions reduction. In firms where employee welfare and dialogue were already embedded in the corporate DNA, transitions were notably smoother and more cooperative.

However, awareness of the just transition concept remained low among the SMEs studied. Companies currently identify isolated components, such as training, OSH and consultations, rather than integrated strategies designed to anticipate and mitigate social risks or maximize positive outcomes.

Drawing from the Japanese experience, the following areas are proposed to strengthen decarbonization efforts and ensure the seamless integration of just transition considerations.

A. Decarbonization and green transition policy and activities

- Launch awareness campaigns to bridge the knowledge gap between technical experts and SMEs by providing accessible curated pools of specialists.
- Enhance information dissemination to increase the visibility of existing programmes, such as Eco-Action 21, SBTs and De ko katsu.
- Establish a one-stop, cross-ministerial information platform to create a unified digital portal, improving SME awareness of available financial and technical incentives.
- Develop capacity-building programmes that assist SMEs in developing phased decarbonization roadmaps that include just transition elements.
- Expand subsidies and support for renewable energy, particularly in contexts where market prices remain a competitive barrier for SMEs.

- Facilitate industry-level dialogue to establish sector-specific mechanisms for identifying and addressing unique decarbonization requirements.
- Scale case study development across all growth sectors identified under the national GX strategy.
- Expand financing mechanisms by increasing access to credit lines and specialized loans to mitigate the high capital costs of green technology.
- Introduce policy and regulatory incentives for green product development, complemented by initiatives to strengthen consumer awareness and market demand.

B. Supporting just transition policy and activities

- Conduct policy research on the GX impacts from the workers' perspectives.
- Assess workforce and managerial training needs to ensure alignment with national green growth strategies.
- Integrate just transition planning into enterprise management, supported by social dialogue and defined organizational roles, such as an environmental manager and dedicated green teams.
- Monitor evolving occupational risk profiles associated with the adoption of new technologies and materials.
- Implement monitoring systems for worker displacement, skills mismatch and job obsolescence, ensuring these are linked to social protection and re-employment programmes.
- Strengthen inter-ministerial coordination between environment and labour ministries, public employment services and training providers.
- Cultivate a deeper understanding among SME leaders regarding the social dimensions of climate action.
- Empower social partners to take an enhanced role in supporting decarbonization and shaping just transition frameworks.
- Co-develop just transition training programmes for SMEs in partnership with social partners.
- Promote enterprise-level case studies that highlight best practices in operationalizing a just transition.

C. Future research

- Expand research coverage to include a larger sample of firms, specifically those participating in the Model SME Project, Eco-Action 21 and related initiatives.
- Incorporate worker perspectives through interviews and workplace observations.
- Analyse non-decarbonizing SMEs to identify barriers, constraints and decision-making factors.
- Engage with additional bodies, particularly the MHLW or labour ministries, to map existing and planned just transition policies.
- Refine environmental policy design to better reflect SME realities while integrating social protection and labour considerations.

► References

- Abdullah, Nor Hazana, Alina Shamsuddin, Eta Wahab and Norhadilah Abdul Hamid. 2012. "Preliminary Qualitative Findings on Technology Adoption of Malaysian SMEs". Paper presented at the IEEE Colloquium on Humanities, Science & Engineering Research, 3–4 December 2012. <https://core.ac.uk/download/pdf/12008293.pdf>.
- Aden, Nate. 2019. "Japan is Leading on Business Climate Engagement. Will Ambitious Policies Follow?" *WRI Insights* (blog). World Resources Institute. 28 June 2019. <https://www.wri.org/insights/japan-leading-business-climate-engagement-will-ambitious-policies-follow>.
- Batty, David et al. 2012. "Japan Shuts Down Last Working Reactor." *The Guardian*, 5 May 2012. www.theguardian.com/world/2012/may/05/japan-shuts-down-last-nuclear-reactor.
- Beer, Patrick and Regina H. Mulder. 2020. "The Effects of Technological Developments on Work and Their Implications for Continuous Vocational Education and Training: A Systematic Review". *Frontiers in Psychology* 11:918. www.frontiersin.org/articles/10.3389/fpsyg.2020.00918/full.
- Bové, Anne-Titia and Steven Swartz. 2016. "Starting at the Source: Sustainability in Supply Chains". *Our Insights* (blog). McKinsey & Company. 11 November 2016. https://www.mckinsey.com/capabilities/sustainability/%20our-insights/starting-at-the-source-sustainability-in-supply-chains#.
- Castillo, Monica. 2023. *Green Jobs, Green Economy, Just Transition and Related Concepts: A Review of Definitions Developed through Intergovernmental Processes and International Organizations*. ILO. www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_883704.pdf.
- CIPD (Chartered Institute of Personnel and Development). 2020. "Workplace technology: The Employee Experience". 2 July 2020. www.cipd.org/en/knowledge/reports/workplace-technology-employee/.
- EIPB (Economic and Industrial Policy Bureau). 2023. *Second Report of the Committee on New Direction of Economic and Industrial Policies*. June 2023. https://www.meti.go.jp/english/policy/economy/industrial_council/pdf/0628_002.pdf.
- EU (European Union). 2022. *Flash Eurobarometer 498: SMEs, Green Markets and Resource Efficiency*. March 2022. <https://europa.eu/eurobarometer/surveys/detail/2287>.
- FSA (Financial Services Agency). 2023. *Report by the Working Group on Financial Institutions' Efforts towards Decarbonization of the Economy: Recommendation (Guide) on financial institutions' works toward Net-zero*. 27 June 2023. <https://www.fsa.go.jp/singi/decarbonization/siryou/20230627/03.pdf>.
- General Insurance Association of Japan. 2024. *10 Largest Claims Paid for Typhoons, Windstorms, etc. in Japan*. 31 March 2024. https://www.sonpo.or.jp/en/statistics/ue089i0000000f17-att/ten_largest_claims_paid_for_typhoons_and_windstorms.pdf.
- Hammerling, Jessie HF. 2022. *Technological Change in Five Industries: Threats to Jobs, Wages and Working Conditions*. Berkeley, CA: UC Berkeley Labor Center, 28 September 2022. <https://laborcenter.berkeley.edu/technological-change-in-five-industries/>.
- Hatch, Carolyn, Diane-Gabrielle Tremblay and Laurence Cazabon-Sansfaçon. 2017. "The Role of Social Actors in Advancing a Green Transition: The Case of Québec's Cleantech Cluster". *Journal of Innovation Economics and Management* 24(3). 63-87. <https://yorkspace.library.yorku.ca/items/2595776b-1b34-4e9f-b0b8-2ae99209fe2a>.
- ILO (International Labour Organization). 2015. Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All. www.ilo.org/global/topics/green-jobs/publications/WCMS_432859/lang--en/index.htm.

- . 2018. World Employment and Social Outlook: Greening with Jobs. https://www.ilo.org/global/publications/books/WCMS_628654/lang--en/index.htm.
 - . 2022a. "How MSMEs can Contribute to and Benefit from a Just Transition". Just Transition Policy Brief. September 2022. www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_858855.pdf.
 - . 2022b. "Sectoral Policies for a Just Transition towards Environmentally Sustainable Economies and Societies for All". Just Transition Policy Brief. 20 October 2022. www.ilo.org/global/topics/green-jobs/publications/just-trans---ion-pb/WCMS_858856/lang--en/index.htm.
 - . 2022c. Greening Enterprises: Transforming Processes and Workplaces. 14 November 2022. www.ilo.org/global/publications---/books/WCMS_861384/lang--en/index.htm.
 - . 2023. *Achieving a Just Transition towards Environmentally Sustainable Economies and Societies for All*. Report VI, International Labour Conference, 111th Session. ILC.111/Resolution V. www.ilo.org/ilc/ILCSessions/111/reports/reports-to-the-co---erence/WCMS_876568/lang--ja/index.htm.
- ILO and UNEP (United Nations Environment Programme). 2008. *Green Jobs: Towards Decent Work in a Sustainable, Low-carbon World*. 24 September 2008. <https://www.ilo.org/publications/green-jobs-towards-decent-work-sustainable-low-carbon-world-full-report>
- IPCC (Intergovernmental Panel on Climate Change). 2022. *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Edited by H.-O. Pörtner et al. Cambridge: Cambridge University Press,
- ITC (International Trade Centre). 2021. *SME Competitiveness Outlook: Empowering Green Recovery*. June 2021. <https://intracen.org/resources/publications/sme-competitiveness-outlook-2021-empowering-the-green-recovery>.
- Jones, Matthew W. et al. 2024. "Annual nitrous oxide emissions including land use" [dataset]. *Our World in Data*. Accessed 12 August 2025. <https://ourworldindata.org/grapher/ghg-emissions-by-gas?stackMode=relative>.
- Kameyama, Yasuko. 2020. *Can Japan Achieve Net-Zero Emissions? Climate Change Policy Development in Japan and its Implications*. Sasakawa Peace Foundation USA. 29 April 2020. <https://spfusa.org/publications/can-japan-achieve-net-zero-emissions>.
- Mabon, Leslie, Andrew Chapman, Benjamin McLellan and Yi-Chen Huang. 2022. *Just Transitions in Japan: Just Transitions to Decarbonisation in the Asia-Pacific*. The British Academy. www.thebritishacademy.ac.uk/publications/just-transitions-in-japan/.
- Matsushima, Shigeru (2006). "Japanese SMEs – Driving the Competitiveness of Japan's Automobile Industry," *Japan Spotlight*. May/June 2006. https://www.jef.or.jp/journal/pdf/C-1_0605.pdf.
- METI (Ministry of Economy, Trade and Industry). 2021. *Study Group on Sustainability of Textile and Apparel Industry Report*. July 2021. https://warp.da.ndl.go.jp/info:ndljp/pid/12315293/www.meti.go.jp/shingikai/mono_info_service/textile_industry/pdf/20210712_1.pdf
- MOE (Ministry of the Environment). n.d. "Details on the Carbon Tax (Tax for Climate Change Mitigation)". <https://www.env.go.jp/content/900453366.pdf>.
- . 2025. *Guidebook for Building Community-Based Support Systems: The Significance of Promoting Decarbonization Management at the Local Level*. May 2025. <https://www.env.go.jp/content/000315401.pdf> (in Japanese)
- OECD (Organisation for Economic Co-operation and Development). 2019. *OECD Employment Outlook 2019: The Future of Work*. https://www.oecd.org/content/dam/oecd/en/publications/reports/2019/04/oecd-employment-outlook-2019_0d35ae00/9ee00155-en.pdf.

- . 2021. "No Net Zero without SMEs: Exploring the Key Issues for Greening SMEs and Green Entrepreneurship". OECD SME and Entrepreneurship Papers No. 30. https://www.oecd-ilibrary.org/energy/no-net-zero-without-smes_bab63915-en.
- . 2022. "2022 Updated G20/OECD High-Level Principles on SME Financing", OECD SME and Entrepreneurship Papers No. 38. <https://www.oecd.org/cfe/smes/2022-Update-OECD-G20-HLP-on-SME-Financing.pdf>.
- . 2023. *Managing Shocks and Transitions: Future-Proofing SME and Entrepreneurship Policies*. Key Issues Paper. OECD SME and Entrepreneurship Ministerial Meeting. <https://www.oecd.org/content/dam/oecd/en/topics/policy-issues/smes-and-entrepreneurship/2023-ministerial-documents/Ministerial-key-issues-paper-2023.pdf>.
- Pathak, M., R. Slade, P.R. Shukla, J. Skea, R. Pichs-Madruga and D. Ürge-Vorsatz. 2022. "Technical Summary". In *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by P.R. Shukla et al., 59–164. Cambridge: Cambridge University Press.
- Ritchie, Hannah, Pablo Rosado and Max Roser. 2022. "Environmental Impacts of Food Production". *Our World in Data*. Accessed 12 August 2025. <https://ourworldindata.org/environmental-impacts-of-food>.
- Romero, Isidoro and Juan A. Martínez-Román. 2015. "Determinants of technology adoption in the retail trade industry – the case of SMEs in Spain". *Amfiteatru Economic Journal* 17 (39): 646–660. <https://idus.us.es/handle/11441/76455>.
- Shibamoto, Masahiko. 2022. *Environmental Awareness and Green Business Practices in the Small Business Sector: Empirical Evidence Using a Small and Medium-sized Enterprises Survey in Japan*. Research Institute for Economics and Business Administration. Kobe University. <https://www.rieb.kobe-u.ac.jp/academic/ra/dp/English/DP2022-08.pdf>.
- SMEA (Small and Medium Enterprise Agency). 2019. *2019 White Paper on Small and Medium Enterprises in Japan*. https://www.chusho.meti.go.jp/pamflet/hakusyo/2019/PDF/2019hakusyodata_eng.xlsx.
- . 2023. *2023 White Paper on Small and Medium Enterprises in Japan*. <https://www.chusho.meti.go.jp/pamflet/hakusyo/2023/PDF/chusho.html> (in Japanese); https://www.meti.go.jp/english/press/2023/pdf/0428_005a.pdf (highlights in English).
- Statista. 2024. "Convenience Stores in Japan - Statistics and Facts". December 2024. Accessed 12 August 2025. <https://www.statista.com/topics/8484/convenience-stores-in-japan/#topicOverview>
- UNRISD (United Nations Research Institute for Social Development). 2018. *Mapping Just Transition(s) to a Low-Carbon World*. <https://www.unclearn.org/resources/library/mapping-just-transitions-to-a-low-carbon-world/>.
- WBA (World Benchmarking Alliance). 2021a. *Just Transition Methodology*. July 2021. <https://assets.worldbenchmarkingalliance.org/app/uploads/2025/05/2021Jtmethodology.pdf>.
- . 2021b. *Just Transition Assessment 2021: Are High-Emitting Companies Putting People at the Heart of Decarbonisation?* November 2021. https://assets.worldbenchmarkingalliance.org/app/uploads/2021/11/2021_JustTransitionAssessment.pdf.
- WEF (World Economic Forum). 2020. "COVID-19 and Technology Adoption in SMEs: The Impact and Way Forward". White Paper. 15 December 2020. <https://www.weforum.org/whitepapers/covid-19-and-technology-adoption-in-small-and-medium-sized-enterprises-the-impact-and-the-way-forward/>.
- WTO (World Trade Organization). 2022. "Small Business and Climate Change". MSME Research Note No. 3. www.wto.org/english/tratop_e/msmes_e/ersd_research_note3_small_business_and_climate_change.pdf.

Yago, Kazuhiko. 2020. "Before the 'Locomotive' Runs: The Impact of the 1973–1974 Oil Shock on Japan and the International Financial System", *Financial History Review*, 27(3); pp. 418-435. <https://www.cambridge.org/core/journals/financial-history-review/article/before-the-locomotive-runs-the-impact-of-the-19731974-oil-shock-on-japan-and-the-international-financial-system/003E6EA62195C509417CE4C021C5885B>.

► **Annex 1: Case studies**

This Annex contains the case studies of the six SMEs that participated in the study. Describing their efforts towards decarbonization enable understanding their starting point and business context, complement the study's findings and give a richer account of their efforts. The SMEs' experiences as described here are culled out from the interviews of key personnel, from print and video documentation supplied by the interviewees, from the company websites and from the published case studies from the Model SME Project on Decarbonization. They are described in the following case studies:

1. Rai Hatome Kogyo's environmental management effectively cuts down carbon emissions
2. Kyohatsu Industry: Green and just transition of the automobile-parts industry
3. Kato Light Metal Industry: Decarbonizing the aluminum business
4. Decarbonization as innovation: NiKKi Fron lowers emissions in fluoropolymer products manufacture
5. Tamamura Delica: Promoting decarbonization and just transition in food production
6. Tsuyakin's eco-friendly textiles and wearables

Rai Hatome Kogyo's Environmental Management Effectively Cuts Down Carbon Emissions

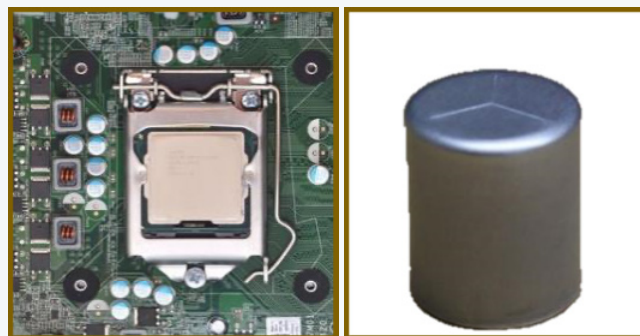
Key finding/Highlight

- An overarching environmental management system approach can facilitate a just transition because it recognizes the need for facilitating capacity building of workers and engaging them in identifying decarbonization measures.
- The creation of an environmental officer position can sustain awareness raising and internal capacity building on decarbonization, and the role may serve as the link between workers and management.

Introduction

Rai Hatome Kogyo is a company in the metal-stamping industry that specializes in manufacturing small items that require great precision. Established in 1946, it grew over the years and by 1998 it focused on using only aluminum as the material in its production process.

► Circuit board and aluminum capacitor



Source: Rai Hatome Kogyo Co., Ltd.

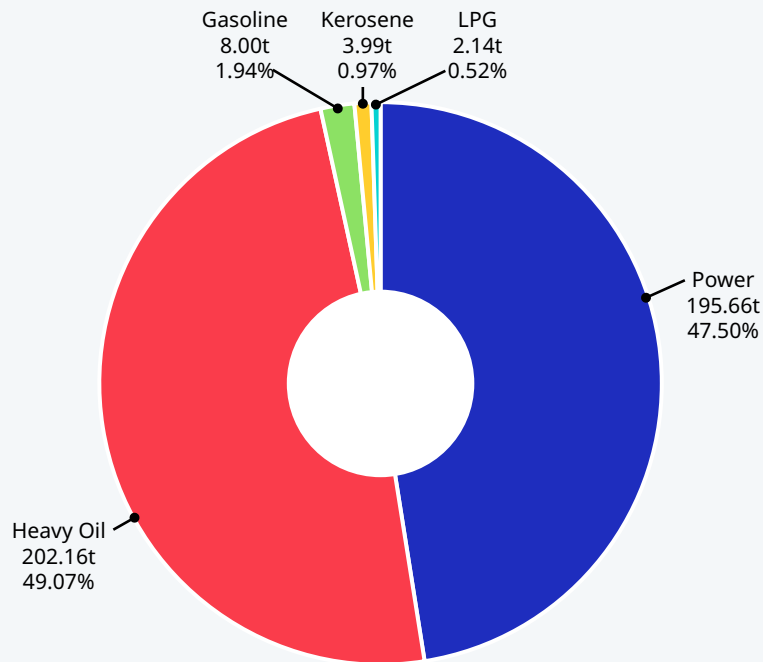
Aluminum is an attractive material, not just for the Rai Hatome Kogyo but also for other manufacturers. It is the second-most widely used metal in the world, owing to its unique characteristics: it is lightweight, flexible, resistant to corrosion, has a high strength-to-weight ratio and is regarded as a cost-efficient material for production. The manufacturing of aluminum products uses a lot of energy and contributes CO₂ or carbon emissions that need to be effectively reduced. Since 2010, the company had already begun efforts to reduce its impact on the environment; measuring its carbon emissions and committing to decarbonization was a way to do even more.

Decarbonization experience

Rai Hatome Kogyo creates a wide range of products, such as casings for capacitors, rivets and caps for glass atomizers such as those used for fragrance bottles. The company's products are part of value chains in the automotive and cosmetic industries. Its main clients are companies that manufacture capacitors that are ultimately installed in cars, comprising 98 per cent of its annual sales. The company makes its products by pressing or pulling aluminum into the desired shape, after which the items are

cleaned, sorted and packaged for delivery. The cleaning process is done in a machine that was originally fueled by crude oil.

► **CO₂ emissions in 2010, Scope 1 and 2, by emission source**



Source: Rai Hatome Kogyo Co., Ltd.

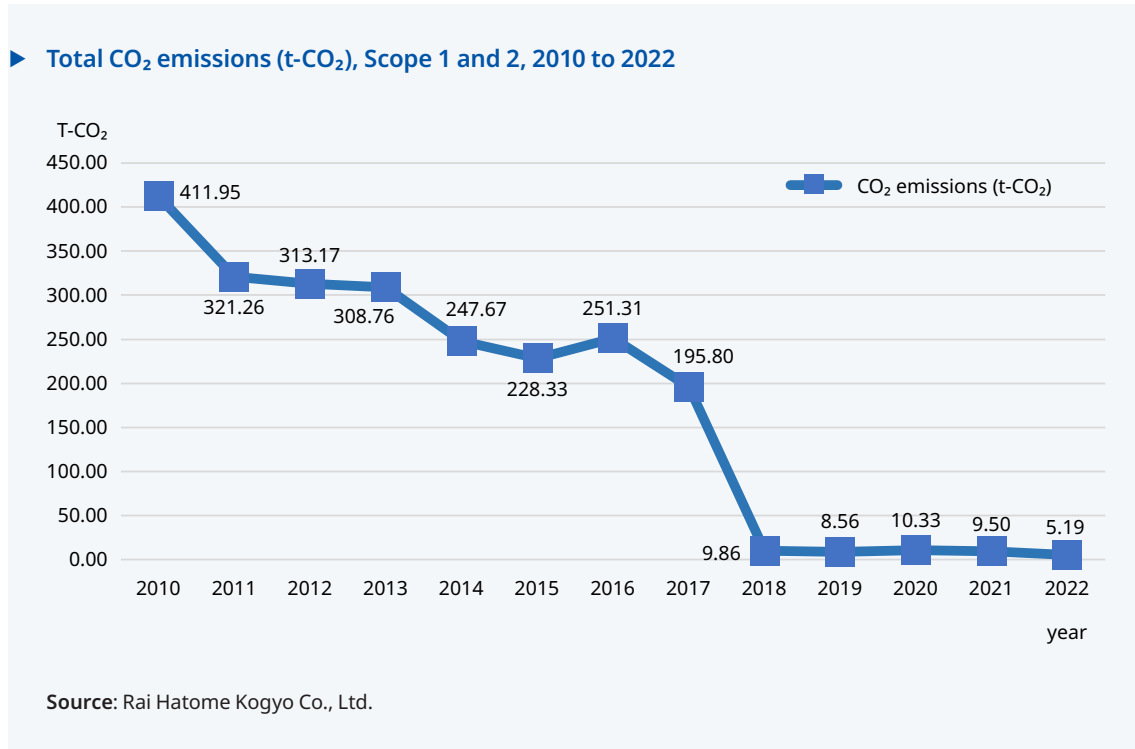
Rai Hatome Kogyo embarked on a series of actions to reduce its environmental impact. In 2010, it joined the Eco-Action 21 programme of MOE. This programme intends to encourage SMEs to develop and implement an environmental management system, as well as make a voluntary and public report of their efforts.

The company appointed an Environmental Manager from among its employees who is responsible for ensuring that the company's environmental programmes are achieved, including undertaking energy saving measures, and earning its Eco-Action 21 certification in 2010. Its initial actions were switching the lights in the factory from fluorescent to LED and installing equipment that monitored its energy consumption.

Its efforts towards decarbonization began when Rai Hatome Kogyo started measuring its CO₂ emissions in 2012, providing it with an important emissions baseline at 411.95 tons (t-CO₂) for that year, mostly generated using crude oil and electricity.

Measurement is important for knowing not only how much is emitted, but also for identifying the sources of the emissions and setting reduction targets. It enables the company to formulate steps to effectively reduce emissions. Rai Hatome Kogyo set its target at 50 per cent CO₂ emissions reduction by the year 2030 compared to 308.76 t-CO₂ in 2013, or about 154 t-CO₂.

The company then switched the energy source for its cleaning machines from crude oil boilers to electric heaters in 2014. Impressively, the switch brought down emissions to only 228.33 t-CO₂ in 2015, which is 44.5 per cent of the emissions in 2010. However, the company still intended to continue lowering emission levels. In 2017, the company's management approved the switch to green energy and began buying its electricity from Idemitsu in the same year.



Rai Hatome Kogyo is still monitoring emissions from the use of LPG and kerosene in the factory, as well as from gasoline fuel of company cars. The employees who work with the equipment helped to come up with suggestions on how to reduce emissions further, including equipment maintenance and replacing kerosene and LPG heaters with electric ones. The company also decided to keep only one company car. By 2018, it had reduced its emissions to 97 per cent of the baseline level, so it set a new goal to achieve carbon neutrality by 2035.¹³

In 2020, it developed worst- and best-case scenarios on decarbonization to identify how to remove the maximum volume of emissions. Scenario-based planning helped demonstrate that it was possible for environmental awareness to weaken if there is turnover among managers without an orientation for new managers into the company's environmental management thrusts. Preparing for the scenarios also brought out that the equipment replacement process could include decarbonization concerns, such as including low emissions and lower energy consumption as criteria for procurement.

In 2022, the company applied to the Ministry's model decarbonization project which enabled it to tap experts who inspected its factory and then gave very specific, technical recommendations on how to cut energy use, such as the application of insulation material and adjustments to equipment settings.

¹³ 2023 Environmental Management Report by Rai Hatome Kogyo

Enabling factors

An environmental manager role was created as part of the Eco-Action 21 system. The first person to hold this responsibility was Mr Ishihara, considered a strong advocate for environmental protection. He attended conferences and other professional networking events and got invited as a speaker to the Ministry's seminars to raise awareness among the private sector on decarbonization. As of the time of writing of this case study, Mr Ishihara was serving as an Eco-Action 21 auditor, reviewing the certification of other SMEs in this programme.

Rai Hatome Kogyo demonstrates commitment to reducing its carbon footprint. After registering for Eco-Action 21 certification, it has submitted the voluntary environmental management report every year without fail.¹⁴ This report publicly records the company's emissions and environmental activities for the past year and plans for the forthcoming year. It has won 12 awards from MOE over the years, with the latest award received in 2023 for the "Decarbonization Challenge Cup." Promoting environmental awareness became part of the company's brand.¹⁵ It is featured as a case study in the "Decarbonization Management Handbook for Small- and Medium-sized Businesses" published by the Ministry in 2022. The company continues to promote various initiatives as a driving force behind its rapid progress as a top runner in environmental management for small and medium-sized businesses.

Finally, Rai Hatome Kogyo has been engaging its employees in its Eco-Action 21 efforts. Rather than hire an environmental manager, it developed a staff member for the role. Mr Ishihara, in turn, conducts formal training and informal awareness-raising activities for all employees. When formulating energy-saving and decarbonization measures, the employees also give their suggestions because they are the ones who directly work with the factory equipment; these suggestions are incorporated into the strategies and reflected in the annual environmental management report.

Government policies and programmes can provide strong support for manufacturing companies. The Ministry's Eco-Action 21 and Rai Hatome Kogyo's participation in it shaped a lot of the company's decisions to go green. The programme promoted a management system for environmental impacts, with its components corresponding to Plan-Do-Check-Act, and the environmental actions integrated into the overall management of the company. This provided an overall framework for the more specific set of activities for decarbonization. The Japanese government's own national target to reduce carbon emissions and the Ministry's model decarbonization project motivated the company's management to work on reducing emissions from its factory.

Challenges to decarbonization

Rai Hatome Kogyo expects that the automotive industry, which is its main customer base will eventually be setting its own targets for CO₂ emissions reduction. Meanwhile, that company has challenges to overcome that include procuring green energy that is cheaper than high-emission electricity, finding customers who see low-emission manufacturing as a selling point and sustaining environmental management efforts even when new managers and workers join the company.

¹⁴ Each report is written in Japanese, and archived on this webpage: <https://www.rai-hatome.co.jp/16564630476220>

¹⁵ Based on an interview with Mr. Ishihara.

Kyohatsu Industry: Decarbonization in the Automobile-parts Industry

Key findings/Highlights

- The process of developing a roadmap for decarbonization raised employees' environmental awareness and engagement in decarbonization efforts.
- Companies can target emissions reduction as a way to be more productive.
- Developing a decarbonization roadmap increases the feasibility and sustainability of the efforts and improves employees' focus on the targets.
- Government policy and awareness-raising can inspire SMEs to pursue decarbonization as their contribution to a better society.

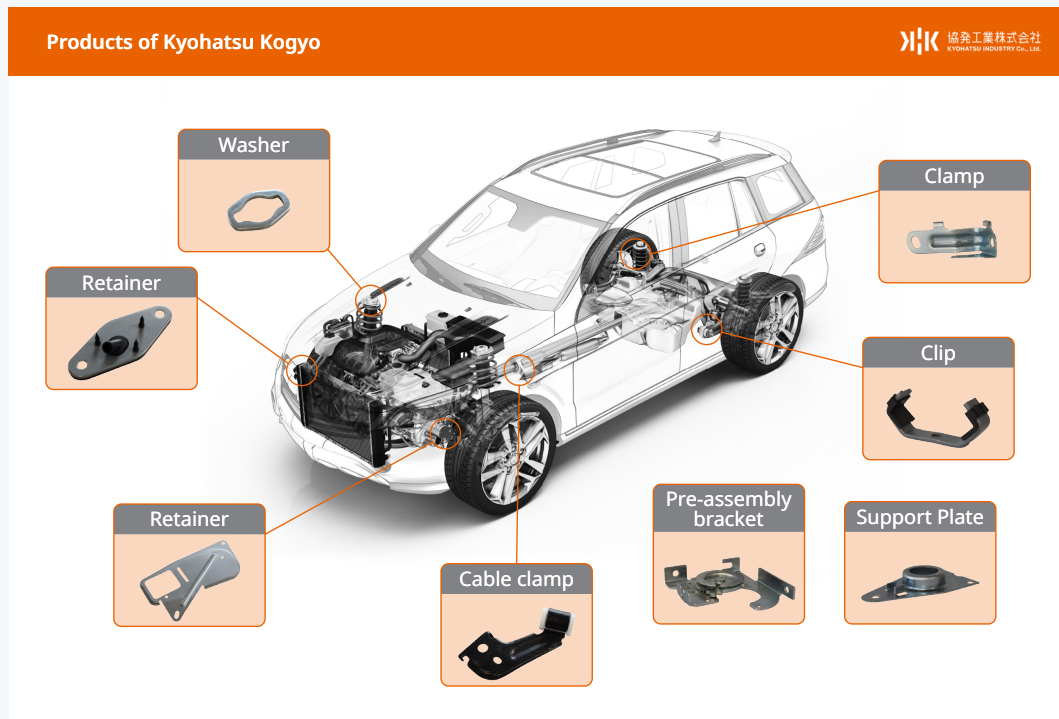
Introduction

The Japanese car industry is the symbol of Japan's industrial strength. It developed from a unique multi-tiered supplier system wherein downstream companies (Tier 1 suppliers) supply the parts needed by car assembly manufacturers, like Toyota Motor Corporation and Nissan Motor Corporation. In Japan, Tier 1 suppliers source their parts and components from other companies (Tier 2 suppliers), and Tier 2 suppliers can outsource the same from Tier 3 suppliers. Most of the Tier 2 and 3 suppliers are SMEs. This multi-tiered supply chain is responsible for the efficient production process of the Japanese car industry and taught the world an effective model for a production network and for technological diffusion (Matsushima 2006).

Kyohatsu Industry was established in 1966 in Okazaki City, Aichi Prefecture. It manufactures metal press products for automobile parts. The company is a Tier 2 and 3 supplier of car parts to Tier 1 upstream companies of Toyota Motor Corporation. It is the first company in the automobile-related industry to earn SBT (Science-Based Targets)¹⁶ accreditation in January 2021.

¹⁶ Science-Based Targets (SBTs) are corporate commitments to reduce CO₂ emissions.

► **Products of Kyohatsu Industry**



Source: Kyohatsu Industry

Since its products are specified and standardized, Kyohatsu Industry does not have the flexibility to change its products and processes; so, at first glance, it might be difficult to engage in environmental actions since the company has very little room for change. However, these limitations did not impede Kyohatsu Industry from pursuing decarbonization and just transition.

Decarbonization experience

Energy usage reduction is the main decarbonization activity of Kyohatsu Industry. The company adopted LED lights and used machines that can cut down on energy consumption. Following energy savings measures, the company improved its monitoring and disclosure of CO₂ emissions. MOE helped the company develop a roadmap to decarbonization: a 50 per cent reduction of its 2018 emissions, estimated at 17.0 t-CO₂, by 2030 and net-zero goal by 2050. The roadmap includes the integration of factories, reduction of exhaust pressure of compressors, the use of LED lights, roof insulation and the reuse of energy produced by the compressors. Other decarbonization actions are planned for 2024 up to 2028, including the use of solar panels, reduction of the number of company vehicles and the increased use of electric vehicles.¹⁷ The company is poised to meet its net-zero goal, having achieved a 75 per cent emissions reduction by 2021.

¹⁷ "Datsu-Tanso Keiei wo Sakidorishi Chusho-Kigyo muke SBT wo Gyokai de Hajimete Nintei Shutoku [The First SBT (Science-Based Targets) for SME in the Automobile Parts Industry]," Shoko Journal, 20 June 2023, 19–21.

When asked whether the company's decarbonization has led to higher productivity, the company president, Mr Hiroshi Kakimoto, explained that it could be the other way around. As the company pursues productivity, it ends up using energy more efficiently. Based on his understanding and the experience of his company, productivity comes first, and energy efficiency follows.

As part of its goal of implementing SDGs in the company, Kyohatsu Industry strives to maintain a healthy working environment. Among the awards received by the company is the Excellent Health and Productivity Corporation (SME Division). The company has implemented flexible policies to support the health and safety needs of its workers and provided compensation to those who come to the office by way of walking to encourage the healthy lifestyle of workers.

Enabling factors

As a supplier of car parts for Toyota Motor Corporation, Kyohatsu Industry has maintained high standards to meet the demands of the upstream companies. When Toyota Motor Corporation announced that it wanted its major suppliers to reduce their CO₂ emissions by 3 per cent per year,¹⁸ Mr Kakimoto knew that he had to change his business model for the company to maintain its position in the supply chain.

As one of the many SMEs competing to do business with a world-famous brand, Mr Kakimoto emphasized the struggle to survive if his company does not explore ways to make its operations more sustainable and relevant. He said that decarbonization is one way of improving the company's position in the industry, and that climate action is necessary to secure humanity's future survival, which explains his own commitment to the decarbonization action.¹⁹ In short, securing the company's future, as well as his own values of helping the next generation, were key factors in his decision to decarbonize the company's manufacturing processes.

During the interview, Mr Kakimoto said that he has always been interested in implementing the SDGs in his company. One day, while listening to a speech by former Prime Minister Yoshihide Suga, he recalled that it made him aware of the issue of high CO₂ emissions that pollute the environment. That led him to look at SBTs to help him cut down his own company's carbon emissions. The efforts to learn how to cut down carbon emissions eventually connected the company to the Model SME Project on Decarbonization.

According to Mr Kakimoto, after developing the company's decarbonization roadmap with the Ministry of the Environment, the awareness of employees towards decarbonization has changed and the employees have become more conscious of meeting the company's decarbonization goals. The company organized a carbon neutrality team to monitor its decarbonization actions.

¹⁸ "Toyota Asks Parts Suppliers to Reduce Carbon Emissions," Reuters, June 2, 2021, <https://www.reuters.com/business/sustainable-business/toyota-demand-parts-suppliers-reduce-carbon-emissions-nikkei-2021-06-02/>.

¹⁹ "Datsu-Tanso Keiei wo Sakidorishi Chusho-Kigyo muke SBT wo Gyokai de Hajimete Nintei Shutoku [The First SBT (Science-Based Targets) for SME in the Automobile Parts Industry]," Shoko Journal, 20 June 2023: 19–21. In this article, Mr. Kakimoto is quoted as saying, "It is clear that we must work on the reduction of greenhouse gas emission to survive. But, more importantly, we as humans definitely need to think and protect environment for our survival on this earth. Therefore, our company is serious and committed to accomplishing the goal set by 2030".

Challenges to decarbonization

Given the competitive market and the high-quality standards set by clients, the cost-effectiveness of products is important. Productivity and efficient energy use are critical for business survival. But even with cost-effective measures, Mr Kakimoto noted that it is difficult to bring down prices because the cost of inputs is increasing in the Japanese market.

He anticipated facing financial and technical difficulties in the future, especially as the company deepens its decarbonization activities. Changing to solar panels will entail a huge cost — a big burden for an SME. Financial assistance would be helpful in this regard as the company is still unable to make drastic changes without consulting with clients because it can affect product quality.

Finally, Mr Kakimoto stressed the importance of strategic planning for achieving the 2050 net-zero goal. While acknowledging the ample time until 2050, he expressed concern about whether the next generation is adequately prepared to address the associated challenges. He underscored the importance of continuous training and education to prepare the younger generation for the future, further stressing the existing knowledge gap between the experts and the people working on the ground and the need to close it to meet the decarbonization goals.

Kato Light Metal Industry: Decarbonizing the aluminum business

Key findings

- A company can make decarbonization a part of its mission and vision even while downstream customers are not yet committed to a green transition.
- Kato Light Metal Industry developed its own input-output model to prioritize suppliers that are greening or utilizing renewable energy.
- Aluminum recycling is a crucial investment that can reduce Scope 2 emissions of SMEs and reduce import dependence on aluminum ore.

Introduction

The global demand for aluminum is expected to continue increasing as economies pursue growth and industrialization. Aluminum production, however, is a significant source of carbon emissions, accounting for 2 per cent of world-wide CO₂ emissions. It is crucial to explore ways by which the aluminum industry can cut down its carbon emissions.

Kato Light Metal Industry was established in 1994 in Ama-gun, Aichi, Japan. The company manufactures extruded aluminum products mainly used in construction, electronics and machinery, transportation parts and accessories and others.

► Aluminum products and manufacturing process

Aluminum products of Kato Light Metal Industry and share to production

業種	割合(%)	
建材 	40	Construction materials 40%
機械部品 	15	Machinery 15%
電機 	15	Electronics 15%
輸送機器 	10	Transportation 10%
その他 	20	Household materials and others 20%

Manufacturing Process

Extrusion →



Stretching →



→ Extrusion →



Heat Treatment →



→ Inspection and Packing → Shipping



Source: Kato Light Metal Industry

The Kato Light Metal Industry is aiming to become a model of decarbonization management in the aluminum industry in Japan. The company's approach is comprehensive, including investing in technology to reduce carbon emissions in the production process, reducing energy consumption and producing more environmentally friendly products, such as lower-carbon aluminum.

Decarbonization experience

The company has been investing in several initiatives to reduce its carbon footprint, focusing on cutting energy consumption. It conducted an energy-saving diagnosis targeting operational waste and equipment deterioration. Based on the result, the company was able to substantially cut its Scope 1 CO₂ emissions by 97 per cent and is working to further reduce Scope 2 and 3 emissions. In 2021, emissions were estimated at 127 t-CO₂.²⁰

One of the most important steps that it has undertaken was changing machinery. In 2016, the company invested in an energy-efficient machine to replace the traditional extrusion machine. Kato Light Metal Industry is the first aluminum company in Japan to use the electric hybrid 2350t extruder machine, which eventually resulted in a 20 per cent reduction in electricity consumption.

► Press machine and heater

契約電力 : 1600kwh → 1470kwh に削減

Reduction of electric power from 1600 kwh to 1470 kwh



Source: Kato Light Metal Industry

Changes in the production process were introduced to enable Kato Light Metal Industry to create a market-based production system. The new system helps in tracking the production output to make sure that the factory does not produce beyond what is needed by the target market, while meeting the needs of its own customers. One way it achieved this was by changing the minimum order policy from 20 kilograms to five kilograms. This allows for a more calibrated calculation of customers' aluminum needs, reducing product wastage. In this way, the company avoids unnecessarily adding to carbon emissions through aluminum overproduction.

The company developed an 'input-output model' of CO₂ reduction to target the reduction of Scope 3 emissions. With this model, it aims to prioritize buying inputs from suppliers who are using renewable energy and are greening their business, as well as to work with clients on aluminum recycling.²¹ It

²⁰ Based on MOE Model SME Decarbonization Project Data

²¹ SME Decarbonization Project Data.

further ventured into the production of low-carbon aluminum, commonly called 'green aluminum', which is produced in a process with significantly reduced carbon emissions. Mr Daiki Kato, company President, explained that the carbon emission ceiling for every ton of green aluminum is four tons of CO₂ (t-CO₂). If the production of one ton of aluminum emits more than four t-CO₂, that aluminum cannot be considered green.

Mr Kato emphasized that producing green aluminum is still more expensive than using recycled aluminum. Moreover, aluminum recycling is more environmentally friendly than manufacturing green aluminum, as the recycling process produces only 1/30th of the CO₂ emissions compared to processing virgin or non-refined aluminum.

Enabling factors

Mr Daiki Kato is the force behind the environmental action of Kato Light Metal Industry. A graduate of the Keio University Faculty of Environment and Information Studies, his academic background trained him to systematically tackle the decarbonization of his company's manufacturing process. Mr Kato also credits his own experience working on environmental issues in his prior job before he joined Kato Light Metal Industry with preparing him for his new role. It was in that previous company where he learned the importance of cutting Scope 3 CO₂ emissions. Scope 3 emissions are indirect emissions that are linked to the company's operations, including both upstream and downstream emissions. In his current company, he developed a programme for calculating Scope 1, 2 and 3 emissions to better monitor its carbon emissions.

Mr Kato shared that while working on reducing carbon emissions in his previous job, he realized that Japan is lagging behind the world in decarbonization practice and management. When he finally joined his family's company in 2020, he was driven to promote aluminum decarbonization. As current company president, Mr Kato has woven decarbonization into the company's mission and goals.

For its environmental action, the company has the support of the government and received technical assistance from MOE as part of its Model SME Project on Decarbonization to identify: 1) operational changes to minimize emissions and develop a business plan to prioritize and implement these; and 2) key measures for the supply chain of the aluminum industry (Scope 3 emissions). Financial assistance was provided by METI in the form of subsidies.

When asked whether decarbonization opened business opportunities for his company, Mr Kato said that the direct impact on the business is not yet significant, but the market potential of the company increased after investing in green technology. It has been receiving inquiries from other companies about the business, and the Kato Light Metal Industry homepage has become prominent when people search for green aluminum and the SDGs in Japan.

Challenges to decarbonization

Aluminum decarbonization is not without its challenges. Mr Kato said that at present, the industry culture is not yet aligned with the need for more dynamic action for decarbonization. He explained that while there is a recognized need to reduce carbon emissions, the industry's preference remains for pure aluminum over either recycled aluminum or green aluminum.

Aluminum is made from bauxite ore, a natural resource that is not found in Japan. As a result, Japan cannot produce virgin aluminum and must rely on imports. At present, the country imports 100 per cent of its aluminum needs. This is seen as the biggest obstacle to decarbonization as aluminum is the lifeblood of the industrial sector. This heavy import dependence not only erodes the competitiveness of the Japanese aluminum industry, but also that of the broader Japanese manufacturing sector. Building an appropriate aluminum recycling facility tailored to the industry's needs would strengthen not only the aluminum industry but also the Japanese industrial sector as a whole, while simultaneously helping to achieve a circular economy. Recycling aluminum is not, in itself, a complicated process: it requires

melting the recycled aluminum and reshaping it. However, a large-scale facility is needed to complete the process. Other SMEs, together with Kato Light Metal Industry, are collaborating and seeking support from relevant government agencies to help them build the much-needed aluminum recycling facility. Mr. Kato also cited the Russia-Ukraine War as another major challenge since it has created a tremendous impact on the supply and price of aluminum imports and energy costs. The company currently imports unprocessed aluminum from Australia, Dubai and Russia.

Another identified challenge was human resources. The company aims to reduce its Scope 3 emissions; however, at this point, Mr Kato said that he is currently the only person actively addressing this issue. There is a clear need for training and awareness campaigns, and these are areas where the government can extend assistance.

NiKKi Fron lowers emissions in fluoropolymer products manufacture

Key findings

- Manufacturing companies can innovate to develop new production methods and materials that produce lower carbon emissions.
- Developing new methods and materials could require significant research, and SMEs may not have in-house expertise for research and development; collaborating with academic or research institutions could bridge this gap.
- A company will occasionally experience a major disaster that results in significant damage to equipment; the need to replace lost assets is also an opportunity to buy more energy-efficient equipment.

Introduction

NiKKi Fron manufactures precision parts and machinery using materials such as fluoropolymer and fiber-reinforced polymer. It is a global company with factories and sales offices in Japan, Thailand and Viet Nam. While its main customer base is in the semiconductor industry, it also has clients in the medical equipment and automotive industries because they can custom-design parts to suit customers' needs.

The company's history began with the wholesale of hemp in 1896, but wartime restrictions on commodities limited the company's access to only discarded hemp. In 1944, the company combined hemp waste with silk textile waste to create and patent a new hemp-plus-silk packing material. Eighty years later, NiKKi Fron works with a class of materials that are called "super engineering plastics" known for heat resistance, strength and chemical resistance.²²

Fluoropolymers are widely used in semiconductor manufacturing processes because the material offers very little friction, is resistant to extreme heat or cold, and does not react to chemicals, and therefore enables optimal and ultra-clean production environments. NiKKi Fron molds, sinters, and shapes fluoropolymer into parts needed in custom machines for semiconductor manufacture. The company also specializes in making friction material and heat insulation material out of fiber-reinforced polymer and fashioning it into clutch parts for manual vehicles and brake parts for bullet trains.

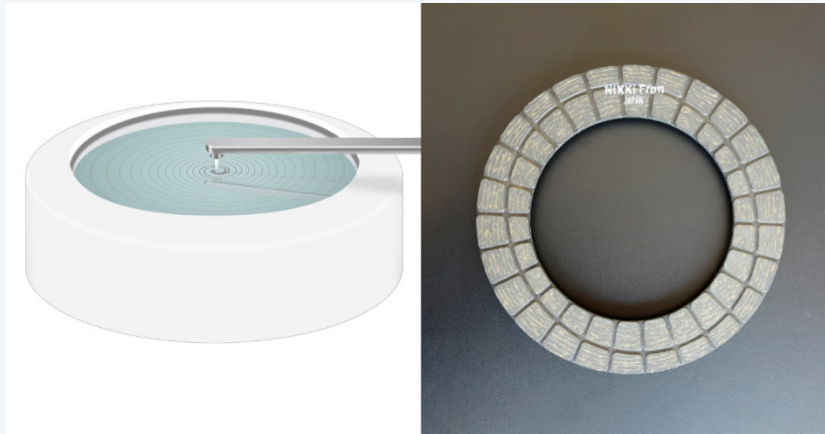
Decarbonization experience

NiKKi Fron earned ISO 14001 accreditation for Environmental Management Systems in 2000. It had been calculating carbon emissions since then as part of maintaining accreditation and has been working on decarbonization since 2008. Decarbonization has been interwoven in the company's decisions for a long time.

Support from MOE enabled technical assistance by experts from the Industrial Technology Center to measure CO₂ emissions precisely in the various manufacturing sub-processes. The experts identified that most carbon emissions came from the sintering furnace and air conditioners. The company has set an emissions reduction target to 30 per cent by 2030, with a 2018 baseline of 518 tons of Scope 1 and 2 carbon emissions (t-CO₂). To reach the target, energy-saving measures and operational improvements are being studied. The company also plans to purchase renewable energy from a local energy utility.

²² Fluorinated polymers are polymers made up of one or several types of monomer blocks that contain carbon-fluorine bonds in their backbones and/or side chains. See European Topic Centre on Waste and Materials in a Green Economy (ETC/WGME), *ETC/WGME Report 9/2021: Fluorinated Polymers in a Low Carbon, Circular and Toxic-Free Economy* (European Environment Agency, 2021), <https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-wmge-reports/fluorinated-polymers-in-a-low-carbon-circular-and-toxic-free-economy>

► **Fluoropolymer precision equipment parts and fiber-reinforced polymer clutch facings**



Source: NiKKi Fron Co., Ltd.

NiKKi Fron could be characterized as a company that strives for innovation. After being hit by floods in 2019 at its Nagano-based factories, most of the production machinery was damaged and had to be replaced or overhauled. This was used as an opportunity to purchase equipment that could enable the company to be more innovative and efficient in its use of energy and production materials.

Looking to the future, the company has developed a process for fluoropolymer recycling. Recycled polymer significantly cuts emissions compared to the manufacture of virgin plastic. NiKKi Fron intends to recycle the machining scraps that arise from fluoropolymer processing and will collect these scraps from the company, from its customers who assemble semiconductor manufacturing equipment and from the secondary customers who use that equipment to manufacture semiconductors.

Enabling factors

The company philosophy, “Utilize limited resources effectively” is based on the SDGs, and it is why energy saving is attempted where possible. The Senior Executive Manager, Mr Takayuki Ito, stressed that because of this philosophy, the company is constantly creating technology or innovating to utilize what limited resources are available. He felt that it was normal to adopt new technology to green the production process.

NiKKi Fron’s president, Mr Kasuga, cited business continuity as the second factor for why the company began decarbonization. The 2011 Tohoku earthquake and 2011 Thailand floods in the Chao Phraya River basin were two major disasters that shook manufacturing companies around the world due to their ability to interrupt the global supply of cars and external hard disk drives. The company management realized that it was important to have business continuity plans ready in case the factories’ production would suffer a prolonged disruption and had developed one by 2015.²³

23 “「回復」から「成長」へ復旧フェーズを格上げ,” [translated: Upgrading the recovery phase from “recovery” to “growth”] <https://www.risktaisaku.com/articles/-/83158>

The company's readiness was tested in 2019 when Japan suffered deaths and severe damage from Typhoon No. 19 (international name Hagibis), which brought record rainfall to Eastern Japan. Naganuma district in Nagano, where NiKKi Fron had several production facilities, experienced two-meter-deep flooding due to a breach of the levee of Chikuma River and the natural characteristics of the river basin in that area.²⁴ Typhoon Hagibis²⁵ and the Chikuma River overflow²⁶ are being studied to determine if these were worsened by climate change impacts. Thanks to the company's preparedness and flexibility, some fluoropolymer parts production was quickly shifted to Thailand to ensure that it could meet some contracts. The experience served to strengthen the understanding that decarbonization is a part of ensuring business continuity in the long run, as it would contribute to reducing the harmful greenhouse gases in the atmosphere (and ultimately reduce climate change impacts such as more frequent or stronger extreme weather events like typhoons).

Challenges to decarbonization

Mr Kasuga stated he felt financial assistance is critical for SMEs because it is difficult to realize environmentally friendly investments. NiKKi Fron applied for subsidies from the Ministry of Economy, Trade and Industry that covered 75 per cent of replacement costs of equipment damaged during the 2019 Typhoon Hagibis and flooding. They applied for subsidies from the Ministry of Economy, Trade and Industry that are intended to improve productivity or support new business. Subsidies are not easy to obtain, but any SME may apply for these and try to meet the criteria of a subsidy programme.

NiKKi Fron has a factory in Thailand that was at first making auto parts and expanded to producing molded and machined fluoropolymer products used in the semiconductor manufacturing, chemical and medical industries. The factory was able to absorb some of the production volume that was supposed to be produced by the factories in Nagano if the equipment had not been damaged by the 2019 flooding. Business continuity was assured by having facilities in another country, but the Senior Executive Officer, Mr Ito, acknowledged that the hot climate in Thailand requires more air conditioning to maintain the optimal temperature range for semiconductor machine parts. At the moment, the emissions outside of Japan are not part of the measurements or decarbonization targets;²⁷ it will be interesting to observe how NiKKi Fron will tackle decarbonization as a global company.

Environmentally friendly investments need to be linked to profitability to be sustainable. For example, while the company intends to use renewable energy, the scale of its operations means that it cannot be feasibly supplied by solar panels. NiKKi Fron has not seen an increase in profitability from its green investments, but with the changes in equipment it is able to maintain the target output at less energy cost (20 per cent less). The management decided to use the amount from energy savings to defray the higher cost of green electricity.

Some new business opportunities have come from environmentally friendly investment, but the volume is still small. Most of the potential clients do not integrate CO₂ emissions as part of the criteria for evaluating their products or services. Despite this, Mr Kasuga expects that continued positive evaluations will lead to an increase in volume in the future, especially since the global semiconductor industry is now studying how to reduce carbon emissions.

²⁴ Shibata et al. (2020) has a study of Naganuma District, Nagano City that presents a flood depth map and describes flood risks in the area; found here: https://www.jstage.jst.go.jp/article/journalofjsce/10/1/10_45/_pdf

²⁵ Li & Otto (2022) modelled the precipitation and impacts of the typhoon against 1951 levels, and estimated that climate change increased the probability that the typhoon would occur by 67 per cent and added a conservative estimate of four billion dollars to the damage; found here: <https://link.springer.com/article/10.1007/s10584-022-03344-9>

²⁶ Nihei et al. (2023) modelled what might be added to flood inundation parameters of Chikuma River, found here: <https://onlinelibrary.wiley.com/doi/full/10.1111/jfr3.12919>

²⁷ Based on an interview with Mr Kasuga and Mr Ito.

Finally, Mr Kasuga feels that SMEs like his lack the staff and facilities that are focused on research and development, which could be a gateway for decarbonizing their production processes. To fill this gap, NiKKi Fron collaborates with academia to develop new materials and new processes. The first such collaboration was with Shinshu University to create the hemp-plus-silk packing material in 1944, and the company still occasionally provides a budget for research collaborations.

Tamamura Delica: Promoting decarbonization and just transition in food production

Key findings

- Productivity and decarbonization are closely linked through reduced energy consumption and reduced resource use, and therefore lower costs for the same level of production.
- Promoting workers' rights and wellbeing should accompany decarbonization efforts.
- SMEs need financing to procure decarbonization technology, and access to subsidies as well as support to develop sound subsidy applications or proposals would be helpful.

Introduction

Convenience stores are part of modern Japanese culture. What sets Japanese convenience stores apart from their counterparts abroad is the variety of fresh, high-quality food sold. For first time visitors, Japanese convenience stores can be a good introduction to local cuisine. For the locals, convenience stores provide the needed support for a busy life, including fresh snacks or meals, any time of the day.

The Japanese convenience store industry is a 12.7 trillion-JPY business, and 7-Eleven is one of the industry leaders (Statista. 2024). Tamamura Delica, a company with headquarters based in Gunma, Japan, has been developing and manufacturing cooked noodles, snacks and side dishes for 7-Eleven since its establishment in 1991.

Food production, however, is a major source of pollution due to its high use of electricity, liquefied petroleum gas and oil waste. Globally, food production accounts for 26 per cent of greenhouse gas emissions (Ritchie, Rosado and Roser 2022). As part of its green branding, Tamamura Delica is changing many aspects of its business to decarbonize. It is also building a reputation as a sustainable company that reflects the principles of just transition by upholding the rights of workers.

Decarbonization experience

Tamamura Delica has undertaken various measures to decarbonize its production and products, particularly through energy-saving measures, shifting to environmentally friendly production processes, and developing greener products. The managers understand that in their business, productivity and decarbonization are closely linked: shortening manufacturing time and increasing production efficiency can also reduce energy consumption. In their estimate, with the current system they are implementing they can reduce energy consumption and meet their target by 2030. MOE aided in developing the company's roadmap for decarbonization to reduce CO₂ emissions by 54 per cent by 2030, based on the 2020 levels of 10,667 t-CO₂.²⁸ Meanwhile, METI has provided a subsidy to install the solar panels in the factories, through a Power Purchase Agreement.

Specific changes have been implemented to boost energy efficiency. For example, since the company produces food, the temperature in the factory must stay cool. To achieve this, the refrigerators were insulated and the factory roof was lowered to keep the temperature optimal without increasing electricity consumption. The company uses high efficiency air conditioners and optimizes the cooling systems by using timers in refrigerators, and putting insulation on pipes and valves, thus preventing outside air from entering the freezers. It also implemented mist spraying on outdoor units and sprinkling water on its roofs in summer to decrease the temperature during the hot and humid summer season.

²⁸ Based on MOE Model SME Decarbonization Project Data

► **Food preparation; factory solar panels; food products**



Source: Tamamura Delica

Innovations have been introduced in the company to reduce CO₂ emissions. Workers often require boiling water to cook noodles, and the company is actively seeking environmentally friendly alternative fuels. The company currently employs wood pellet boilers but is exploring the possibility of incorporating waste cooking oil boilers to recycle its own and other companies' waste oil. This switch is expected to substantially reduce energy consumption. Solar panels have been installed on the roofs of some factories, and the company is planning to procure energy from third-party sources selling green energy.

As for greener products, simple changes are introduced that go a long way in reducing plastic waste. The company stopped filling small packets with seasoning, choosing instead to mix the flavoring into the food. It changed the design of the lid so that it sticks firmly to the bowl without using adhesive tape. The change in product design also reduced the tasks of the workers on the production line.

Tamamura Delica strives to maintain a culture which values skills, competence and dedication to the job. Being part of the supply chain of 7-Eleven means being able to meet the strict, high-quality standards it maintains for its products and services. The company needs to comply with the Seven & i Group Human Rights Policy, which promotes the "creation of a sustainable society where human rights are respected". The management is conscious of workers' rights and maintaining the welfare of its employees.

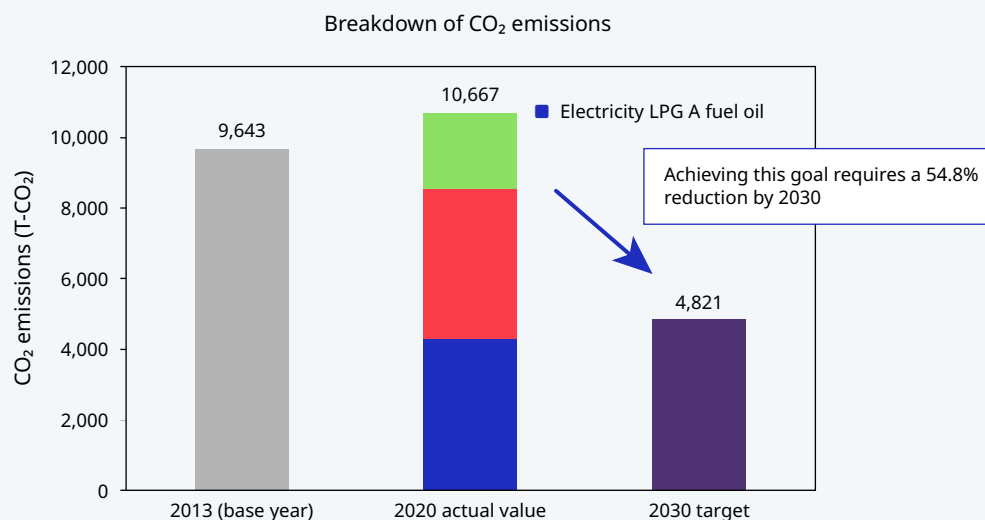
Enabling factors

Tamamura Delica's management team, which professed a deep commitment to climate action, is the most important factor in the successful implementation of the company's decarbonization efforts. The President and Representative of the company, Naoyuki Kojima, comes from a farming family, and as a farmer himself, he understands the impact of climate change on crops and food sources. During the interview, he was joined by two members of the management. The Managing Director, Mr Yasuyuki Takahashi, serves as the CSR Environment Promotion Team Leader. Mr Takahashi designs environmental actions inside and outside of the company. As Chief Electrical Engineer and Production Technology Department-Technology Section Manager, Mr Masanori Okazumi, oversees the planning for energy saving and decarbonization.

The company's decarbonization initiative could be considered part of the process to nurture the company's growth and prepare it for the future. The March 2011 Tohoku earthquake in the Kanto region provided the impetus to explore ways to save energy. Considering the unstable electricity supply at that time, it led the company to explore renewable energy to secure the electricity supply for its factories. In 2015, the company joined Eco-Action 21, an environmental management system developed by MOE to help businesses undertake voluntary environmental measures. The company has various initiatives to promote environmental awareness in the communities around its four factories and a green farm. On the business side, it develops food products with ingredients that are locally grown, and available through 7-Eleven stores in the prefecture where the factory is located. The company also publishes a voluntary environmental management report, and in August 2023 Tamamura Delica was recognized by MOE for its long-standing and active participation in the Eco-Action 21 project.

At present, Tamamura Delica is working with 7-Eleven & i Holdings on a long-term vision called Green Challenge 2050 — a long-range plan to achieve net-zero GHG emissions by 2050 and to promote a circular economy, including sustainable sourcing of inputs for products. Furthermore, the company developed an environmental management policy in 2023 that seeks to reduce food waste and carbon emissions. The management team and staff are motivated to cooperate with their business partners to achieve this long-term vision.

► CO₂ emissions in 2013 and 2020, Scope 1 and 2, by emission source, with reduction target



Source: MOE Model SME Decarbonization Project Data

For its decarbonization action, support from the government has been important. The company received technical support from MOE in 2022 through the SME Model Project for Decarbonization on how to measure its emissions and draw up a plan to gradually increase its use of renewable energy.²⁹

²⁹ Based on MOE Model SME Decarbonization Project Data

Challenges to decarbonization

The increasing cost of raw materials has been identified as the main challenge for the company now, as it has an impact on the cost of maintaining its environmental actions. The health and well-being of workers is also a main concern, especially due to workers' vulnerability to diseases during the pandemic and post-pandemic period.

The company wants to sustain its climate actions and hopes to access government support and subsidies more easily to overcome challenges with the current subsidy application process, including a short application period, a high number of requirements, and a short execution period. In addition to subsidies provided at the planning stage, subsidies that can be obtained by submitting actual results after completion would be attractive to the company as an incentive to set a target and receive a reward. The company also hopes that some tight regulations such as those based on the Waste Management Act and the Fire Service Act implemented by the government will be relaxed to allow more flexibility to implement its decarbonization programmes. Finally, it hopes for other sources of financing apart from the public sector to support its decarbonization activities.

Tsuyakin's eco-friendly textiles and wearables

Key findings

- Decarbonization measures can be wide-ranging; aside from energy conservation, companies can creatively develop processes and products that support a circular economy through reusing materials and upcycling inventory.
- Companies can conduct business that is safe for the environment and protects the future of children.
- Fashion trends should be influenced towards the products and companies that care for sustainability, decent work and the environment.

Introduction

Tsuyakin is a textile dyeing and finishing company founded in 1899. It has a long history that began with traditional methods for cotton and silk. In 1955, it was distinguished for being the first factory to introduce chemical dyeing and processing of synthetic fibers. Tsuyakin offers a range of services that include the preparation of textiles, dyeing and finishing. The dyeing process itself was responsible for most of the company's emissions because it requires heating enough water to high temperatures, ranging from 60°C for cotton to 135°C for polyester, and then sustaining those temperatures for 1.5 to 2 hours while the fabric is being dyed.

In 2021, it achieved a different kind of milestone as the first textile dyeing company from among the SMEs to obtain SBT certification from MOE.³⁰ Tsuyakin has a comprehensive approach to decarbonization. In addition to investing in equipment and processes that lower its environmental impact, the company is creating new products that are in harmony with environmental protection.

Decarbonization experience

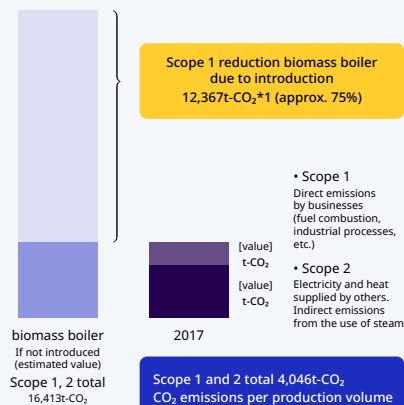
Decarbonization is a significant commitment in the textile and apparel industry, which is responsible for a lot of carbon emissions and environmental pollution. Each part of this value chain contributes to carbon emissions, from the cultivation of the plants or raising of the animals that are the source of fibers, to the production of thread, weaving and dyeing of textiles, sewing of apparel and the transport of textiles and finished clothes. The impacts are multiplied by the number of times that fashion changes in a single year. Around the world, the impacts of the industry include: the release of harmful chemicals into the air, ground and water bodies; microplastic pollution from washing synthetic fabrics; and the dumping or incineration of clothing or textiles.

As early as 1987, the company had already switched from a gas industrial boiler to a biomass boiler. Biomass is a clean, renewable energy source derived from plants or animals. Tsuyakin uses wood chips that are recycled from demolished houses. While burning wood releases carbon dioxide (CO₂), the emission is considered at net zero because it comes from carbon that was previously sequestered (captured) while the tree was alive. In 2017, the company's total annual Scope 1 and 2 emissions were measured at 4,046 t-CO₂, for an estimated reduction of 12,367 t-CO₂ compared to using gas boilers.

Tsuyakin made additional investments to change its dyeing machines to a hybrid version that the company jointly developed with the manufacturer and has replaced 15 out of 50 dyeing machines at the cost of 15 to 20 million JPY per machine. This change allows for a shortened time to boil the dyeing broth, reduced electricity usage, and improved productivity for the same volume of output. The company still has some way to go to replace all the units with hybrid dyeing machines and to switch to renewable energy. The financial challenge is considerable.

³⁰ Stated in the company's 2021 SBT certification (in Japanese).

► Industrial biomass boiler and graph comparing Scope 1 and 2 emissions of the biomass versus a traditional boiler



Source: Tsuyakin Co., Ltd.

Tsuyakin has developed its own brands and products that are more environmentally friendly and contribute to decarbonization — Retricot and Kurakin. The company's bolts of cloth that are sitting as unsold inventory are upcycled into shirts, pants, skirts, cardigans and other apparel and sold under its own brand, Retricot. Cloth inventory is a problem in Japan, constituting an estimated 50 per cent of what is produced in a year. This inventory either adds to landfill or is incinerated, and so the act of upcycling prevents emissions from disposal and contributes to the circularity of the textile industry.

Kurakin is the Tsuyakin brand of natural textile products whose colors come from natural pigments, creating bags, shawls, shoes and household items in soft colors. The company developed its own process called *Nokori-zome* (のこり染) to extract those pigments from food waste that food manufacturing companies might otherwise throw away. The company has already developed dyes from a variety of plant sources including adzuki red bean (*Vigna angularis*), sakura cherry blossom (*Cerasus* sp.), blueberry (*Vaccinium* sect. *Cyanococcus*), kaki persimmon (*Diospyros kaki*), spinach (*Spinacia oleracea*), oolong tea and wine. With this line of products, Tsuyakin is contributing to the circularity of the Japanese snack food industry.

Tsuyakin concentrated its factory production in Ogaki, Gifu Prefecture to take advantage of the abundant groundwater. In order to be in harmony with its environment, the factory has its own wastewater treatment process to remove harmful chemicals, match the original pH levels of the stream, and allow the wastewater to cool. These steps help prevent eutrophication, water pollution and die-off of plants and animals that live in the waters.

Enabling factors

As of 2023, Tsuyakin's formal management philosophy was changed to pursuing business that is safe for the environment and for the future of our children. It wants to promote environmental protection through textile dyeing, and to integrate environmental values into the criteria for evaluating business decisions.

The company president, Mr Yuji Sumi, publicly advocates for the industry to extend the lifecycle of fashion, increase the circularity of its products, decarbonize and address the sustainability of its inputs. He also took action to raise the awareness of his workers on the importance of decarbonization and environmental protection, and how these concepts add value to products.³¹ This is a contrast to the idea of how, if poorly regulated, the global textile and garment industry is a polluter and maintains unsafe working conditions to maximize profit.

► Kurakin natural textile products



Source: Tsuyakin Co., Ltd.

³¹ Based on an interview with Mr Sumi.

Tsuyakin was approached in 2008 by the Gifu Prefectural Industrial Technology Center, a research and development support center that brings together manufacturing companies and academia. They collaborated to find textile dyeing applications using food waste sources, and from this, the company's *Nokori-zome* process and Kurakin brand were born. This type of collaborative research and development effort is very helpful for SMEs with limited resources to develop new products and processes that support the net-zero emissions objective of decarbonization.

In 2018, Tsuyakin applied for the Ministry's programme that assists SMEs to calculate their CO₂ emissions and set medium- and long-term reduction targets. Although the major decarbonization effort happened in 1987, they proposed Scope 1 and Scope 2 emission levels in 2018 as the base year under the Ministry's programme, and the target the company selected was for a 50 per cent emissions reduction by 2030. Through the Ministry, the factory set-up was reviewed by experts who made specific suggestions on how to save energy and reduce emissions. The company is now addressing the recommendations that include switching to renewable energy, adjustments to machinery and replacing lighting with LED.

Challenges to decarbonization

Domestic companies in the textile and apparel industry compete for market share; they drive their unit costs down by raising productivity and increasing mass production. The global supply chain for fashion also adds to the competition within Japan, as evidenced by how the import penetration of clothing reached 98 per cent in 2019 (METI 2021). Mr Sumi stated that fashion trends will need to be influenced towards considerations of sustainability and decent work, to support manufacturers who promote labour rights and decent working conditions and to remove their polluting by-products and carbon emissions.

Tsuyakin is presently a supplier to United Arrows, a leading clothing manufacturer in Japan that recently obtained SBT certification. If other apparel companies follow suit, then Mr Sumi hopes that the company is recognized and well-positioned to meet the demands of customers who are environmentally conscious.

About the SME interview respondents

Text provided by the respondents

Kato Light Metal Industry

Mr Daiki Kato is the President of Kato Light Metal Industry. He graduated from the Keio University Faculty of Environment and Information Studies. Prior to his current role as company president, he worked at Moriya Shokai Company and Persol Carrier Company. In his previous jobs, he realized that Japan is lagging behind in decarbonization. This motivated him to work on the decarbonization of his company and the aluminum industry.

Kyohatsu Industry

There is a famous quote saying, “geography is destiny”. Born in Okazaki City, Aichi, the city next to where the world-famous Toyota Motor Corporation is located, Mr Hiroshi Kakimoto was almost destined to have an interest in the car industry. A graduate of the Nagoya Institute of Technology, Mr Kakimoto is an engineer by education and training. He has led Kyohatsu Industry as its President and Representative for more than a decade. Under his leadership, the company motto is “to realize a sustainable society and a healthy working environment engaged in initiatives that contribute to a prosperous future for the world and local communities”.

NiKKi Fron

Mr Takayuki Kasuga is the President of NiKKi Fron. At university, he majored in applied chemistry. He began his career as an engineer at DIC Corporation, a major chemical corporation. He later returned to his hometown and succeeded in the family business.

Takayuki Ito is the Senior Executive Officer of NiKKi Fron. He worked for several foreign manufacturing companies for almost 20 years in financial planning and analysis and started working for NiKKi Fron in 2010. He managed the factory in Thailand for eight years.

Rai Hatome Kogyo

Mr Takanari Ishihara joined Rai Hatome Kogyo in October 2005 after working for a trading company for five and a half years and was appointed as the company's Eco-Action 21 Environmental Manager in June 2010. He contributed to the company winning a total of eight awards. Mr Ishihara has a dual role supporting the Ministry as an Eco-Action 21 auditor. Although his university degree is in History, he studied for and obtained a license of Kougai Boushi Kanrisha, which qualifies one as a pollution control manager.

Tamamura Delica

Mr Naoyuki Kojima is Representative Director and President of Tamamura Delica. As CEO of the company, Mr Kojima oversees the overall company management. He is concerned about the impact of climate change on Japanese agriculture, and he wants to promote sustainable agriculture and food production in his company.

Mr Yasuyuki Takahashi is Managing Director, Management Assistant Product Development Supervisor, Tamamura Delica Environmental Management Officer and CSR Environment Promotion Team Leader. Mr Takahashi is responsible for ensuring that local farmers and domestic suppliers are given priority to supply the inputs for the company's products to create a more sustainable and community-oriented company.

Mr. Masanori Okazumi works in the Production Technology Department as Technology Section Manager and Chief Electrical Engineer. Mr Okazumi sees his position as an opportunity to promote decarbonization and energy security after experiencing the Tohoku earthquake in 2011.

Tsuyakin

Mr Sumi is Representative Director and President of Tsuyakin, having been appointed in 2010. He holds a degree in Chemistry.

► Annex 2: SME interview questions

What is the new technology adopted and new processes introduced for decarbonization?

Technology for greener or environmentally friendly production process/operations

Technology for more efficient energy use

Technology for greener/environmentally friendly products

1, 2 and 3 (all of the above)

Other (please specify):

How did the company make the decision to decarbonize?

a. The owner made the decision.

b. The management made the decision.

c. The owner, manager and the employees/workers' union made the decision.

d. External parties made the decision (for example, government).

e. Other (please specify):

What support or other assistance did you receive from the government to implement decarbonization changes, and what other support do you still need?

a. Financial assistance

b. Technical assistance

c. Both financial and technical assistance

d. Other (please specify):

e. None

Did your decarbonization efforts result in business opportunities?

a. Yes

b. No

c. I cannot tell now.

d. Possibly, in the future.

e. No expectations for business opportunity.

What challenges did you experience during your efforts to decarbonize your business practice, and how did you overcome the challenges?

a. Financial challenge

b. Technical challenge

c. Human resource challenge

d. 1, 2 and 3 (all of the above)

e. None

Were there shocks that pushed or reinforced you to decarbonize?

- a. Disasters
- b. War
- c. Pandemic
- d. Inflation
- e. Other (please specify):

Does decarbonization help your productivity? Please elaborate on your answer.

- a. Yes:
- b. No:
- c. Unsure:

What are the typical changes that are created by efforts to reduce carbon emissions? Please select all that apply.

- a. Workers' tasks relating to use of new equipment or production process
- b. Workers' tasks relating to saving energy
- c. Needing new workers who possess new/different skills
- d. Changes in productivity of workers related to the change in equipment or production process (whether improvement or decline)
- e. Creation of new roles for workers to support environmentally friendly measures
- f. Benefits/assistance for workers who are laid off due to the changes

What kind of training should be the priority for workers employed by SMEs? Please rank from 4 (highest priority) to 1 (lowest priority).

- a. Environmental awareness:
- b. Measurement of carbon emissions:
- c. Training related to new tasks or changes in tasks:
- d. Environmental officer role:

What are the challenges to eliminating the risk factors related to occupational and safety and health needs of workers in SMEs that are adopting environmentally friendly actions?

- a. New risks are emerging with the efforts to be green
- b. The investments needed to make the workplace more comfortable and safer to accompany the environmentally friendly actions
- c. Assistance required of government to meet occupational safety and health needs of workers while companies are switching to environmentally friendly actions
- d. Other (please specify):

► Annex 3: Just transition focus group discussion questions and interview

Focus group discussion questions

- 1) What are the typical changes that are created by efforts of SMEs to reduce carbon emissions?
- 2) What are the challenges to eliminating the risk factors related to occupational and safety and health needs of workers in SMEs that are adopting environmentally friendly actions?
- 3) What kind of training should be the priority for workers employed by SMEs and who should provide the training?

Participants

- Mr Daiki Kato, President, Kato Light Metal Industry
- Mr Takahito Ito, Senior Executive Officer, NiKKi Fron
- Ms Shino Mochida, Human Resources, NiKKi Fron
- Mr Masanori Okazumi, Technology Section Manager, Tamamura Delica
- Mr Yuji Sumi, President, Tsuyakin
- Ms Yuko Miwa, Chief Administrator, Tsuyakin

► **Annex 4: Just transition questions for the Japanese Trade Union Confederation**

Interview questions, Japanese Trade Union Confederation

- 1) What is your overall perception about just transition efforts in Japan so far?
- 2) What is your impression of the impact of GX and decarbonization on the welfare of workers — is it an opportunity or a burden?
- 3) GX will be a massive change in the economy, and we could expect there will be winners and losers in GX. Based on studies in Japan, which sectors is likely to win, and which will be the losers in green transformation?
- 4) Has there already been any feedback from workers represented by JTUC-RENGO? Do you see any “symptoms” or signs of transition? Are they shifting across sectors, needing new skills or training, any observations of this type?
- 5) What are the challenges to eliminating the risk factors related to occupational and safety and health needs of workers in factories and establishments that are adopting environmentally friendly actions?
- 6) Are you aware of subsidies and other support from METI, MOE, or other ministries?
- 7) Which sector do you think needs the most assistance?
- 8) Given that the green transition seems to be very specific per sector, social dialogue might be a process we could study as an enabler for just transition. It was not mentioned by anyone we interviewed. Could you comment how important this could be as a factor for just transition in Japan?

Interviewees

- Yamaguchi Hiroomi, Director, Economic and Social Policy Division
- Yuichi Hoshino, Section Chief, International Division

► **Annex 5: Ministry interviews**

MOE interview questions

- 1) MOE had the technical assistance project for 22 SMEs to undertake decarbonization. So far, what are the main challenges encountered by the Ministry in guiding the SMEs' green transition? How are/were these challenges overcome?
- 2) What is the Ministry's role in promoting decarbonization and other climate change mitigation efforts by SMEs?
- 3) How important are SMEs to the Ministry's strategy to promote decarbonization and the transition to a Green Economy?
- 4) What incentives are the Ministry making available for SMEs to pursue their green transitions?
- 5) Are there or will there be disincentives/penalties for SMEs that have no plans to decarbonize or are proceeding too slowly in their decarbonization?
- 6) Are there country or countries which you're looking into as role model/s in the green transition, particularly, in the way they guide their SMEs' green transition?
- 7) Did MOE find that SMEs experience non-technical challenges that need to be supported to make decarbonization successful? For example, these other challenges could be related to skills, workers, clients. If there were other challenges, how were they supported?
- 8) Have there been collaboration between MOE and METI or MHLW? What were these on?
- 9) Will the Ministry collaborate with the Ministry of Labour regarding issues that affect workers during green transition?

Interviewees

MOE Decarbonization Business Promotion Office

- Ritsuko Minegishi, Deputy Director
- Ryosuke Kato, Environmental specialist

METI interview questions

- 1) Is the Ministry the lead government agency for supporting SMEs to decarbonize or is it the responsibility of other agencies? How is the division of roles between METI and MOE?
- 2) What are the highlights of your collaboration with the Ministry of Environment since they are your main partner for SME decarbonization?
- 3) What incentives does METI provide for decarbonizing SMEs and can they expect penalties in the future if they are not decarbonizing?
- 4) Does the Ministry anticipate any shocks to the labour supply in the sectors that are shifting to more carbon-neutral production processes? Are there collaborations with MHLW regarding possible labour issues?
- 5) Is there a policy to help make cheap renewable energy easily accessible for SMEs?
- 6) What are the steps that the Ministry is taking to protect the Green Transformation policies and programmes from changes in political preference at parliament level?

Interviewees

- Takehiro Nagai, GX Planning and Promotion Office
- Sae Kawasaki, Environmental Economy Office

