



Japan's turning point
How climate action can
drive our economic future

August 2021



We have a narrow window of time. The choices made today and over the next decade will determine our future. We have the opportunity to create a new engine for sustainable economic prosperity while at the same time preventing the worst consequences of a warming world.

Deloitte Economics Institute

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Foreword

Our planet is our most precious asset and yet, without dramatic efforts to address climate change, the world as we know it is at risk.

No-one is immune to the impact of climate change, but for Japan and Asia Pacific, this crisis also presents a clear opportunity. That is to lead the world and find the next wave of economic growth by accelerating action to mitigate climate change.

By taking bold action now, we can create a new engine for sustainable economic prosperity, while at the same time reducing the impacts of climate change. In doing so, we can leverage our leadership in the consumer economy and advanced manufacturing to supply the low-emission innovations, processes, and know-how the world needs.

With that aspiration in mind, Deloitte Tohmatsu (Deloitte Japan) has developed this report "Japan's turning point: How climate action can drive our economic future" in collaboration with Deloitte Asia Pacific.

Addressing the climate crisis creates huge opportunities for economic growth.

Through bold action now and in the decades that follow, we could avoid the worst effects of climate change.

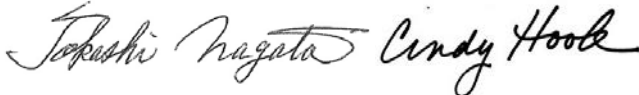
At Deloitte Tohmatsu, we launched a CEO-led initiative called "Climate Sustainability Initiative" last December to encourage our professional members to collaborate more closely across their professional boundaries with the aim to proactively contribute to achieving the goal of "carbon neutral by 2050" declared by the Japanese government. In so doing, we are strengthening the collaboration with Deloitte's global network in order to accelerate our initiative from a standpoint of addressing the climate issues on an Asia Pacific region-wide and thoroughly global basis.

This report discusses how this can be achieved and quantifies Japan's potential gains. Our research challenges one of the main concerns stopping governments, businesses, and individuals from acting on climate change—the cost. It reframes the debate to show that what seems like a cost today is an investment in a climate-driven transformation to a better future.

The choices we make today and over the next decade will determine whether the worst effects of climate change are locked in or avoided. We are at a turning point, and it is time to discover how Japan and Asia Pacific can reshape the arc of economic history. But we can only do it if we do it together and we act now.

At Deloitte, we have set a bold target to reach net zero emissions by 2030. We are also empowering our professionals, connecting with others, and engaging our broader ecosystem to create solutions that facilitate the transformation to a low-emission economy in Asia Pacific and globally.

We look forward to working with you to help prevent the worst consequences of a warming world and realize the many opportunities presented by decarbonization.



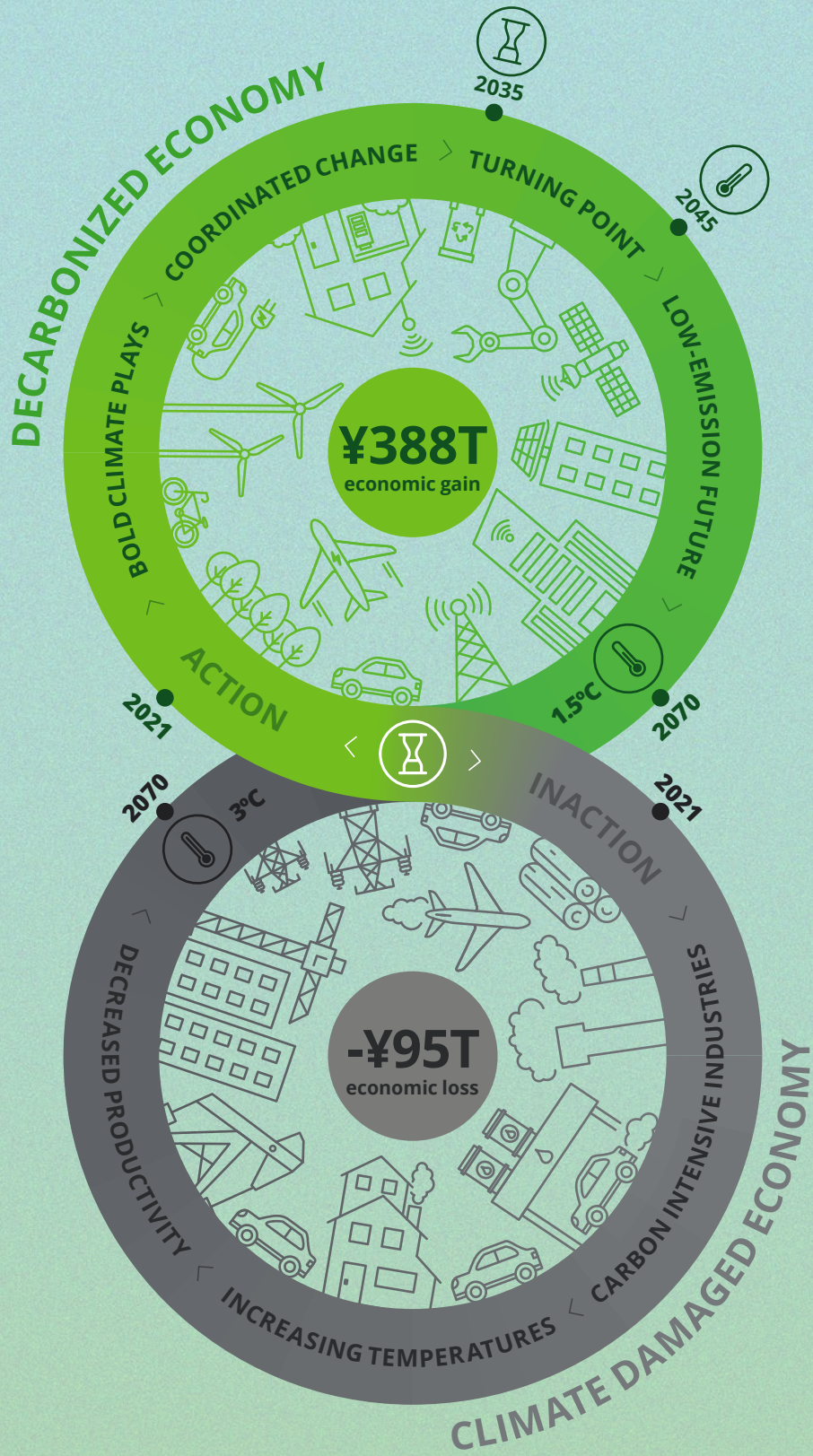
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Executive summary



Leading the way to a low-emission economy

If left unchecked, climate change will impose steep economic costs on Japan. These costs will threaten the progress and prosperity the nation has enjoyed in recent decades. But there is an alternative path.

Rapid reductions in emissions in Japan and across the global economy, beginning now and continuing through this next critical decade, offer a way forward to a low-emission future. This potential future not only avoids the worst impacts of climate change, it also creates prosperous long-term economic growth for Asia Pacific and the world.

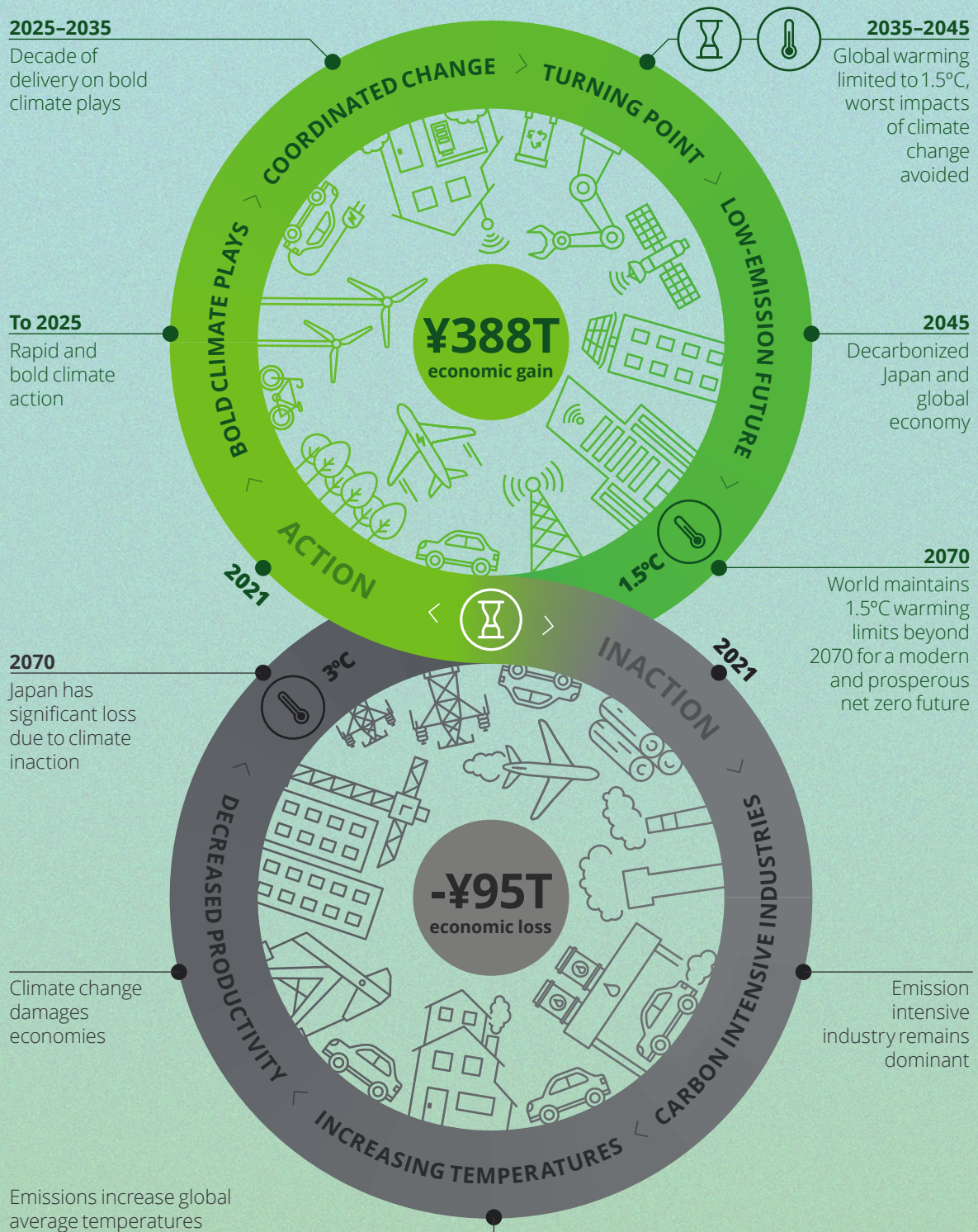
Japan's future is particularly bright in a decarbonized world that keeps warming within 1.5°C of pre-industrial levels. The country is already a global pioneer in innovative and advanced manufacturing technologies. Now is the time to reorient economic structures to leverage this complexity and reap the economic benefits of a low-emission future.

However, there is a need to pivot from seeing efforts to limit global warming as optional costs, and instead view them as necessary and new areas of economic opportunity. This will require quantifying the value of climate change mitigation and the benefits that can come from decarbonization. This report aims to achieve these goals.

At the center of our research is Deloitte's uniquely calibrated Regional Computable General Equilibrium Climate Integrated Assessment Model, the D.CLIMATE model. This model integrates the economic impacts of physical climate change into a baseline economic trajectory to overcome the myopia of many current economic models. By factoring the costs of climate change into the baseline, our framework reveals the tremendous economic harms of inaction or inadequate action, as well as the significant opportunities that present themselves in transforming Japan's economy.

Rapid reductions in emissions—in Japan and globally—offer a way to avoid the worst impacts of climate change while creating long-term growth and prosperity.

Figure 1.1: Economic growth in Japan is the trend in a 1.5°C world



Source: Deloitte Economics Institute D.CLIMATE model.

Note: Japan's stylized economic loss pathway reflects global average warming aligned with the RCP 6.0 baseline. The stylized economic growth pathway reflects limiting global average warming to no more than 1.5°C by 2050, in line with the current ambition of the Paris Agreement.

The cost of climate inaction

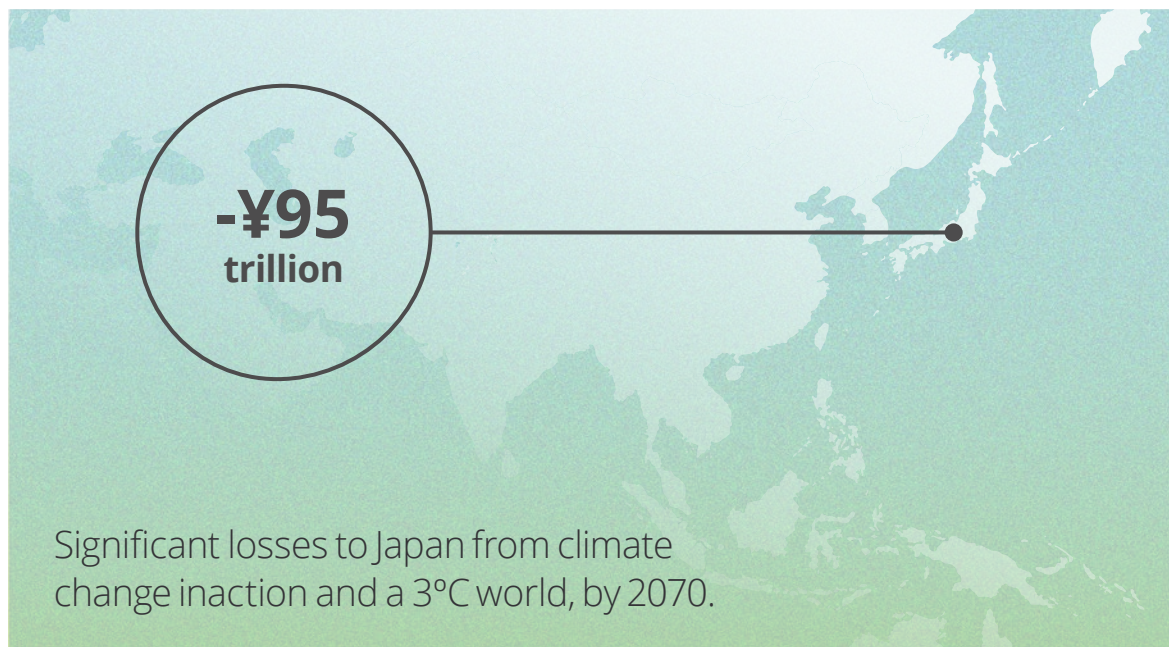
In the economic future Deloitte has modeled, Japan and the rest of the world do not significantly reduce emissions relative to current levels. This future has an emissions pathway that leads to global average warming of more than 3°C by 2070.

This pathway would lead to economic losses of more than ¥29 trillion in present value terms by 2050—or nearly 0.6 percent of Japan's gross domestic product (GDP) in 2050 alone. On average over the 30 years to 2050, that is an annual loss of 0.2 percent of GDP.

The result over the next half-century would be climate change-induced economic losses to Japan of approximately ¥95 trillion in present value terms.^a This lost economic potential would total more than 1.5 percent of GDP in 2070 alone.

For comparison, the economic losses associated with 2019's destructive Typhoon Hagibis exceeded a comparably minimal ¥1 trillion.¹ **The economic cost of unchecked climate change in Japan would be equal to a typhoon of this magnitude occurring more than 85 times between now and 2070.**

Figure 1.2: Economic loss in Japan due to climate inaction



Source: Deloitte Economics Institute D.CLIMATE model.

a. Total net present value (NPV) of deviation loss to GDP in Japan over the period to 2070, at a 2 percent discount rate. Refer to the Technical Appendix for a discussion on the selection and application of the discount rate.

Leading the way to a low-emission economy

Fortunately, the temperature changes and costs described above are not fixed. Although some degree of global temperature rise and climate impact is already “locked in” due to historical emissions, there is an opportunity to take bold action to enable economic prosperity and avert the worst impacts of an altered climate. Supported by the right economic framework, these actions can put Japan—and the world—on a path to realizing strong, equitable, and shared growth.

Japan is at the frontier of a new economic era and the development of a new system of production. By making the right choices now, it could chart a more prosperous path toward a low-emission future, accelerating progress in the rest of the world by exporting key technologies, processes, and know-how.

But time is of the essence. Policy and investment decisions made in the next few years will largely shape the economy and climate that Japan and the world inherit. This narrow window makes it even more important to understand the economics of a warming world and incorporate them into decision making that addresses the multiple market failures of climate change.



Decarbonization is a new economic engine

Our modeling shows that rapid decarbonization could yield economic gains of approximately ¥388 trillion (in present value terms) for Japan's economy by 2070. Compared to a world of climate inaction (the Representative Concentration Pathway (RCP) 6.0 baseline), Japan's GDP would grow by an average of 2.5 percent per year over the modeled decades to 2070.

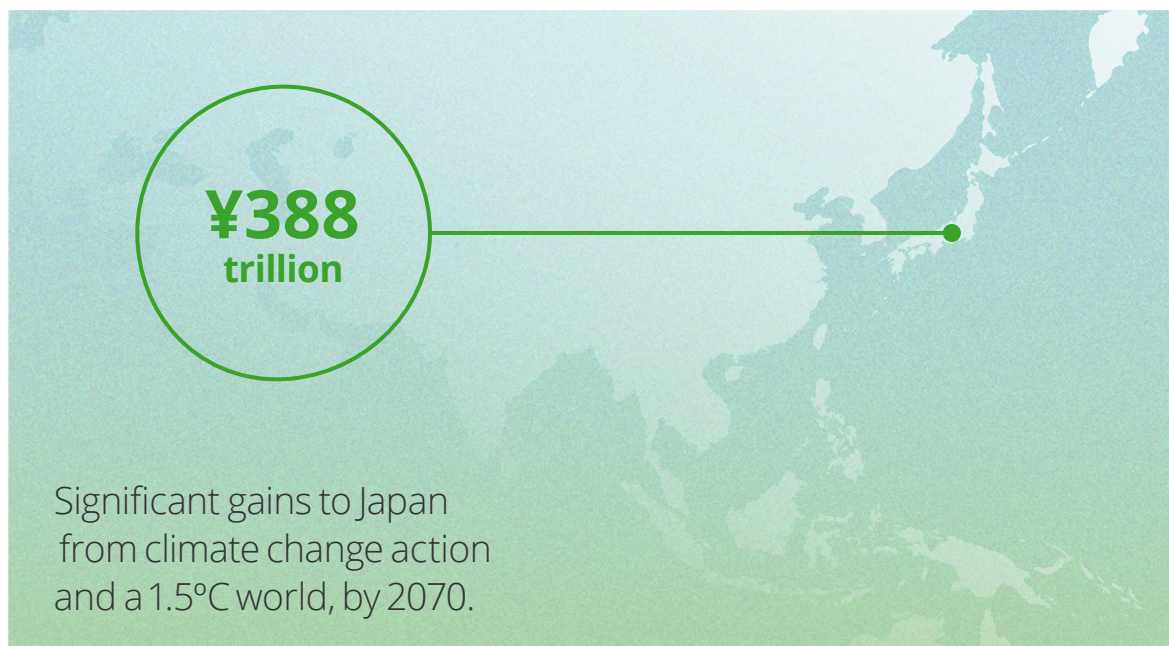
In 2070, that would equate to GDP growth of 4.5 percent and a gain in economic output of ¥32 trillion—equivalent to adding the combined recent market value of Toyota and Nintendo to Japan's economy in 2070 alone.²

These economic benefits would accrue from the rapid investment, technology development, market maturation, and regulation that collectively drove decarbonization, consistent with limiting global average warming to 1.5°C by 2050.

RCP 6.0 explained

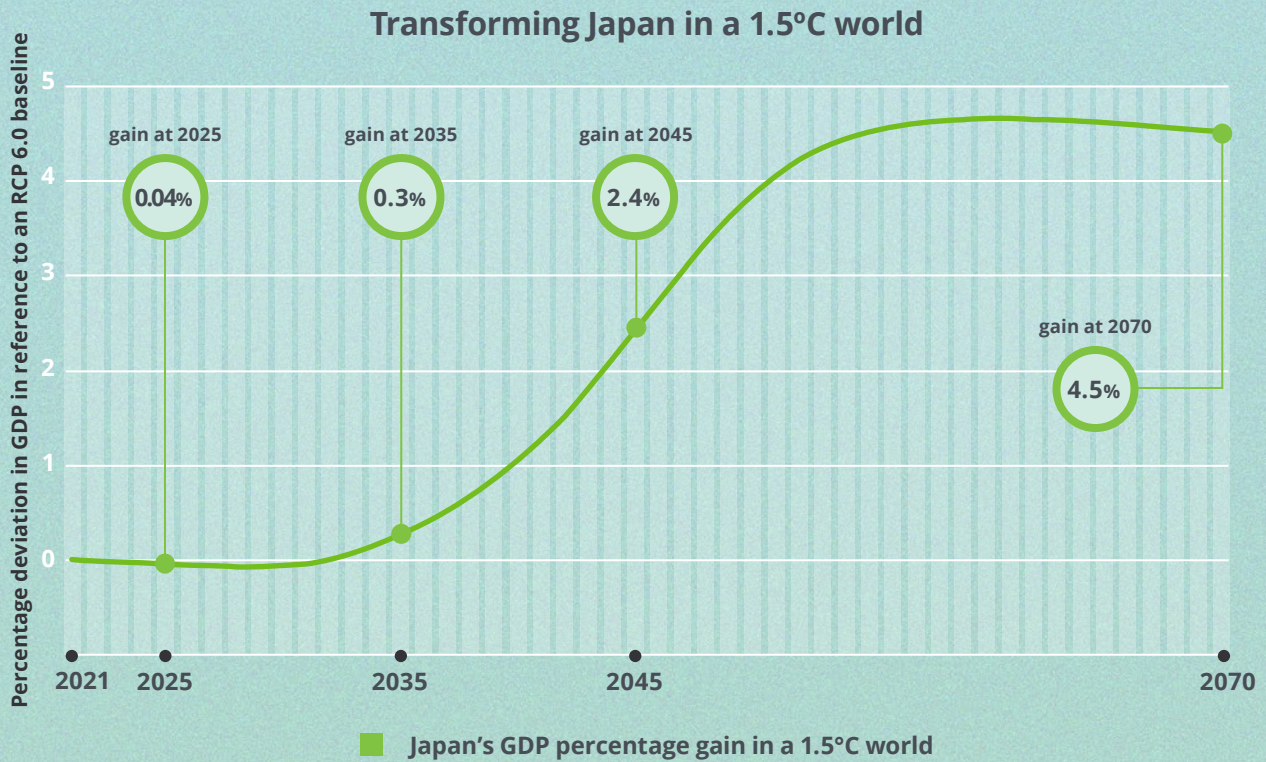
RCP 6.0 is one of the emission scenarios used by the Intergovernmental Panel on Climate Change (IPCC). RCP 6.0 assumes a scenario where the global community largely fails to introduce significant climate mitigation policies, making it an appropriate baseline for forecasting the potential effect of inaction. The IPCC's scenarios vary widely, depending on socioeconomic development and climate mitigation policy settings.





Figure 1.3: Potential economic gain for Japan due to decarbonization in a 1.5°C world



Source: Deloitte Economics Institute D.CLIMATE model.

Figure 1.4: Four phases of action to achieve a decarbonized Japan in a 1.5°C world

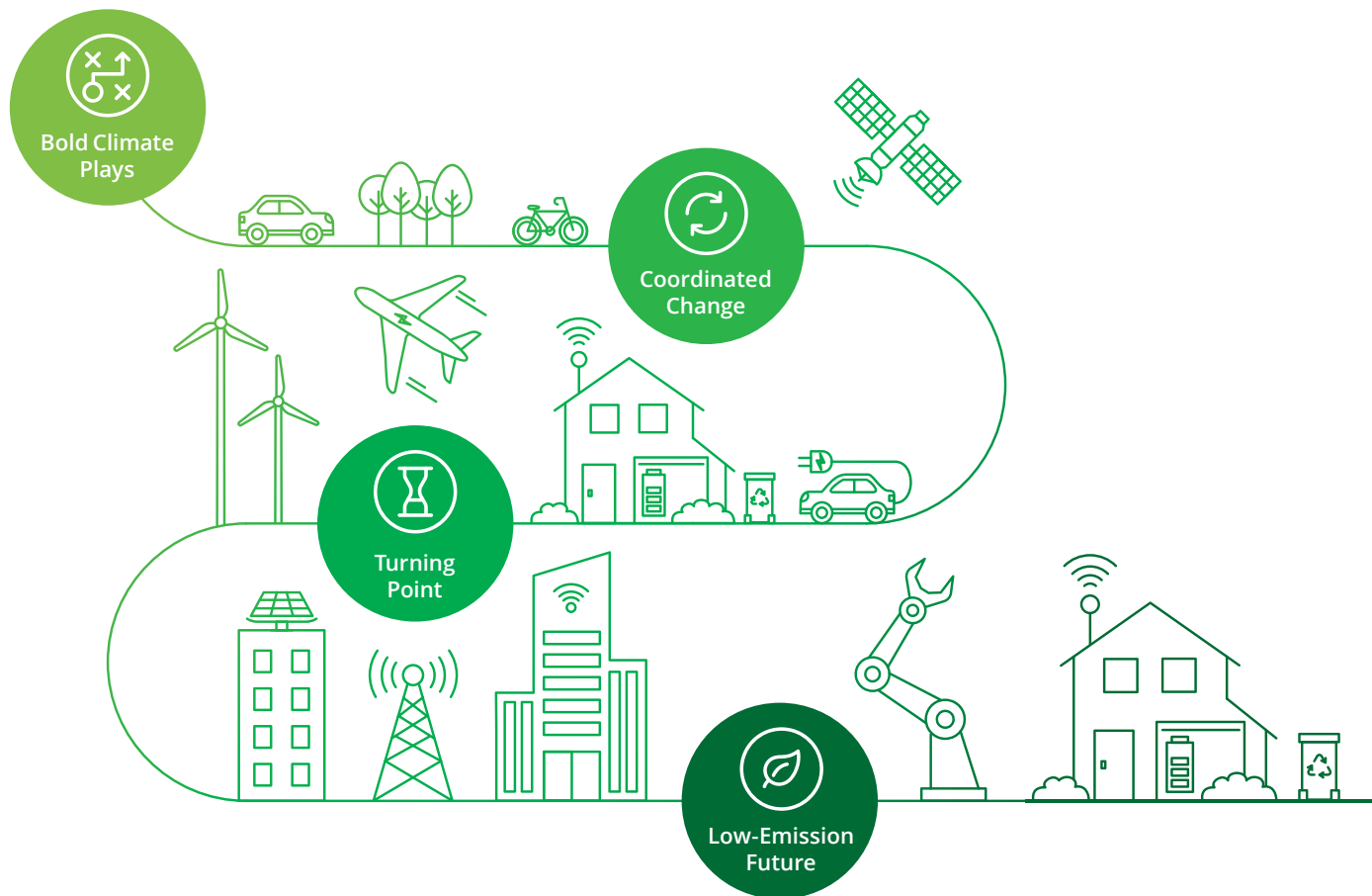


		Largest economic gains during transformation Ordered by largest GDP gain, level terms (¥)
2021-2025	 <p>Bold Climate Plays Some industries enjoy immediate GDP gains due to bold climate plays toward a 1.5°C world</p>	<ul style="list-style-type: none"> New energy Construction Public and private services
2025-2035	 <p>Coordinated Change Some industries gain consistently in the key decade of change toward a 1.5°C world</p>	<ul style="list-style-type: none"> New energy Public and private services Construction Retail and tourism Water and utilities
2035-2045	 <p>Turning Point Significant industry decarbonization is achieved and rapidly gaining in a 1.5°C world</p>	<ul style="list-style-type: none"> New energy Public and private services Retail and tourism Construction Water and utilities
2045-2070	 <p>Low Emission Future New economic structures and outputs remake Japan in a decarbonized 1.5°C world</p>	<ul style="list-style-type: none"> New energy Public and private services Retail and tourism Construction Water and utilities Agriculture and forestry

Source: Deloitte Economics Institute D.CLIMATE model.

Japan's turning point

In our modeling, the economic benefits of climate action for Japan would emerge gradually at first, before growing rapidly toward the middle of the century. Our analysis shows that after the first decade or so, the structural adjustment costs of rapid decarbonization would be offset by positive returns in the capital and technology that shift economies onto a decarbonized pathway. We also show how rapid decarbonization toward a 1.5°C world^b would be likely to occur through the following four economic phases.



b. References to 1.5°C in this report describe a situation in which nations successfully achieve rapid decarbonization, limiting global average warming to 1.5°C by the middle of the century and maintaining that average until the end of the century. Under this scenario, Japan would achieve nearly net zero emissions by 2050. This scenario has been dimensioned and modeled by Deloitte Economics Institute.



Bold Climate Plays

from 2021 to 2025

The next few years set the stage for rapid decarbonization. The decisions by government, regulators, business, industry, and consumers would reinforce initial progress and create the market conditions to deliver decarbonization at pace and scale. This would send price signals, transform supply chains, and lay the foundation for a structural shift that limits global average warming to 1.5°C. We expect bold climate plays would take hold of the economy as Japan's Green Growth Strategy—and its policies in areas such as budgets, taxes, regulation reform and standardization, and international collaboration—sent market signals to regulators, businesses, and consumers. Industries including clean energy sectors, construction, and services would enjoy immediate gains as companies acted on these policies.



Coordinated Change

from 2025 to 2035

The hardest shifts in industrial policy, energy systems, and consumer behavior would occur in this decade. Businesses and economies would begin to see the consequences of bold climate plays, with different industries and countries transforming at different paces. Japan would be able to import the low-emission technologies and hydrogen it needs to maintain its competitive advantages. Its economic gains would accumulate as it extended its position in exporting decarbonization technologies and goods to the world.



Turning Point

from 2035 to 2045

The decarbonization of high-emitting industries should be nearly complete by this period. The cost of new low-emission technologies would be decreasing and net economic gains would be shared more widely. Efforts to curb emissions would begin to manifest in lower global average temperatures relative to a higher-emitting posture (a 0.13°C average decrease across the decade to 2045, compared to the RCP 6.0 baseline). This pathway would result in a 1°C difference in the global mean temperature by 2070, relative to the RCP 6.0 baseline. **This decade would be the climatic and economic turning point** that avoids a “locked in” higher-emission pathway and realizes the economic dividends of technological progress. Japan would shift to a new green economic structure, in which increased productive capabilities—founded on technological know-how and innovation—created a more complex and services-based economy.



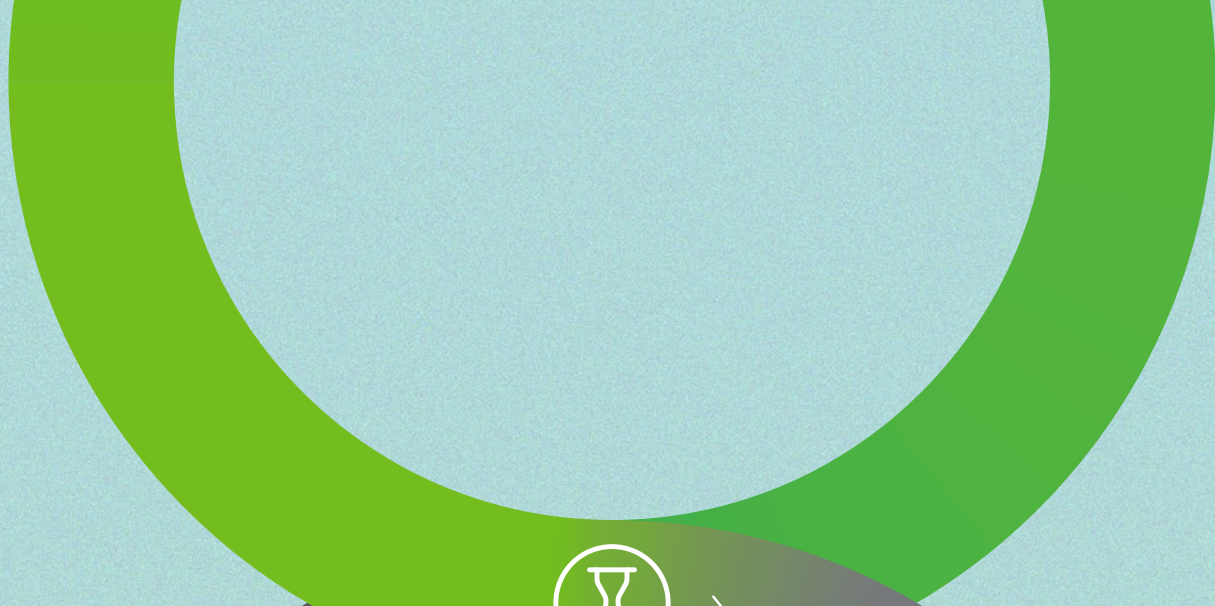
A Low-Emission Future

after 2045

By the end of the century, Japan's economy would be near net zero emissions and the world's economic systems of production would be keeping global average warming to around 1.5°C. Economic structures would be radically transformed, underpinned by a series of interconnected, low-emission systems spanning energy, mobility, manufacturing, and food and land use. The energy mix would be dominated by low- or zero-emission sources across every market, with green hydrogen and negative-emission solutions, both natural and technological, playing prominent roles. Complex services would drive the economy in Japan, enabled by advances in technologies, entrepreneurship, and other competitiveness factors as a result of Japan's early investment in the 2020s.



The economic costs of climate inaction



2070

3°C

2021



DECREASED PRODUCTIVITY

INCREASING TEMPERATURES

CARBON INTENSIVE INDUSTRIES

CLIMATE DAMAGED ECONOMY

-¥95T
economic loss



The new normal: a climate-damaged economy

Most economic thinking has it wrong.

Dominant economic projections do not account for the consequences of climate change, or the world's efforts to adapt to or mitigate the impacts. When they do consider climate change damage and mitigation policy, it is often in scenario analyses that compare alternative future states to the same incorrect starting point—and against an erroneous “business as usual” trend that assumes unconstrained economic growth via emissions-intensive economic production. This is the economic baseline that informs how most decisions and investments are made, for governments and businesses alike.

And no wonder. Since the Industrial Revolution, economic growth has moved nearly in lockstep with rising greenhouse gas (GHG) emissions.

As humanity burned fossil fuels, removed forests, and converted land to intensive agriculture, it enjoyed the “fruits” of those actions: economic growth, rising standards of living, and better quality of life.^c The world economy has expanded almost every year since 1750. While growth has not been constant or even—across regions and individual countries—GDP growth has, on average since the Industrial Revolution, been around 1.5 percent per year.³

That emissions-intensive growth has been perhaps most evident in the Asia Pacific region, where the past several decades have seen dramatic economic expansion and hundreds of millions rising out of poverty—alongside rapidly increasing carbon dioxide (CO₂) emissions.⁴

Growth with consequences

Japan's economy is integral to this growth story. In the decades following World War II, Japan achieved extraordinary economic growth on the back of emissions-intensive industrial production. It is the world's third largest economy, trailing only the United States and China, and the sixth largest GHG emitter.⁵

From the 1960s to the 1980s, Japan achieved one of the highest economic growth rates in the world. This was led in part by high rates of investment in productive capital, the application of efficient industrial techniques, ready access to leading technologies, significant investment in research and development, and an increasingly open global trade framework.⁶

Economic growth and rising standards of living have come at a huge cost.

c. Economic growth as measured by GDP, and improved standards of living as measured by increasing GDP per person.

Figure 2.1: Trends in Japan’s per capita GDP growth and emissions⁷



Source: Deloitte Economics Institute analysis of World Bank data.
 *Per capita GDP growth to 2019; per capita emissions to 2016.

Changing the economic narrative

Mainstream economic theory and models assume unconstrained emissions do not have negative consequences for economic growth potential.

This view of the world has now come up against the overwhelming scientific consensus—and increasingly our own lived experiences—telling us that the current system of economic production is generating untenable changes in the climate.⁸ These changes put at risk Japan’s hard-earned economic growth and prosperity.⁹

Japan is already moving. The country recently pledged a climate action target (a “nationally determined contribution”) of a 26% reduction in GHG emissions below 2013 levels by 2030. In October 2020, Japan pledged carbon neutrality by 2050, and in March 2021, strengthened its interim pledge by planning to reduce emissions to 46% below 2013 levels by 2030.¹⁰ These commitments define Japan’s economic endgame: a low-emission economy that maintains productivity and growth.

But for Japan to deliver on these commitments and balance decarbonization and development, the economic impacts of a changing climate need to be included in economic baselines, and therefore decision making. A failure to do so will result in poor economics, poor risk management, and dangerously inadequate efforts to address the climate crisis.

Deloitte’s D.CLIMATE model integrates the economic impacts of physical climate change into a baseline economic trajectory, to overcome the myopia of many current economic models. By factoring the costs of climate change into the baseline, our framework reveals the tremendous economic harms of inaction or inadequate action, as well as the significant opportunities that present themselves in remaking Japan’s economy.

The high costs of inaction

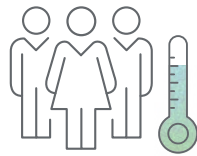
Unmitigated climate change threatens to wipe out decades of hard-won economic growth in Japan. The foundations of the nation's prosperity—its natural and human capital—are at risk, and along with them its standard of living, its prospects for future growth, its place on the global stage, and the wellbeing of its people.¹¹

If Japan's recent economic story is one of growth, unchecked climate change would turn it into one of decline.

Climate change could reverse Japan's hard-won economic gains.¹¹



Figure 2.2: How climate change impacts the economy



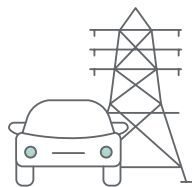
Impacted workers

Heat stress, the “slowing down” of workers, and their reduced ability to perform results in lower labor productivity.



Lost productive land

A loss of productive land through rising sea levels and a reduced level of productive activity on the land impacts low-lying and coastal areas.



Stalling productivity and investment

Economies suffer as investment repairs existing assets instead of contributing to new, more productive capital. Climate change stalls economic progress.



Diminished health and wellbeing

Increased incidence of mortality and morbidity disrupts living standards and the lives of the working population.



Disrupted flow of global currency

The scale of loss of tourism and international money circulating in economies impacts business, jobs, and livelihoods.



Agricultural losses

Despite adaptation, climate change inaction limits what farmers can do. Significant variations in crop yields damage the agricultural sector’s output.

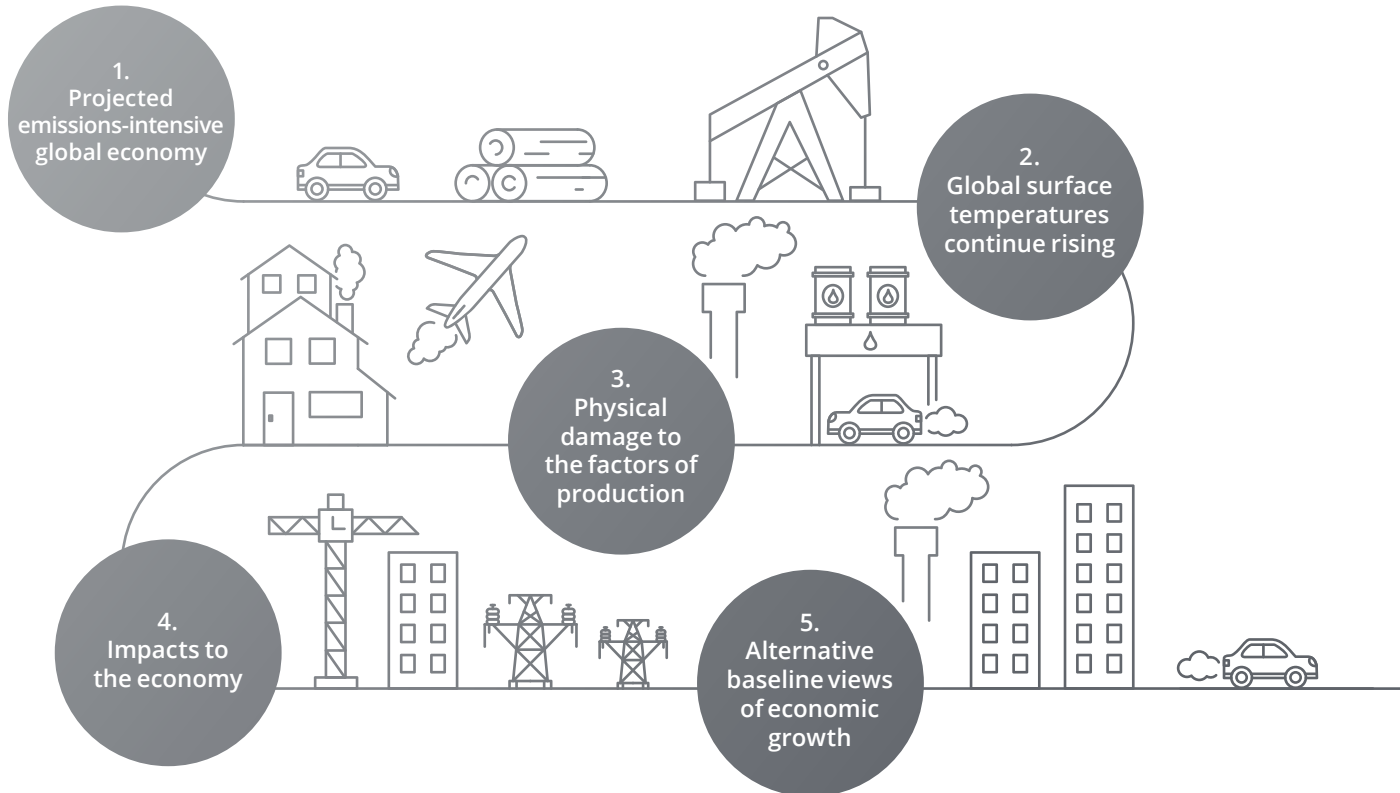
Source: Deloitte Economics Institute.

Modeling climate inaction in Japan

Global emissions will continue to rise if no further significant action is taken to mitigate climate change. The outcome would be increasing global average warming toward the end of the century. In this world, inaction on climate change would be the baseline path for the economies of Japan and the world. This baseline scenario would negatively impact economic growth when compared to a world without climate change (refer to the Technical Appendix for more detail).

This modeling framework involves significant research on region-specific climate and economic impacts across Asia Pacific, which are used as inputs for Deloitte's D.CLIMATE model (refer to the Technical Appendix for more detail).

To quantify this conclusion, Deloitte modeled the economic impacts of a changing climate on long-term economic growth in Japan, using the following stepped process.



1

The model projects economic output (as measured by GDP) with emissions reflecting RCP 6.0 to the year 2100.^d RCP 6.0 represents a single scenario without significant additional efforts to constrain emissions (a baseline scenario).¹² This results in a projected emissions-intensive global economy.

2

Increased atmospheric GHGs cause average global surface temperatures to continue rising above pre-industrial levels.^e In the RCP 6.0 baseline scenario, global average temperatures increase more than 3°C above pre-industrial levels by the end of the century.^f (Note that present-day temperatures have already risen more than 1.0°C above pre-industrial levels.)

3

Warming causes the climate to change and results in physical damage to the factors of production. The Deloitte model includes six types of economic damage, regionalized to the climate, industry, and workforce structure of each defined geography in Asia Pacific.

4

The damage to the factors of production is distributed across the economy, impacting GDP. Any change in emissions (and, correspondingly, temperatures) over time results in changes to these impacts and their interactions. The economy impacts the climate, and the climate impacts the economy.

5

The key variables of time, global average temperature, and the nature of economic output across industry structures combine to offer alternative baseline views of economic growth. Specific scenario analysis is then conducted, referencing a baseline that includes climate change damage. Scenarios can also include policy actions that either reduce or increase emissions and global average temperatures relative to the RCP 6.0 baseline view.



- d. IPCC adopted emission scenarios vary widely, depending on socioeconomic development and climate mitigation policy settings. RCP 6.0 is chosen as an intermediate baseline scenario as it includes no specific or significant climate mitigation policy effort, making it an appropriate baseline for reference.
- e. Pre-industrial is defined in IPCC assessments as the multi-century period before the onset of large-scale industrial activity around 1750.
- f. The associated climate data (like annual temperature increases and atmospheric concentrations) are sourced from a synthesis of the models available through the Coupled Modeling Intercomparison Project (CMIP6). See the Technical Appendix for further detail.

Figure 2.3: Sector loss at 2070, in a climate damaged Japan in a 3°C+ world



Source: Deloitte Economics Institute D.CLIMATE model.

Figure 2.4: Loss to the economy over 50 years



Source: Deloitte Economics Institute D.CLIMATE model.

Note: Total NPV of deviation loss to GDP in Japan over the period to 2070, at a 2 percent discount rate. Refer to the Technical Appendix for a discussion on the selection and application of the discount rate.

The economic cost of climate change

In the economic future modeled, Japan and the rest of the world do not significantly reduce emissions relative to current levels. This future has an emissions pathway that would lead to global average warming of more than 3°C by 2070.^g

The result over the next half-century, by Deloitte's estimates, would be climate change–induced economic losses to Japan of approximately ¥95 trillion in present value terms.^h This loss to economic potential would equal more than 1.5 percent of GDP in 2070 alone.

For comparison, the economic losses associated with 2019's destructive Typhoon Hagibis exceeded ¥1 trillion.¹³

The economic cost of climate change in Japan would be equal to a typhoon of the same magnitude occurring more than 85 times between now and 2070.

If substantial actions are not taken, climate change would, in average annual terms, reduce Japan's economic potential by 0.6 percent per year over the next 50 years.

This pathway would lead to economic losses of more than ¥29 trillion in present value terms by 2050—or 0.6 percent of Japan's GDP in 2050. On average over the 30 years to 2050, that is an annual loss of 0.2 percent of GDP.

Substantial losses to industries, firms, and workers

The impacts of a changing climate would be felt across most Japanese industries, with some bearing the economic burden more than others. The five most impacted industries in terms of economic activity comprise 93 percent of the country's current output over the modeled period.

These industries—services (both government and private), manufacturing, retail and tourism, construction, and transport—are economic powerhouses and major sources of employment in Japan. Together, they form the basis of the country's contemporary economic engine.

Deloitte estimates that by 2070, these five industries would experience an average annual loss in the value added to GDP of more than ¥3.5 trillion per year.

The economic cost of unchecked climate change in Japan would be equal to 2019's devastating Typhoon Hagibis occurring more than 85 times between now and 2070.

g. IPCC-adopted emission scenarios vary widely, depending on socioeconomic development and climate mitigation policy settings. RCP 6.0 is chosen as an intermediate baseline scenario as it includes no specific or significant climate mitigation policy effort, making it an appropriate baseline for reference.

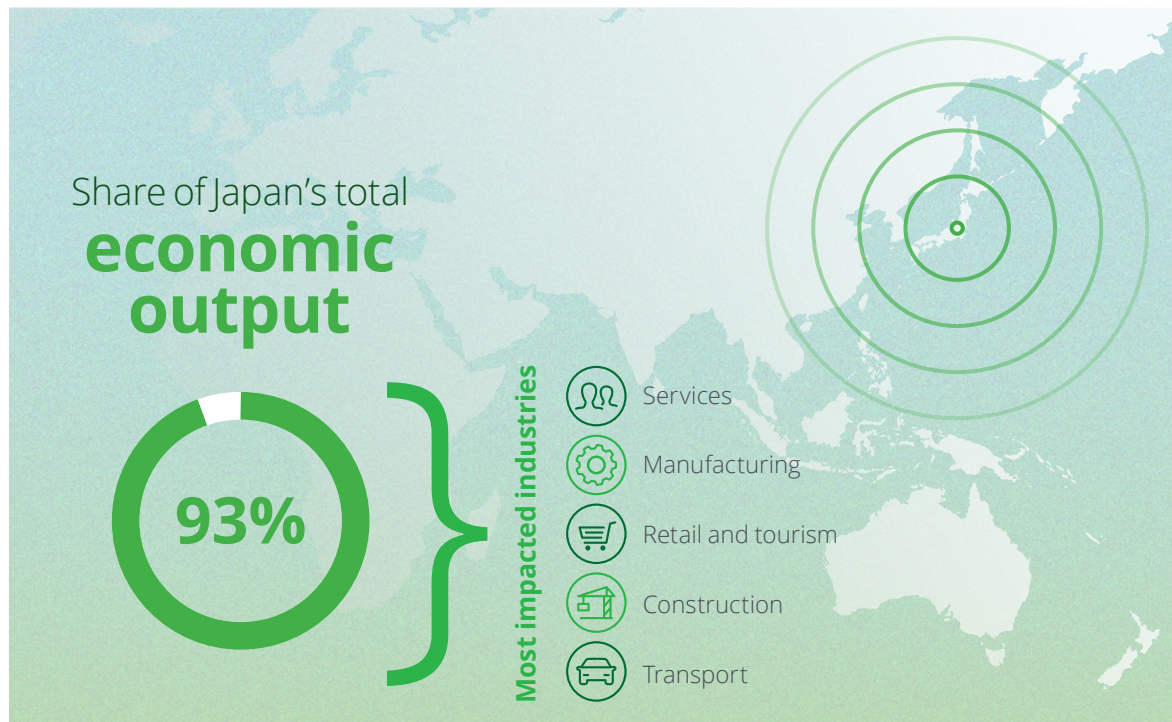
h. Total NPV of deviation loss to GDP in Japan over the period to 2070, at a 2 percent discount rate. Refer to the Technical Appendix for more details on the selection and application of the discount rate.

In our model, the distribution of climate damage would put Japan’s transition from an industrial manufacturing economy to a services-based one at risk. By far the greatest industry costs would be felt across the services sectors. Over the next 50 years, unchecked climate change would, in average annual terms, reduce Japan’s services output by ¥1.7 trillion per year.

Japan’s manufacturing sector, still among the world’s largest and most advanced, would not be spared. Extreme weather events such as typhoons would be more severe and frequent, and an uneven shift to low-emission energy would combine to reduce Japan’s manufacturing output by ¥690 billion per year in average annual terms over the next 50 years.

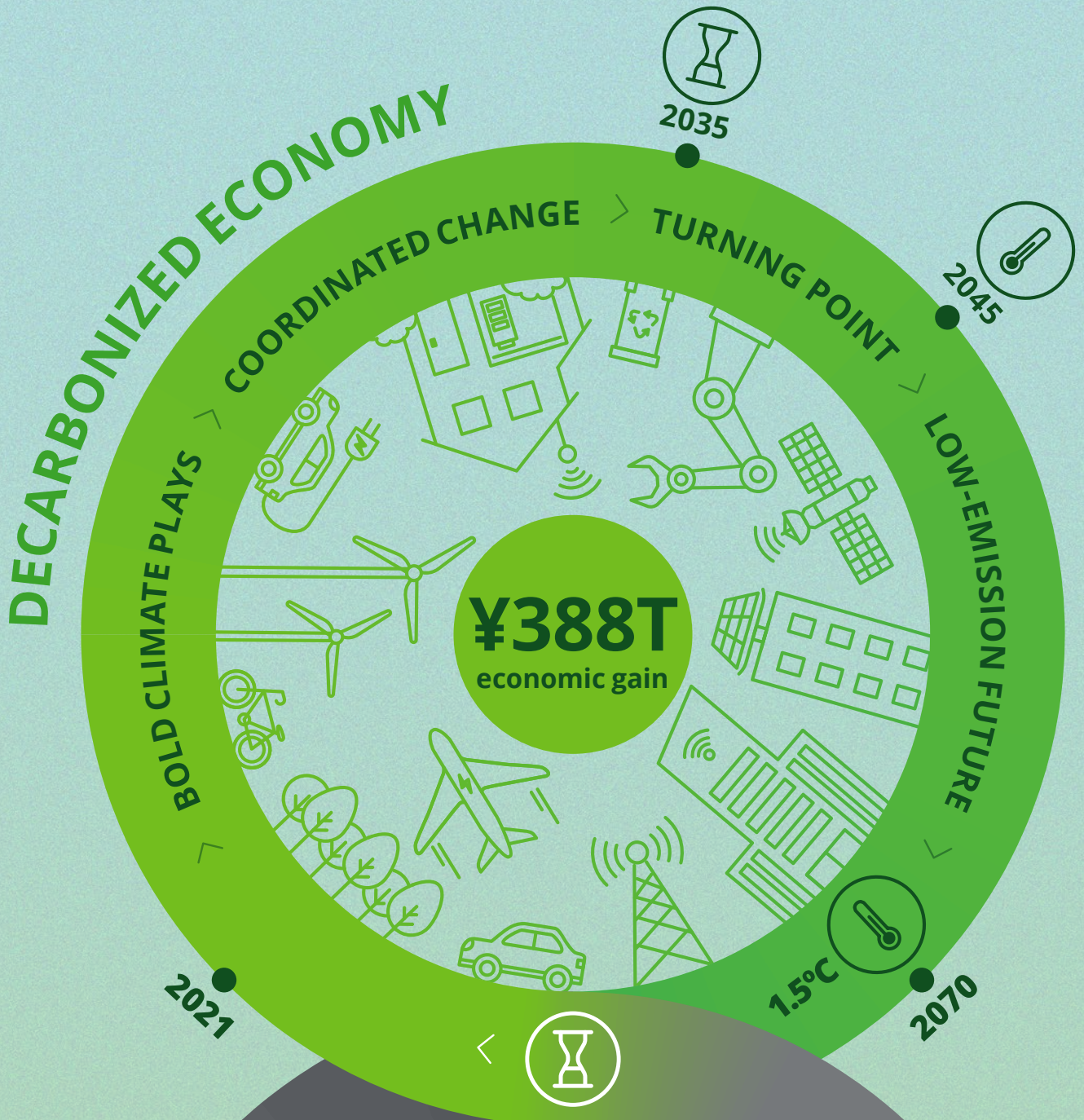
Japan is also home to more than 500 ski resorts and has an international reputation as a world-class skiing and snowboarding destination.¹⁴ The ski industry is deeply vulnerable to the direct and immediate effects of climate change.¹⁵ As temperatures rose and snowfall became more variable and lower overall, ski resorts would likely be forced to close, impacting a wide range of adjacent businesses as tourist numbers plummeted. Deloitte estimates that by 2070, the retail and tourism industry could experience a loss of ¥15 trillion in present value terms—nearly ¥620 billion on average every year.

Figure 2.5: Largest industry losses in Japan due to climate change



Source: Deloitte Economics Institute D.CLIMATE model.

The economic gains of rapid decarbonization



A new economic climate

The economic costs of climate change are not fixed. Although some degree of global temperature rise and climate impacts are already “locked in” due to historical emissions, there is an opportunity to take bold action to enable economic prosperity and avert the worst impacts of an altered climate. Supported by the right economic framework, these actions can put Japan—and the world—on a path to realizing strong, equitable, and shared growth.

Japan is at the frontier of a new economic era and the development of a new system of production. By making the right choices now, it could chart a more prosperous path toward a low-emission future while accelerating progress in the rest of the world by exporting key technologies, processes, and know-how.

But time is of the essence. Policy and investment decisions made in the next few years will largely shape the economy and climate that Japan and the world inherit. This narrow window makes it even more important to understand the economics of a warming world and incorporate them into decision making that addresses the multiple market failures of climate change.

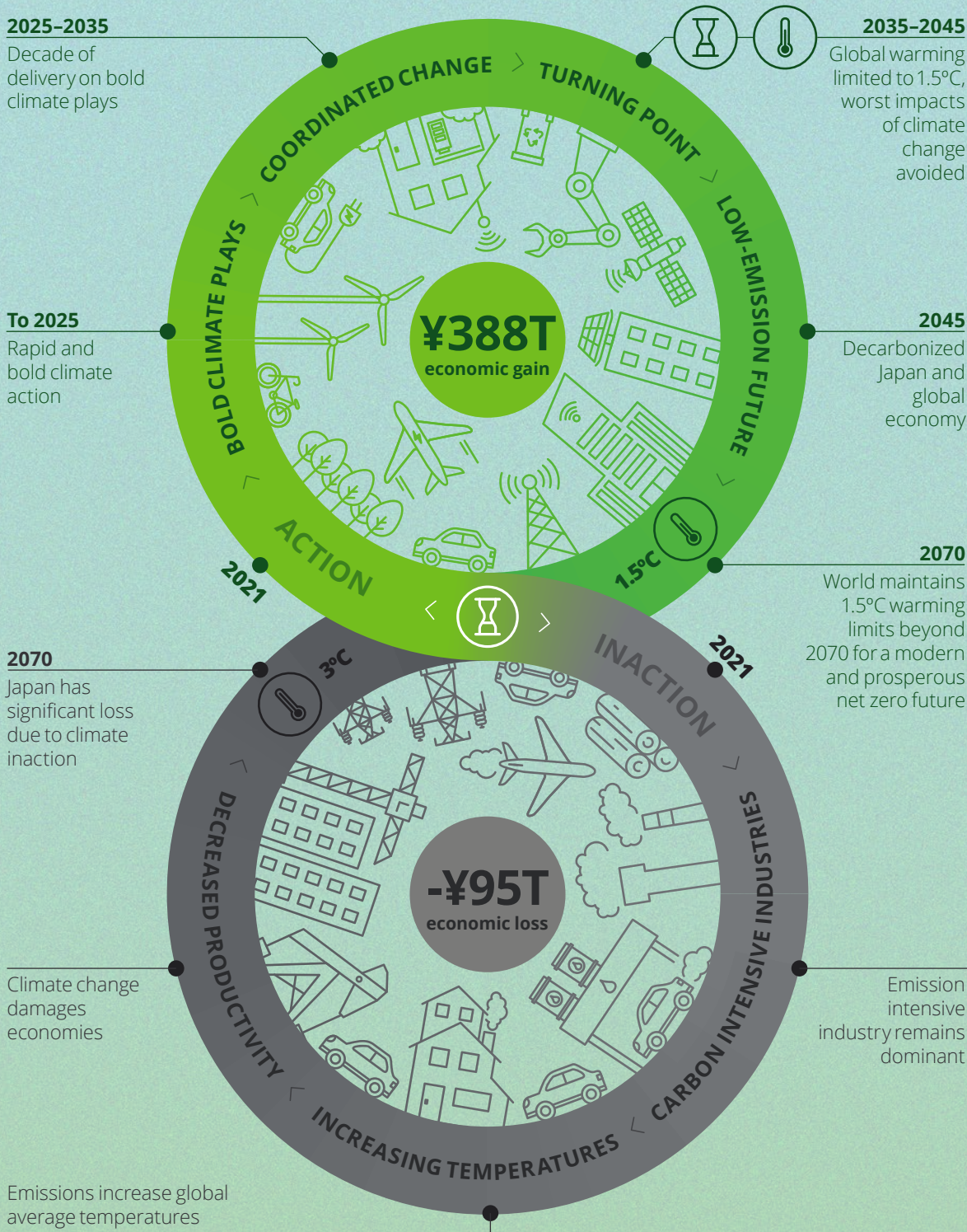
Japan needs to act now to avoid the worst impacts of climate change and reap the economic benefits on offer.

Japan's pledge to reduce emissions to 46 percent below 2013 levels by 2030, and to achieve carbon neutrality by 2050, suggests it is getting serious about the economic opportunity in climate-led transformation. Japan accounts for around 3 percent of global emissions today, and more than 70 percent of its power generation comes from emissions-intensive fossil fuel sources.¹⁶ Japan's heavy industry uses the highest share of fossil fuels of any rich nation; industrial manufacturing accounts for a quarter of Japan's emissions, despite manufacturing only contributing to just over 6 percent of its GDP.¹⁷

By making the right choices now, Japan could chart a more prosperous path toward a low-emission future.

Japan's plans for decarbonization were significantly set back after the 2011 nuclear power plant disaster in Fukushima. Nuclear power played a significant role in Japan's energy mix from the mid-1970s onwards, generating up to 40 percent of the country's power by 2000.¹⁸ After the 2011 disaster, all of Japan's nuclear reactors were switched off and the missing power was replaced by a significant expansion in the use of gas and oil.¹⁹ The country's emissions rose progressively between 2009 and 2013 before falling slightly from 2014 to 2015, and they have been flat since.²⁰

Figure 3.1: Economic growth in Japan is the trend in a 1.5°C world



Source: Deloitte Economics Institute D.CLIMATE model.

Note: Japan's stylized economic loss pathway reflects global average warming aligned with the RCP 6.0 baseline. The stylized economic growth pathway reflects limiting global average warming to no more than 1.5°C by 2050, in line with the current ambition of the Paris Agreement.

Japan's transformation to a low-emission economy is already underway, even if the challenges are formidable. In April 2021, Japan canceled its last coal power plant project.²² The country is restarting nuclear plants, expanding renewable energy, and regulating improvements in energy efficiency.²³

Since 2012, renewables have been supported by Japan's feed-in tariff (FIT) law, which covers solar, wind, hydro, geothermal, and biomass energy sources. The expansion of large-scale solar farms, in particular, has been helped by the FIT law.

However, challenges persist in the expansion of renewables. Solar prices remain higher than in many other countries; deep waters near coastlines could limit development of offshore wind power projects; and onshore wind power faces constraints given population density, fragmented electricity grids, mountainous terrain, earthquakes, and typhoons.

Japan would begin to feel the economic benefits of climate action shortly after 2030.

Decarbonization is a new economic engine

Rapid decarbonization could yield gains for Japan's economy of approximately ¥388 trillion in present value terms by 2070. Compared to a world of climate inaction (the RCP 6.0 baseline), Japan's GDP would be an average of 2.5 percent higher each year over the modeled decades from today to 2070.

In 2070, that would equate to GDP growth of 4.5 percent and a gain in economic output of ¥32 trillion—equivalent to adding the combined recent market value of Toyota and Nintendo to Japan's economy in 2070 alone.²⁴

The economic benefits of action would be felt shortly after 2030. As the country made bold climate policy choices and the rapid decarbonization of the global economy began, Japan would be impacted by short-term structural adjustment costs leading up to the end of the 2020s. But as coordinated and strategic change flowed through the nation's economy—and industry, energy systems, and consumer behaviors started to change—the costs would begin to turn to net benefits.

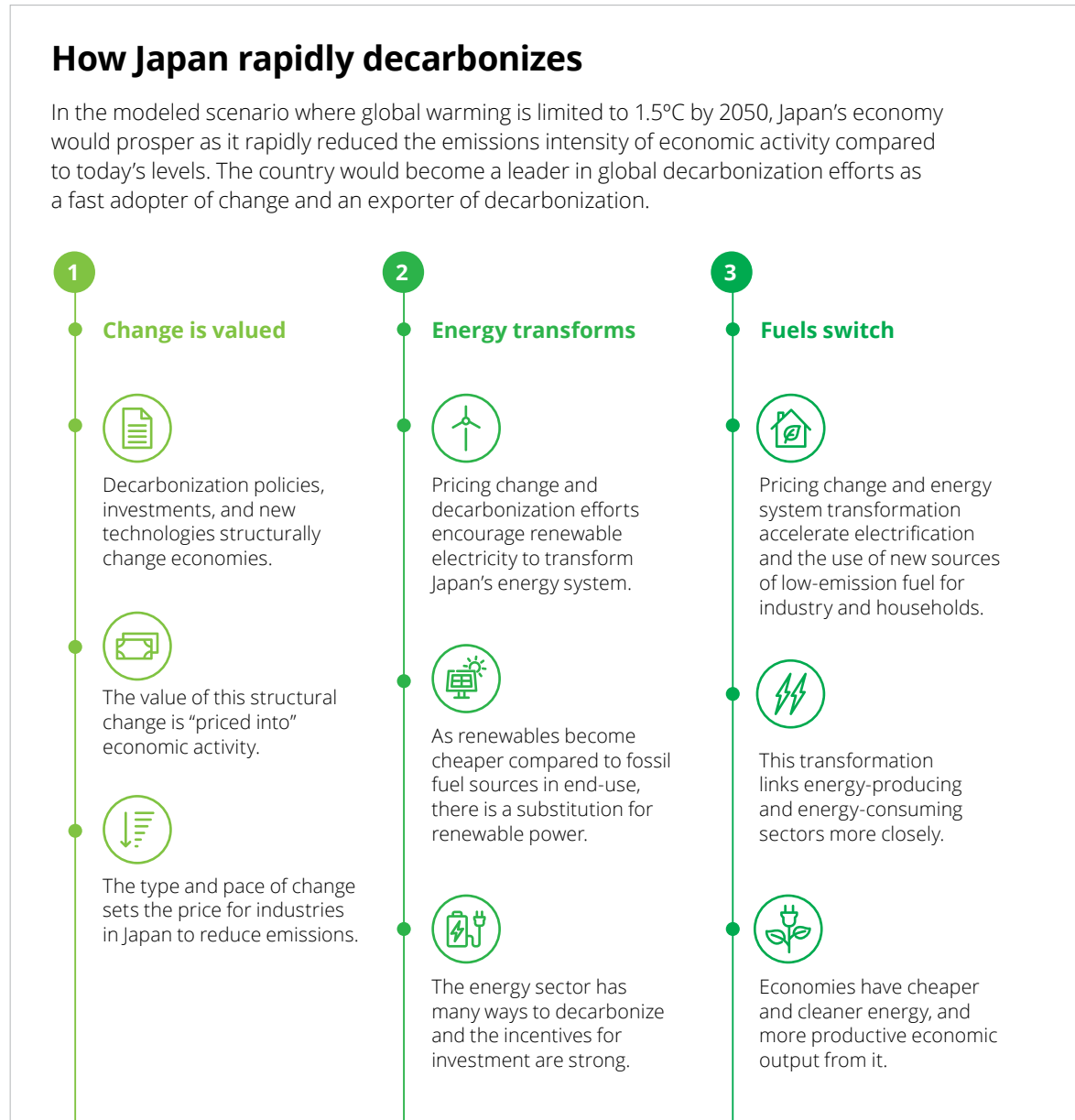
These economic benefits would accrue from the rapid investment, technology development, market maturation, and regulation that collectively drove decarbonization, consistent with limiting global average warming to 1.5°C by 2050.

Figure 3.2: Share of renewables, nuclear, and fossil fuels in Japan's power generation 1990-2019

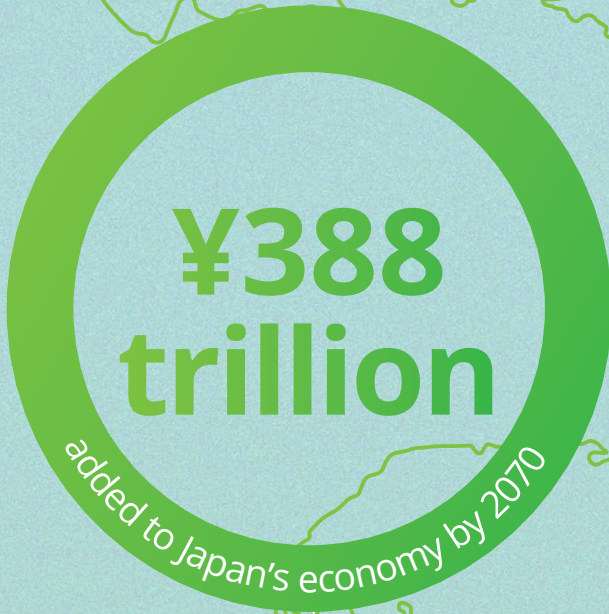


Source: International Energy Agency (2021).²¹
Note: Data is in five-year intervals.

Figure 3.3: The process of economic adjustment to decarbonization in a 1.5°C world scenario



Source: Deloitte Economics Institute D.CLIMATE model.



Note: Total NPV of deviation gains to GDP in Japan over the period to 2070, at a 2 percent discount rate. Refer to the Technical Appendix for a discussion on the selection and application of the discount rate.

Japan's turning point

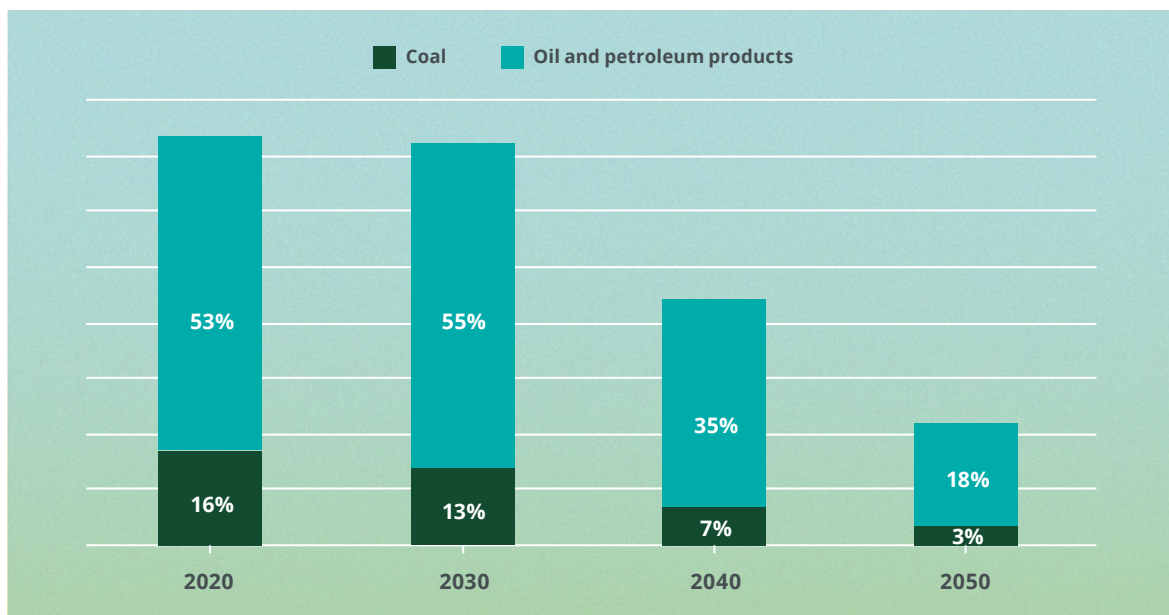
Realizing the economic benefits of decarbonization will require broad changes across the Japanese economy, particularly in its energy mix and industrial base. In the modeled scenario, renewable energy (primarily solar and wind) would be foundational and used for electrolysis to create “green” hydrogen, which can be transported for use.

A decarbonization pathway for Japan and its heavy industrial plants requires the retention of some fossil fuels, to allow for fluctuating outputs from renewables. Development and deployment of carbon capture and storage technologies will be critical to reaching net zero emissions.

Japan's future energy mix would continue to include fossil fuels, but their share would fall significantly over time: from 95 percent in the early 2020s to around 25 percent by 2050. The composition of Japan's fuel mix would shift to cleaner energy sources over the next 50 years, largely driven by the use of green hydrogen.

Japan recently received the world's first shipment of hydrogen from Brunei. Japanese and Australian ministers met earlier this year to agree on a future hydrogen trade to supply Japan.²⁵ The country's ongoing technological advances bring hydrogen to the cusp of adoption for a range of applications, including passenger cars, power-generation turbines, steelmaking, heavy-duty vehicles, and ships.²⁶ In the Deloitte model, hydrogen would make up 40 percent of Japan's fuel mix by 2070, compared to 3 percent in 2030. Some of Japan's end-use green hydrogen would likely have to be imported.²⁷

Figure 3.4: Japan's fossil fuel usage by 2050

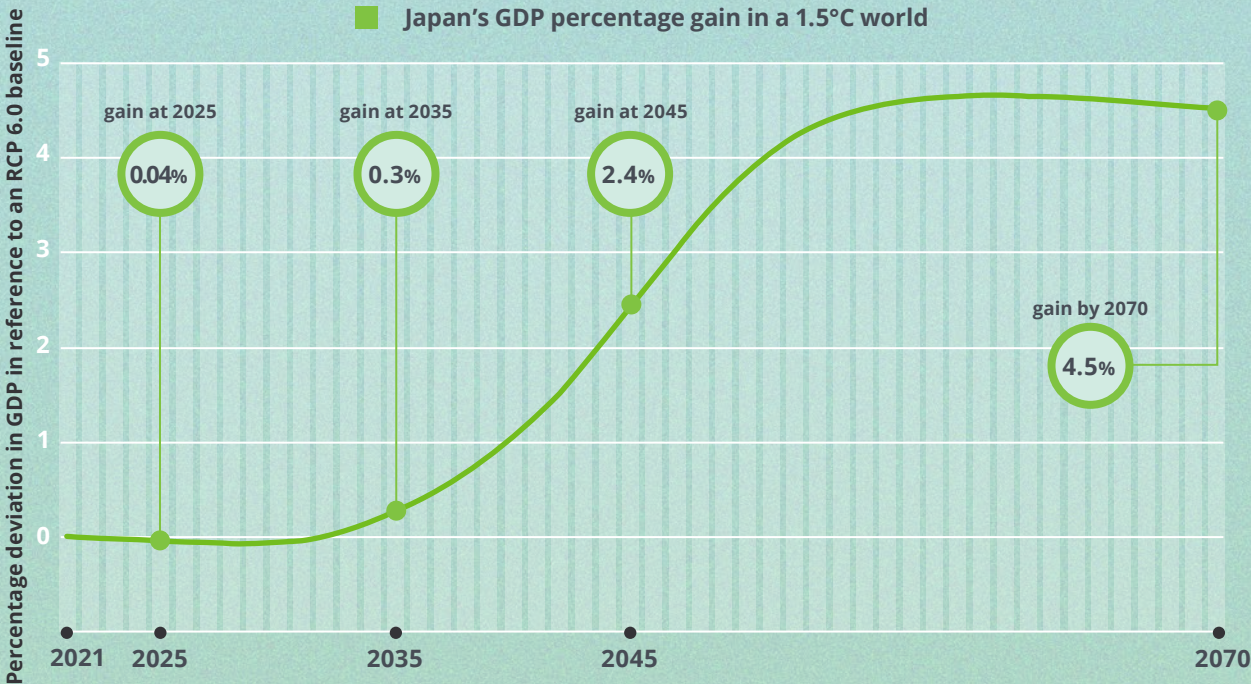






Source: Deloitte Economics Institute D.CLIMATE model.

The path to decarbonization

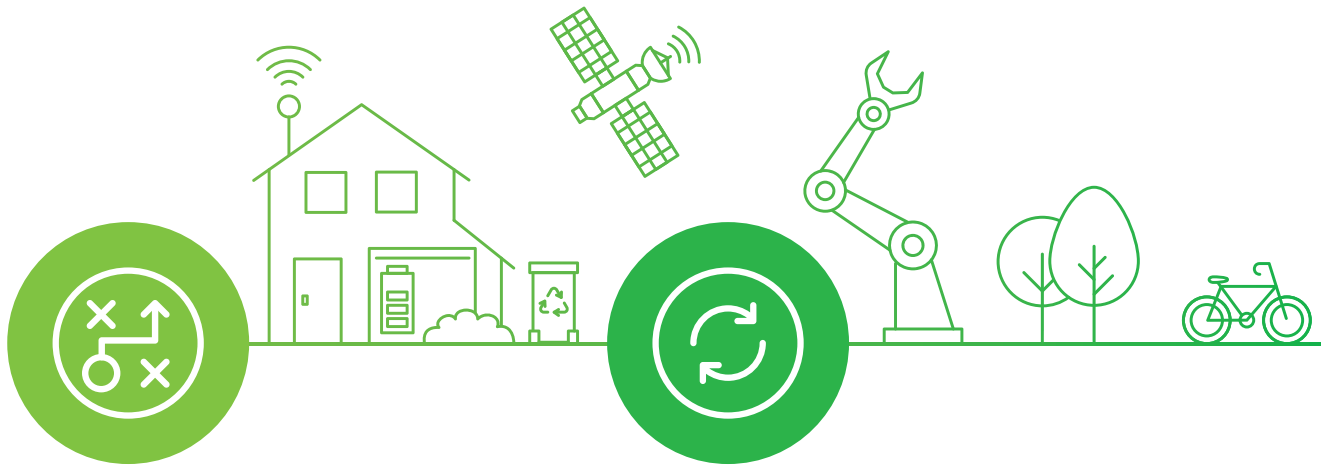
Deloitte expects rapid decarbonization to a 1.5°C world to follow four key economic phases.

Figure 3.5: Four phases of action to achieve a decarbonized Japan in a 1.5°C world



Largest economic gains during transformation		
Ordered by largest GDP gain, level terms (¥)		
 Bold Climate Plays 2021–2025	New energy Construction Public and private services	
 Coordinated Change 2025–2035	New energy Public and private services Retail and tourism	Construction Water and utilities
 Turning Point 2035–2045	New energy Public and private services Construction	Retail and tourism Water and utilities
 Low Emission Future 2045–2070	New energy Public and private services Retail and tourism	Construction Water and utilities Agriculture and forestry

Source: Deloitte Economics Institute D.CLIMATE model.



Bold Climate Plays from 2021 to 2025

The next few years set the stage for rapid decarbonization. The decisions by government, regulators, business, industry, and consumers are expected to reinforce initial progress and create the market conditions to deliver decarbonization at pace and scale. This would send price signals, transform supply chains, and lay the foundation for a structural shift that limits global average warming to 1.5°C.

In Japan, bold climate plays would begin to take hold of the economy, as Japan's Green Growth Strategy—and its policies in areas such as budgets, taxes, regulation reform and standardization, and international collaboration—started to send market signals to regulators, businesses, and consumers.²⁸ Industries including clean energy, construction, and services would enjoy immediate gains as companies acted on these policies.

Japan's clean energy sector would benefit from the development of new technologies, and the falling costs of existing technologies and markets would enable a degree of switching from imported fossil fuel energy to cleaner domestic energy sources.

Coordinated Change from 2025 to 2035

The hardest shifts in industrial policy, energy systems, and consumer behavior would get underway by this point. This would be the decade in which economies, businesses, and industries began to see the consequences of bold climate plays, with different industries and regions transforming at different paces.

Japan would bear the greatest costs of structural adjustment during this phase. But just after 2030, these costs would turn to net economic gains. During this period, there would be a need for globally coordinated change in the development and deployment of clean energy technology opportunities, particularly in the production and distribution of hydrogen. Japan would coordinate its own domestic capabilities in clean energy generation but would still require imported hydrogen.



Turning Point from 2035 to 2045

Our model suggests the decarbonization adjustments in industry should be almost complete by this decade. The cost of new low-emission technologies would continue to decrease, and net economic gains would be shared more widely. This is when the material benefits of limiting global average warming through decarbonization would be likely to materialize, in the form of a 0.13°C average difference in the global mean temperature in the decade leading up to 2045, compared to the RCP 6.0 baseline.

This decade would be the climatic and economic turning point, preventing the shift to a “locked in” higher-emission pathway while realizing the economic dividends of systems-level transformations. In Japan, a structural adjustment would have occurred towards a new, green economic structure. Having built on the economic transition already underway in the first two decades of the century—which took it from being a manufacturing powerhouse to a consumer- and services-led economy—Japan would have leveraged its technological know-how and innovation to increase its economic complexity and production capabilities. By 2045, it would have shifted to become a more complex and services-based economy.

A Low-Emission Future after 2045

Beyond 2045, our model predicts Japan’s economy would be near net zero emissions and the economic systems of production would keep global average warming to around 1.5°C by the end of the century. Economic structures would be radically transformed, underpinned by a series of interconnected, low-emission systems spanning energy, mobility, manufacturing, and food and land use.

The energy mix would be dominated by low- or zero-emission sources across every market, with green hydrogen and negative-emission solutions, both natural and technological, playing prominent roles.

Services would drive the economy in Japan. The bold policy plays made in the 2020s would see competitiveness factors—entrepreneurship, know-how, technologies, and new business creation—drive the growth in Japan’s services sectors. A diffusion of investment in information and technologies would have allowed Japan to expand its domestic economic capabilities and global presence in complex services sectors.

The result would be a strong growth trajectory. Japan’s economy would experience annual net gains in a decarbonized 1.5°C world of more than 4.5 percent by the late 2050s, compared to a future in which no climate action is taken.

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