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60% reduction in Greenhouse Gas driven by Digital transformation of Economy

10,000-yen Carbon tax for an 80% Reduction by 2050

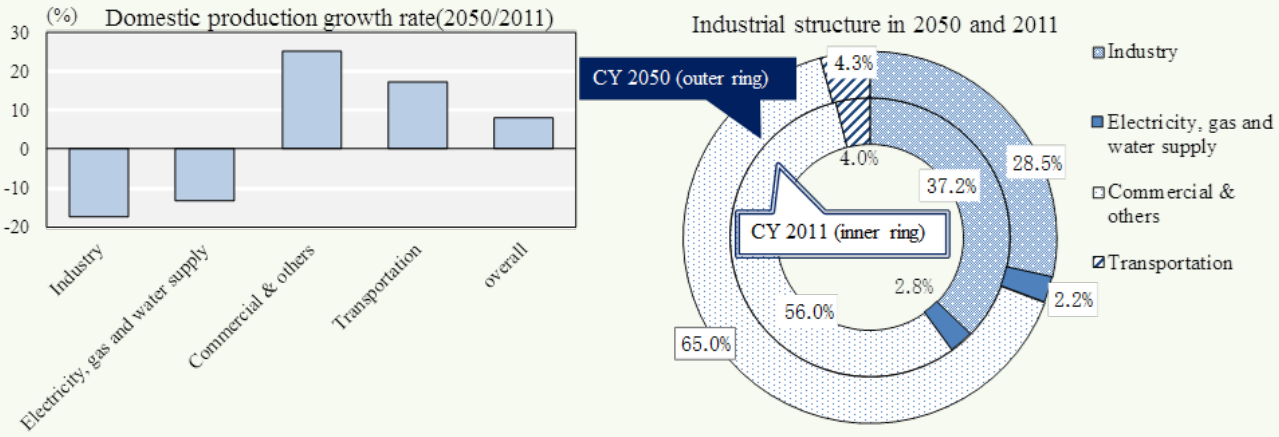
Extensive Carbon Capture and Storage Necessary for Zero Emissions

The United Nations Intergovernmental Panel on Climate Change (IPCC) has reported that unless the global temperature increase following the industrial revolution is kept at 1.5°C or below, there will be a major impact on health and agricultural crops. The Japanese government published a draft of long-term growth strategy under the Paris Agreement, and clearly stated an 80% reduction (with the goal of less than 2°C increase) in greenhouse gas emissions (mainly CO_2) by 2050, and a contribution toward limiting the temperature increase to 1.5°C (zero emissions). JCER simulated a digitalized economy following the Fourth Industrial Revolution, where artificial intelligence (AI), the Internet of things (IoT) —internet connectivity of various devices and objects—and big data are widespread. From this simulation we forecasted economic structure and cost in 2050 based on an assumption that there had been an 80% reduction in the level of greenhouse gas emission since 2013.. The result was that, if we could fully transform to the digital economy, energy consumption can be reduced by 60%. Additionally, if 10,000 yen/ton-CO_2 carbon tax were imposed, an 80% reduction in emissions can be achieved. To achieve the target of a temperature increase of 1.5℃ or lower, the tax rate needs to exceed 21,000 yen. If transitioning away from nuclear power production, carbon capture and storage (CCS) becomes necessary. We need to strongly promote a transform to the digital economy, which not only improves productivity, but also ultimately contributes to reduction of greenhouse gases, notably increasing the potential for zero emissions.

<Points>

1. The forecast of the 2050 economic structure, where the Fourth Industrial Revolution has progressed, indicates strong focus on service sector—fully utilizing information and communication technology (ICT) — and on dematerialization due to progress in digitalization. Symbolically, it would be a point between “the Iron Age” and “the digital information age” (Figure 1).

Figure 1: In 2050, society would be centered around services (the 2050 industrial structure).



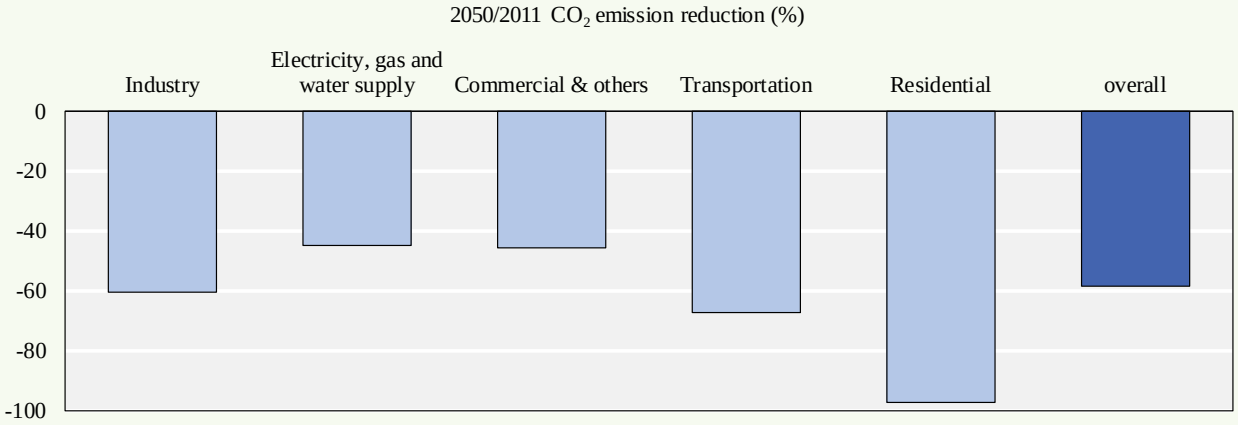
(note) Industry = agriculture, forestry, and fisheries + mining + manufacturing + construction, and business = wholesale and retail + information communication + services, etc.

(sources) The 2011 Input-Output Table, "The long-term economic forecast" by JCER (December 2018).

2. According to our estimation, transformation to the service-oriented digital economy would have a ripple effect on the energy consumption structure and by 2050; fossil fuel imports would be reduced by 60% even if the price of fossil fuels remains flat, and the level of CO_2 emissions would be reduced by 60% from 2011 (Figure 2). For example, as a premise, we assume a situation where passenger vehicles have completely shifted to electric vehicles (EV)[1] with fully automated driving systems, and where car-sharing is drastically improving the vehicle utilization rate and, accordingly, reducing the volume of domestic car production to about 20% of the current production. Demand for paper such as newspapers, magazines, and flyers would almost disappear, and the workstyle that requires people to gather in one location (such as offices and factories) every day would also fade. This would lead to a drastic reduction in energy demand for commuting, which should reduce CO_2 emissions.

[1] The Japanese Government aims to realize a hydrogen society as part of their environmental strategy, but in the present calculation, we assumed that it transitions to EV, which is becoming widespread globally.

Figure 2: CO_2 reduction with changes in the industrial structure.



(Note) The price of fossil fuels is assumed to remain unchanged. Based on the present technical trends and government plans, we assumed that, by 2050, power generation efficiency would double, renewable energy would account for half of power generation, and nuclear power generation would be zero. Based on the long-term economic forecast, it is assumed that the real GDP in 2050 would be 600 trillion yen (labor productivity increases by 1% annually).
(Sources) The Institute of Energy Economics, Japan database, the 2011 Input-Output Table, "The Long-term Economic Forecast" by the Japan Center for Economic Research (December 2018).

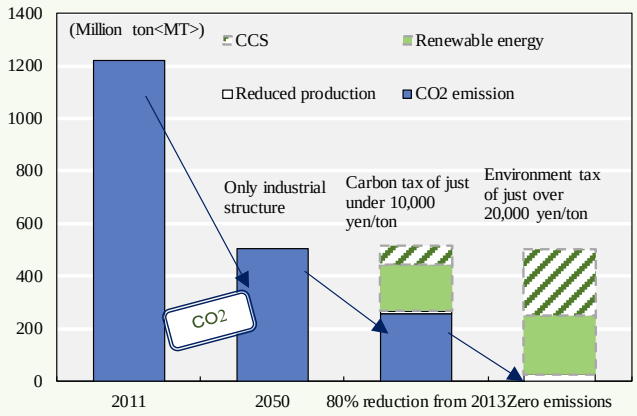
3. Another promotion of energy saving and introduction of renewable energy is essential to achieve an 80% reduction of emission level from the 2013 by 2050. To abandon nuclear power generation[2] and maintain a certain number of thermal power stations, CCS would become necessary. It cannot be achieved solely by the trend of energy saving, dematerialization, and introduction of renewable resources based on the Fourth Industrial Revolution. Carbon pricing that sets the price for CO_2 emissions (e.g., carbon taxes or emissions trading[3]) is necessary. When simulated using the model, 80% reduction was achieved by imposing a carbon tax of around 10,000 yen/(t-CO_2) (about half of the tax rate on gasoline, 2/3 level of Swedish carbon tax rate). Moreover, zero emissions became achievable with a tax rate of 20,000 yen or more.

For example, if the tax rate was increased by 330 yen every year for 30 years from the fiscal year 2021, it would reach 10,000 yen by 2050. If we assume that the level of emissions would decrease in a linear fashion, the carbon tax revenue would be about 360 billion yen in the first year, and by 2050, it becomes about 2.5 trillion yen. To achieve zero emissions, the annual increase needs to be 700 yen. The economic downturn due to carbon tax would be 602.5 to 601.1 trillion yen if there were a smooth transition of the economic structure, and 602.5 trillion to 597.7 trillion for zero emissions (Figure 3).

[2] Since building new nuclear power plants is difficult, it was assumed that there would be no nuclear power plants in 2050 when regulations related to CO_2 reduction would be strict.

[3] Hereafter, pricing on CO_2 emissions was assumed as the carbon tax, but a method of pricing is not limited to a carbon tax.

Figure 3: The carbon tax is an important measure in the 80% reduction.



	Only industrial structure change	Additional energy conservation + CCS	Zero emissions
CO2 emission from energy	505.7	332.4	253.1
CCS	0.0	73.5	253.1
Net CO2 emission	505.7	258.9	0.0
Compared to 2013 (%)	-60.9	-80.0	-100.0
Carbon tax rate(Yen/t-CO2)	0.0	9712.4	21359.4
Real GDP (Trillion yen)	602.5	601.1	597.7
Price of electricity (before carbon tax = 1)	1.0	1.3	1.7

(Note) Unit of CO2 emission and CCS is 1Mt

(Sources) See Figure 2. The estimation performed with the computable general equilibrium (CGE) model.

4. For this predicted result to be actualized, many realistic issues must be solved. In the JCER's long-term forecast, it is assumed that labor productivity would continue to increase by 1% per year until 2060. Japan would have to fully accommodate the digital economy that boldly incorporates AI and IoT, in which it is currently falling behind. Japan must also maintain its vitality in post-manufacturing economic structure. Otherwise, investment on the digital transformation of economy cannot be made. While renewable energy must account for 70% of power production to achieve the goal to cut CO_2 level by 80% or more, reinforcement of the power grid and development of batteries are also essential. A total of 15 trillion yen must be invested for reinforcement and development [4]. If we assume lower dependency on nuclear power generation, implementation of CCS is also essential. Beyond the issues of cost for CCS, it is important to determine how much strata can actually be secured for CO_2 storage; research and development including verification tests by the Japanese government is necessary. Along with CCS, research and development are needed for technology that separates natural gas into carbon (solid) and hydrogen, and imports and utilization of hydrogen manufactured by low-cost foreign renewable energy should be examined.

With the UN "Sustainable Development Goals (SDGs)," Europe is leading in a rapid transition to coal-free thermal power generation and expansion of renewable energies. Even in the US, where the Trump administration continues to create policies against the prevention of climate change, there are independent efforts against climate change at the

[4] Although it was not explicitly obtained in the present calculation using CGE, we estimated the investment necessary by 2050 based on interviews with those in the electric power industry and experts in "CO_2 Emissions Reduction of 70% by 2050 is Possible with the Introduction of an Environmental Tax" and "60% Reduction in CO_2 Emissions by 2050 Relative to 2005 is Achievable".

state or municipality levels, represented by the “we are still in” movement. Economic scale of these states and municipalities is over half the US GDP. Even China is accelerating their efforts against climate change.

The G20 will hold the 2019 Osaka Summit in June, along with the Ministerial Meeting on Trade and Digital Economy in Tsukuba, Ibaraki Prefecture, and the Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth in Karuizawa, Nagano Prefecture. Indeed, the transformation to the digital economy focuses on an economic structural reform with productivity improvement and lifestyle changes, and not on energy conservation or regulating greenhouse gas emissions. However, it is important to note that its promotion will lead to accelerated energy saving.

General opinion in Japan supports the prevention of climate change, but specific measures such as carbon pricing (carbon tax or an emissions trading system) or expansion of renewable energy still experience deep-rooted opposition. This is because these measures could lead to drastic changes in the economic structure dependent on high-energy consumption industries and the existing energy policy-related systems. However, the Fourth Industrial Revolution is requiring the transformation. The electronics industry—unprepared and falling behind—can be said to be heading for its own downfall. It may be swallowed by the digital economy led by the Big Four (Google, Amazon, Facebook, and Apple), and Japan could lose its competitive edge in manufacturing and even services. If Japan could utilize global environmental issues as a leverage to lead an adaptation to the digital economy, we could show our stance to lead the climate change countermeasures at the G20 both domestically and internationally, and may be able to maintain vitality following the Fourth Industrial Revolution.

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