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International Renewable Energy Agency

EXECUTIVE SUMMARY

Socio-economic footprint of the energy transition

JAPAN

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About IRENA

The International Renewable Energy Agency (IRENA) serves as the principal platform for international co-operation, a centre of excellence, a repository of policy, technology, resource and financial knowledge, and a driver of action on the ground to advance the transformation of the global energy system. An intergovernmental organisation established in 2011, IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. **www.irena.org**

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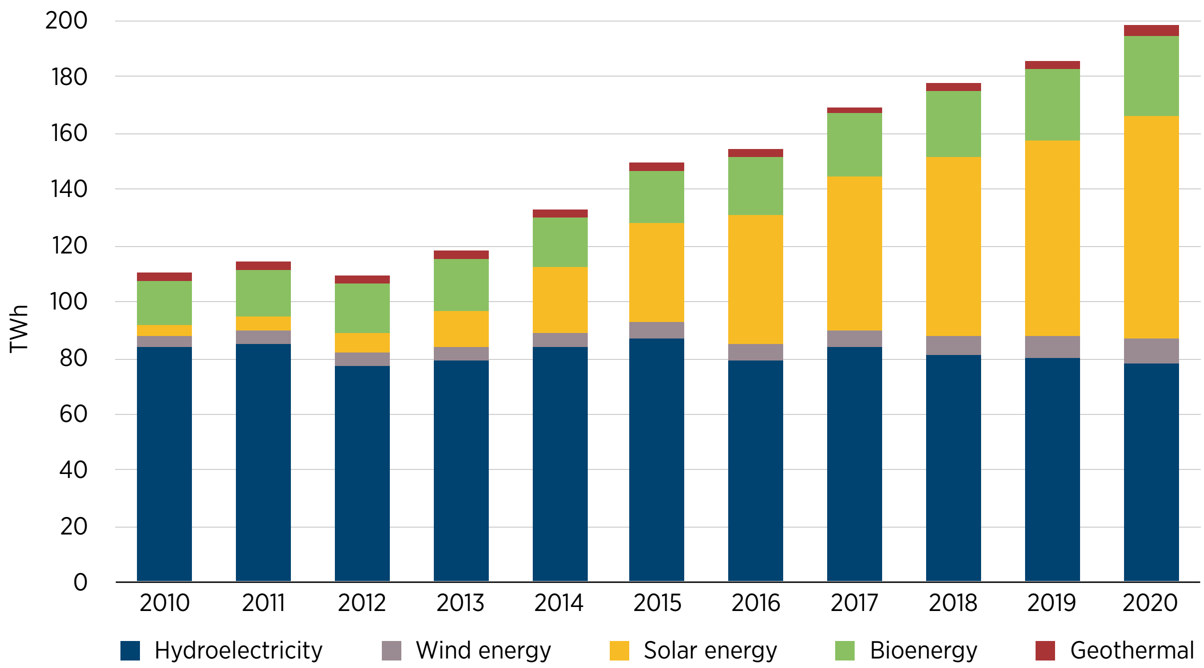
Executive summary

Japan is one of the world's most economically and industrially advanced nations. It is also one of the world's largest consumers and importers of energy. The country is still heavily dependent on fossil fuel imports; however, renewables play a small but growing role in the energy mix, and deployment is increasing every year (Figure S1).

Figure S1 Renewable energy generation in Japan, 2010 to 2020



Source: METI, 2021

In 2020, in terms of its renewable energy power capacity, Japan has one of the highest installed capacities. The country ranked third in the world for solar power and pumped storage, seventh for biomass, and tenth for geothermal and hydropower. The deployment of renewables in the power sector has been hampered by difficulties in connecting projects to the grid and in harmonising regional grids, as well as by low land availability and the occurrence of natural disasters.

Japan has put in place a diverse set of policies to support renewable energy deployment. In the power sector, policies have included liberalisation of the sector as well as instruments such as renewable portfolio standards (RPS), feed-in tariffs and auctions. Policies in the transport sector include measures related to biofuels as well as the promotion of e-fuels and electric vehicles. Some policies have also been enacted to strengthen research and development (although with limited budgets) as well as innovation and industrial development, for example in hydrogen. Carbon pricing policies are found in Japan, mostly at the local level.

Japan pledged to achieve carbon neutrality by 2050 in October 2020. In April 2021, the country reviewed its 2030 target for reducing greenhouse gas emissions and increased it from 26% reductions to 46% reductions from 2013 levels (Figure S2). The country's new, more ambitious emission reduction pathway is closer to the energy transition roadmap outlined by the International Renewable Energy Agency in its 1.5 degree Celsius scenario (1.5-S). Japan's new strategy for carbon neutrality has made the analysis provided in this report even more relevant, as the present discussion portrays the potential impacts (benefits and costs) of such a roadmap in comparison to the less ambitious targets of the past.

The transition's capital-intensive projects can boost investment while lowering dependence on fossil fuel imports, hence improving the trade balance and increasing gross domestic product (GDP). But in Japan and around the world, citizens care about more than just GDP; the sustainability and equity of economic activity is becoming increasingly important.

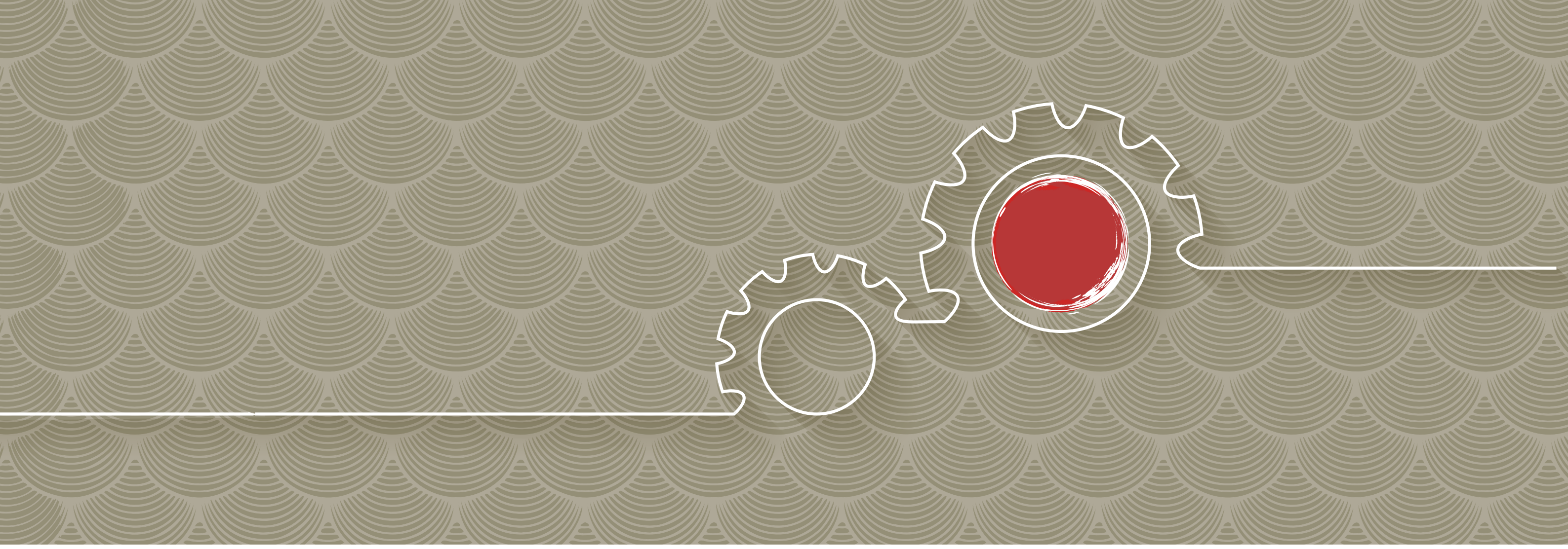
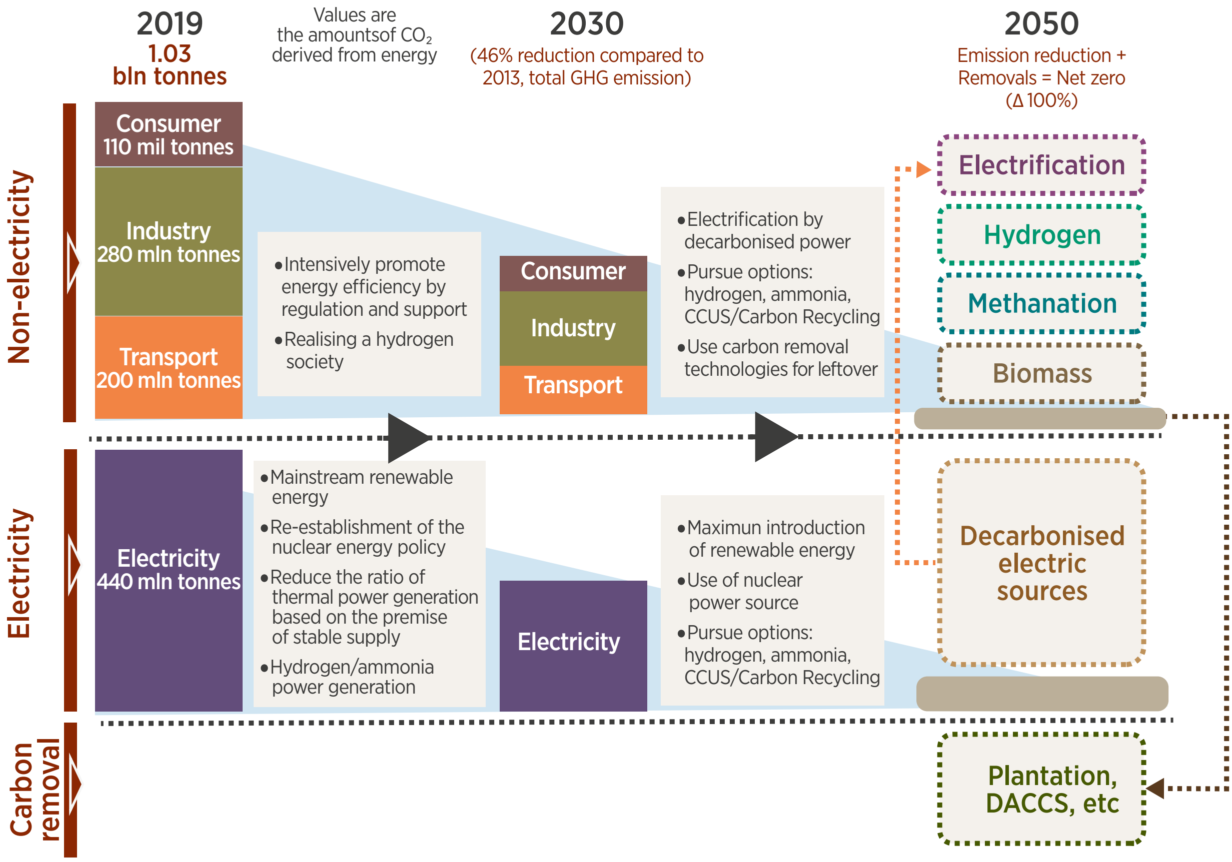


Figure S2 Japan's strategy for carbon neutrality by 2050



Note: CCUS = carbon capture, utilisation and storage; DACCS = direct air capture with carbon storage.

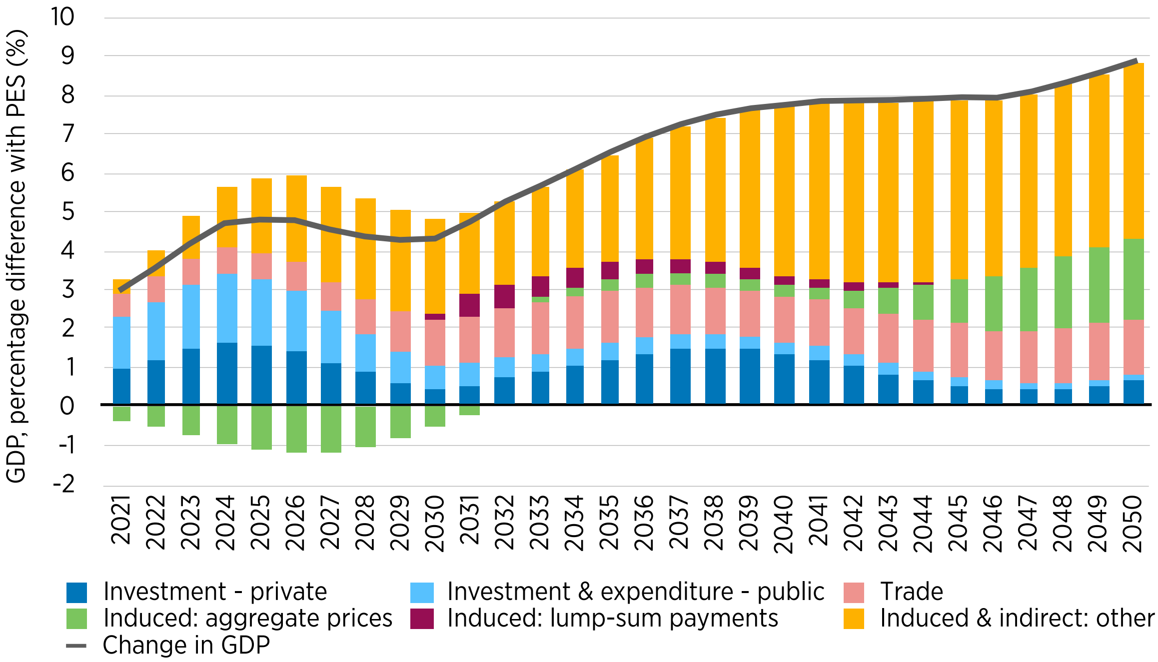
Source: METI, 2022.

The energy transition presents great potential to improve Japan's performance on broader socio-economic indicators and help Japan alleviate some of the existing challenges. Income and wealth inequalities have been long-standing issues, as well as relative poverty and low female participation in the labour force. Japan is the world's fifth largest emitter of carbon dioxide (CO_2) from fuel combustion, which, in addition to its impact on climate change, also causes significant deterioration in local air quality. Employment is high, but challenges and pressures imposed by the ageing and shrinking workforce have resulted in a labour shortage. While the nation and its economy are recovering from the impacts of the COVID-19 pandemic, these issues will continue to play an important role in the years ahead.

The energy transition can support in a multitude of ways. This is shown by this analysis that compares an ambitious 1.5 degree compatible pathway (1.5-S) and a reference Planned Energy Scenario (PES). Through higher shares of renewables, the energy transition will bring larger CO_2 emission reductions and lower local air pollution. The transition can also result in improved welfare, more jobs and higher GDP.

Under the 1.5-S, the country's economy is estimated to perform much better than under the PES: the average GDP difference compared with the PES is 6.3% over the period 2021-2050. In the PES, Japan is already expected to experience GDP growth of 1.1% per year from 2021 to 2050 (Figure S3) – therefore, the economic gains from the energy transition are significant. In cumulative terms, the country will add USD_{2019} 13.1 trillion to the growth already anticipated in the PES. This is the result of interplay between several drivers (defined in Box 3.1 in the main chapter) of the economy.

Figure S3 Japan's GDP percentage difference between the 1.5-S and the PES, by driver, 2021 to 2050

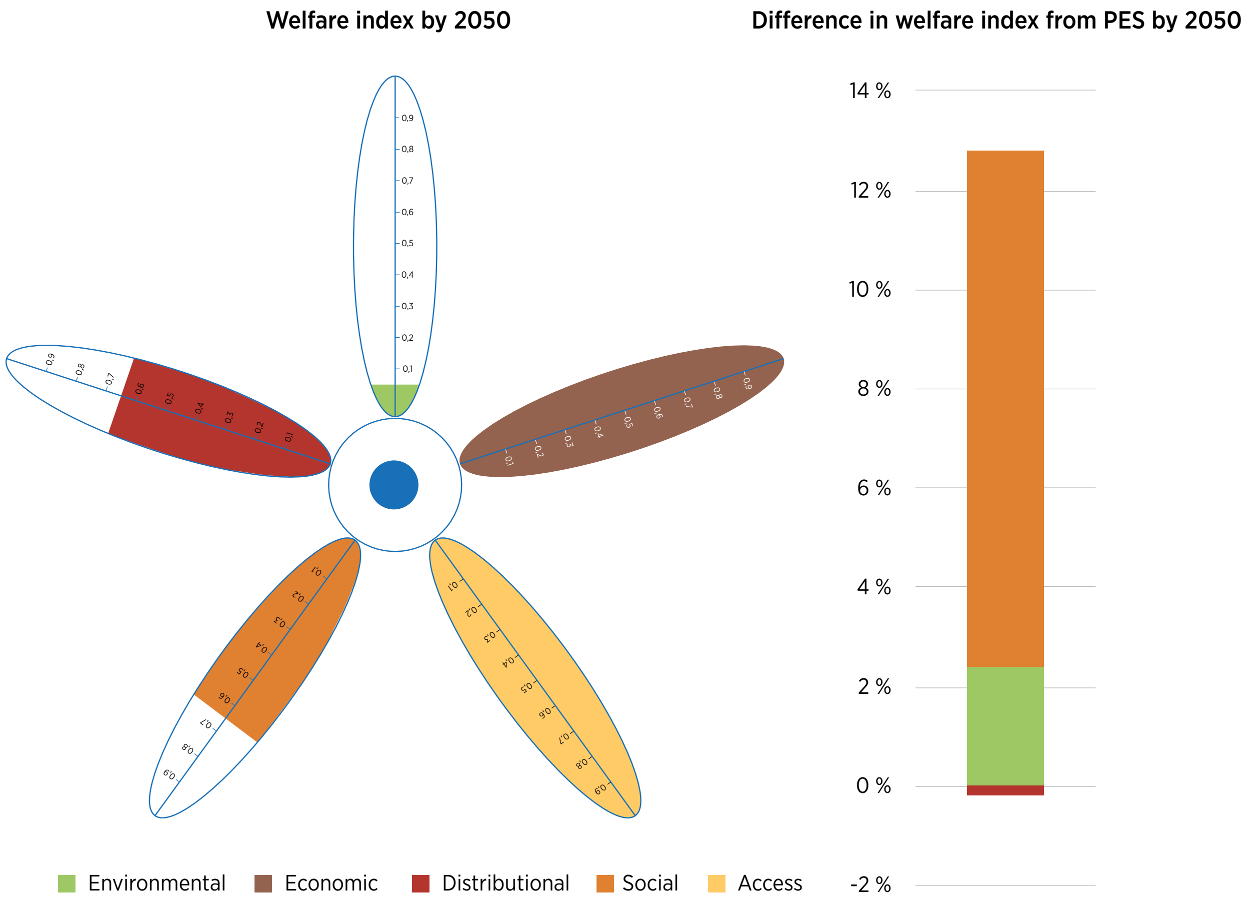


Some of the key drivers of growth are consumption, trade and investment. Household consumption has historically accounted for the largest share of GDP, and this trend continues in the 1.5-S, with the "induced and indirect effects (other)" driver holding the largest share in the additional GDP gain. Trade is also a positive and steady driver of the GDP differences during the transition. As Japan relies heavily on imports of fossil fuels, the lower fuel imports in the transition period improve the cumulative trade balance by an estimated USD_{2019} 3 trillion, or on average 18% of the total economic gain observed. Government spending also increases and results in an increase in GDP when compared to the PES (0.1% or USD 567 billion in 2050). It leads to increased spending on social services predominantly provided by the government including public administration, health care, and education, therefore mainly benefiting the public and personal services sector. This results in wider improvements in welfare.

Under the 1.5-S – and driven by the social and environmental dimensions – welfare in Japan improves compared with the PES (right side of Figure S4). The welfare improvement for Japan under the 1.5-S over the PES reaches 12.6% by 2050. This is a result of the reduced negative health effects from local air pollution, paired with reduced cumulative CO_2 emissions. The economic and energy access dimensions play less of a role in differentiating the 1.5-S and the PES, given that Japan already performs well in economic indicators and has achieved universal energy access. The distributional dimension performs slightly worse (-0.9%) under the 1.5-S, reflecting a balance between improvements in international distribution and a worsening of domestic distribution, the latter due in part to low carbon pricing limiting the fiscal space for domestic redistributive policies.

The analysis suggests that additional policy actions would be needed to further improve the human welfare indicators in Japan (as shown in the welfare index - left side of Figure S4). The environmental dimension offers the highest room for improvement, with a focus on limiting the consumption of materials. The social and distributional dimensions also offer room for improvement. Policies to increase social spending and further reductions in pollution would improve the social dimension index. Supportive policies would be crucial to close inequality gaps in Japan. To improve the distributional index, policy action to improve wealth distribution and to provide additional fiscal space (*e.g.,* higher carbon taxes) to increase lump-sum payments (addressing income distribution) would help.

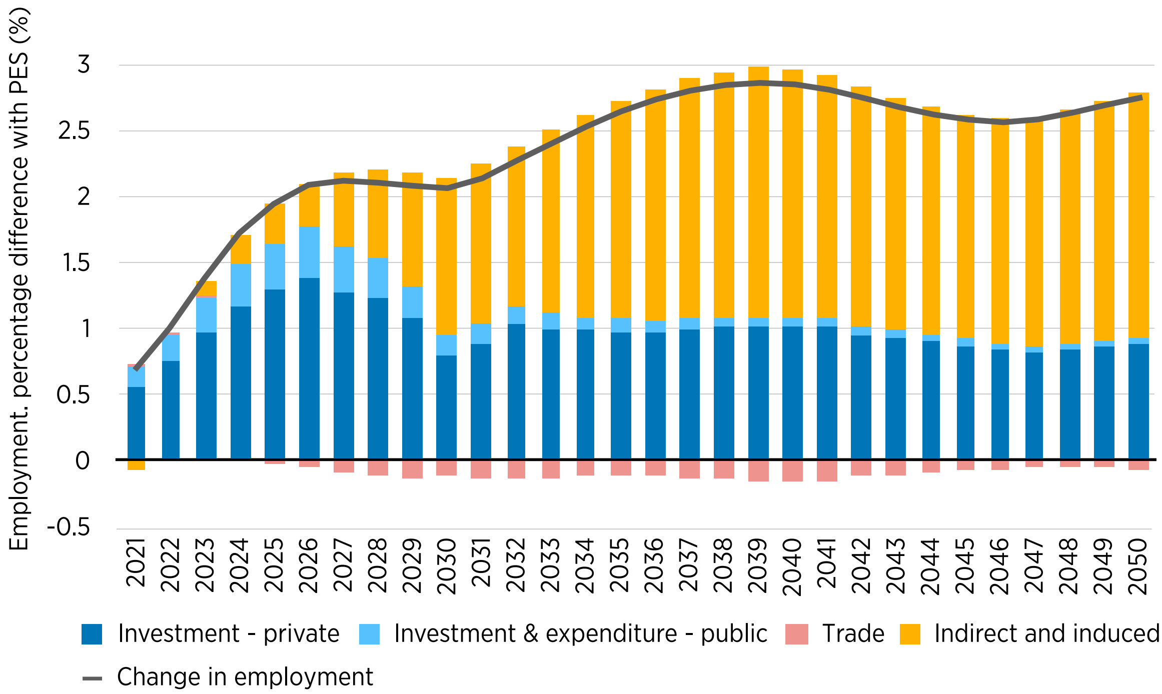
Figure S4 Welfare index for the 1.5-S and difference in welfare between the 1.5-S and the PES, 2050



Under the 1.5-S, employment is higher than the PES by an average of 2.3% over the 2021-2050 period, while population declines at a compound annual growth rate of -0.50% over the same period. Given the low unemployment rate in Japan today, there is little leeway for additional employment in both scenarios. By 2050, the 1.5-S results in 1.6 million additional jobs compared with the PES, corresponding to a 2.7% difference.

Similar to GDP, this trend is underpinned by drivers related to investment, trade, and indirect and induced effects (Figure S5). Front-loaded investment in capital-intensive transition technologies (renewables and other transition-related technologies) – both public and private – is the first driver of the additional jobs in the initial years to 2030. This effect is reduced and stabilises over the following decades with the decline in the relative weight of investment in GDP. After the first decade, the indirect and induced effects of consumer expenditures become the main driver of the increase in economy-wide employment.

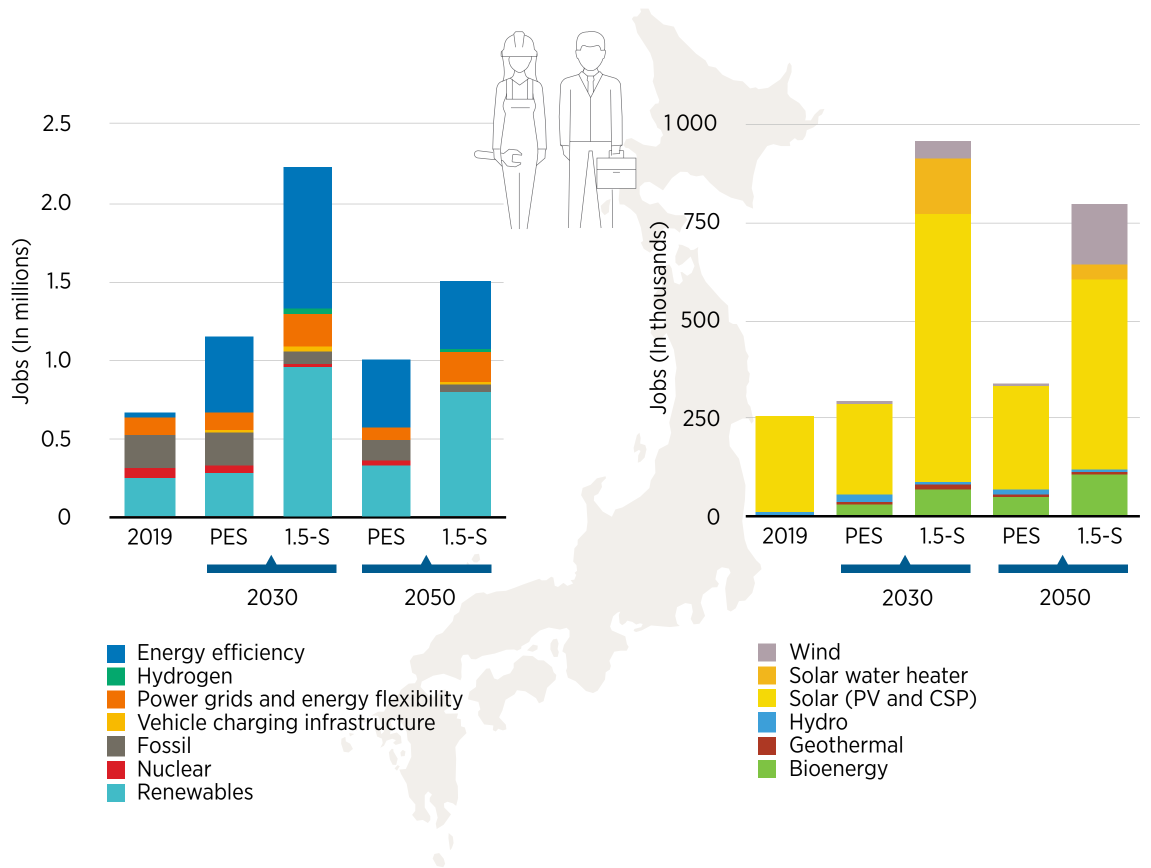
Figure S5 Employment in Japan, percentage difference between the 1.5-S and the PES by driver, 2021 to 2050



The number of energy sector jobs is estimated to be higher in the 1.5-S than the PES as the sector would have a total of 1.5 million jobs in the 1.5-S compared to 1 million in the PES (left side of Figure S6). A decline in jobs in 2050 compared with 2030 is a result of the front-loaded construction of new plants and infrastructure (including energy efficiency), the planned reduction of energy demand and an increase in productivity. Renewables contribute more than 50% (0.8 million) of the total energy sector jobs in the 1.5-S in 2050, followed by jobs in energy efficiency with a share of almost 30% (0.5 million jobs). Power grids and flexibility create 0.17 million jobs (11%). Nuclear, vehicle infrastructure and hydrogen each contribute 1%.

More specifically in jobs related to renewables, solar technologies (mainly PV) dominate the share of renewables (right side of Figure S6): under the 1.5-S, they account for 71% of renewable energy jobs by 2030 and 61% by 2050. Wind and bio-energy account for 19% and 13%, respectively, of renewable energy jobs by 2050. Comparing the PES and the 1.5-S, the highest relative differences in employment are seen in wind energy.

Figure S6 Energy sector (left) and renewable energy (right) jobs in the PES and the 1.5-S, 2019, 2030 and 2050



The additional jobs are more likely to be created in rural areas where renewable resources are more available, helping the country achieve its objective of improving rural demographics. The energy transition will also bring growth in jobs related to energy efficiency and energy flexibility. Simultaneously, jobs in fossil fuels will decline but are more than compensated by the growth in energy transition-related jobs.

The energy transition (1.5-S) can enable the country to meet its climate pledges, while supporting aggregated economic activity. Renewables can help to address concerns about declining rural populations and economies. A shift in technologies will create jobs across the value chain. There will be opportunities to create or revitalise the domestic manufacturing base across all transition-related technologies.

Self-reliance will increase significantly with local resource supply, reducing Japan's vulnerability to external geopolitical shocks and enhancing its energy security. Similar to many countries in transition, Japan faces challenges in the energy sector and beyond. With the global climate challenge, solutions are needed to swiftly advance the transition.

In short, a comprehensive and more ambitious energy transformation will lead to improved social well-being in Japan. But technological deployment alone will not necessarily deliver these socio-economic gains. The transition towards clean energy involves far-reaching changes across different dimensions of the economy, society and the surrounding natural ecosystems. To maximise the benefits of the energy transition, a wider policy framework is needed – one in which a set of structural and just transition policies are in place to manage potential misalignments. Ultimately, achieving Japan's goals will require fine-tuning the country's existing support policies and addressing the remaining policy gaps (as discussed in the report) in a holistic and comprehensive way.

Scenarios and perspectives in this report

This outlook report presents two scenarios and their socio-economic outcomes:

The **Planned Energy Scenario (PES)** is the reference case for this study, providing a perspective on energy system developments based on governments' energy plans, as well as other planned targets and policies as of 2019, including Nationally Determined Contributions (NDC) under the Paris Agreement. This report considers policy targets and developments until April 2019. Policy changes and targets announced since then are not considered in the modelling exercise but are mentioned in the analysis to provide insights on latest developments.

The **1.5°C Scenario (1.5-S)** describes an energy transition pathway aligned with the 1.5 degree Celsius (°C) climate ambition – that is, to limit the global average temperature increase by the end of the present century to 1.5°C, relative to pre-industrial levels. It prioritises readily available technology solutions including all sources of renewable energy, electrification measures and energy efficiency, which can be scaled up at the necessary pace for the 1.5°C goal.

The time frame of the analysis covers the period to 2050.

The socio-economic analysis of these scenarios is carried out using a global macro-econometric model, E3ME[1], which links the energy system and the world's economies within a single quantitative framework. E3ME analyses the impact of the energy transition on variables such as gross domestic product (GDP), employment and welfare to inform energy system planning and policy making to ensure a just and inclusive energy transition at the global, regional and national levels. Energy mixes and the related investment based on the REmap Model[2] of the International Renewable Energy Agency (IRENA) are used as exogenous inputs for each scenario, as well as climate and transition-related policies. Annex II lists some of the key policy assumptions underlying each scenario and considers how indicators vary (or not) across both scenarios.

The outcome of implementing energy transition planning is closely linked to its socio-economic impacts. This socio-economic footprint of energy transition roadmaps results from the many interactions and feedbacks between the energy system and the wider economy and social systems. Understanding the socio-economic footprint of energy transition roadmaps informs policy making for a successful transition.

IRENA has been exploring the socio-economic footprint of energy transition roadmaps since 2016 (IRENA, 2016a, 2017, 2018, 2019a 2019b, 2020a, 2020b, 2021a, 2022a), analysing key drivers and impacts, providing insights to support energy transition planning and implementation at the global, regional and national levels. Throughout its reports, IRENA has emphasised that a holistic global policy framework is needed for the energy transition to be successful and broadly beneficial. Different policy elements complement and reinforce each other, covering a broad spectrum of technical, social and economic issues to accelerate the transition and ensure that its benefits are broadly shared, and its burdens minimised.

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[1] *More information can be found at www.e3me.com*

[2] *More information can be found at irena.org/remap*

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