A Scenario Analysis on the Energy Demand and Supply Aiming for the 1.5℃ Climate Target

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Background: The 1.5-degree Climate Target

How we can attain more rapid and deeper reduction?

- *Limiting warming to 1.5℃ involves rapid, deep and in most cases immediate GHG emission reductions (IPCC, 2023)*
- *Unprecedented action is now needed by all countries. For high-income countries, this implies further accelerating domestic emissions reductions (UNEP, 2023)*

Importance of considering carbon budget constraint, not just a single year (e.g. 2050) emission constraint

How we can facilitate transition of socio-economic systems?

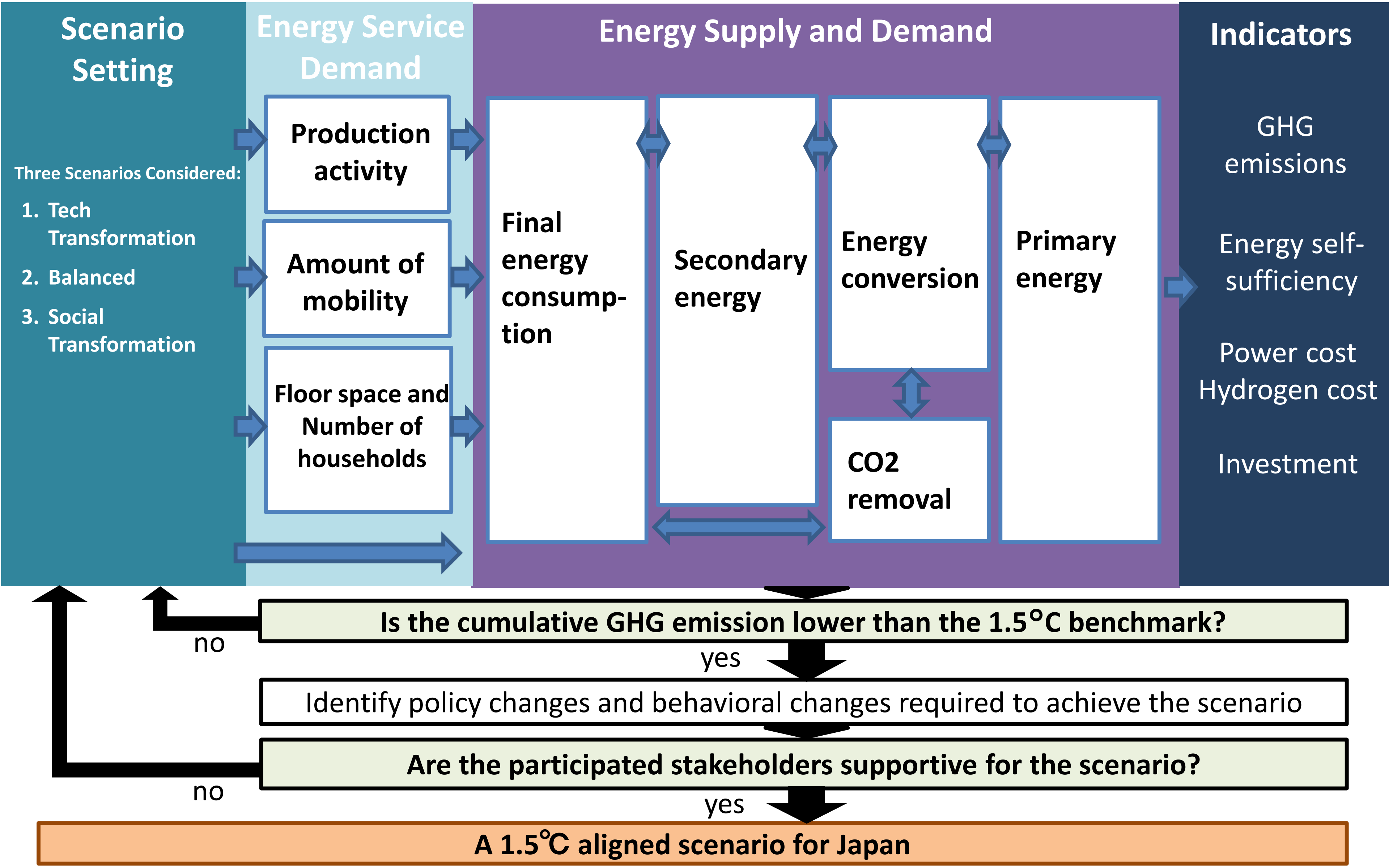
- *Pathways limiting global warming to 1.5°C with no or limited overshoot would require rapid and far-reaching transitions in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (IPCC, 2018)*

Importance of identifying pathways to benefit entire society, not just optimized for energy system costs

Research Question:

How we can co-create national scenarios to align with 1.5℃ target with stakeholders, incorporating socio-economic transitions for which they can support

An Overview of the Methodology



Scenario Design

- ✓ Three scenarios with different levels of socio-economic change and energy technology deployment
- ✓ Renewables, Imported hydrogen, CCS/DACS are assumed to achieve the cumulative emission benchmark

<table>
<tr><th rowspan="2">Scenarios</th><th colspan="4">Assumptions</th></tr>
<tr><th>Socio-economic transformation</th><th>Energy saving, Electrification</th><th>Renewables, Hydrogen</th><th>CO_2 Removal</th></tr>
<tr><td>1. Tech-transform</td><td>Status quo</td><td rowspan="3">Maximum acceleration (all scenarios in common)</td><td>Maximum acceleration</td><td rowspan="3">Forest sink remains with the status quo

DACS/CCS deployed after 2035</td></tr>
<tr><td>2. Balanced</td><td>Intermediate between 1. and 2.</td><td>Maximum renewables and moderate hydrogen</td></tr>
<tr><td>3. Social-transform</td><td>Significant transformation to digital and circular economy</td><td>Moderate acceleration</td></tr>
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Note: population and GDP are common assumptions to all scenarios.

Scenario Settings for the Activity Drivers

Approach: developing the future Input-Output Tables, by adjusting the input coefficients, import coefficients and final demands, according to the scenarios.
Scenarios: assuming a fraction of potential socio-economic development will be realized - 100% for Social-transform, 50% for Balanced, 0% for Tech-transform.

Examples of elements for socio-economic development		**Potential change** until 2050
Digitalization	Digital transformation	Investment on intangible assets expands up to 100 trillion JPY, increasing value added ratio up to 30%. Decreasing material inputs to industrial sectors (e.g. building construction ▲20%, papers ▲90%).
	CASE（Connected, Autonomous，Shared, Electric mobility)	Autonomous vehicles reduces car ownership and annual sales up to 50%. Safety improvement enables to substitute steel materials with resin products.
Material use	Cross-laminated timber	50% of non-wooden new construction at present will be replaced with wooden architectures.
	Replacing machine components to resin	40% of steel material inputs to machinery manufacturing are replaced with resin products.

Note: Baseline development is set in common reflecting the projections from the Japan Center for Economic Research. Parameters for 2030 and 2050 are exogenously set, and interpolated for other years.

Other Scenario Settings

- ✓ **Energy Consumption**
  Acceleration of electrification (e.g. 100% of new car sales will be EV/PHEV by 2040, 100% of new residential water heaters will be electrified by 2040)
- ✓ **Renewables**
  Assume the installation targets of each industry association will be achieved (e.g. solar: 300GWac by 2050 plus efficiency improvement, offshore wind: 405GW including 360GW of floating wind at EEZ by 2050)
- ✓ **Others**: phasing out coal power plants by 2035, replacing LNG with hydrogen for backup power plants, domestic green hydrogen production, V2Gs, etc.

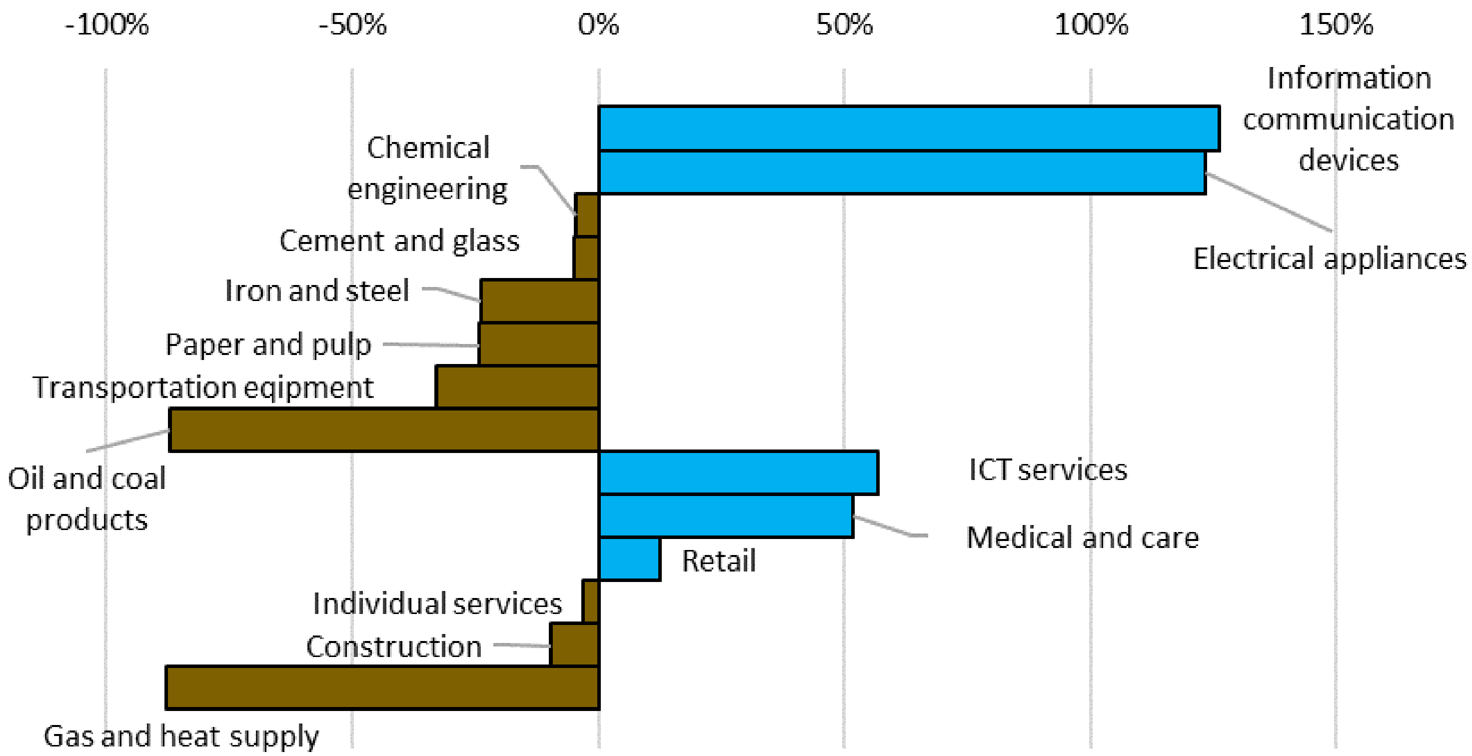
Please explore our report for details

Akihisa KURIYAMA, Yugo TANAKA, Ikuru IWATA, Kentaro TAMURA,
IGES 1.5℃ Roadmap : An action plan for Japan - more ambitious emissions reduction and a prosperous, vibrant society
Published in December 2023

https://www.iges.or.jp/en/pub/onepointfive-roadmap-en/en

Results(1) Socio-economic Transformations

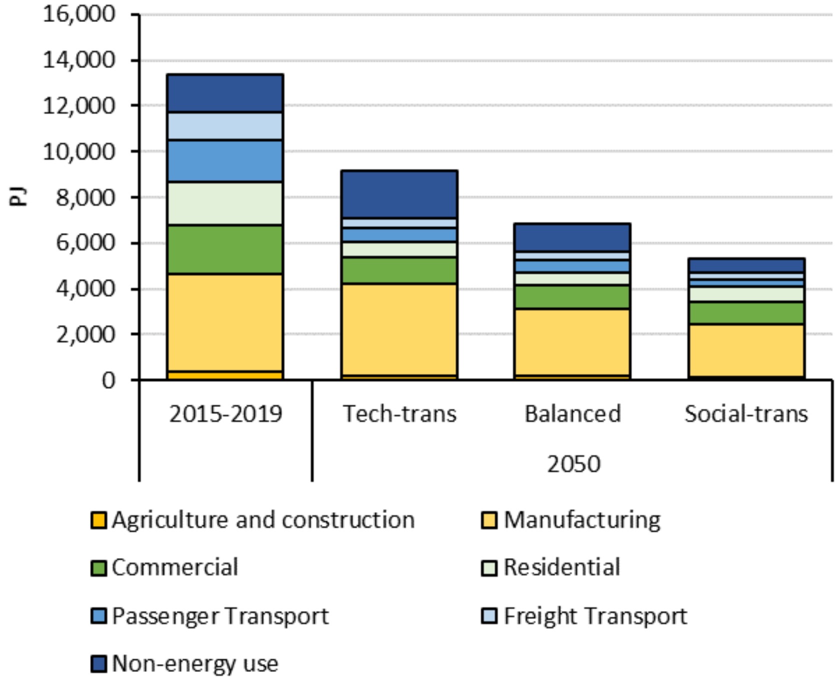
Change of production in 2050 compared to 2015 in Balanced scenario



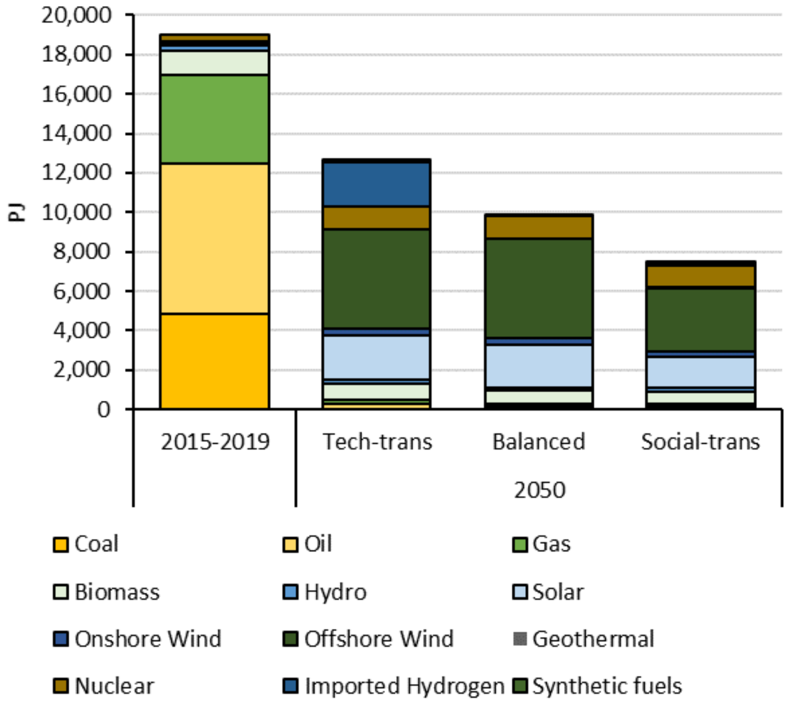
Iron and steel production dropped by 24% due to reduced demand from machine manufacturing and construction. A certain level of industrial structure shift is observed.

Results(2) Energy Demand and Supply

Final energy consumption in 2050

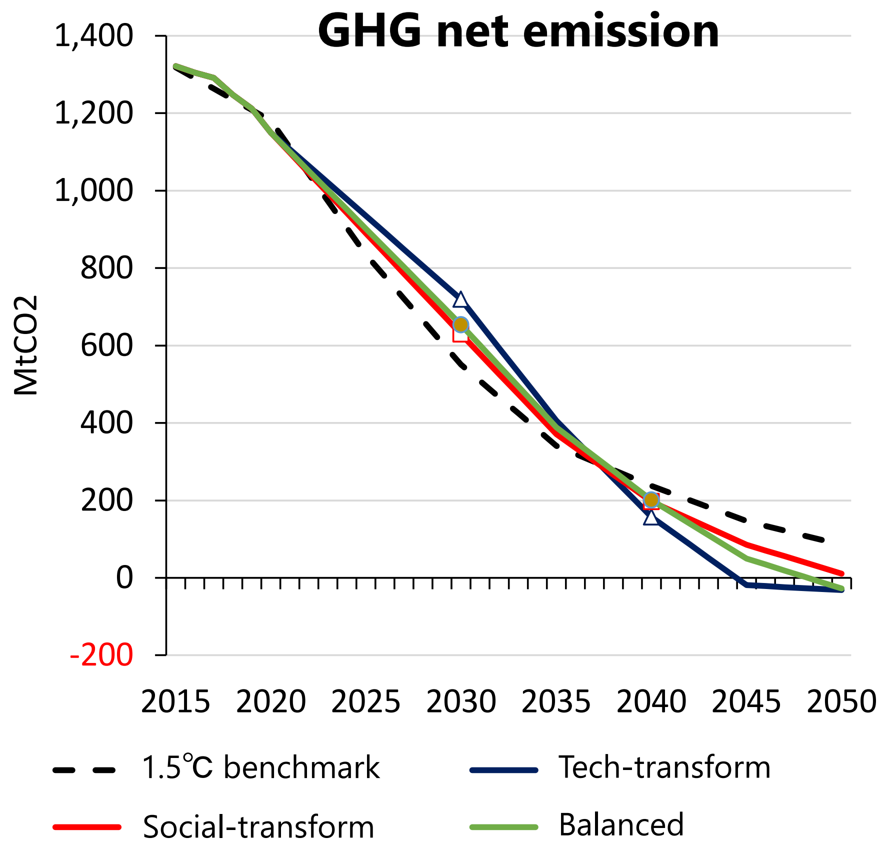


Primary energy supply in 2050



Significant decrease of final energy consumption (▲49% for Balanced scenario, ▲60% for Social-transform scenario) mainly due to electrification as well as shift away from conventional material production and consumption. Renewables dominates 85% of primary energy supply in Balanced scenario.

Results(3) GHG Emissions



Cumulative GHG emission（2020-2050）are less than the benchmark (14.3GtCO2eq) for all scenarios. The greater the level of socio-economic transformation, the less reliance on negative emission technologies because emission reduction can be faster and more efficient.

Summary

- ✓ A methodology for constructing scenarios that incorporate "rapid and deep emission reduction" as well as "socio-economic transformation" is developed. Three scenarios are co-created with stakeholders, and the comparative analysis of these scenarios are presented.

- ✓ Socio-economic transformation is very important to attain 1.5℃ climate target and it reduces the reliance on negative emission technologies.

- ✓ In all scenarios cumulative emissions are likely to exceed the benchmark without phasing out coal fired power plants, as well as high level of electrification.

- ✓ Although the methodology requires further improvement, stakeholder participation has contributed to clarify policy issues (e.g. how we should address uncertainty both in socio-economic and technology development). At the same time the co-development process nurtured the stakeholders' ownership to the constructed scenarios.

Cumulative emission benchmark

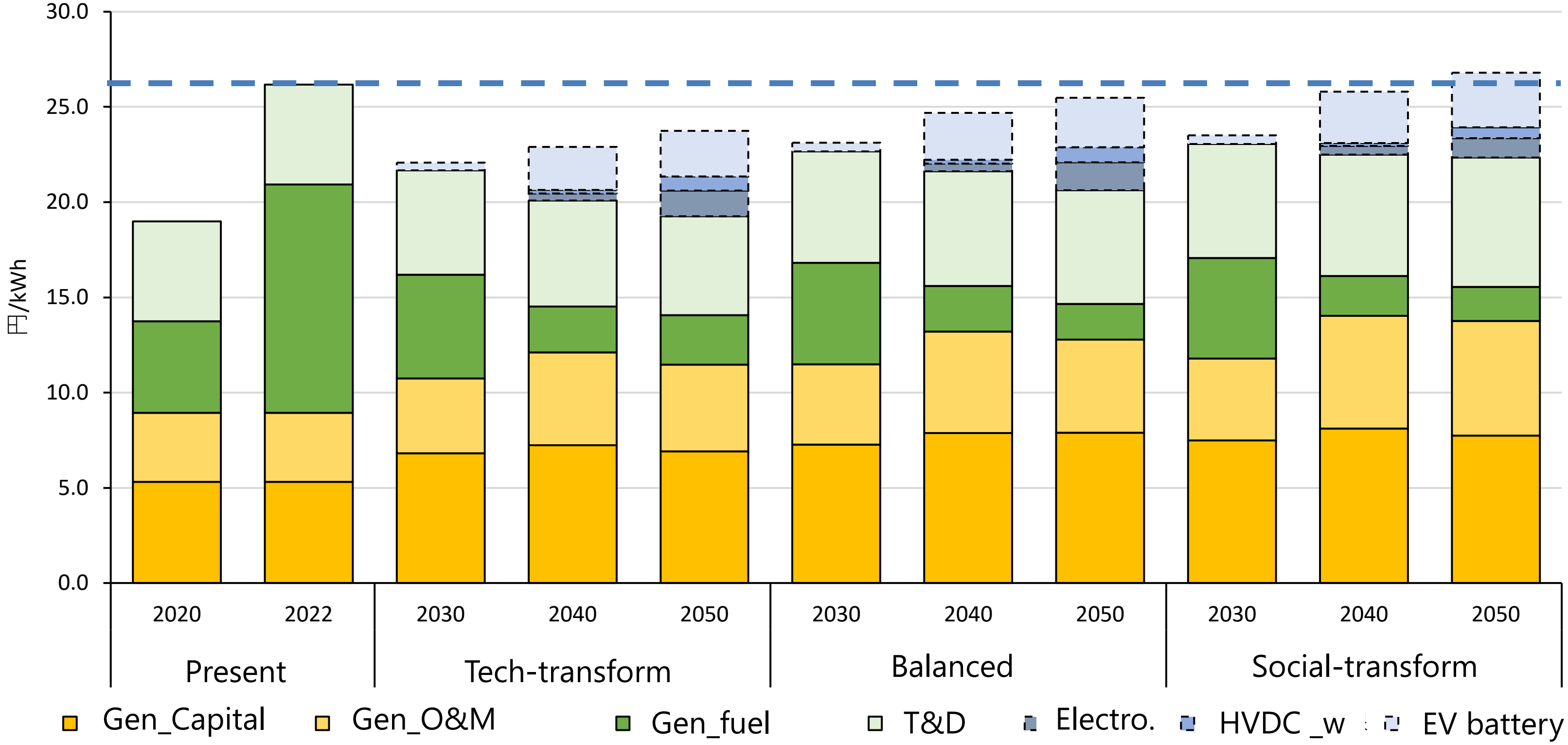
Multiple attribution approaches are considered based on the global carbon budget (2020-2050). In this research we assumed 14.3 Gt CO2eq for cumulative GHG emission.

Approach	Key concept	Emission from Japan	Note
Climate Action Tracker (2021)	Global cost minimization	14.3 Gt	Emission from OECD region is attributed based on population, GDP, emission intensity
Cumulative emission per capita (2020-2050)	Equity	9.5 Gt	Population forecast from UN
Cumulative emission per capita (1990-2050)	Responsibility, Equity	-4.6 Gt	Already exceeded the budget
Reduction accordingly with GDP per capita	Capability	9.0 Gt	Net zero by 2040
Emission per GDP conversion	Efficiency	20.7 Gt	
Emission per GDP reduces at the same rate	Efficiency	10.8 Gt	

Average cost of electricity

Case with renewables cost reduction

Shaded areas are shared costs between electricity and other sectors, a part of which may be included in electricity cost



Average cost of electricity

Case with renewables cost reduction