A 1.5°C Roadmap for Japan

"1.5℃ Business Transformation Plan:
Navigating the Net-Zero Future with a Roadmap"

JCLP Side Event at Japan Pavilion, COP28

6 December, 2023

Report Summary (English)

Technical Report and Summary (Japanese)

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Please visit IGES website

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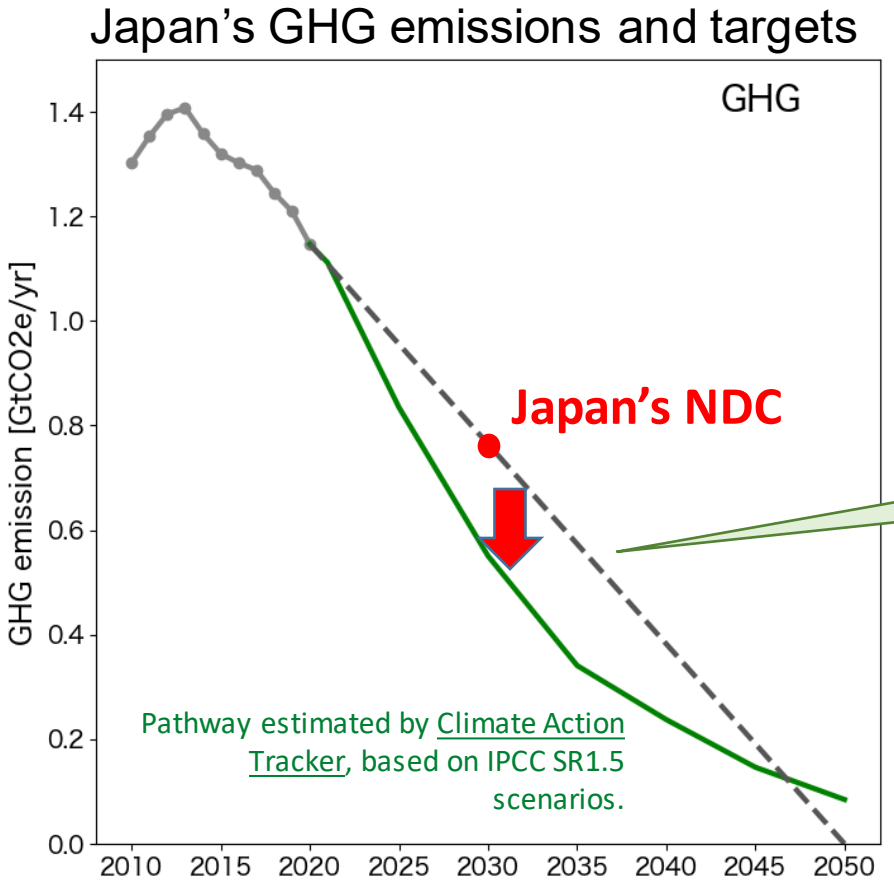
Background

To achieve the 1.5℃ goal, "unprecedented action is now needed by **all countries**. For **high-income countries**, this implies **further accelerating domestic emissions reductions**…"

UNEP Emissions Gap Report 2023 (emphasis added)



How can we attain more rapid and deeper reduction that is still achievable at this point?

We need a roadmap to show what action is necessary and when.

Background

Need a roadmap to encourage positive changes

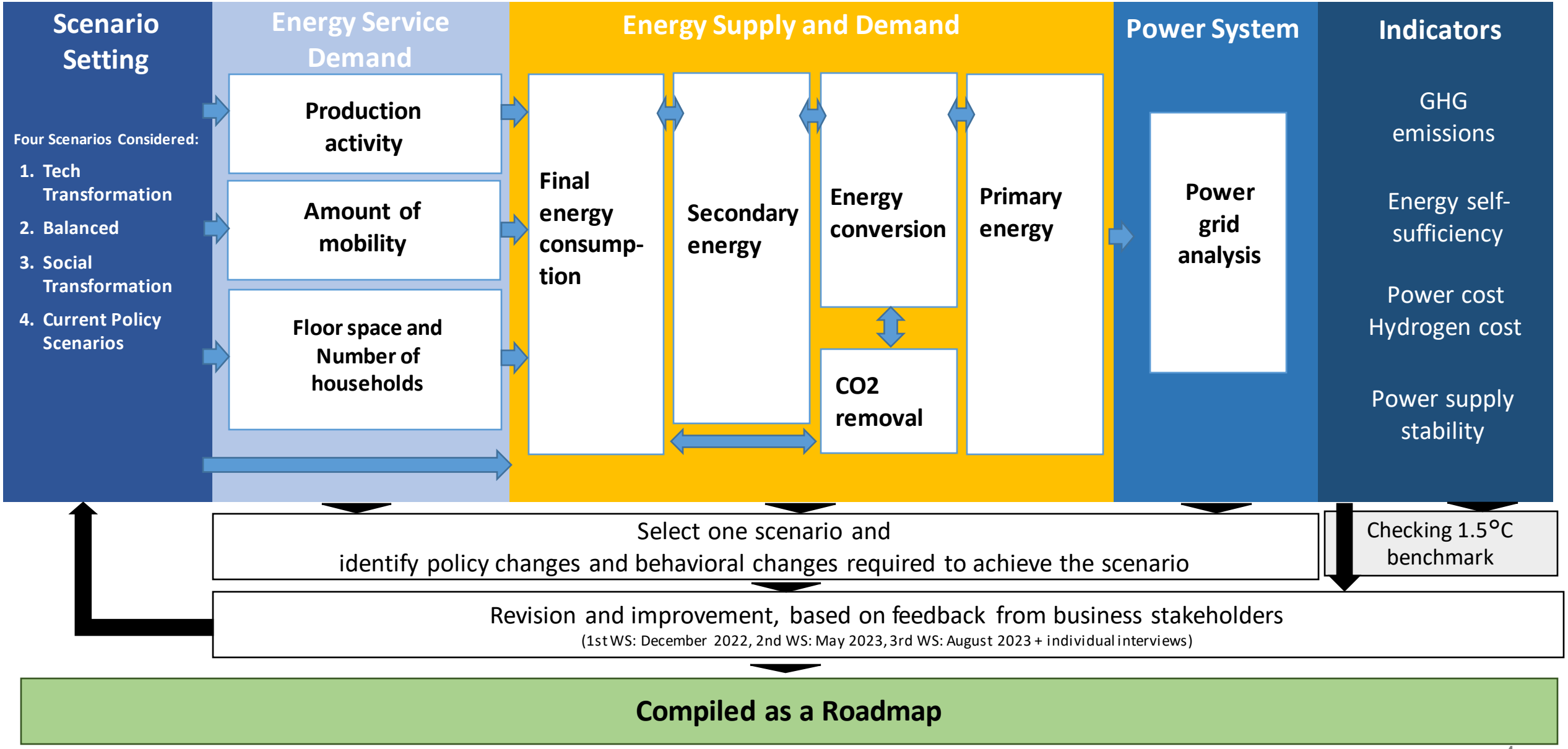
The world is under drastic changes in response to climate change and other socio-economic challenges.

We need to act with a foresight on
when and how changes will happen.

Pathway to carbon neutrality
aligned with the 1.5°C goal

Stakeholder engagement: IGES is co-developing the roadmap with stakeholders in order to reflect their views and practical knowledge and to make it more acceptable to them.

Key Components of Roadmap Development



Key Components of Roadmap Development

Scenari Setting

Four Scenarios Con

1. Tech Transformat
2. Balanced
3. Social Transformat
4. Current Poli Scenarios

Science-based:

- Scenario analysis to deal with uncertain future
- Input / Output table analysis to make a socio-economic parameters in a scenario as consistent as possible
- Power grid simulation

Consultation-based:

- A series of consultation workshop with stakeholders
- A series of interviews with business persons

Indicators

GHG emissions

Energy self-sufficiency

Power cost
Hydrogen cost

Power supply stability

Checking 1.5°C benchmark

(1st WS: December 2022, 2nd WS: May 2023, 3rd WS: August 2023 + individual interviews)

Compiled as a Roadmap

Key Steps to Develop a 1.5°C Roadmap

STEP 1 Identify a **1.5°C Benchmark** for Japan's emissions pathway

STEP 2 **Scenario Setting**

- 2-1 Energy demand side
- 2-2 Energy supply side

STEP 3 **Estimating**
Energy Demand and Supply
GHG Emissions

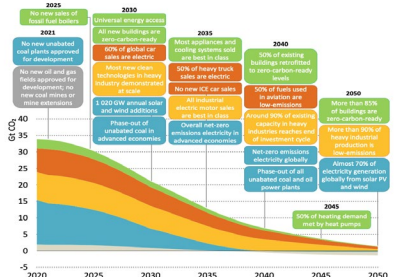
STEP 4 **Check Consistency** with the 1.5°C Benchmark

Feedback

Scenario Fixing

STEP 5 Renewables Integration to Power System and Cost **Assessment**

STEP 6 Identification of **Policies and Action** required (time series)



Chronological Action List (Roadmap)

Identification of a 1.5°C Benchmark

STEP 1 — Identify a 1.5°C Benchmark for Japan's emissions pathway

STEP 2 — Scenario Setting
- Energy demand side
- Energy supply side

STEP 3 — Estimate Energy Demand and Supply GHG Emissions

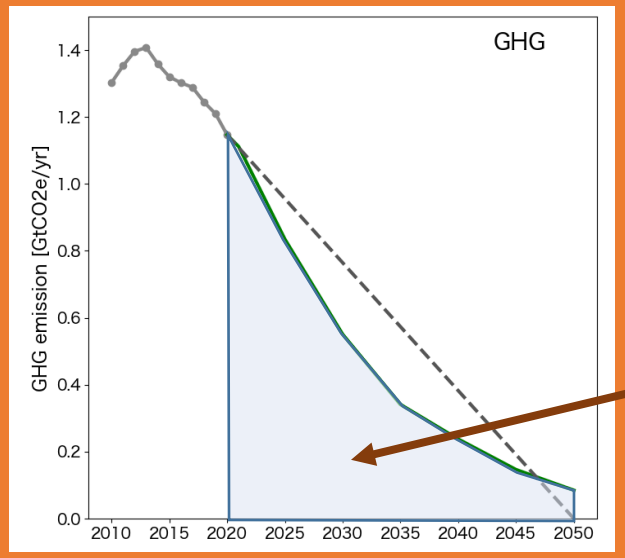
STEP 4 — Check Consistency with the 1.5°C Benchmark

STEP 5 — Renewables Integration to Power System and Cost Assessment

STEP 6 — Identification of Policies and Action required (time series)

✓ Emission pathway for Japan, based on a set of scenarios assessed by the IPCC 1.5°C Special Report and assuming long-term convergence of emission intensities within the OECD.

(See Van Vuuren, et al. (2007); Gidden, et al. (2019); Climate Action Tracker (2021))



The cumulative GHG emissions of this pathway for the period 2020-2050:

14.3Gt CO2e

We use this number as a benchmark of the scenarios we consider.

STEP 1 Identify a 1.5°C Benchmark for Japan's emissions pathway

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STEP 3 Estimate Energy Demand and Supply GHG Emissions

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STEP 5 Renewables Integration to Power System and Cost Assessment

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Scenario Setting

Key idea 1: Incorporate **socio-economic changes** to demand side scenarios

Supply side
- Maximum use of renewable energy
- Decarbonization of the hard-to-electrify sectors through green hydrogen

Demand side
- Socio-economic transformation with digitalization
- Energy conservation and electrification

IPCC: The **systemic change** required to achieve rapid and deep emissions reductions .. include: deployment of low- or zero-emission technologies; **reducing and changing demand** through infrastructure design ana access, **socio-cultural and behavioural changes, and increased technological efficiency and adoption**; .. (high confidence)

Cf. IPCC AR6 SYR (2023), SR1.5 (2018)

Scenario Setting

Socio-Economic Changes Associated with Digitalisation and Other Drivers

Changes toward higher productivity and more comfortable and safer lifestyle

- Teleworking
- Autonomous mobility
- Car sharing
- Automated manufacturing
- Circular economy
- Digital health

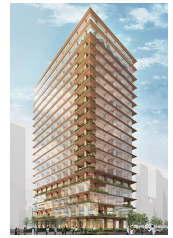
Visions in government documents

- Industry shift
- Macro-frame setting

On-going initiatives by business

- Work-style
- Material use
- New techs
- New business


(Fujitsu, MOE COOL CHOICE)


(Mitsui Fudosan)


(Toda Corp)

Set socio-economic parameters toward 2050
→ Changes in industry activities → Energy demand changes

- Manufacturing to service industry
- Work style and mobility
- Efficient use of energy

Scenario Setting

Key idea 2: Technology timelines considering **market readiness**

We refer to Technology Readiness Level (TRL) of Clean Energy Technology by IEA to determine technology implementation timeline with additional considerations on feasibility and importance in emission reduction.

TRLs by IEA

Level 1-3: Concept

Not adopted

Level 4: Small prototype

Level 5-6: Large prototype

Level 7-8: Demonstration

Low maturity (TRL 4-8):

Assumed to be deployed in 2040 or later

- Hydrogen-based direct reduced iron
- CCS/DACS
- Plastic and cement recycling
- Electrification of / hydrogen for high temperature industrial heating
- Pure hydrogen power generation

Level 9-10: Market uptake

Level 11: Mature

High maturity (TRL >9):

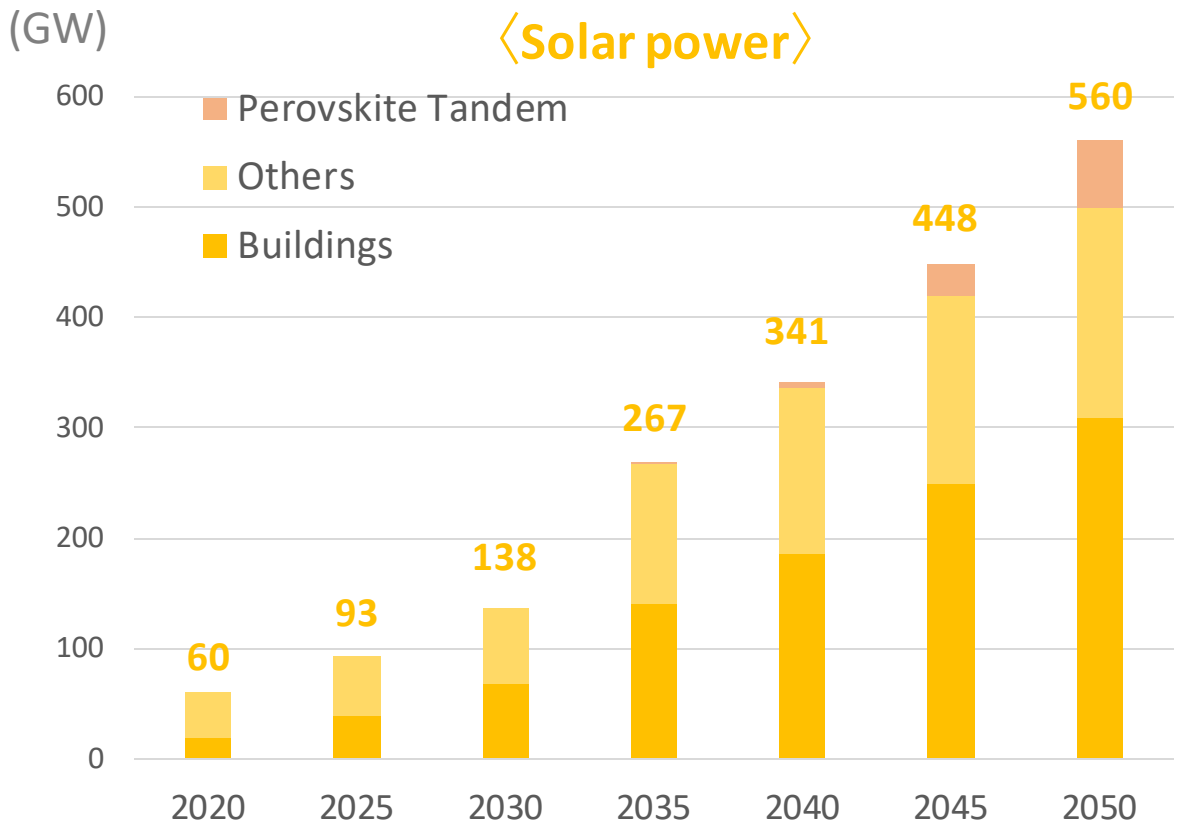
Assumed to be deployed when facilities are renewed

- Electrification and energy efficiency in the residential and commercial sectors
- Electrification flow temperature industrial heating
- Renewable Energy (PV, Wind)
- Power generation with hydrogen co-firing

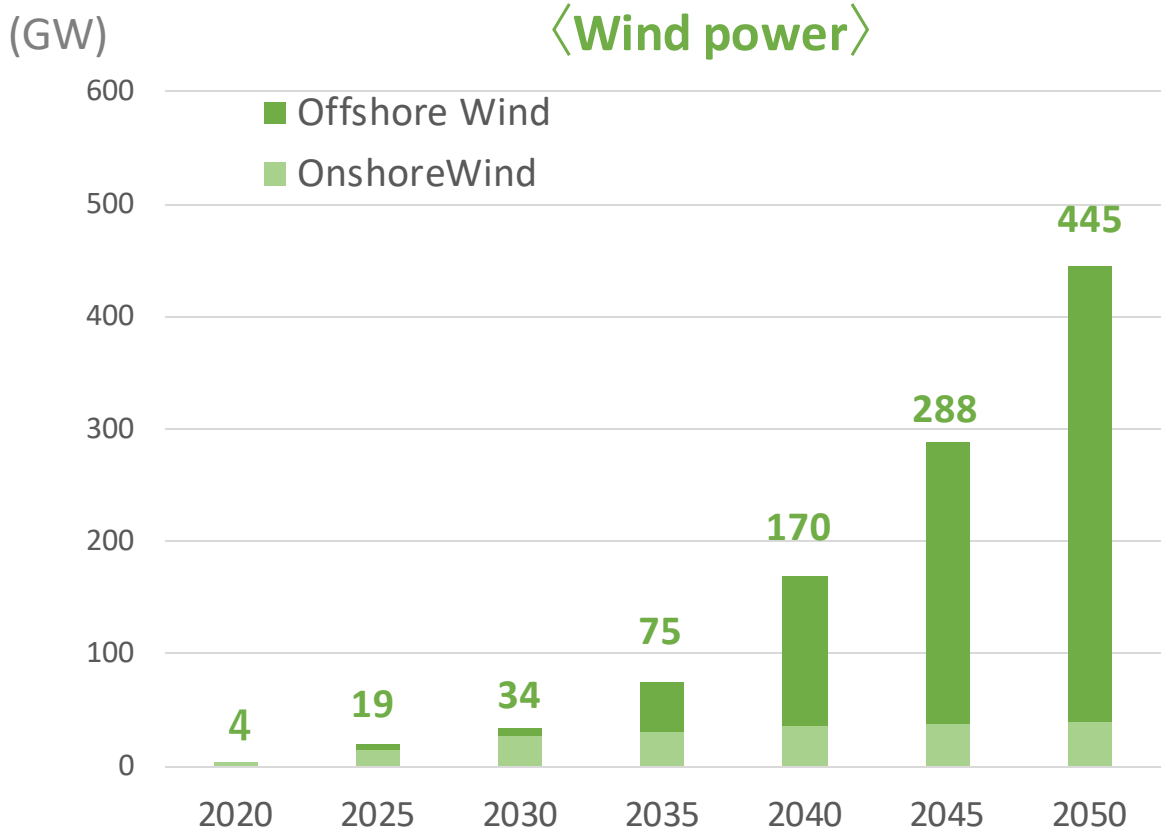
Scenario Setting

Key idea 3: Maximum deployment of RE is a key to the 1.5℃ pathway.

Assuming the **highest targets** announced by RE industry associations to be achieved.



- Reference: Japan Photovoltaic Association
- We assume that tandem-type combining silicon and perovskite will be introduced after 2035. This will increase power generation output per area).



References:

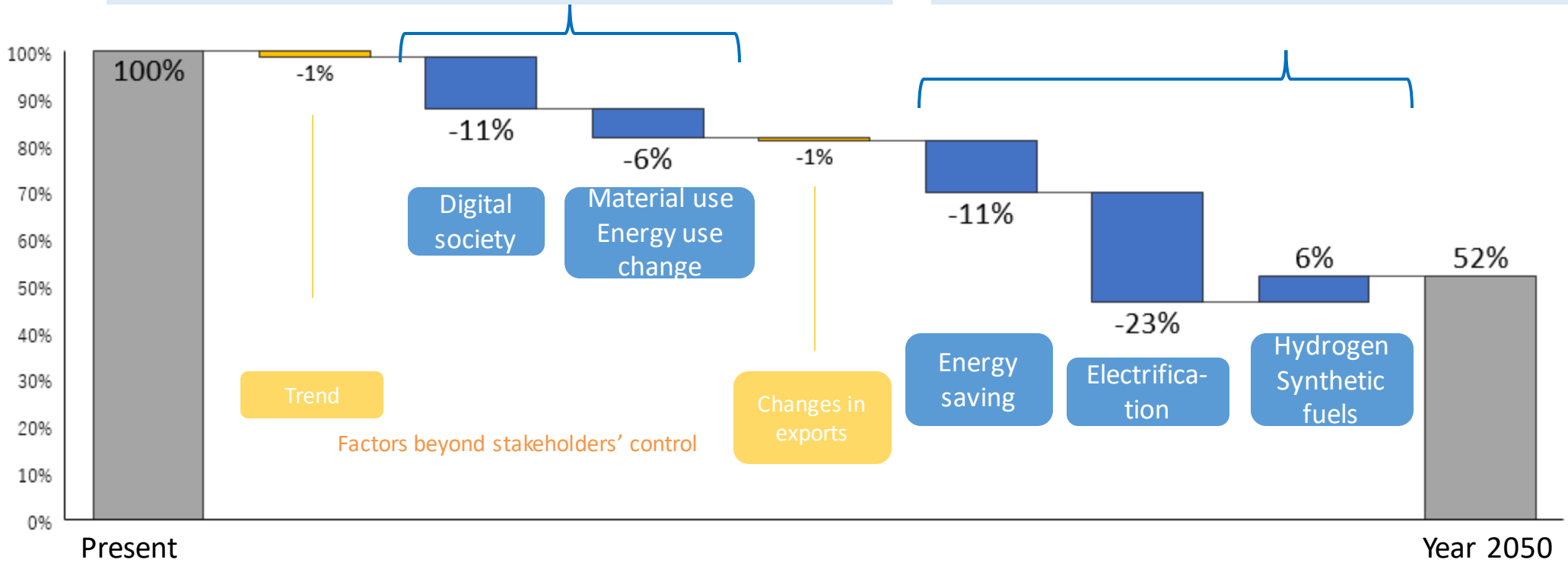
- Wind Energy Association Vision
- Offshore Wind Public-Private Council Vision
- Marine Technology Forum Recommendations (ambitious goals)

Socio-Economic Changes driven by Digitalization have Large Impact on Energy Demand Reduction.

<Rates of change in final energy consumption by element in 2050>

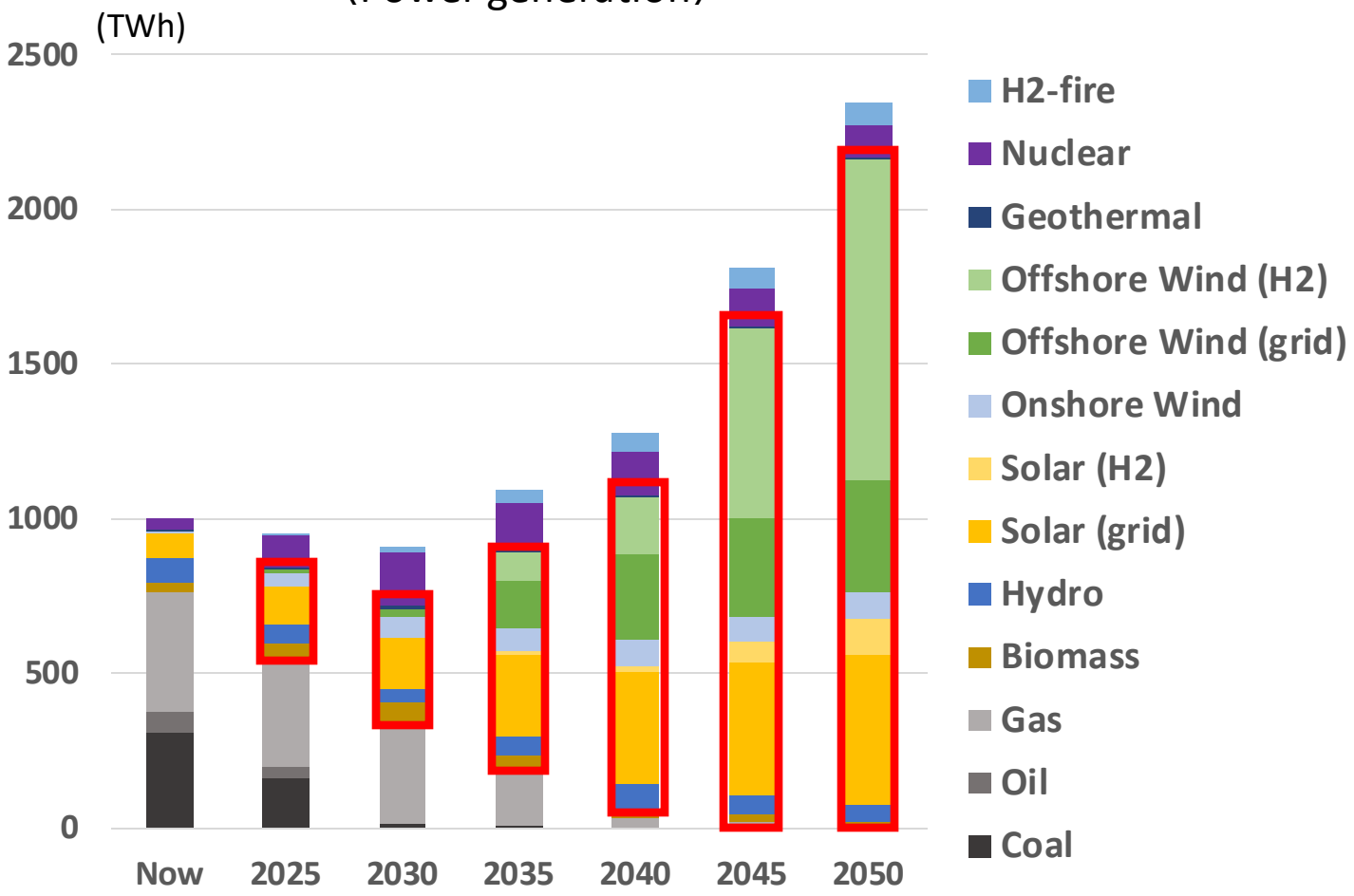
(1) Socio-economic changes driven by digitalization and other factors ▼17%.

(2) Energy saving, Electrification, Hydrogen ▼ 28%.



Renewable Energy, Particularly Offshore Wind, Plays a Significant Role to Meet Growing Electricity Demand to Produce Hydrogen.

〈Power generation〉

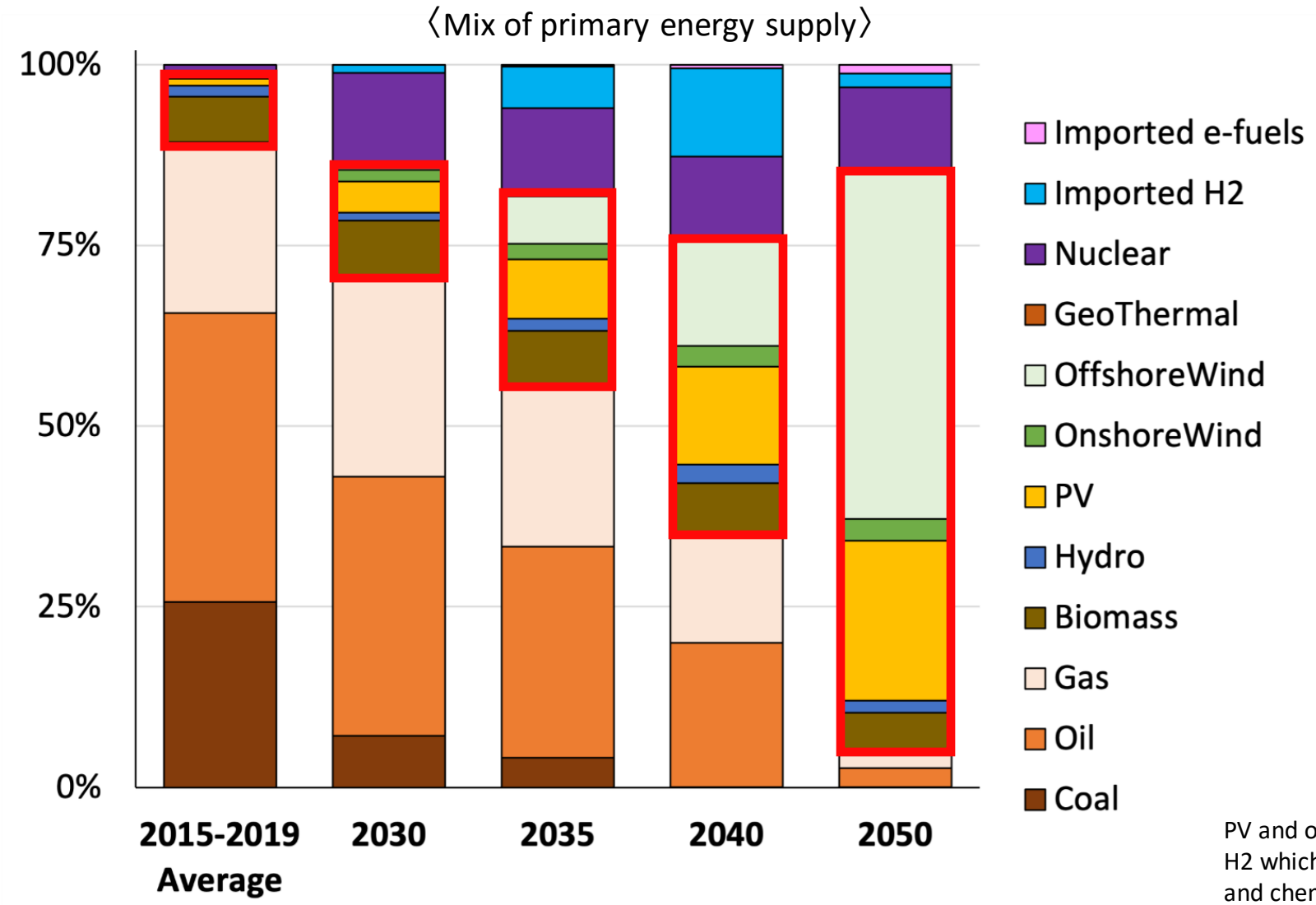


〈Power mix〉
(excl. power for H2 electrolysis)

Power	2035	2050
Decarbonised	81%	100%
Renewables	62%	85%
Solar (grid)	27%	41%
Onshore Wind	8%	7%
Offshore Wind (grid)	15%	30%
Other RE	12%	6%
Nuclear	15%	9%
H2-fire	4%	6%
Gas	18%	0%

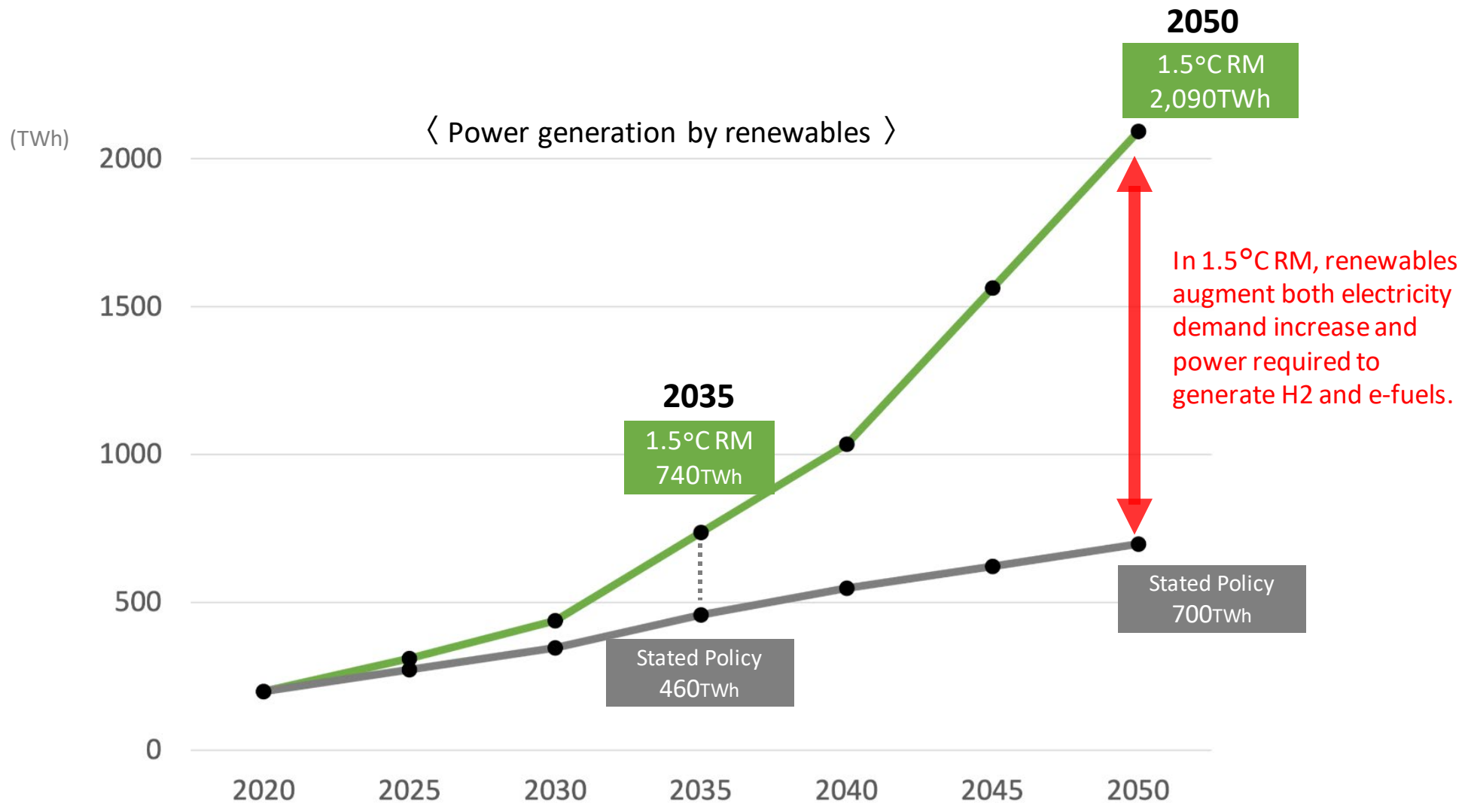
* Due to rounding the sum may not be 100%.

Renewable Energy will Dominate 90% of Primary Energy Supply by 2050.



PV and offshore wind will also generate green H2 which is necessary to decarbonize steel and chemical industries.

Rapid Deployment of Renewable Energy: 3X by 2035 and 10X by 2050 are Required.



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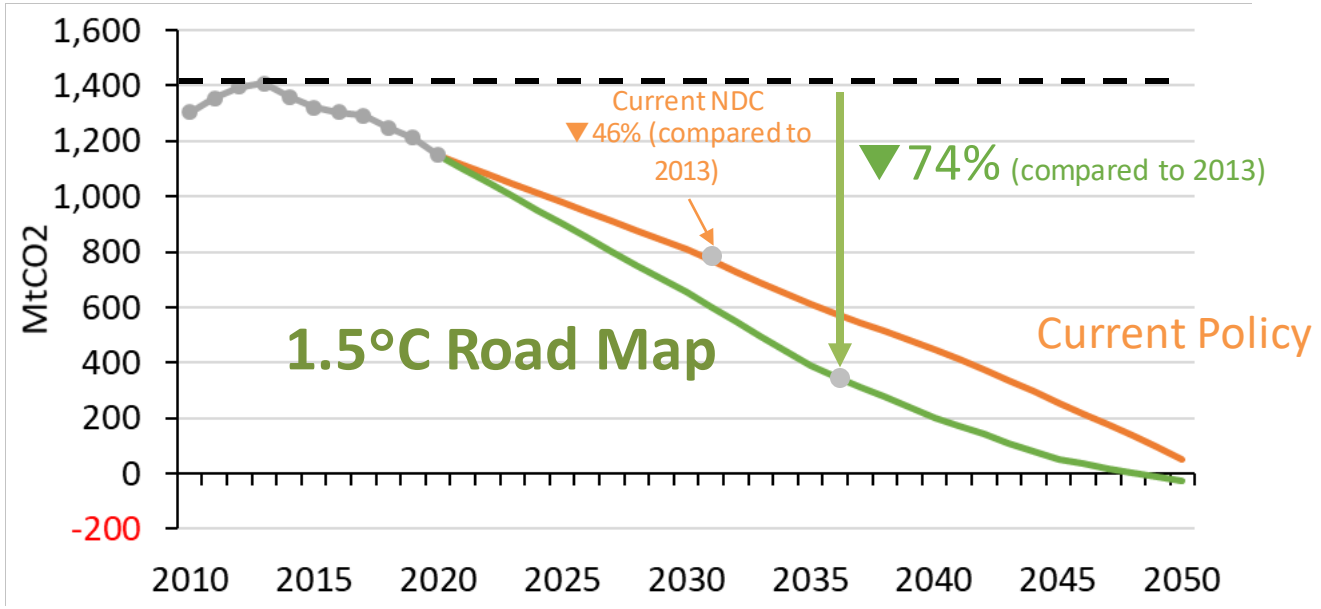
STEP 6 — Identification of Policies and Action required (time series)

Check Consistency with the 1.5°C Benchmark

- ✓ Cumulative emissions do not exceed the 1.5°C benchmark (14.3 Gt)
- ✓ 74% reduction from 2013 levels by 2035



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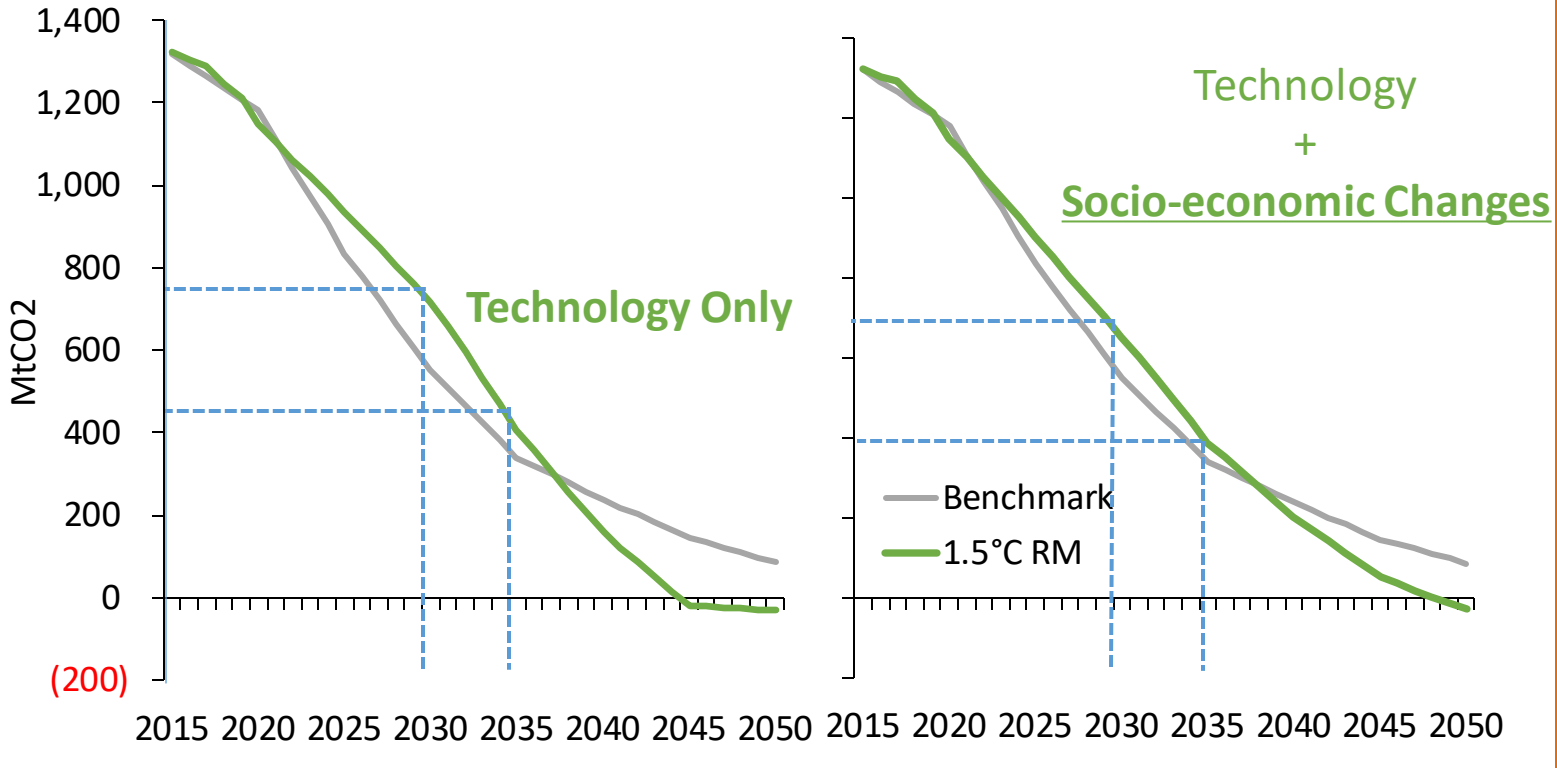
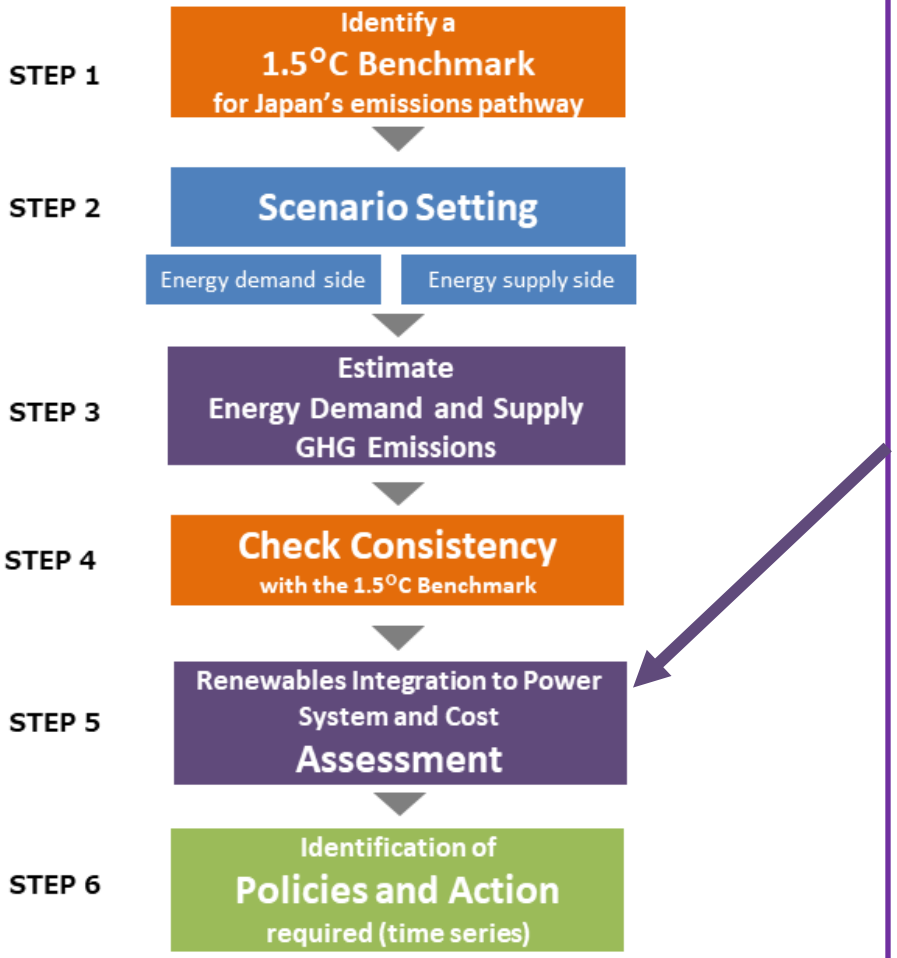
Socio-economic changes enable faster emission reduction.



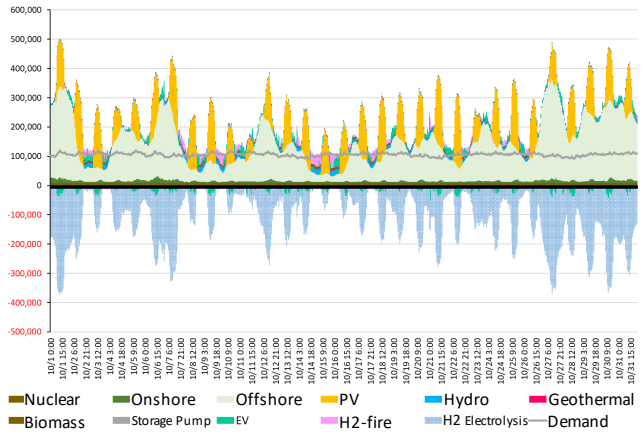
Grid Integration and Cost Assessment

It is possible to meet electricity demand by the power mix with 85% renewables without cost increases.

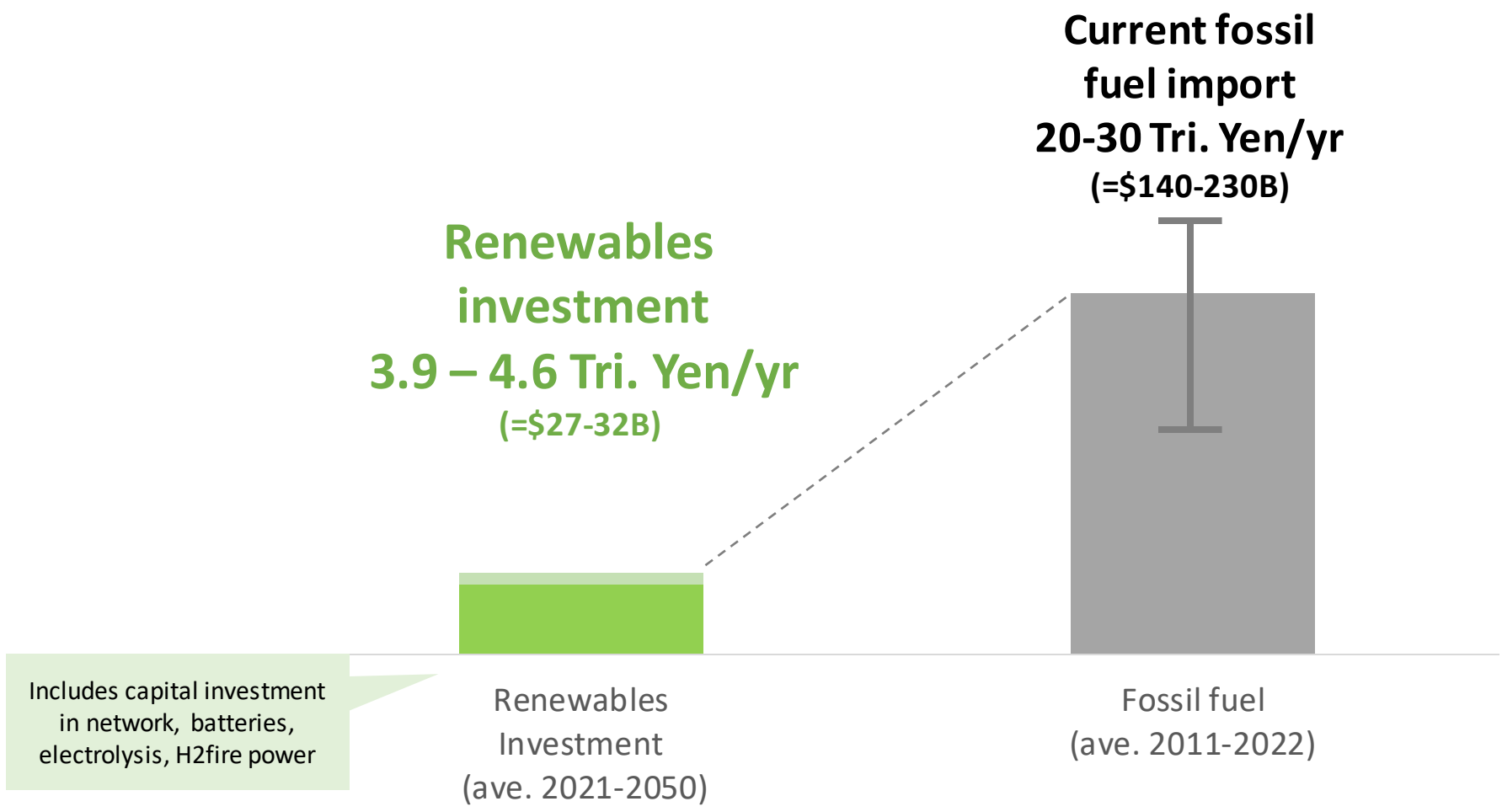


- Simulating hourly supply-demand balance at 450 nodes
  - **Various options of power system flexibility**: water electrolysis with surplus renewable energy, V2G, residential/grid scale storage batteries, pumped storage hydro, and H_2-fired thermal power (gas-fired power retrofit) for long-duration energy storage
  - **Strengthen transmission Lines** to encourage cross-regional power interchange, including submarine HVDC
  - Introduction of **grid operation rules based on merit orders**
- Examining electricity costs (generation costs + transmission costs)

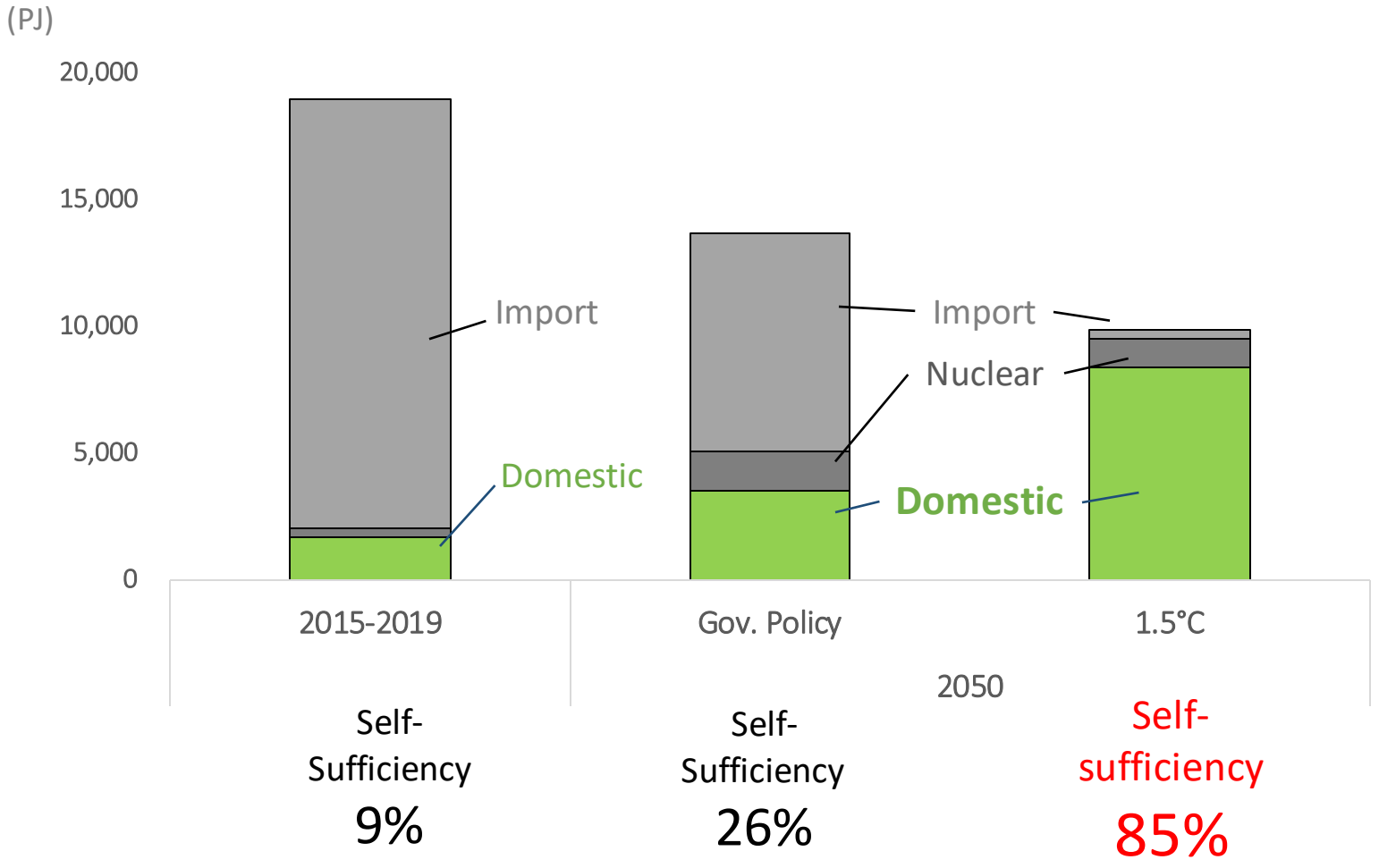
Hourly electricity supply and demand at the national level



Required Investment in Renewables is Much Smaller than Current Fossil Fuel Imports.



Substantial Improvement of Energy Self-sufficiency Driven by Renewables and Domestic Green Hydrogen

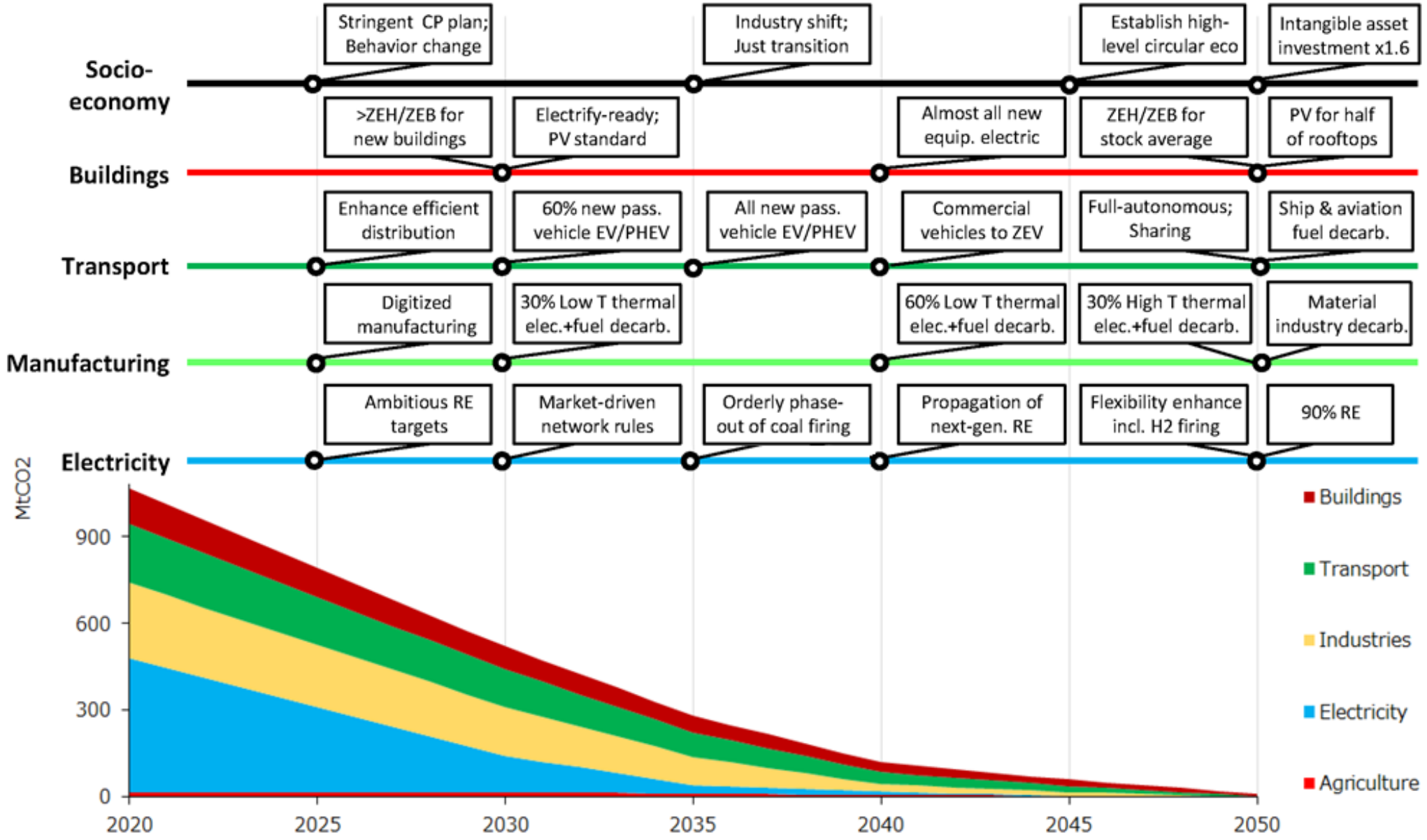


Notes

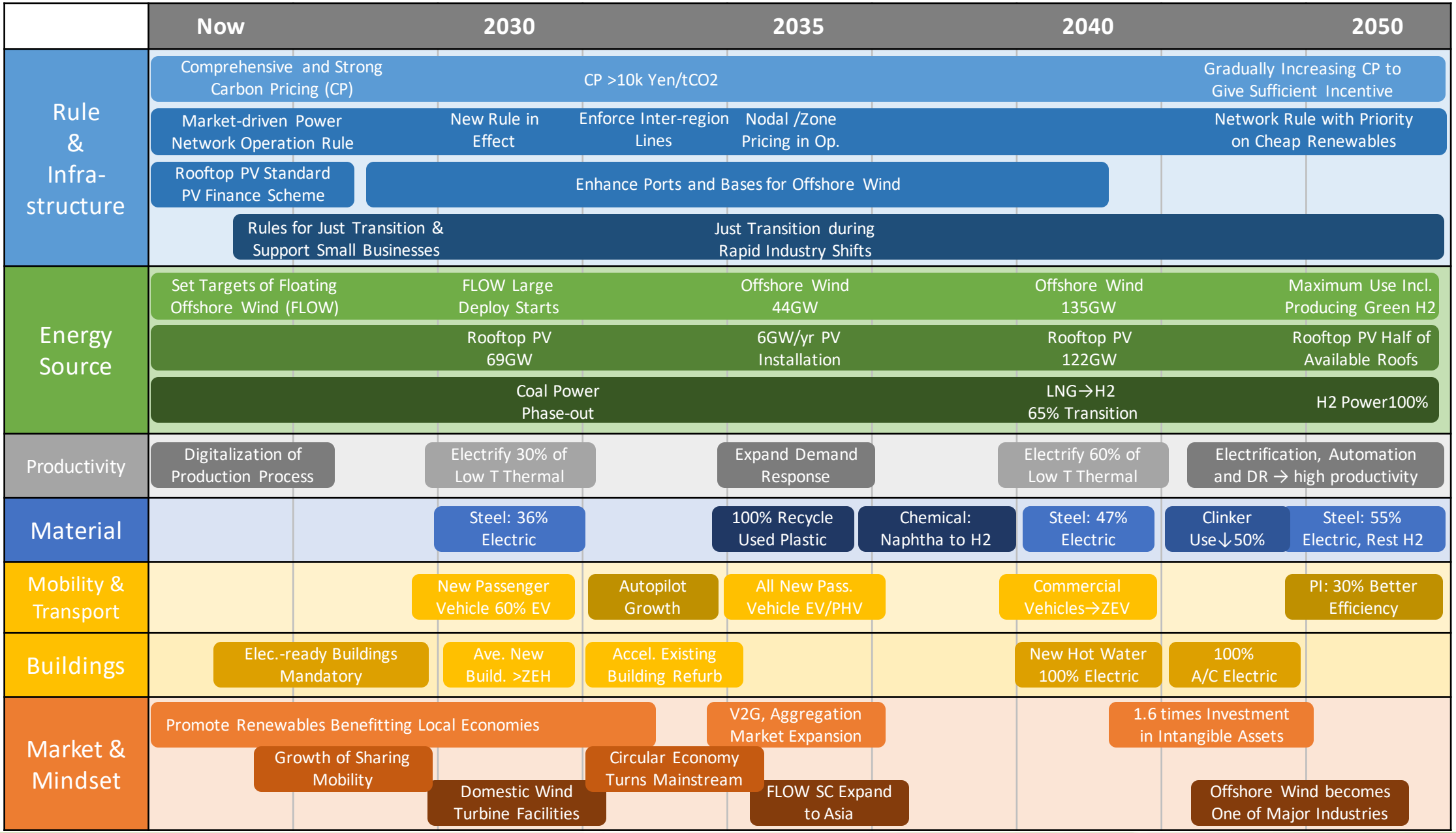
- In IGES RM, nearly 100% domestic green H2 (by PV and offshore wind) is assumed. It should be beneficial in light of energy security and domestic economy.
- Importing green H2 could be a compelling option if there is a significant cost gap between domestic and overseas green H2 productions.

※ Imported energies in IGES RM (2050): small amount of H2 and remaining petroleum and LNG (offset by DACS)

Roadmap to Achieve Rapid and Deep Emission Reduction



Roadmap to Achieve Rapid and Deep Emission Reduction



1.5°C Roadmap: Summary

Features

- Rapid and deep emission reduction, consistent with the 1.5°C Goal
- Reflecting major changes not only on the energy supply side but also on the demand side
- Based on science and dialogue with stakeholders

Key messages:

- **Bold actions on the energy demand side**
  - ✓ Socio-economic changes associated with digitalization
  - ✓ Energy conservation and electrification
- **Rapid and substantial expansion of renewable energy**
  - ✓ Expansion of solar PV, mainly roof-top solar PV
  - ✓ Floating offshore wind (utilizing EEZ potential and promoting domestic industry)
  - ✓ Grid operation rules that give priority to renewable energy

⇒ Pursuit of the 1.5°C goal is "opportunities" to build new businesses and a prosperous, vibrant social economy.