Policy trends of Japan and the world, and Scenarios of long-range strategy for deep CO_2 emission reduction

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Policy Trends of Japan and the World

Paris Agreement (framework after 2020 covering all major countries) :
Adopt(2015) → Effective(2016) → Implementation scheme(2018；exc. market mkm)

IPCC 1.5℃ Special Report (2018)：net zero emission required in 2050

5th Strategic Energy plan of Japan decided in July, 2018：
Target for 2030 maintained、Vision for 2050 as an ambitious goal

Schedule for Future：
June 2019：G20 in Japan、long-term low emission develop. strategy？
Nov. 2019(COP25)：rule for market mechanism
Nov. 2020(COP26)：limit for submission of NDC for 2030
Nov. 2020：election of US President、US exit?、（G7 in the USA）
Nov. 2022：technical review for global stocktake
Dec. 2023：high level event for global stocktake
End of 2024：1st biennial report of Paris Agreement due
2025：submission of second NDC

Targets for 2030 and Goal for 2050

- **Predictable future with a reasonable likelihood**
  (Predictability ⇔ Realistic)
- **Given infrastructure and system**
  - ✓ Existing human resources
  - ✓ Existing technologies
  - ✓ Existing infrastructure

Straight-line efforts to achieve realistic targets
(PDCA cycle)

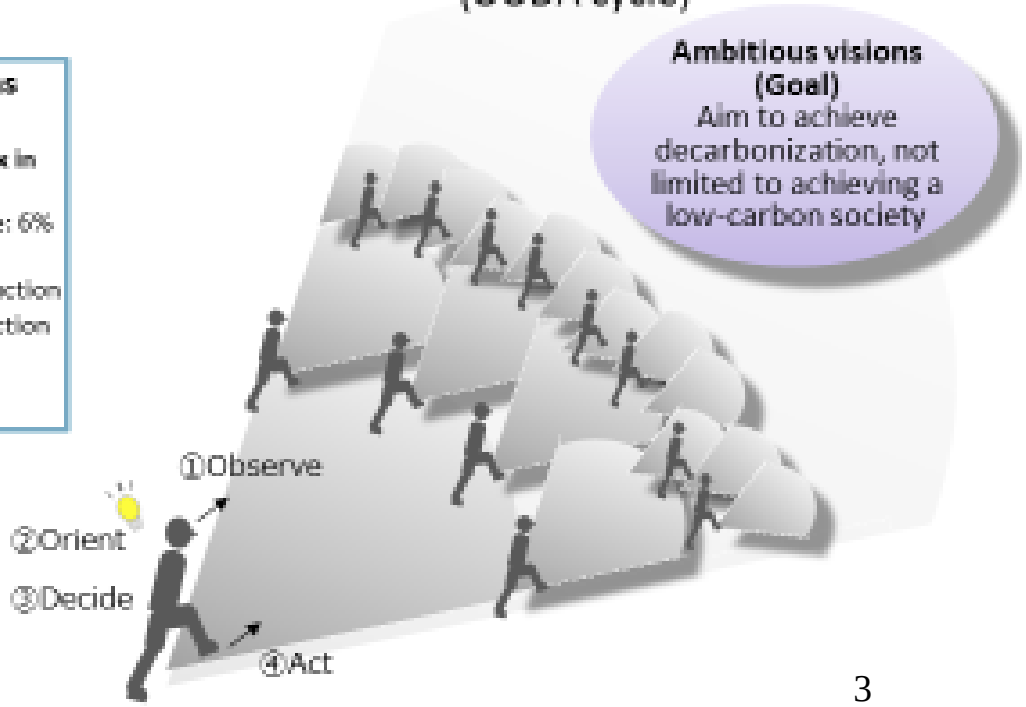
Concrete actions (Targets)
(= Optimal energy mix in 2030)

- Self-sufficiency rate: 6% → Approx. 25%
- Electricity cost reduction
- CO2 emission reduction by 25%

- **Uncertain future containing diverse possibilities**
  (Uncertainties ⇔ Ambitious
  (VUCA : Volatility, Uncertainty, Complexity, Ambiguity)
- **Changeable infrastructure and system**
  - ✓ Human resource development
  - ✓ Technological innovation
  - ✓ Updated infrastructure

Multiple track scenario with diverse options
(OODA cycle)

Ambitious visions (Goal)
Aim to achieve decarbonization, not limited to achieving a low-carbon society



The energy mix for 2030 is kept as that of the previous plan

<Policy target for 3E+S>

safety

Most essential

Energy Security

Approx. 25%, more than 20% of the pre-quake

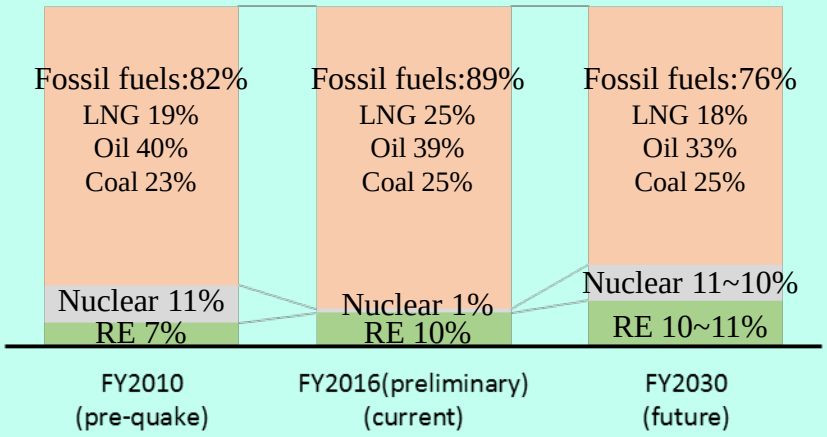
Economic Efficiency

Smaller cost than current

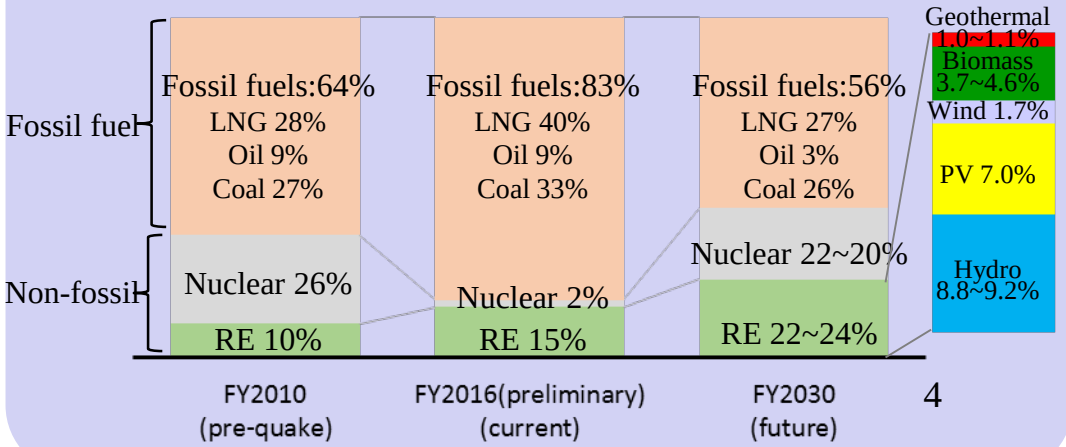
Environment

GHG reduction target comparable to Europe or U.S.

Primary energy supply



Composition of power sources



Provisional translation of Government publication

Direction of energy trend in Japan towards 2050

- Key points of Recommendations by the Round Table for Studying Energy Situations - 5

■ **Possibility → Ambitious scenario: Energy transitions toward decarbonization**

■ **Uncertainty → Multiple track scenario: Seeking possibility in all choices**

■ **Unclarity → Scientific review mechanism: Flexible determination of priority**

■ **Energy transitions under complex uncertain environments**

→ Sophistication of 3E+S

- Safety at the top priority → Enhancement of safety through innovations by technologies and governance reforms
- Energy Security: Resource self-sufficiency rates → Improvement of technology self-sufficiency rates + Securement of diversity of energy options
- Environmental friendliness → Taking on decarbonization
- Economy: Curbing public burdens → Enhancement of domestic industrial competitiveness

Source) Government data

The First Pillar

Ambitious and multiple-track scenario
→Renewables to be major power sources, meanwhile decreasing the dependency on nuclear energy
→All options in pursuit of possibilities

To 2030 -> Electricity ZE44 & Energy efficiency 30

- Single target = Energy mix in 2030

→ Zero emission electricity 44%
→ Increase in energy efficiency by 30%

- From fulfillment and acceleration towards 2030 to advanced development by 2050

→ Decrease CO_2 by 26% with the same cost, then by 80%

- Technology-based 3E+S

Safety → Increased security with technology
Energy security → Securing energy with technology
Environment→ Decarbonization with technology
Economic Efficiency→ Strengthening industrial competitiveness with technology

To 2050 -> ZE80 & Negative emissions

- Multiple scenarios = determined by scientific review

Electricity system
-> Renewables, battery storage
-> Renewables, hydrogenation or methanation
-> fossil fuel, CCS, hydrogenation or methanation
-> International renewables, hydrogenation or methanation
-> Next gen. nuclear (small reactors etc.)

Thermal system
-> Electrification
-> Hydrogenation or methanation
-> Next gen. industrial thermal system

Transportation system
-> Electrification
-> Hydrogenation
-> Autonomous

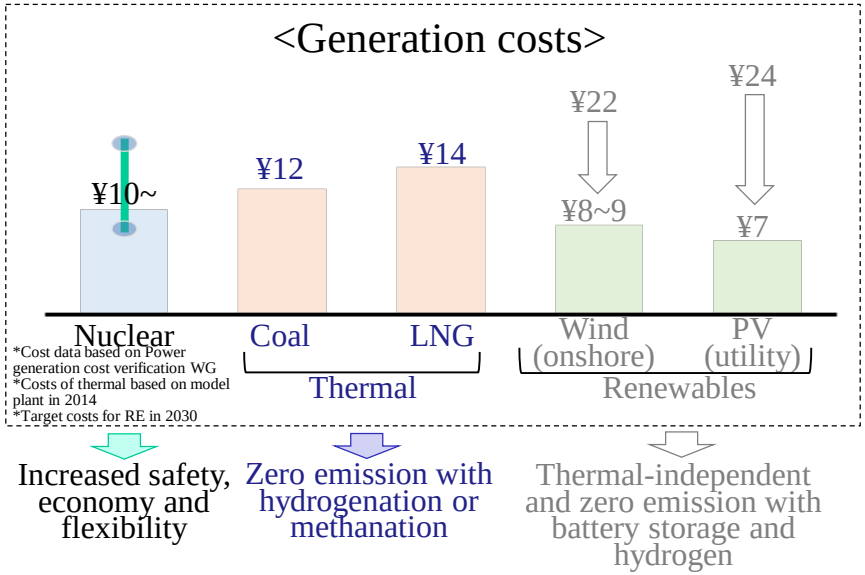
Distributed energy system
-> Adjacent to demand, small battery storage and IoT

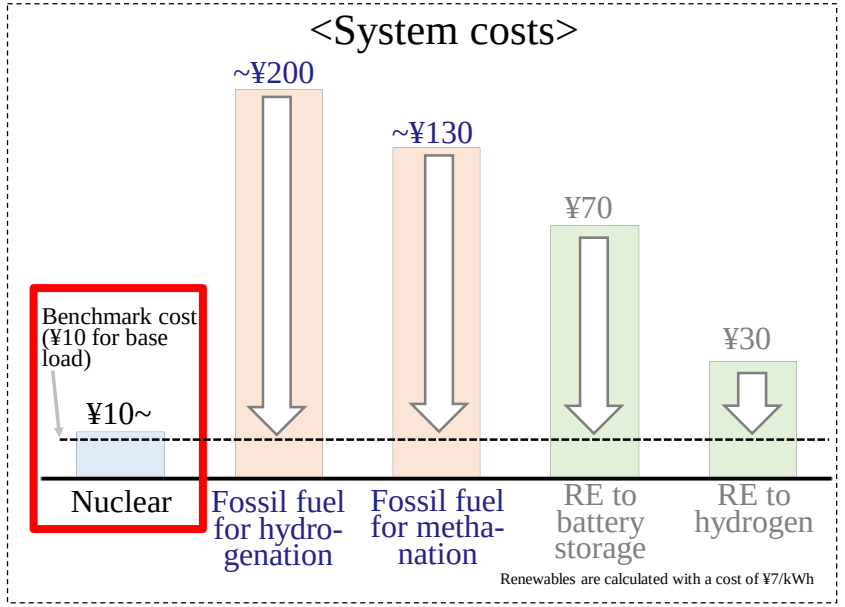
The Second Pillar

Introduction of Scientific Review Mechanism

→Priority of energy option will be determined considering leading-edge technologies and situations

Shift from verification of electricity generation to that of system cost





2030=single target (energy mix) -> must be fulfilled
Existing technologies -> securing safety, maintaining cost, increasing self sufficiency, decreasing emission by 26%

2050=multiple scenarios -> with all strength, immediate start
Innovative technologies -> innovating safety, increasing competitiveness, energy security, decreasing emission by 80%

Scientific review for energy transition by every 2 to 3 years
Determine priority issues in light of latest technological and geopolitical situation

Third-pillar: All-out efforts ➡ Actions aligned with world, finance, and industry

Review cycle

Review➡Project, international cooperation, financial dialogue, policies➡Structural transformation

Energy Big data ➡ **Scientific review Mechanism** ➡ **Decision on priority of energy choices**

Project on energy transformation/de-carbonization➡ industry-government-academia collaboration

(Unified understanding of technological maturity by examining systems costs)

Renewable energy Storage of electricity	fossil Hydrogen	Next-generation Nuclear power	Industrial Process	✚	Decentralization

International alliance for energy transformation/de-carbonization

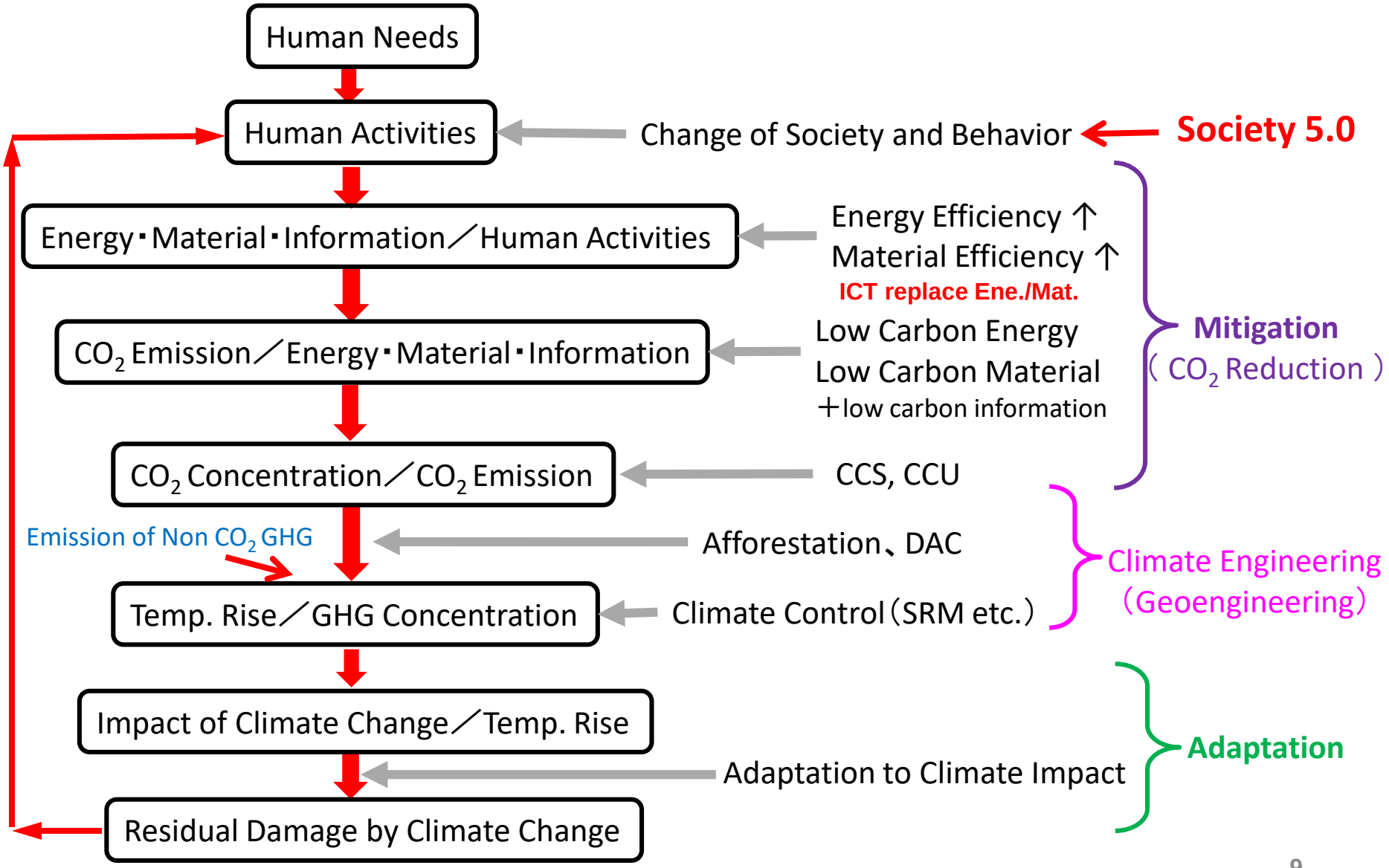
➡Cooperation among resource-rich countries, emerging countries and developed

Energy finance dialogue➡ Cooperation with financial sectors

Energy transformation/de-carbonization policies

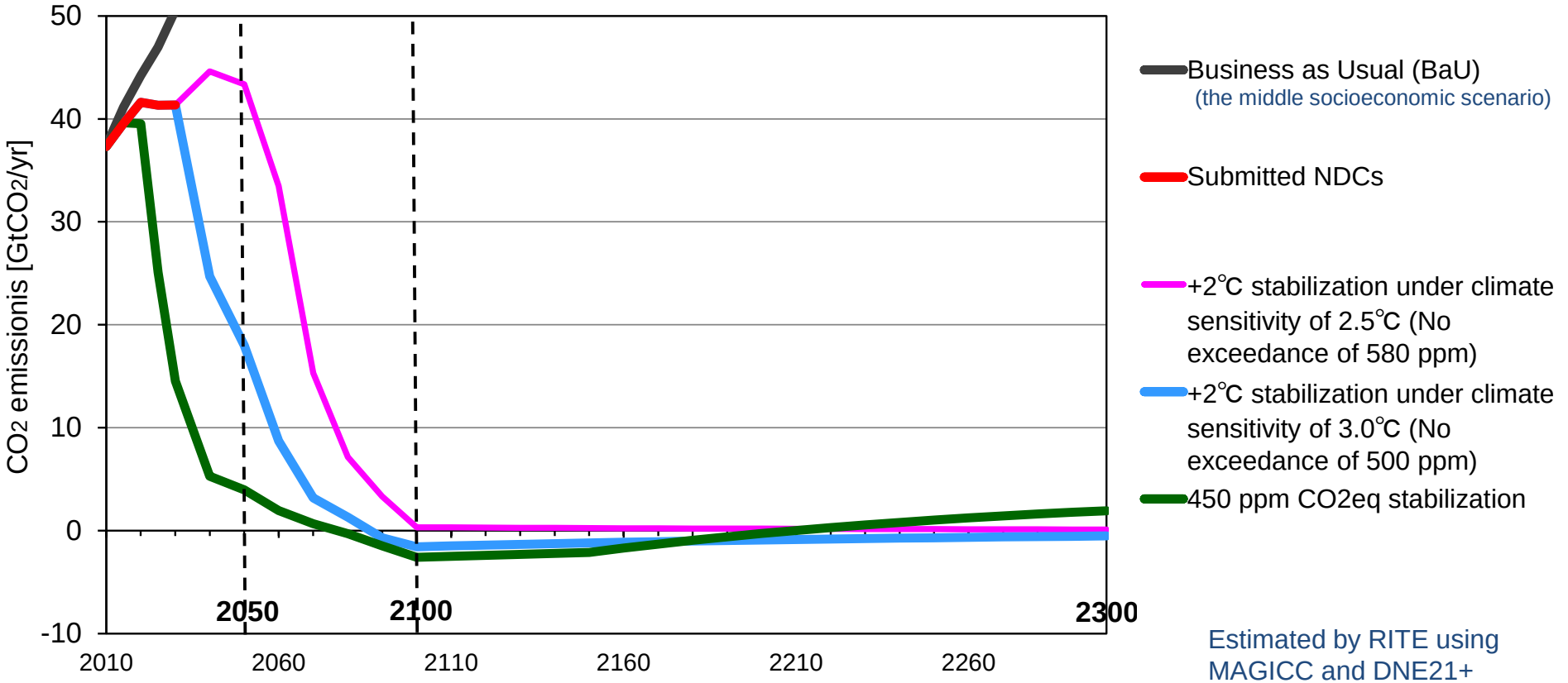
Strengthening energy industries	Reorganizing energy infrastructure	Structural reforms in energy system

Structure of Climate Change Response



Source：Kenji Yamaji, 2006：「Theory of 3E Systems Analysis」, Iwanami-Shoten (in Japanese) + modifications by KY

Global CO_2 emission profiles toward 2300 for the 2 °C targets



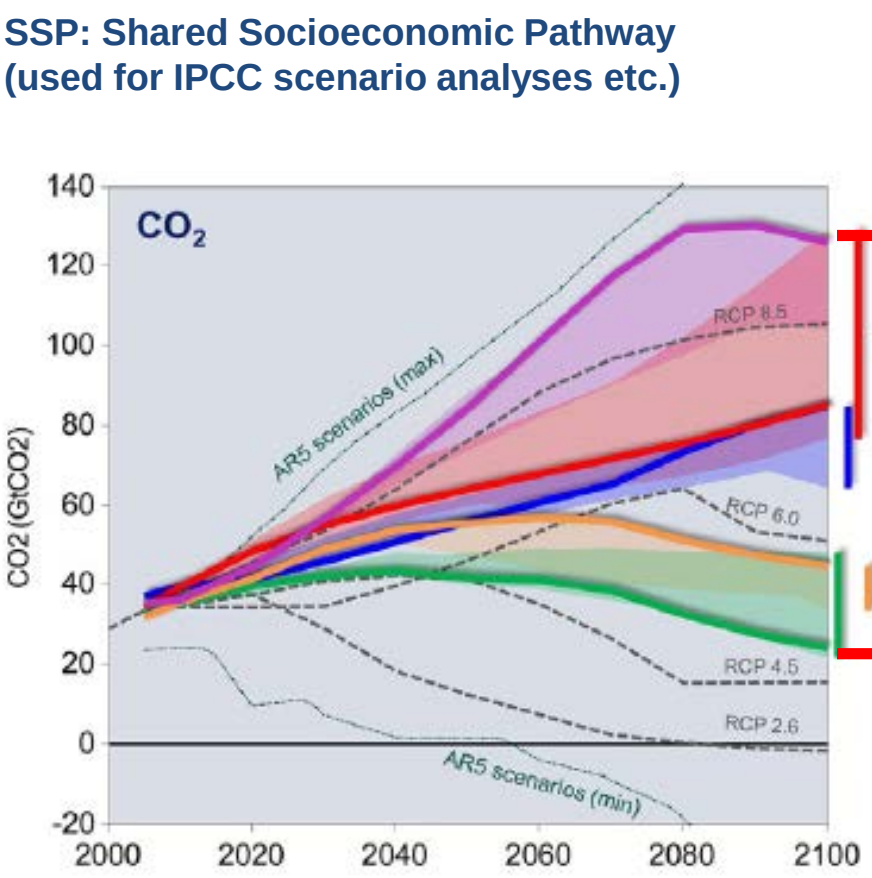
Estimated by RITE using MAGICC and DNE21+

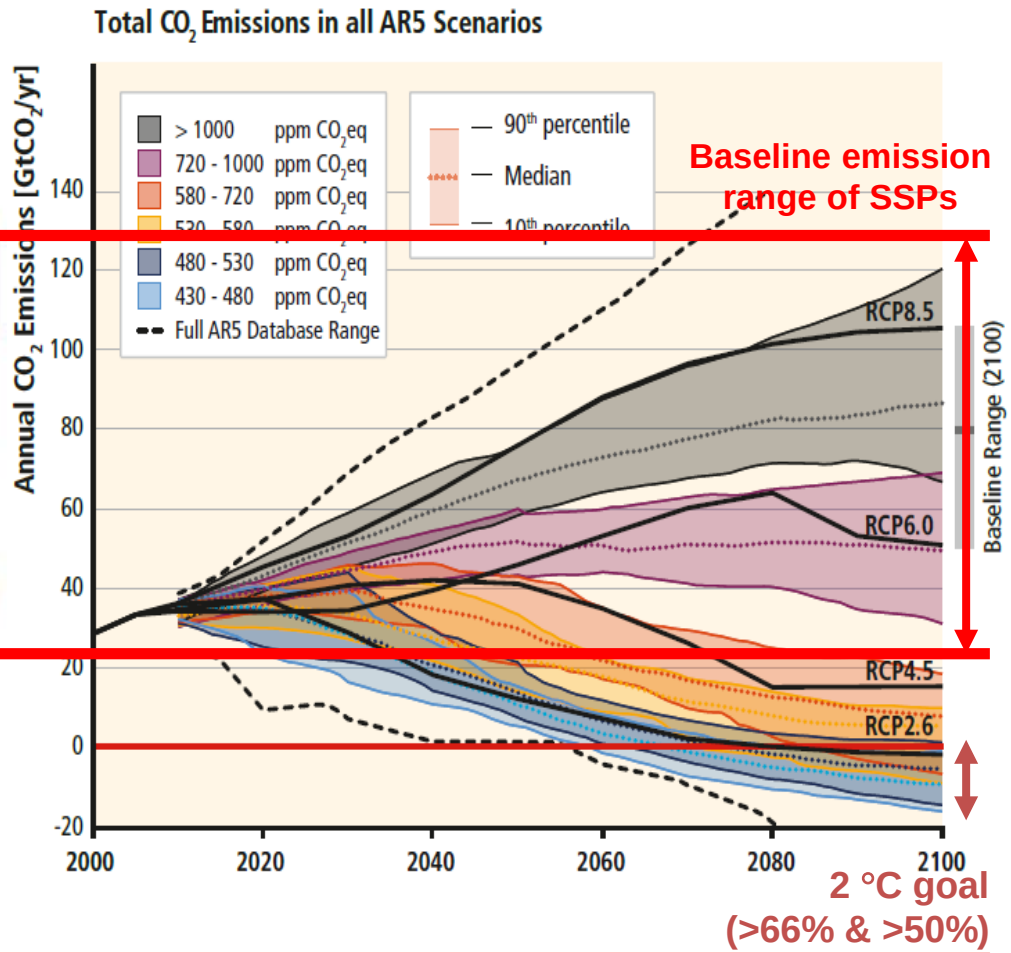
- The global CO_2 emissions should be nearly zero for a long period of time in the far future in any pathway to achieve temperature stabilization.

- On the other hand, the allowable global CO_2 emissions toward the middle of this century have a wide range according to the uncertainties in climate sensitivity (or achieving probability) even when the temperature target level is determined as a 2 °C. We should use this flexibility to develop several kinds of innovative technologies and societies.

The relationship between baseline emissions due to different socioeconomic scenarios and those for 2 °C goals

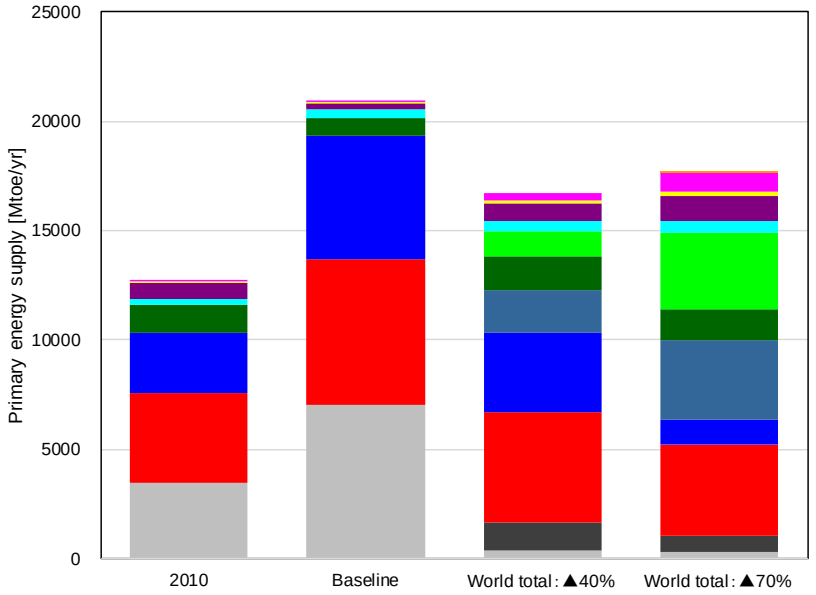
SSP: Shared Socioeconomic Pathway
(used for IPCC scenario analyses etc.)

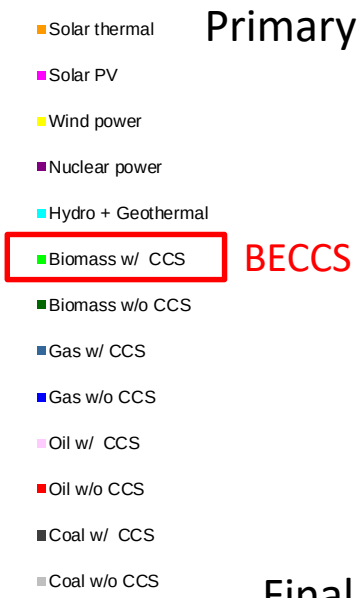




- There are large uncertainties in baseline emissions due to uncertainties in socioeconomic conditions. The uncertainty ranges are much larger than those for different target levels of temperature (e.g., ±0.5 °C, that is, 1.5 to 2.5 °C target).
- It is significant to achieve low emissions in baseline, that is, technologies with net negative costs achieving such low emissions.

Primary energy supply and final energy consumption (World, 2050)





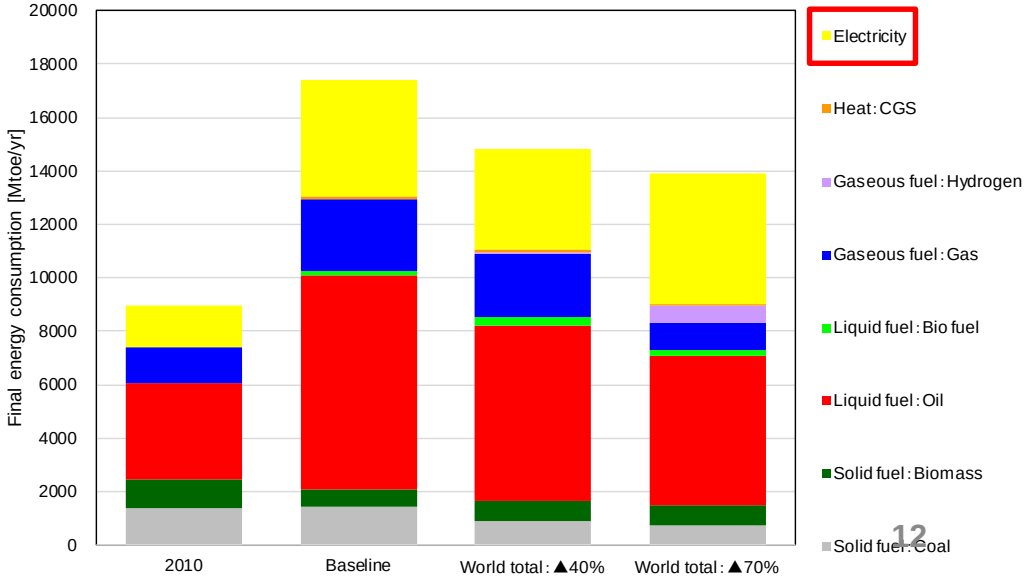
Primary energy supply

BECCS

Electrification to decarbonize electricity

Japan: ▲65%

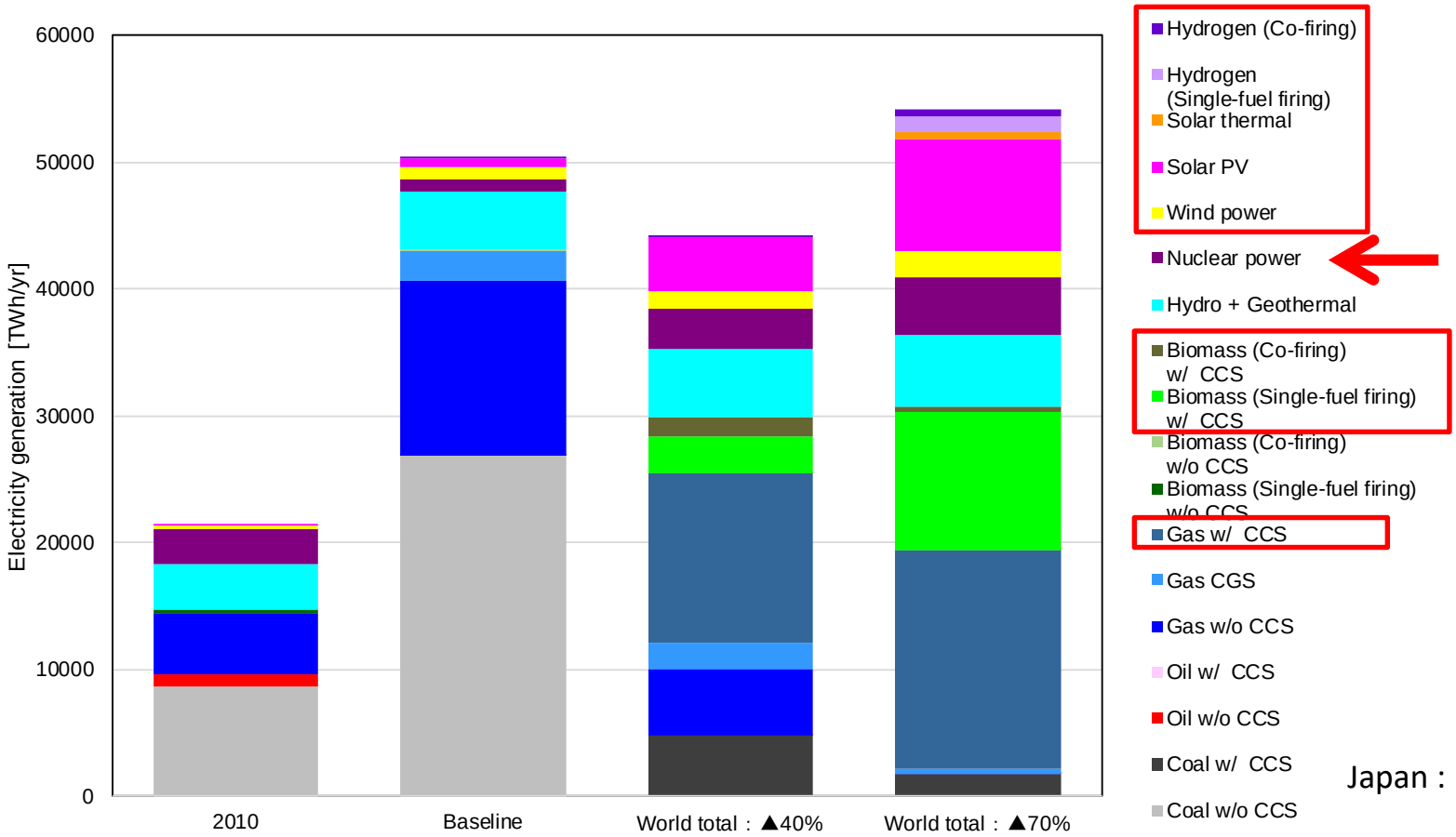
Final Energy Consumption



For 70% GHG mitigation:

- considerable BECCS is required
- significant reduction on oil and gas
- electrification ratio should be increased for cost-effective measures

Generated electricity (World, 2050)



*Biomass (co-firing) assumed co-firing with coal fired power. The generated electricity is proportionally divided into coal and biomass by the ratio of input heat quantity, biomass content is shown in the figure.

*Hydrogen (co-firing) assumed co-firing with gas fired power. The generated electricity proportionally divided into gas and hydrogen by the ratio of input heat quantity, and hydrogen content is shown in the figure. Gas content is included in gas w/o CCS.

A considerable amount of CCS introduction even at 40% reduction.

BECCS should be introduced instead of Coal with CCS at 70% reduction.

A considerable amount of renewables, especially PV, and hydrogen is required at 70% reduction.

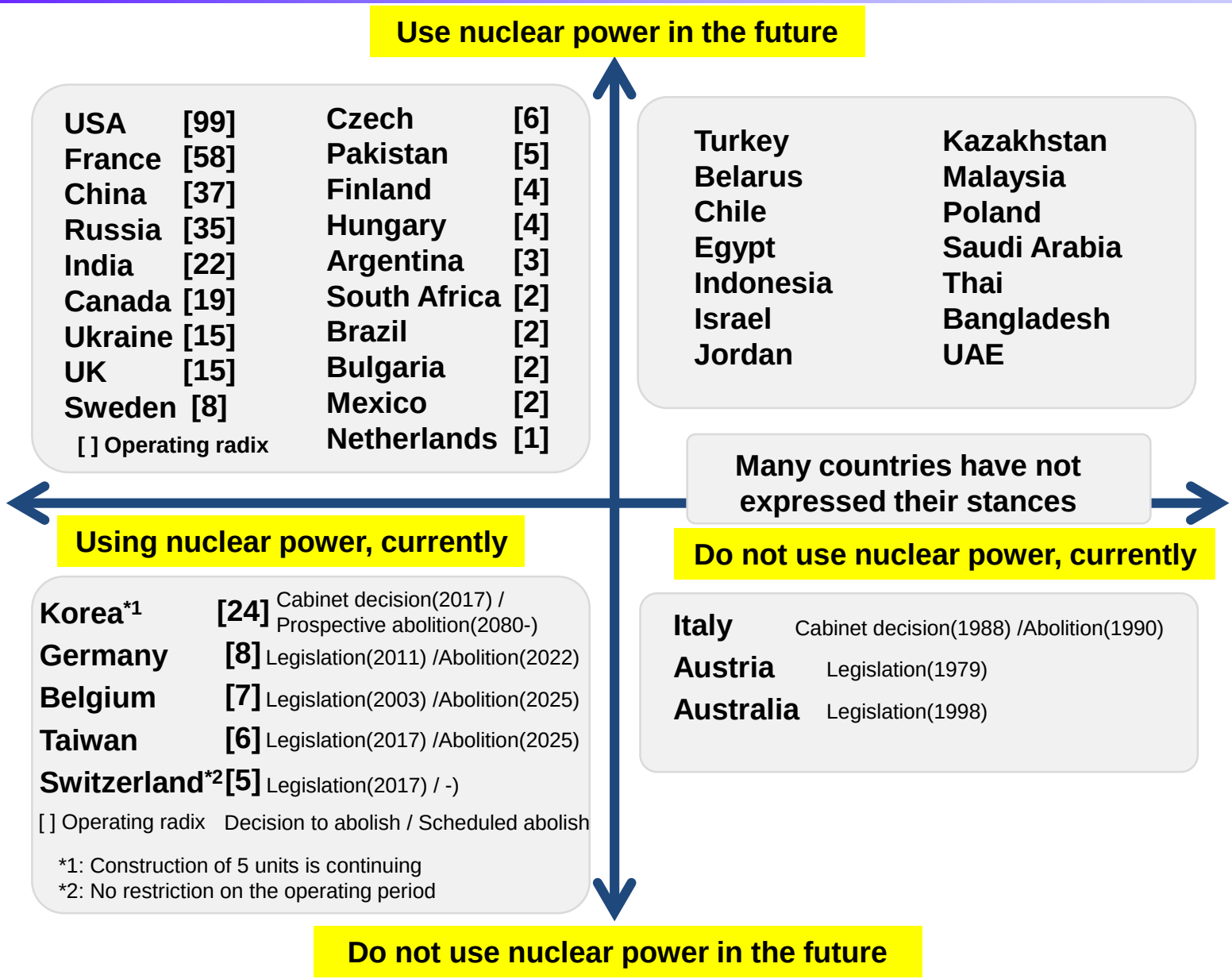
Changes in per capita CO2 emissions in major countries

CO2 emissions in Japan rise after the earthquake.
In Germany, CO2 reductions are sluggish, while UK and France steadily reduce.
China's CO2 emissions has increased to the comparable level of developed countries, while the US tends to decline, the level is still high.

	2000		2009		2015
USA	20.0t	-3.3	16.7t	-3.3	15.5t
Japan	9.0t	-0.7	8.3t	+0.7	9.0t
* Germany	10.0t	-1.1	8.9t	±0	8.9t
China	2.5t	+2.8	5.3t	+1.3	6.6t
UK	8.8t	-1.4	7.4t	-1.4	6.0t
France	6.0t	-0.8	5.2t	-0.8	4.4t

* Adjusted by coal-fired power to increase renewables ⇒ No CO2 reduction

Utilization of nuclear power



Source : Energy situation roundtable discussion, April 10th 2018

Impacts of "Super Smart Society" (Society 5.0)

Society 5.0 is characterized by the sophisticated integration of cyberspace with physical space ("the real world")

Society 5.0 is capable of providing the **necessary goods and services to the people who need them at the required time and in just the right amount**; a society that is able to respond precisely to a wide variety of social needs; a society in which all kinds of people can readily obtain high-quality services, overcome differences of age, gender, region, and language, and live vigorous and comfortable lives.

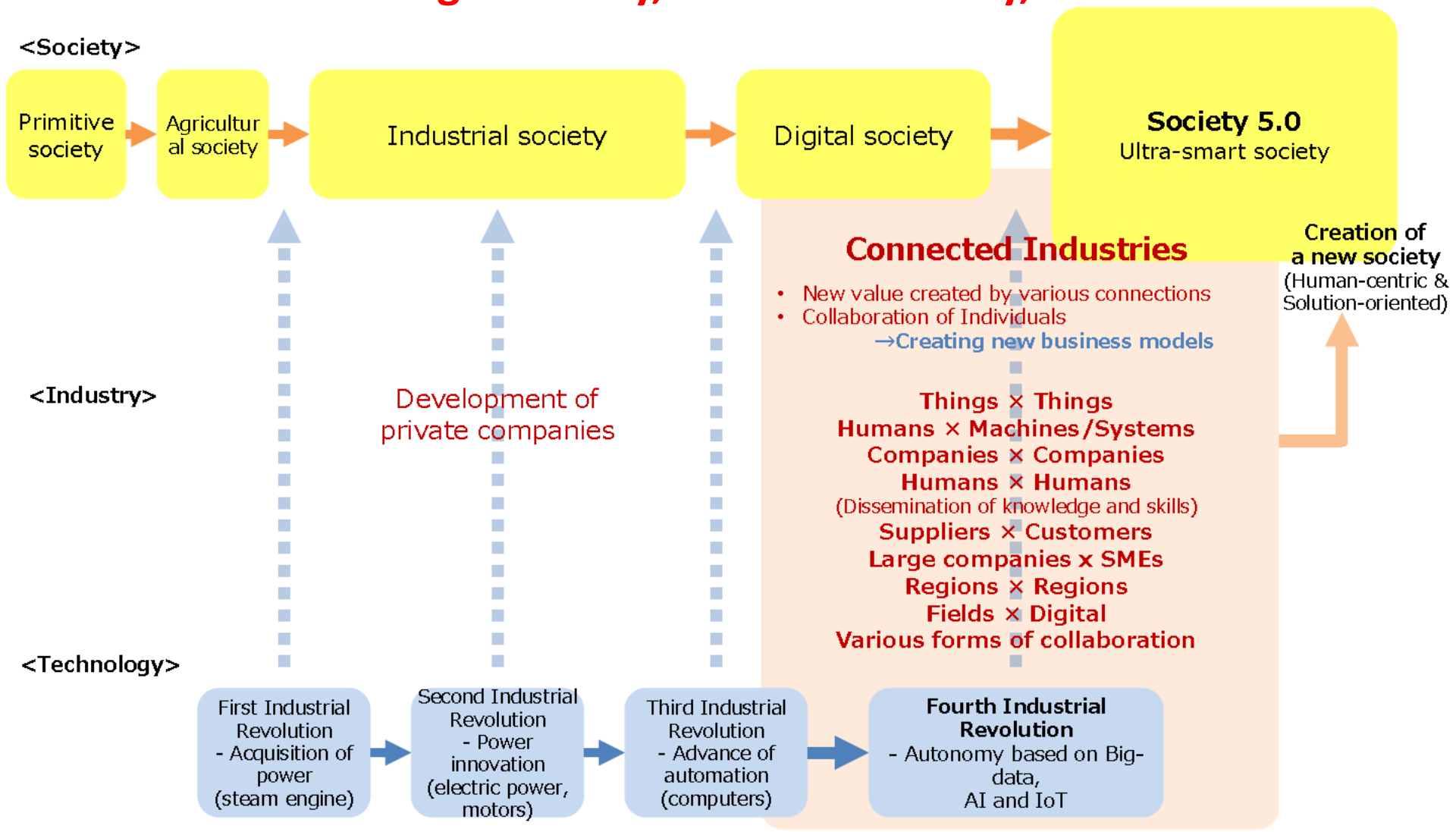
Beyond energy saving, Society 5.0 promotes sharing economy to shift the industry from manufacturing to service providers leading to a ultimate circular society.

Information replaces Material

1) car/ride share → car ↓ → car productions ↓ → material needs ↓ → energy/CO_2 ↓
2) smart maintenance → component replace↓ → material needs ↓ → energy/CO_2 ↓
3) IC tag for all component → recycling rate ↑ → material needs ↓ → energy/CO_2 ↓

“Society 5.0” and “Connected Industries”

⇒ Sharing Economy, Circular Economy, …



Source: METI, “Connected Industries” Tokyo Initiative, October 2017

There are a lot of things in every sector we can reduce.

- Operating rate of automobiles: **4%**
- Vacant houses: **13%**
- **More than half** of the people have leftover medicine.
- **One third** of foods are wasted.
- **Twenty-two pieces of unused clothing** in women's closet
- **40%** of rooms in hotel is unoccupied.

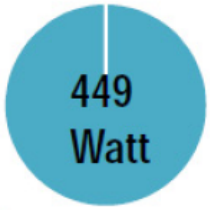
(Lacy and Rutqvist (2015))

(Sources): Sugiyama (2017), SCJ (Science Council of Japan) symposium, Sept. 27, 2017

There are a lot of things in every sector we can reduce.

(Source: IIASA)

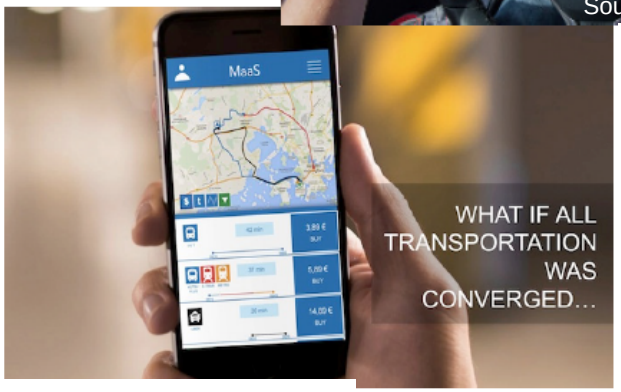
Telephone, Camera, Sound devices, TV, PC, Lighting…



Power consumption

Stand-by

- Our society does not consume energy as the purpose, but consume energies associated with products and services which increase our welfare.
- The end-use products and services which increase our welfare will usually diffuse rapidly, and energy use and CO2 associated with those may decrease rapidly.

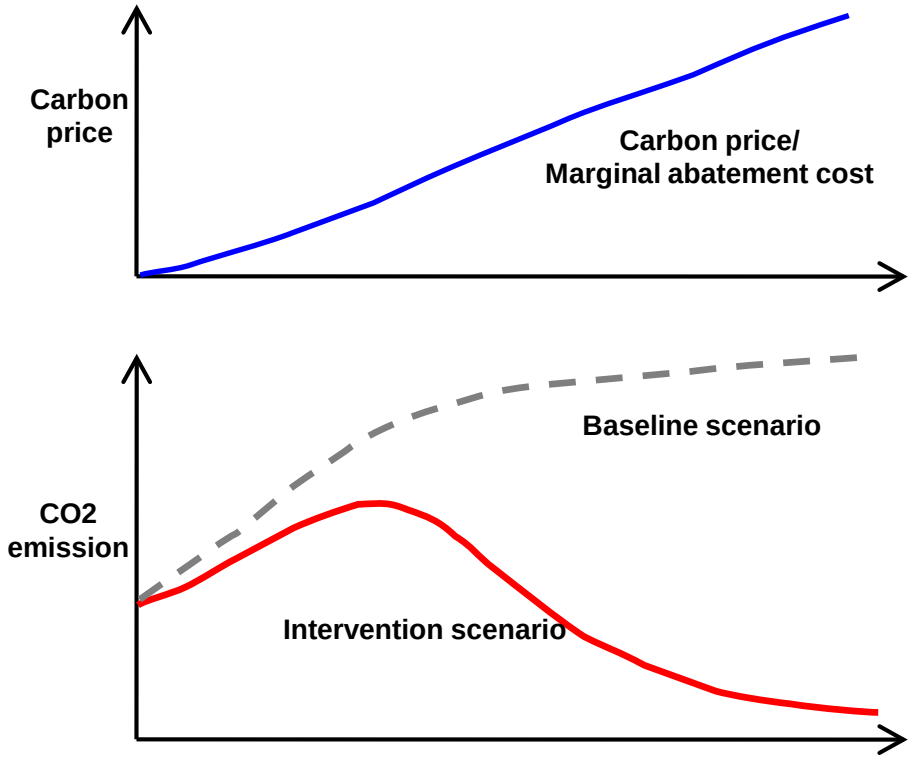


(Source: Finland)

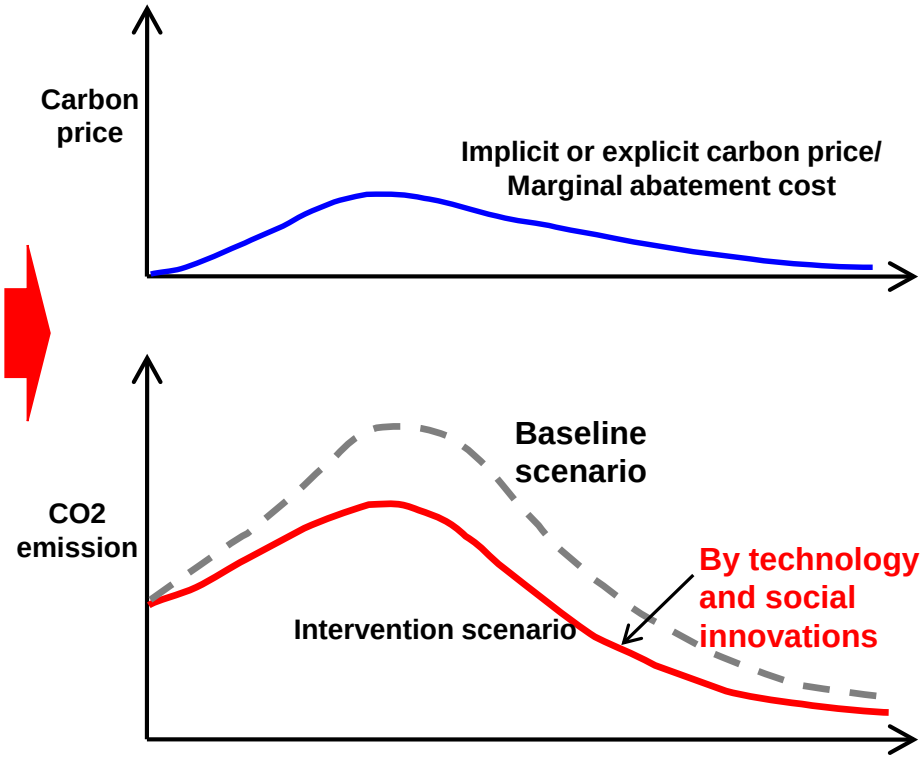
Social changes (by the development of AI, IoT, Big data) in cooperation with services (e.g. MaaS) through fully autonomous cars, car sharing and IoT

Image of standard scenario by models and real world scenarios for deep cuts

Model world:
Ordinary technology progress



Realistic world requirement:
Innovations stimulated & implemented



Explicit high carbon prices of such as over 100$/tCO2 in real price are unlikely in a real world. Technology and social innovations resulting in low (implicit or explicit) carbon prices (including coordination of secondary energy prices) are key for deep emission cuts to be implemented.

Pathways to Net Zero Emission

Super Smart Society (Society 5.0)
IoT, AI, Big Data, Blockchain, Smart Sensor, …

Integration of Energy and ICT

Mobilize demand side
DR, V2G, VPP, etc.

Social system reform: material producer → service provider, etc.
→ utilization rate up, recycle up, longer life, etc.

Reduced material demands, Behavior change, etc.

Revolutionary Energy Saving through
Electrification and Digitalization of Energy
(EV, PHEV, FCV, Heat Pump, …..)

Carbon Free Power Source:
Renewables, Nuclear,
Fossil Fuel with CCS

Energy
Storage
Battery, PtX…

Clean and Efficient Energy Carrier
(Electricity, Hydrogen etc.)

Carbon Free Fuel:
Biomass, Fossil Fuel
with CCS, etc.

Carbon Free Heat Source:
Solar Heat, Geothermal, etc.

Power sector will be requested to be negative emission in Global Net Zero Emission Scenarios:
BECCS(Bioenergy+CCS) should be comparatively evaluated with other options such as afforestation, CO_2 use, geoengineering (DAC, (SRM) …), etc.

SDGs

+ Adaptation

Keep Options as Many as Possible!


ご清聴ありがとうございました
Thanks for your attention