15th Japan-Europe Forum:
The impact of geopolitical developments on energy security, environment, supply chains and green transformation
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The impact of geopolitical developments on energy security and environment: Japan's perspectives

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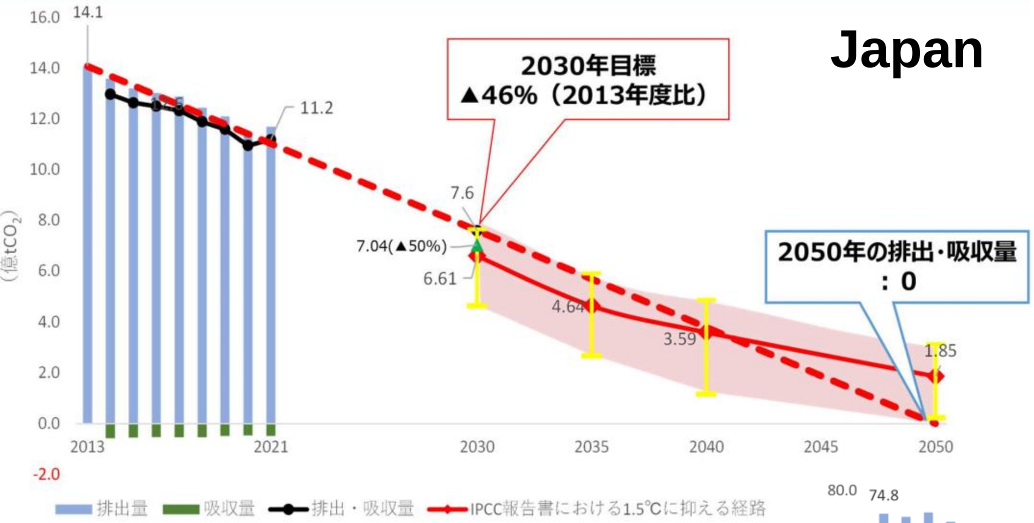
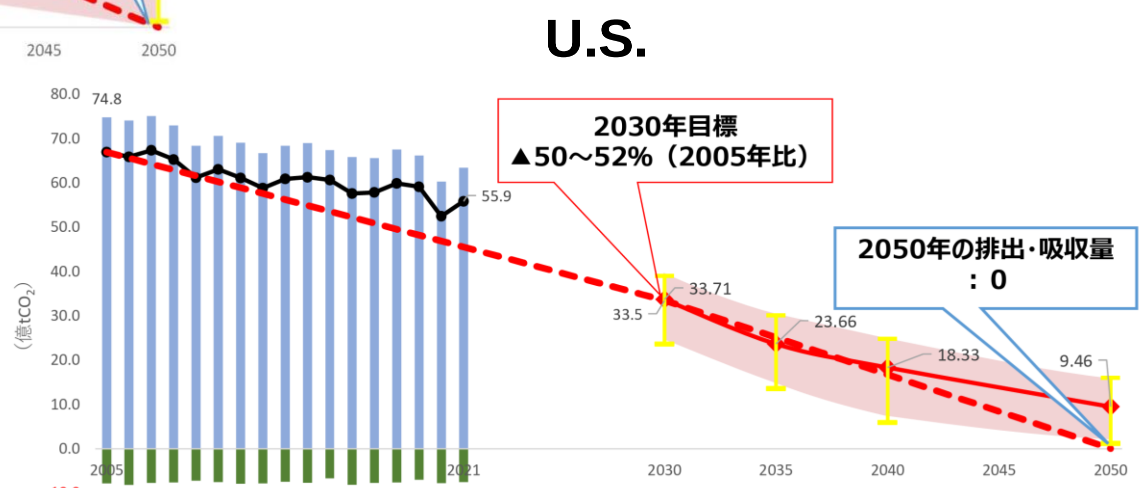
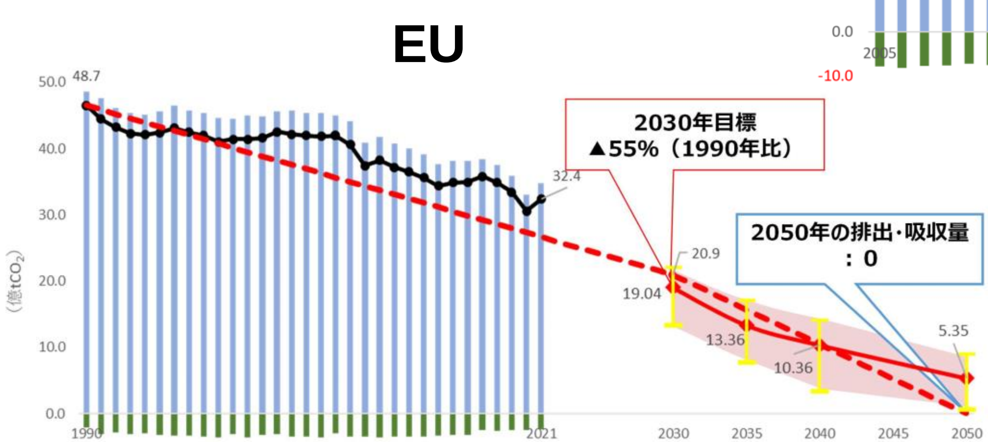
Status of Emissions Reductions



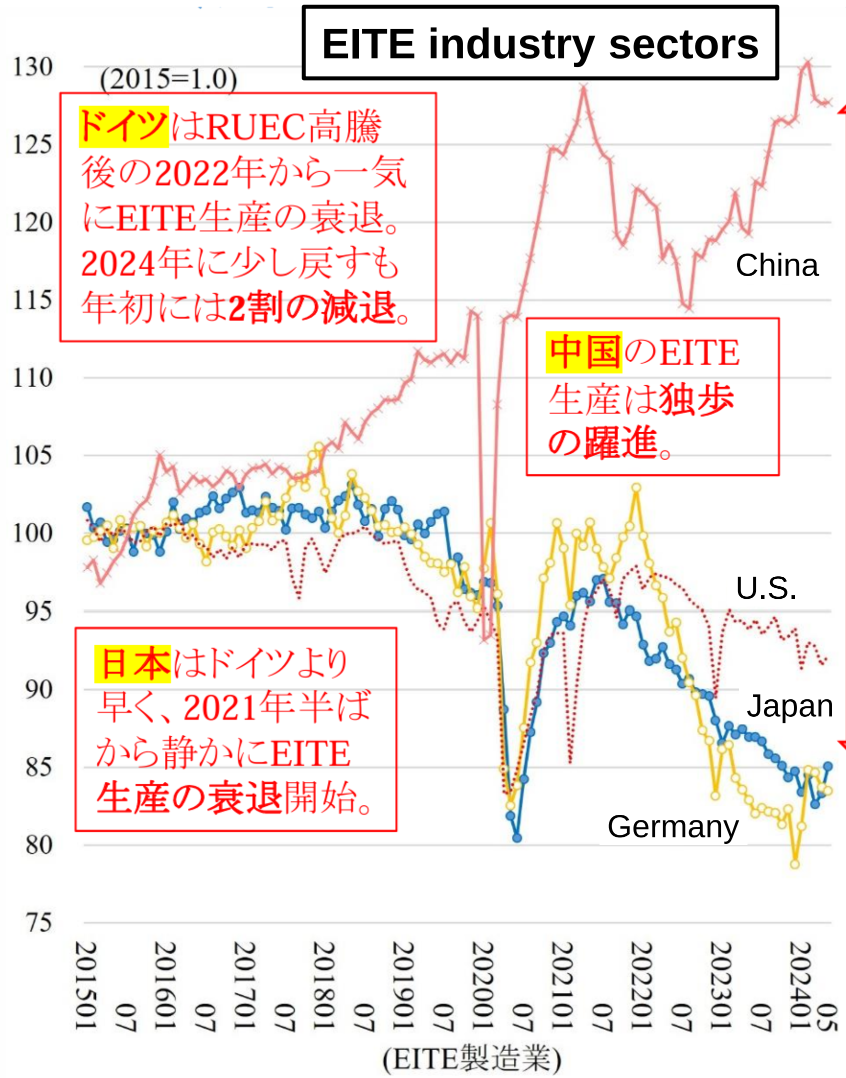
- ✓ **The emissions in many developed countries are off-track toward the 2030 NDC or net-zero in 2050.**
- ✓ **The Government of Japan claims it is "on-track," but …**

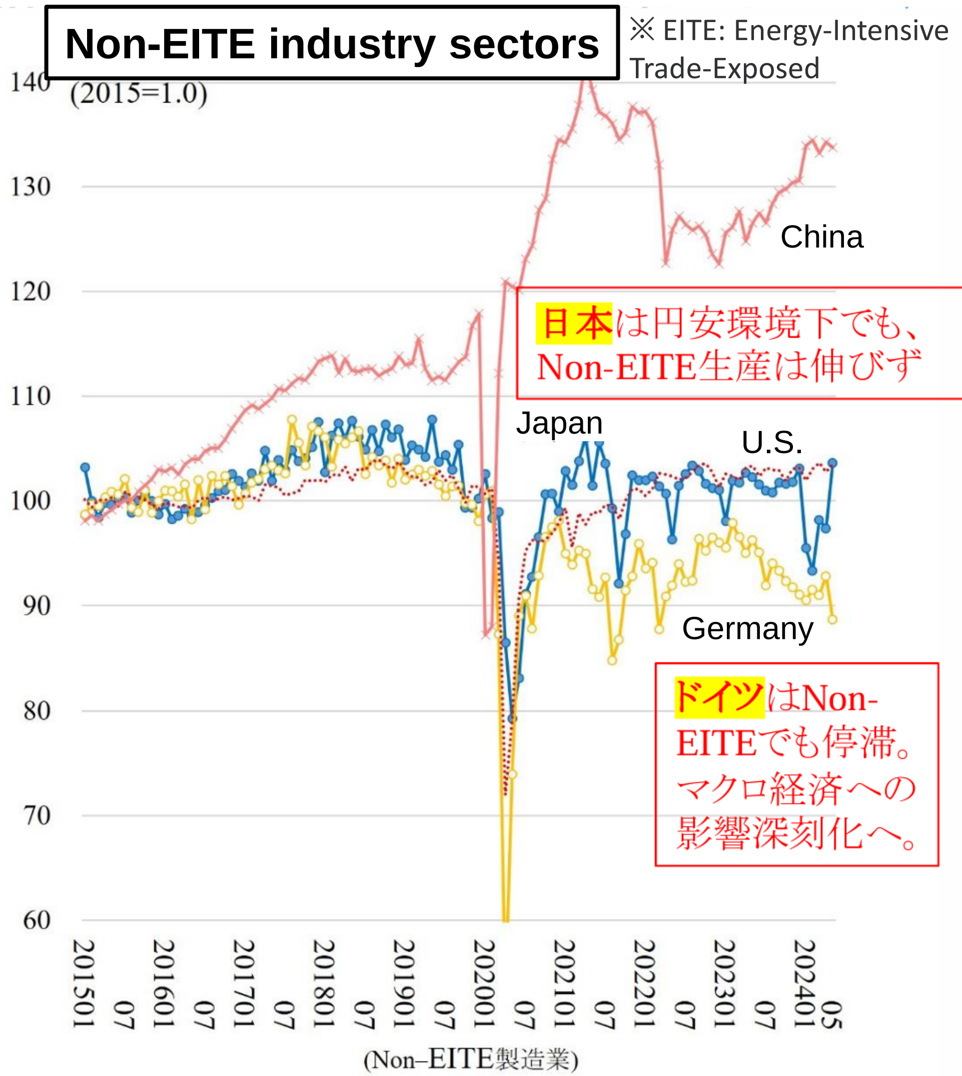




Source) The Government of Japan (2023)

Weighted Production Index in Japan, Germany, US, and China: Industry leakage



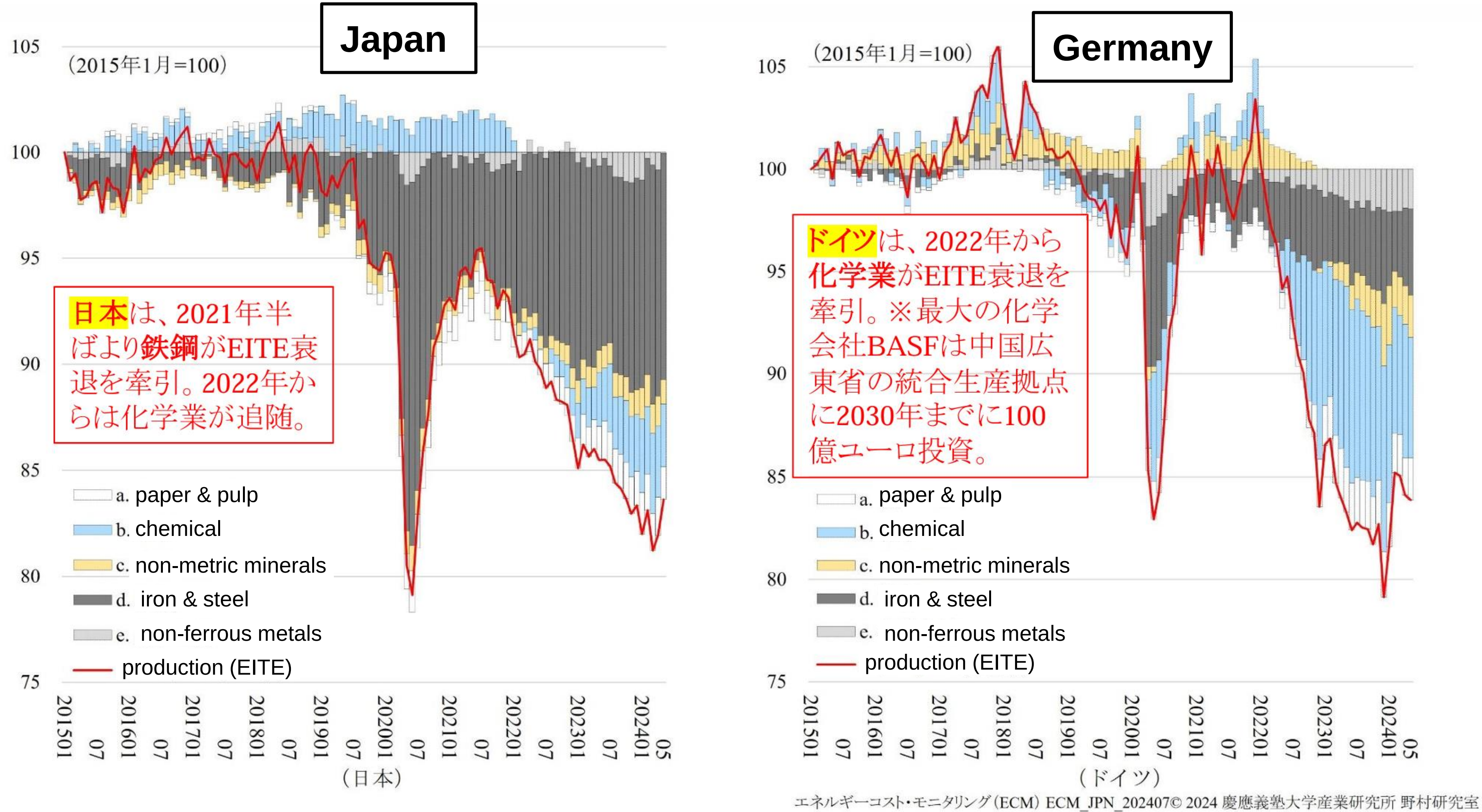


エネルギーコスト・モニタリング（ECM）ECM_JPN_202407© 2024 慶應義塾大学産業研究所 野村研究室

単位：2015年値＝100 。出典：ECM_JPN_202407（慶大産研野村研究室, 2024年8月3日公表）。測定の詳細はNomura and Inaba (2024)"Post-Pandemic Surges of Real Unit Energy Costs in Eight Industrialized Countries,“ RCGW Discussion Paper, Research Center on Global Warming, Development Bank of Japan.

Source) Koji Nomura (Keio Univ.) (2024)

Production changes by EITE sector in Japan and Germany

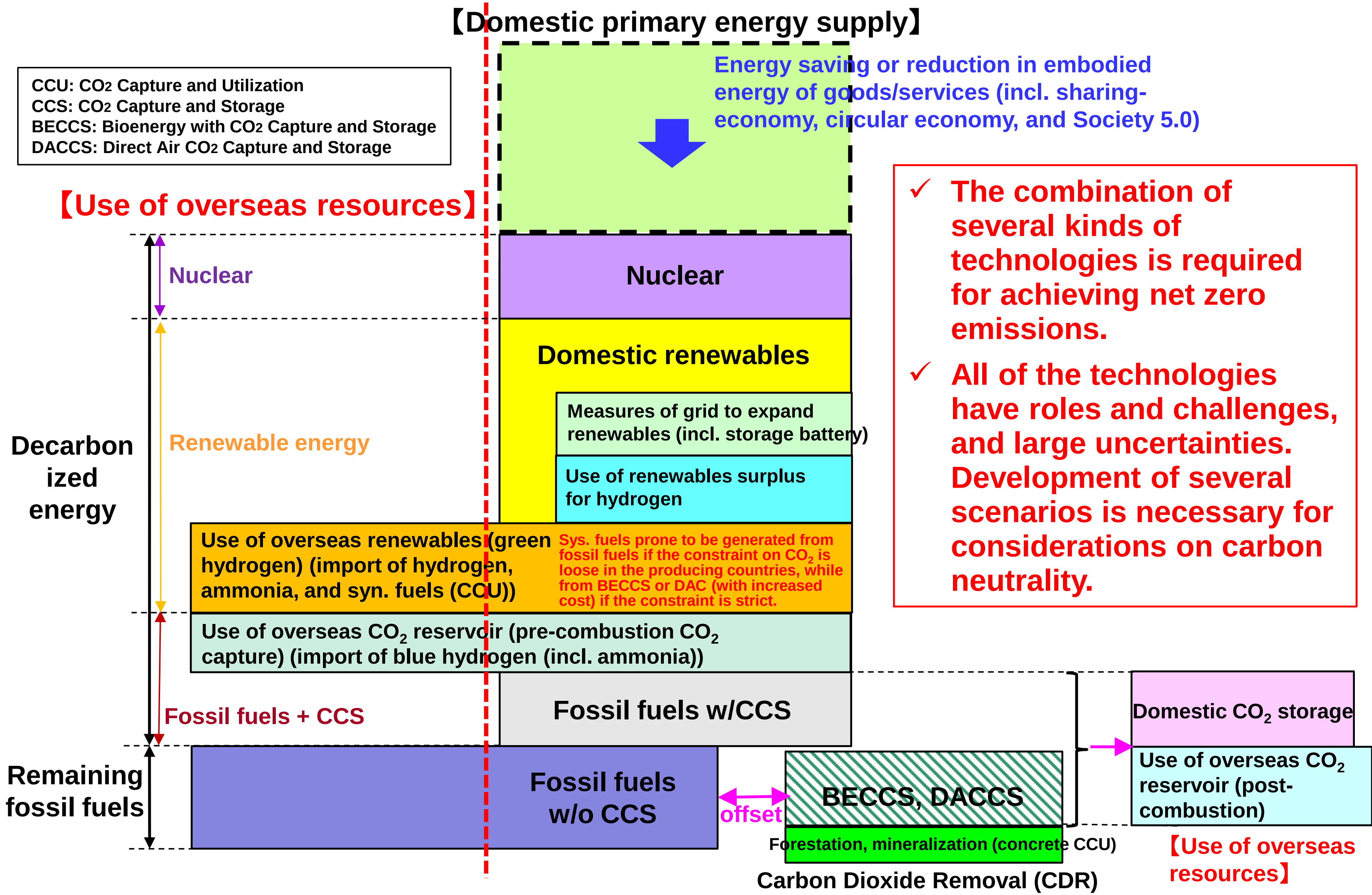


単位：2015年1月値＝100 。出典：ECM_JPN_202407（慶大産研野村研究室，2024年8月3日公表）。測定の詳細はNomura and Inaba (2024)"Post-Pandemic Surges of Real Unit Energy Costs in Eight Industrialized Countries,“ RCGW Discussion Paper, Research Center on Global Warming, Development Bank of Japan.

Source) Koji Nomura (Keio Univ.) (2024)

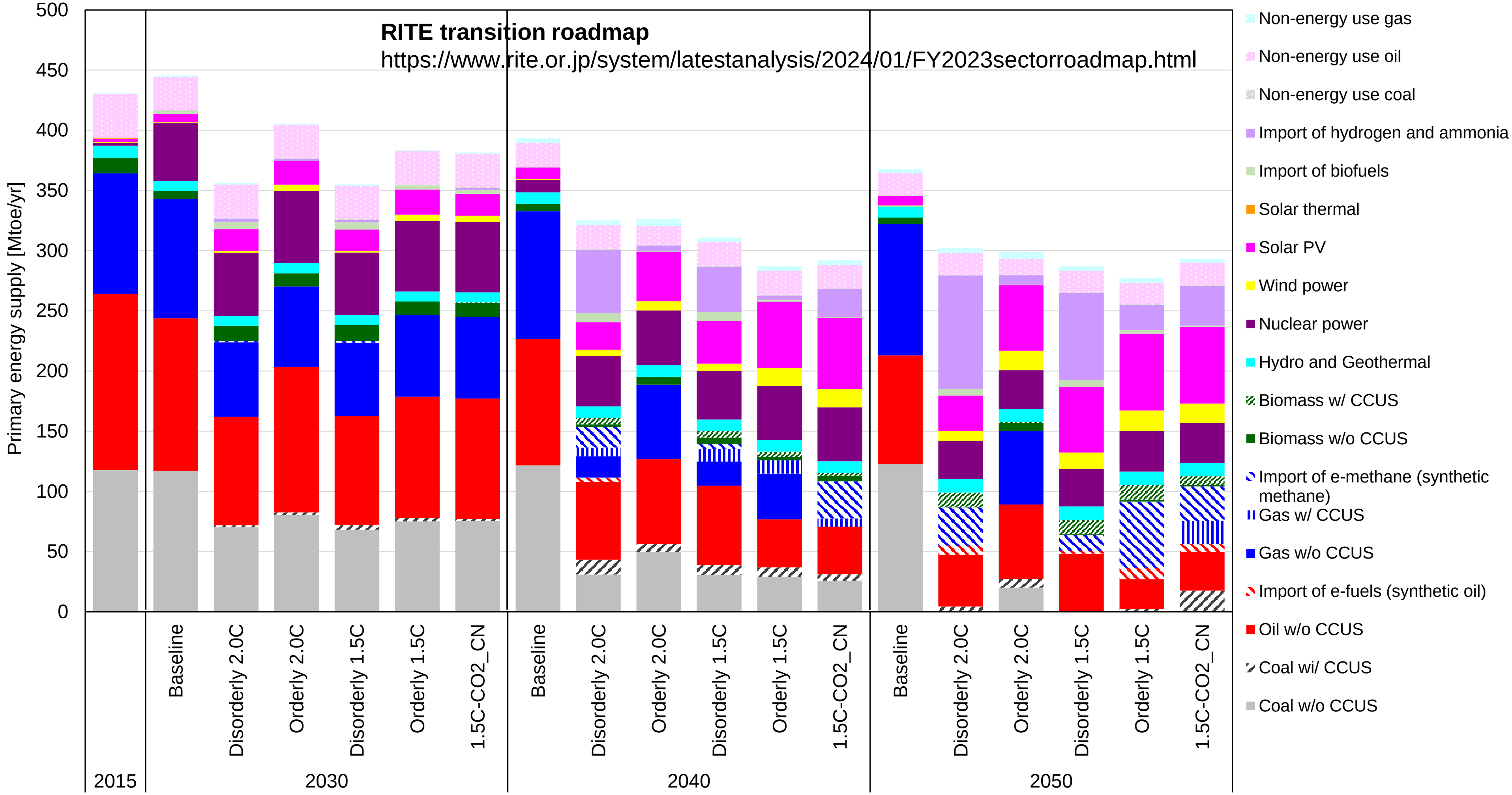
Image of Primary Energy in Japan (or a Country) for Net Zero Emissions

CCU: CO_2 Capture and Utilization
CCS: CO_2 Capture and Storage
BECCS: Bioenergy with CO_2 Capture and Storage
DACCS: Direct Air CO_2 Capture and Storage



- ✓ The combination of several kinds of technologies is required for achieving net zero emissions.
- ✓ All of the technologies have roles and challenges, and large uncertainties. Development of several scenarios is necessary for considerations on carbon neutrality.

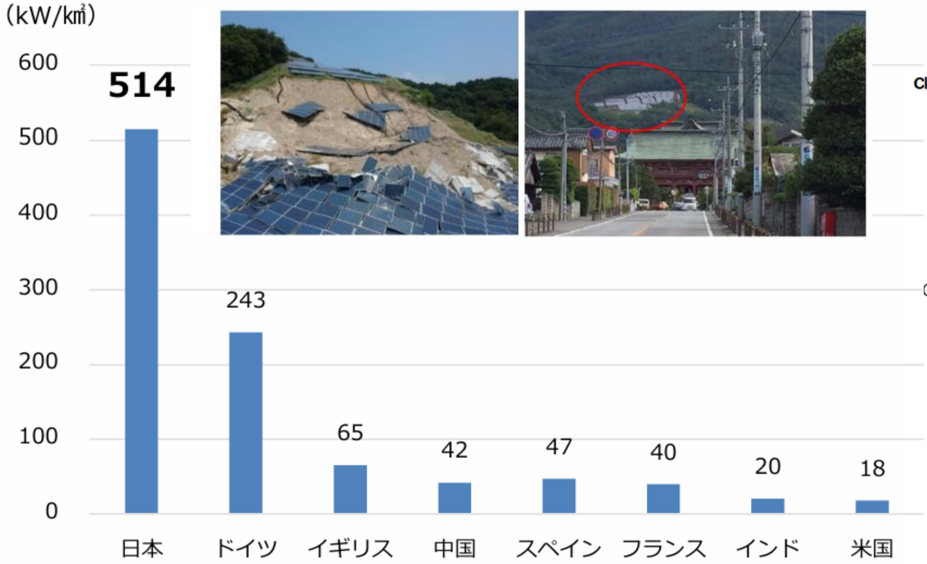
Energy transition meeting the 2C/1.5C scenarios: primary energy supply in Japan



- ✓ **There are several kinds of pathways to meet the 2C or 1.5C goals.**
- ✓ **Import of hydrogen and ammonia, e-methane, and biofuels would be cost-effective as the MAC of Japan is higher than other countries. However, those amounts in Orderly 2.0°C are relatively small (-69% in 2050).**
- ✓ **Import of hydrogen and ammonia, e-methane, and biofuels would be cost-effective as well in 1.5C -CO_2_CN.**

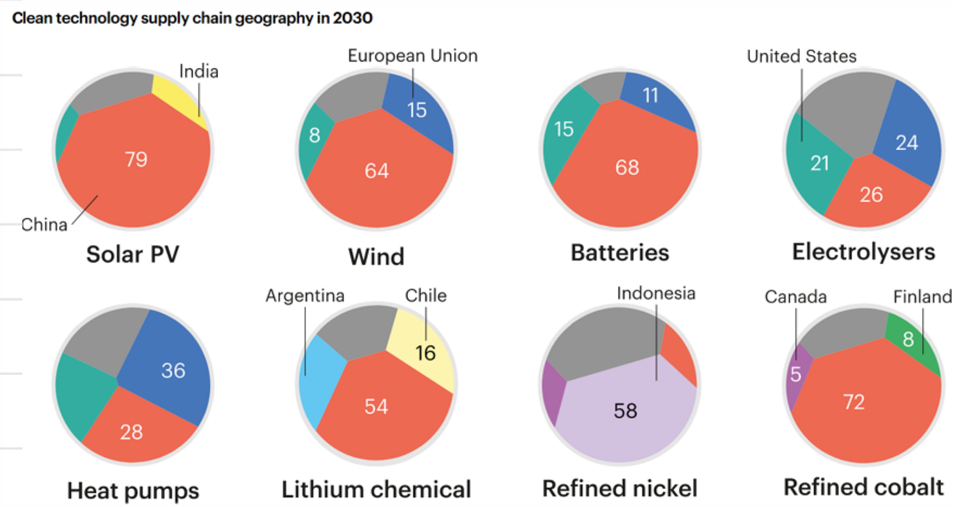
Challenges of renewables

【平地面積あたりの太陽光設備容量】



（出所）外務省HP（https://www.mofa.go.jp/mofaj/area/index.html）、Global Forest Resources Assessment 2020（http://www.fao.org/3/ca9825en/CA9825EN.pdf）
IEA Renewables 2022、IEAデータベース、2021年度エネルギー需給実績(確報)、FIT認定量等より作成
※平地面積は、国土面積から、Global Forest Resources Assessment 2020の森林面積を差し引いて計算したもの。

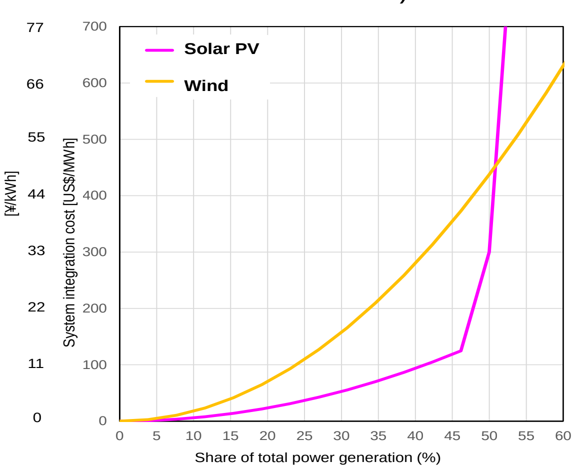
【環境関連技術の国際サプライチェーンの見通し（IEA）】



（注）数字は2030年の国別製造能力のシェア（%）。計画段階のものを含む。
（出所）IEA World Energy Outlook 2023

Source) The Government of Japan (2024)

[Estimated grid integration costs of VRE in Japan]
Grid integration costs approximated from the analysis of the Univ. of Tokyo – IEEJ power generation mix model



- ✓ **Challenges in good harmonizations with other land uses, due to low energy intensity**
- ✓ **High dependences on China**
- ✓ **High grid integration costs of VRE**

LNG price spike

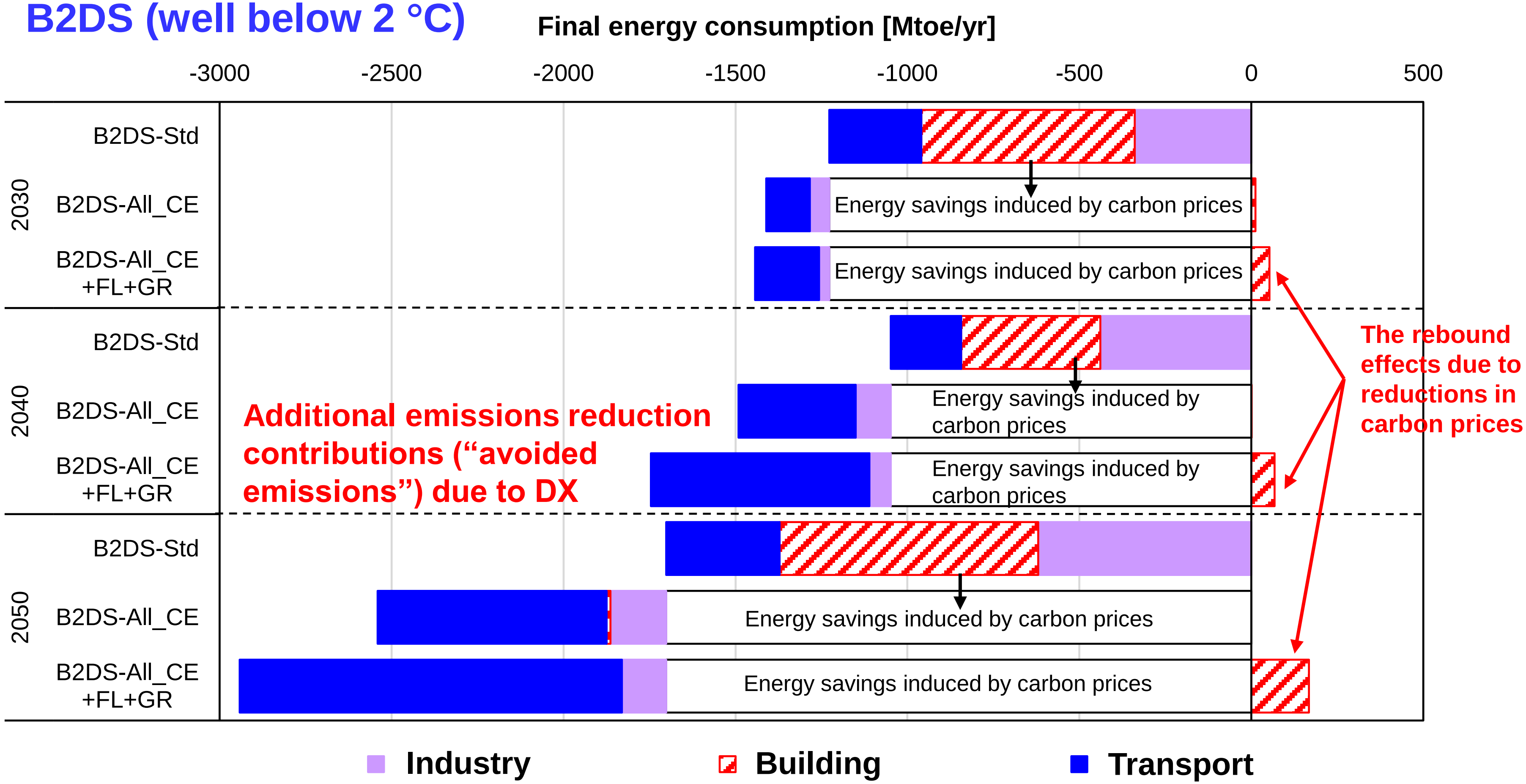
（出所）Platts 、IMF 、ICE ほか、各種資料により JOGMEC 作成　　※日本平均 LNG 輸入価格内にスポット契約による購入 LNG カーゴが含まれることに留意。

Source) The Government of Japan (2024)

- ✓ **Long-term contract for LNG will be important.**
- ✓ **For the long-term contract with affordable prices, a certain levels of amounts of LNG demands for long-term will be required.**
- ✓ **Pragmatic and effective emissions reduction will be important particularly in the transition periods toward net-zero emissions.**

GX induced by DX: Low Energy Demand Society

B2DS (well below 2 °C)



Ref.) Global final energy consumption in 2019: 10 Gtoe/yr; baseline final energy consumption in 2050: 14 Gtoe/yr

The impacts of 1) ride- and car-sharing, 2) virtual meeting, 3) e-publication, 4) Recycling and reductions in apparels, 5) longer life time of buildings due to improv. in city planning, 6) reductions in food losses due to better demand projection, 7) AM (3D-printing) for applying aircraft, and 8) reductions in freight shipping services due to reductions in basic materials and products are considered for the estimations.

- ✓ **There are the opportunities achieving a low energy demand society through sharing- and circular economies with low costs potentially due to DX.**
- ✓ **Low energy demand society will enhance the energy securities.**

Conclusion

- **The leakages of energy-intensive industries from developed countries can be observed. The leakages are largely concerned also from energy/economic security viewpoints, as well as economic and employment issues. It is important to keep within a certain levels of the relative costs of energy between domestic and overseas to avoid the leakages.**
- **Renewable energies, particularly of solar PV and wind power, are important options to achieve deep emissions reduction and robustness to price spike of fossil fuels. However, the grid integration costs will be high according to their expansions particularly in Japan.**
- **The importance of long-term contracts for LNG even under the pathways to net-zero emissions (e-methane may play some flexible roles).**
- **Nuclear power will be a necessary option to achieve 3E (energy security, economics, and environment).**
- **There are the opportunities achieving a low energy demand society through sharing- and circular economies with low costs potentially due to DX. Low energy demand society will enhance the energy securities.**

Appendix

Energy Assessment Model: DNE21+
(Dynamic New Earth 21+)

- Systemic cost evaluation on energy and CO_2 reduction technologies is possible.
- Linear programming model (minimizing world energy system cost; with appox. 10mil. variables and approx. 10mil. constrained conditions)
- Evaluation time period: 2000-2100
  Representative time points: 2005, 2010, 2015, 2020, 2025, 2030, 2040, 2050, 2070 and 2100
- World divided into 54 regions
  Large area countries, e.g., US and China, are further disaggregated, totaling 77 world regions.
- Interregional trade: coal, crude oil/oil products, natural gas/syn. methane, electricity, ethanol, hydrogen, CO_2 (provided that external transfer of CO_2 is not assumed in the baseline)
- Bottom-up modeling for technologies on energy supply side (e.g., power sector) and CCUS
- For energy demand side, bottom-up modeling conducted for the industry sector including steel, cement, paper, chemicals and aluminum, the transport sector, and a part of the residential & commercial sector, considering CGS for other industry and residential & commercial sectors.
- Bottom-up modeling for international marine bunker and aviation.
- Around 500 specific technologies are modeled, with lifetime of equipment considered.
- Top-down modeling for others (energy saving effect is estimated using long-term price elasticity.)

- **Regional and sectoral technological information provided in detail enough to analyze consistently.**
- **Analyses on non-CO_2 GHG possible with another model RITE has developed based on US EPA's assumptions.**

- **Model based analyses and evaluation provide recommendation for discussions on some energy and climate change policy making processes, e.g., cap-and-trade system, Environmental Energy Technology Innovation Plan, 6th Energy Strategic Plan for the Government of Japan, and also contribute to IPCC scenario analyses.**

The transition scenarios for the 2 °C and 1.5 °C goals

Scenarios	Global average temp. increase	Policy speed#	CDR contribution	Renewables and BEV	Differences in policy intensity among regions	Relation to other scenarios		
						IPCC AR6 (IPCC 2022)	NGFS (2022)	IEA
Disorderly Below 2 °C	1.7 °C in 2100 (peak:1.8 °C)	Gradual (NDCs in 2030)	medium	Medium cost reductions	Large (major developed countries: CN by 2050)	Likely below 2 C, NDC [C3b]	Disorderly: Delayed Transition	APS (WEO 2022)
Orderly Below 2 °C	1.7 °C	Rapid	Small	High cost reductions	Small (equal MAC among countries)	Likely below 2 C with immediate action [C3a]	Orderly: Below 2C	SDS (WEO 2021)
Disorderly 1.5 °C	1.4 °C in 2100 (peak:1.7 °C)	Gradual (NDCs in 2030)	Large	Medium cost reductions	Large (major developed countries: CN by 2050)	1.5 C with high overshoot (IMP-Neg) [C2]	(Disorderly: Divergent Net Zero)*	
Orderly 1.5 °C	1.4 °C in 2100 (peak:1.6 °C)	Rapid	Medium	High cost reductions	Medium (major developed countries: CN by 2050)	1.5 C with no or limited overshoot [C1]	Orderly: Net Zero2050	
1.5C-CO2_CN	Approx. below 1.5 °C	Rapid	Small (Near-zero of CO_2 by sector)	High cost reductions	Large (major developed countries: CN by 2050)	1.5 C with no or limited overshoot [C1]		NZE

The emission reduction targets in 2030 of NDCs submitted in the end of December 2021 are considered.

* The emissions pathway is rather similar to the Orderly 1.5 °C

- ✓ **The assumed scenarios are consistent with the long-term goals of Paris Agreement, and cover the existing scenarios which are widely referred globally.**
- ✓ **The scenarios also cover a certain range of uncertainties in technologies and policies.**

Low energy demand scenarios due to DX (1/2)

Digitalization and innovations, and induced social changes – Demand reductions (1/2)

Changes due to digitalization	Direct impacts	Indirect impacts
1) Ride and car-sharing associated with fully autonomous cars	- Energy consumption reductions due to ride-sharing	- Reductions in consumption of basic materials due to reductions in number of cars - Reductions in freight shipping => 8)
2) Virtual meeting and teleworking	- Reductions in travel service demand and the associated reductions in energy consumptions in transport sector	- Potential reductions in numbers of commercial building, and the resulting reductions in basic materials *[Not yet]*
3) E-publication etc.	- Reductions in paper consumptions due to large deployment e-publications etc.	- Potential reductions in freight services for papers. *[Not yet]*
4) Recycling and reductions in apparels due to e-commerce and other digitalization	- Reductions in energy consumptions for apparel productions	- Potential reductions in energy consumption at shopping centers etc. *[Not yet]*

Red: residential sector, Green: commercial sector, Blue: transport sector, Purple: industry sector , Brown: Non-CO2 GHGs etc.

Low energy demand scenarios due to DX (2/2)

Digitalization and innovations, and induced social changes – Demand reductions (2/2)

Changes due to digitalization	Direct impacts	Indirect impacts
5) Longer life time of buildings due to improv. in city planning	- Potential Reductions in cement and steel due to longer life time of buildings	
6) Reductions in food losses due to better demand projection	- Reductions in nitrogen fertilizer, plastics, etc. and the resulting energy consumption reductions - Potential reductions in energy consumption at supermarkets etc. - Red. in CH4 and N2O	- Reductions in freight shipping services => 8) - *Pot. red. in construction for supermarkets etc., and the resulting reductions in basic materials [Not yet]* - *Pot. increases in afforestation due to increase in rooms of land area [Not yet]*
7) AM (3D-printing) for applying aircraft	- Reduction in aluminum and steel production - Reduction in electricity for productions	- Energy efficiency improvements of aircraft and the consumption reductions - *Energy efficiency improvements of cars and the consumption reductions [Not yet]*
8) Red. in freight shipping services due to reductions in basic materials and products	- Energy consumption reductions in freight shipping	

Red: residential sector, Green: commercial sector, Blue: transport sector, Purple: industry sector , Brown: Non-CO2 GHGs etc.