Vision of the energy industry toward a decarbonized society

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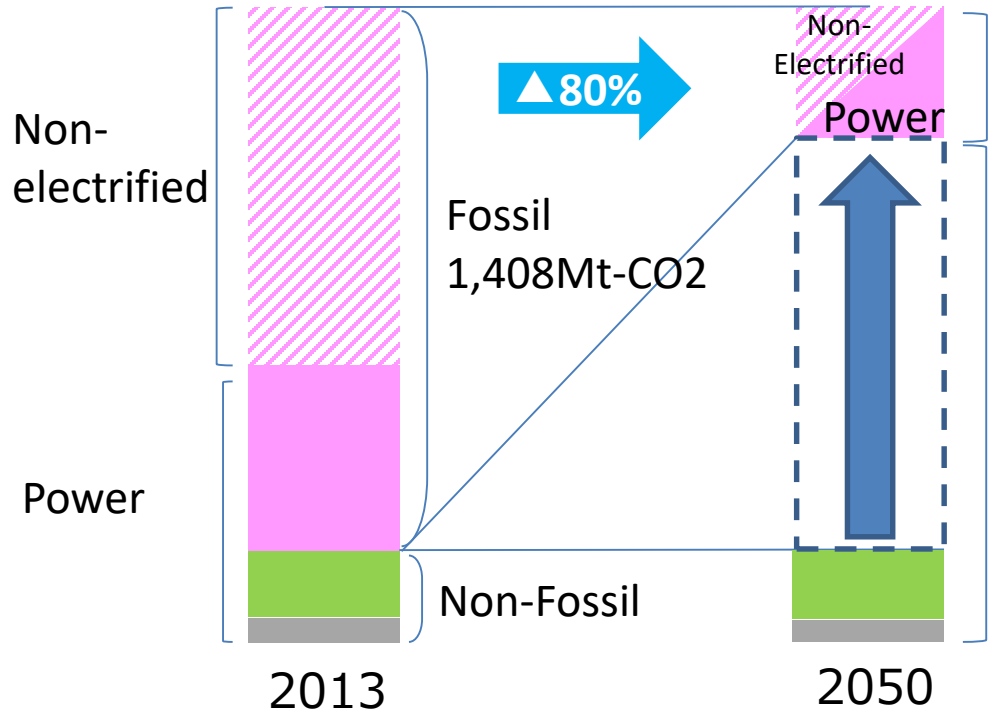
Toward a decarbonized society

■ CO2 emission from fossil fuel shall be suppressed to 170 Mt-CO2※ to meet the Japanese government GHG reduction target ▲80%(280 Mt-CO2) in 2050

※ Reduction of other GHGs and elimination through sinks
(Energy policy target deferred) ⇒115 Mt-CO2
CO2 emission from fossil fuel ⇒282 – 115 ≒170 Mt-CO2

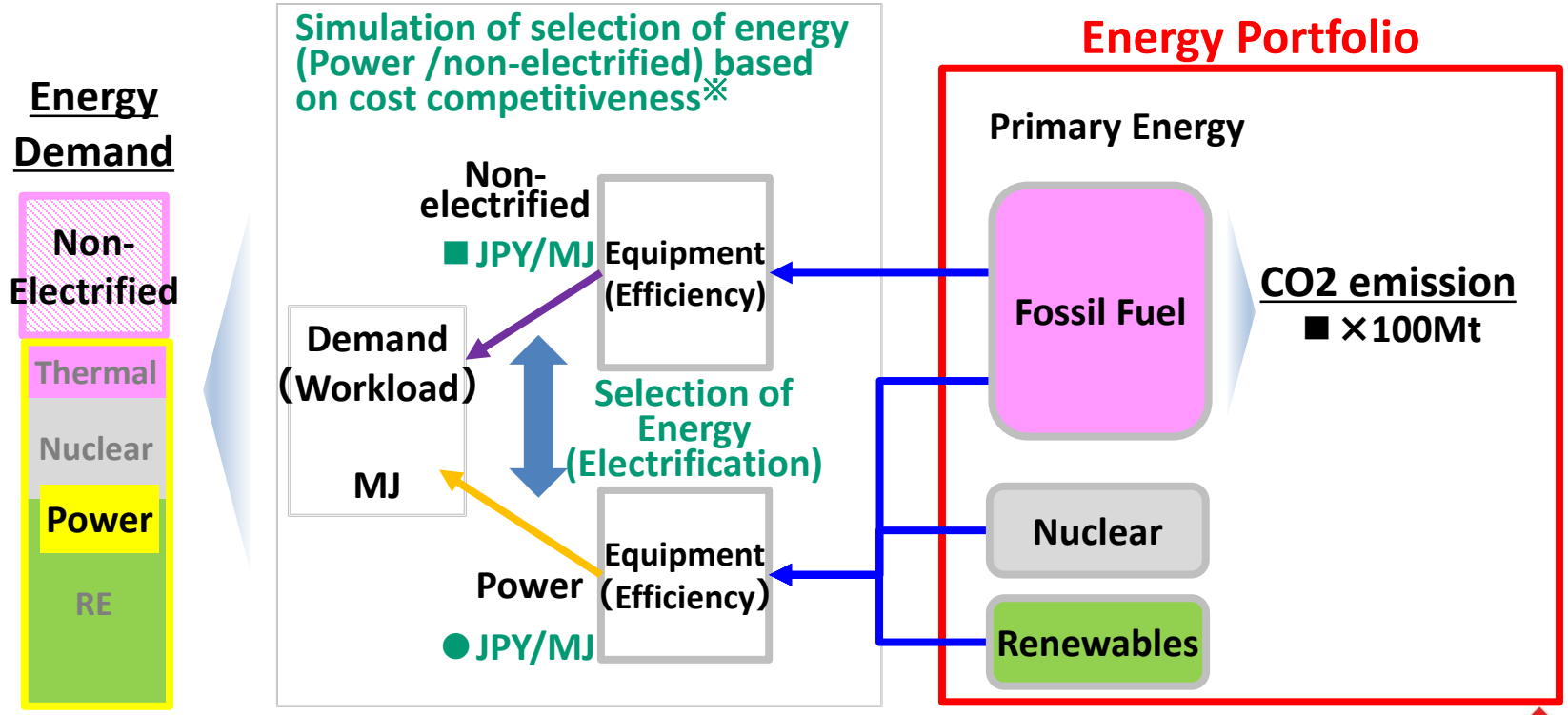
Energy demand and CO2 consumption



The future energy portfolio of Japan ?

Concept of energy portfolio estimation

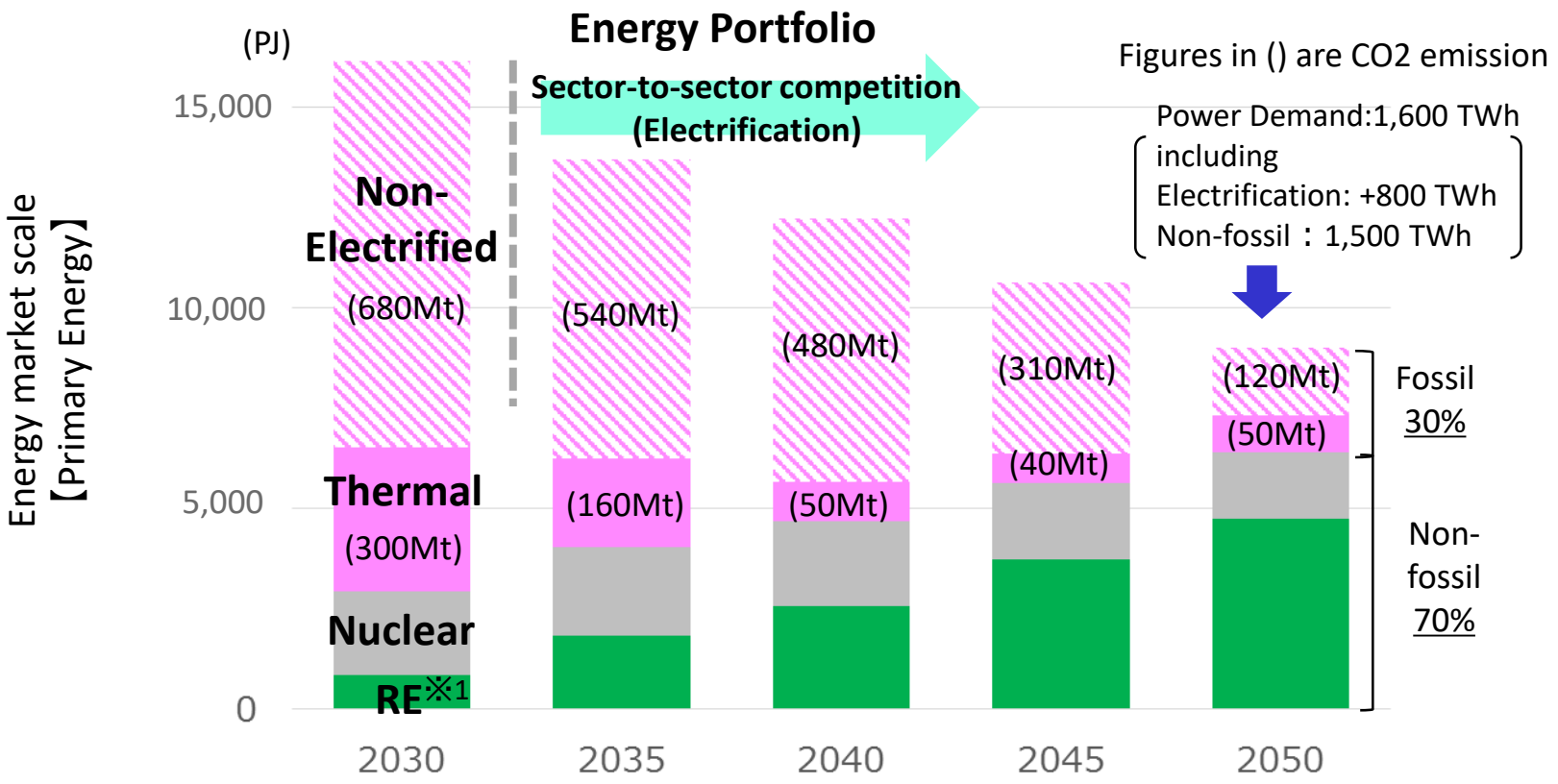
- Scenarios to realize low carbon energy portfolio by RE integration and Electrification are considered
- Optimal energy portfolio in terms of national burden satisfying the GHG reduction target is estimated
- Measures such as CO2 free H2, CC(U)S, Next Gen. Nuclear are excluded here, however, they may be alternatives of RE integration and Electrification



※Deployment of EVs reflected as a precondition

Estimated Energy Portfolio

■ Overall energy consumption reduced due to improvement of energy efficiency by the transition of fossil to non-fossil sources



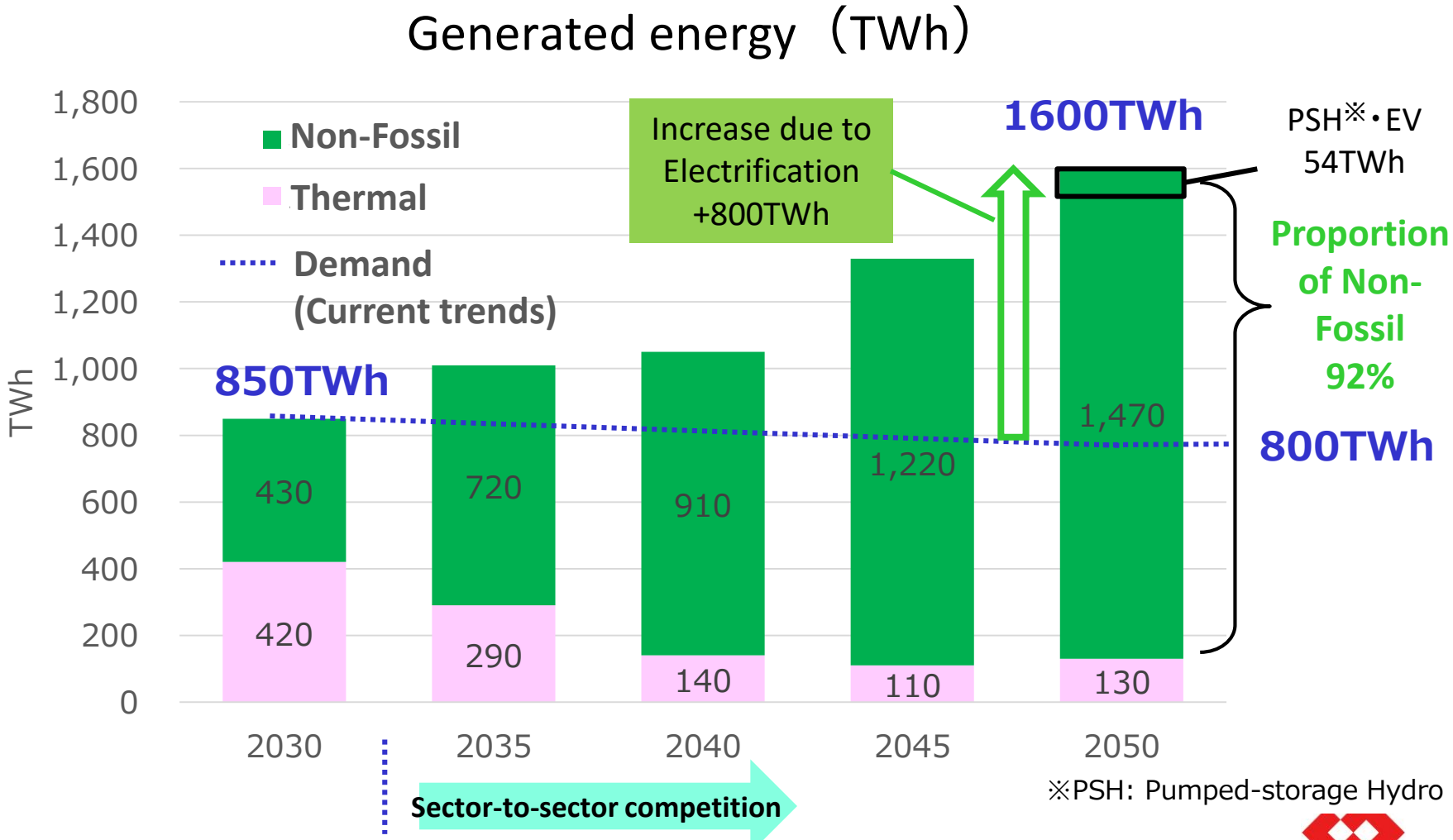
	2030	2035	2040	2045	2050
CO2 emission(Mt-CO2) (GHG reduction from 2013 level) ※2	980 (▲22%)	710 (▲42%)	530 (▲54%)	350 (▲67%)	170 (▲80%)

※1 Generated energy of RE considered as their primary energy

※2 GHG reduction considers those of other GHGs and elimination through sinks (115Mt)

Estimated Energy Portfolio【kWh balance】

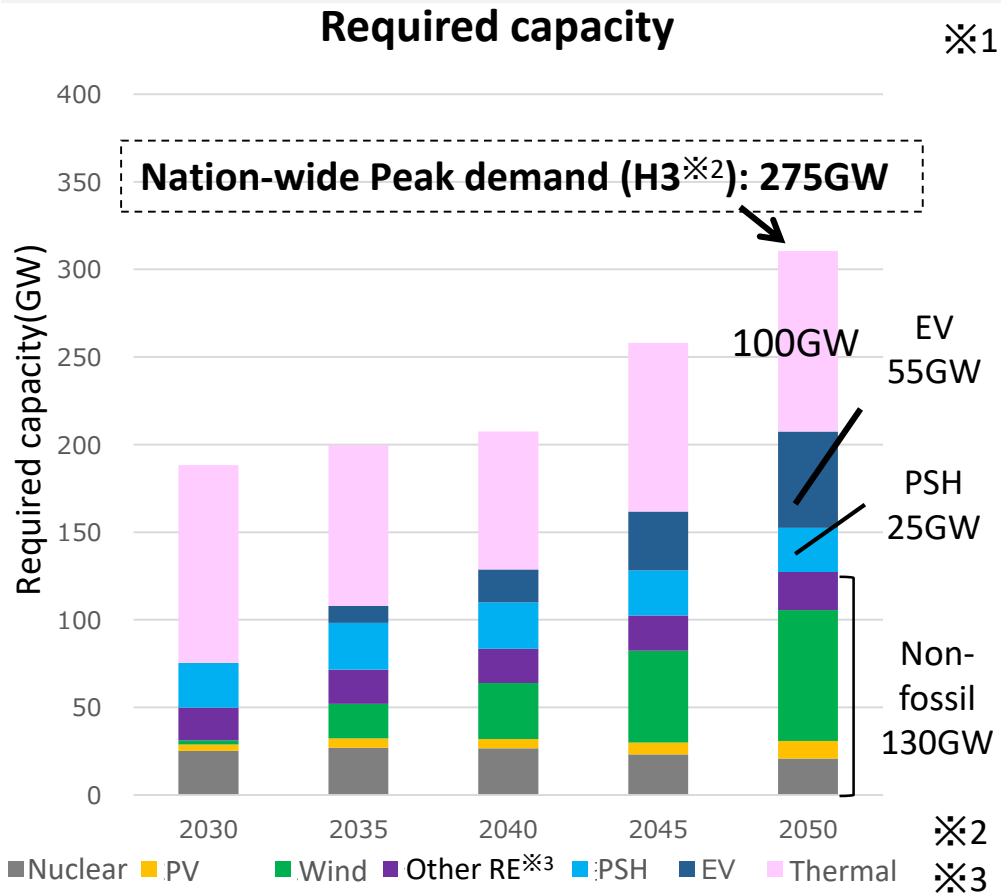
- Generation of Non-fossil power source increase due to the cost reduction of RE
- Thermal contributes as the backup for supply-demand gap



Estimated Energy Portfolio 【Required capacity】

■ Even considering maximum utilization of EVs※1, certain amount of conventional generation (nuclear, thermal, PSH) are required since the kW value (de-rating factors) of REs are relatively low

(in other words, their contribution to supply reliability)



※1 EV: 40 million vehicles in 2050 (5kW_60kWh/ vehicle)
30% of the total are assumed connected to the grid
(60GW_720GWh)

	De-rating factor
PV	Approx. 5%
Wind	Approx. 20%
PSH・EV	Approx. 90%

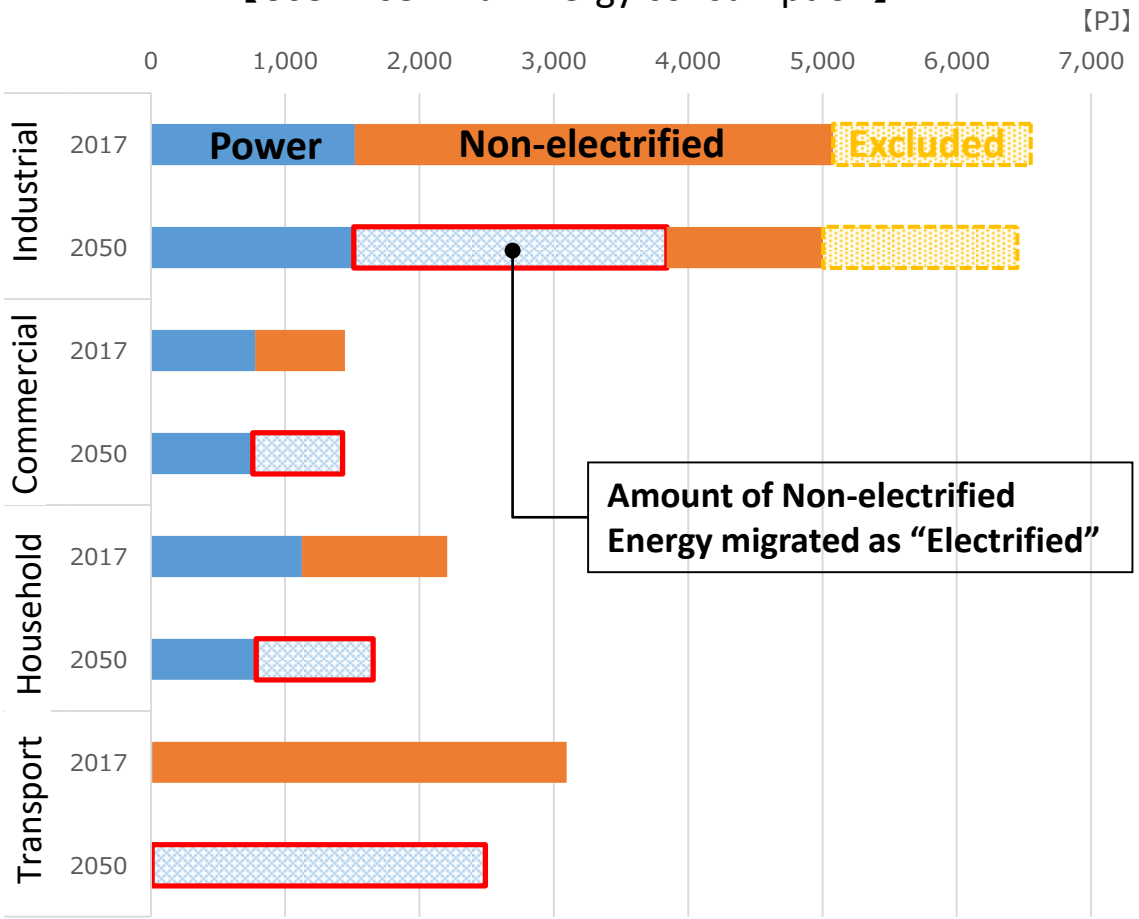
※2 H3: Average of the highest 3 peak demands

※3 Other RE : Hydro and Geothermal and Biomass

Estimated Energy Portfolio 【Progress of Electrification】

■ Fossil fuel usage in the final energy consumption are categorized according to their use (Industrial, Commercial, Household, Transport) and fuel type (Coal, Oil, Gas)(total 12 categories), and their electrification are decided separately

【Use-wise Final Energy consumption】



TWh(Sending-end)

	2050 Power demand after decision	Electrification rate※
Industrial	870 (1,130)	67%
Commercial	260 (260)	100%
Household	290 (290)	100%
Transport	180 (180)	100%
Total	1,600 (1,860)	85%

Figures in () are the potential of electrification
※Proportion of those energy migrated from "Non-electrified" to "Electrified"

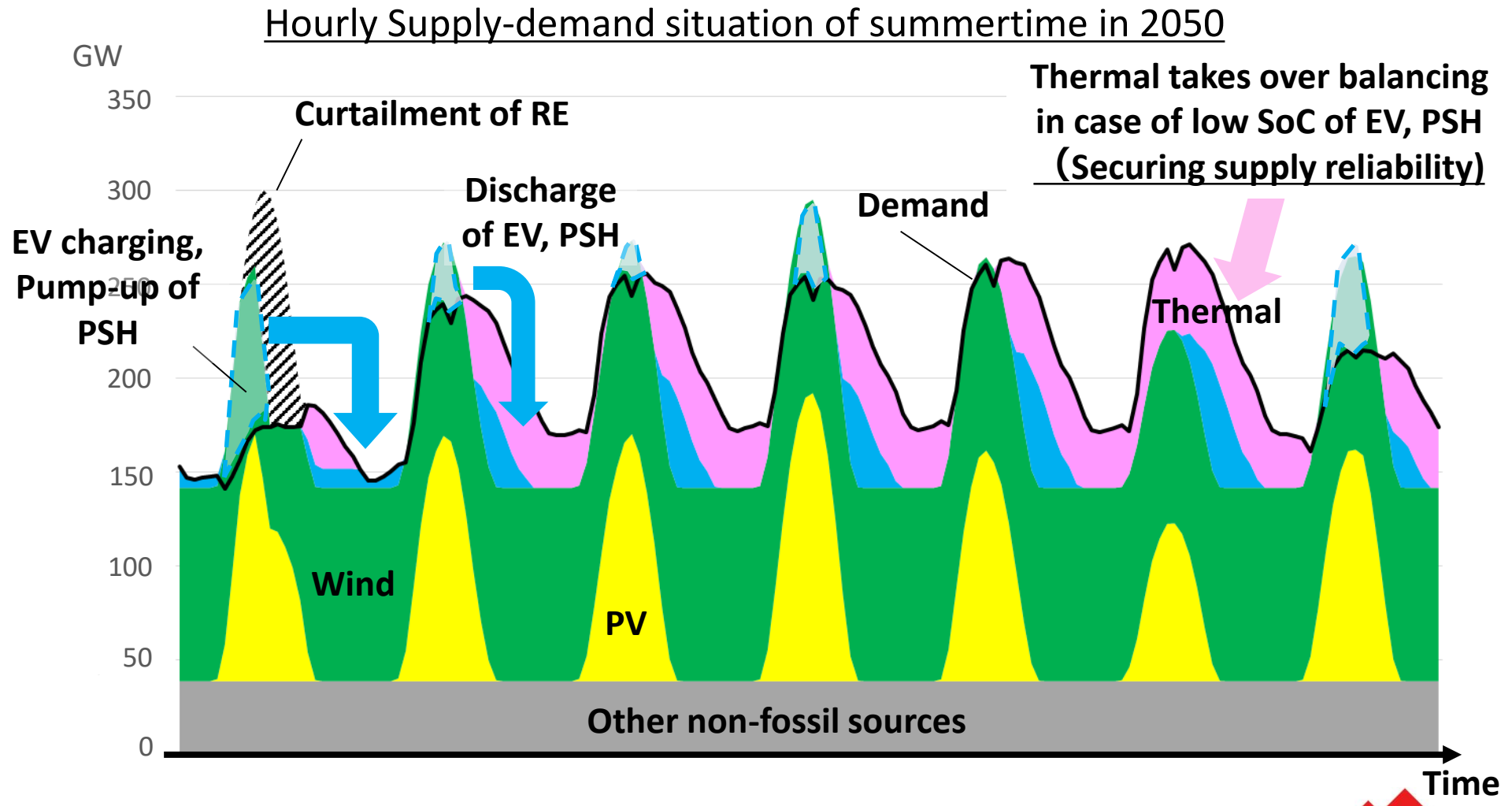
Ingredients of chemical industry (naphtha & LPG) are excluded in this study

Issues in moving toward a decarbonized society

- Discontinuous progress of Decarbonization of generation and Electrification are required for reduction of CO2 emission of the energy industry
- Issues in proceeding Decarbonization of generation are as follows:
  - Establishing the portfolio of low-carbon generation
    (Renewables, Nuclear, CC(U)S, CO2 free Hydrogen etc.)
  - Temporal Gap (Gap between the timing of Demand and non-dispatchable RE generation) ➲Slides 8・9
  - Spatial Gap (Distance between the area of demand and RE potential) ➲Slide 10

Temporal Gap -Issues in moving toward a decarbonized society-

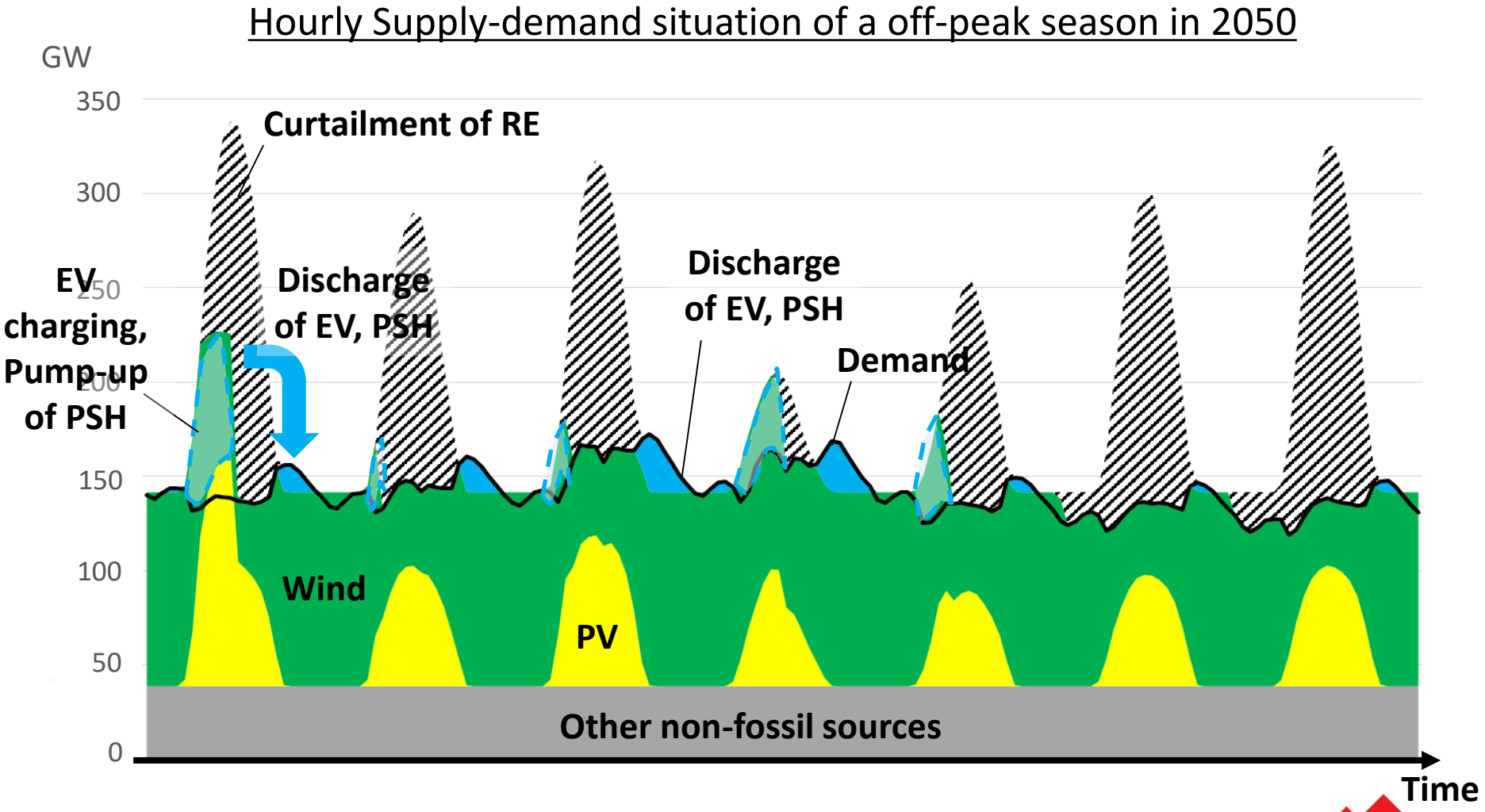
■ ①Utilization of demand-side flexibility (battery storage incl. EVs) and ② Back-up from grid-scale power sources (Thermal, PSH etc.) are required



Temporal Gap -Issues in moving toward a decarbonized society-

■ Significant curtailment of RE sources observed in off-peak season

✓ Measures such as Power-to-Gas may be considered to utilize surpluses

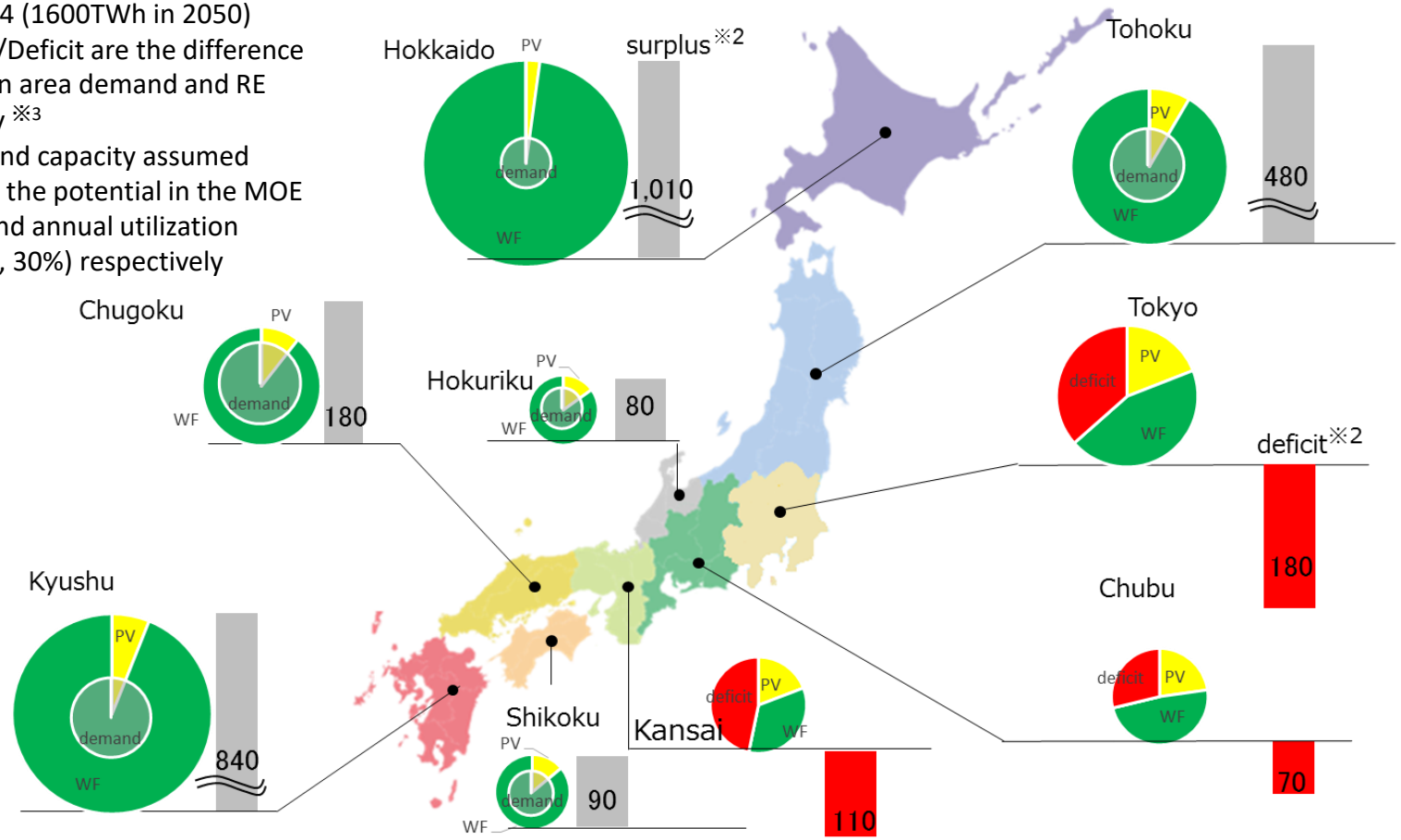


Spatial Gap -Issues in moving toward a decarbonized society-

- There are a geographical distance (Spatial gap) between areas with large demand and where suitable for RE integration
- Network developments are required to bridge those gaps.

※1 Assumed power demand is that in Slide 4 (1600TWh in 2050)
※2 Surplus/Deficit are the difference between area demand and RE capacity ※3
※3 PV & wind capacity assumed based on the potential in the MOE report, and annual utilization rate(13%, 30%) respectively

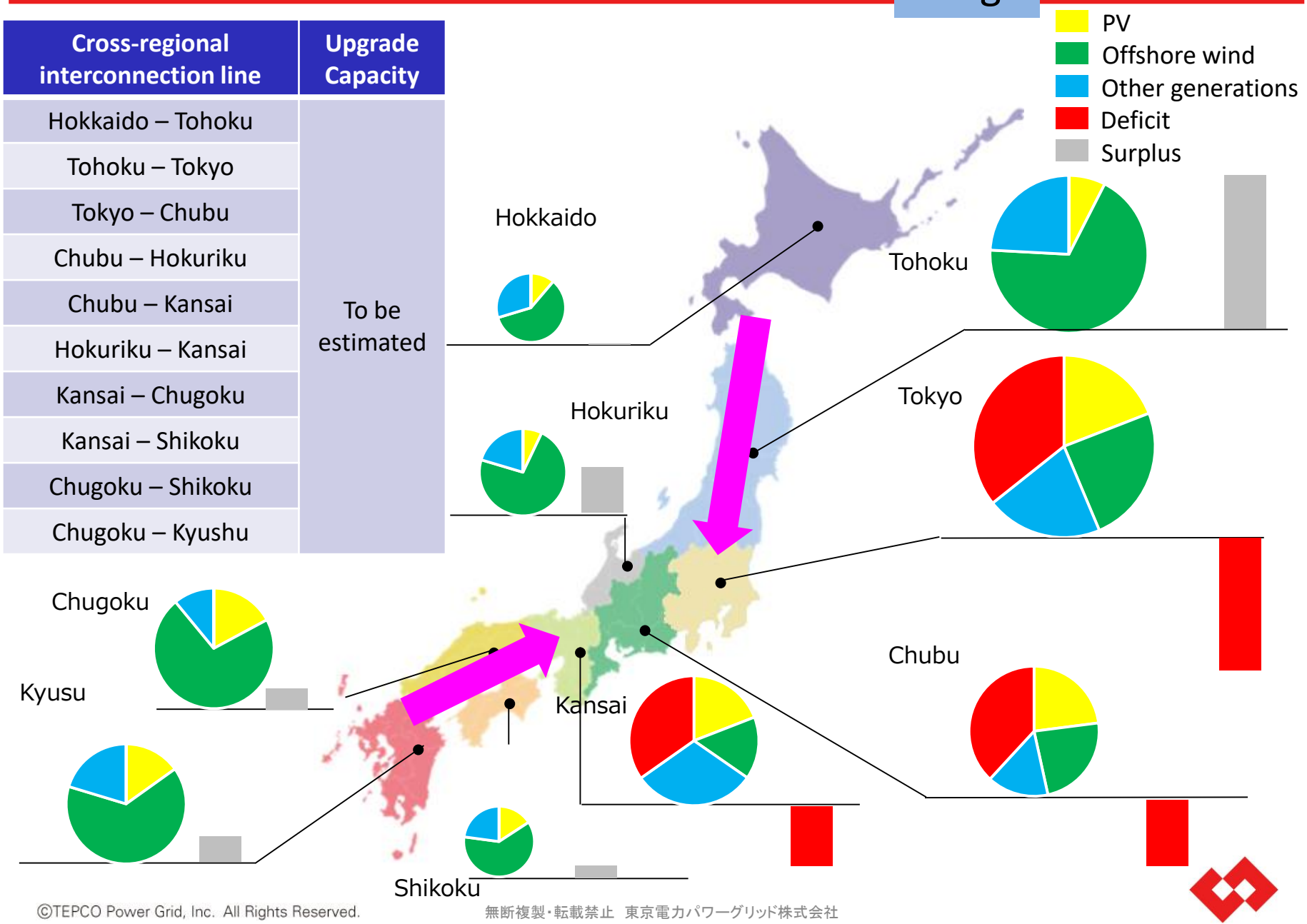
[TWh]



Overview of Cross-regional interconnection line in the 80% GHG reduction scenario

Cross-regional interconnection line	Upgrade Capacity
Hokkaido – Tohoku	To be estimated
Tohoku – Tokyo	
Tokyo – Chubu	
Chubu – Hokuriku	
Chubu – Kansai	
Hokuriku – Kansai	
Kansai – Chugoku	
Kansai – Shikoku	
Chugoku – Shikoku	
Chugoku – Kyushu	

Image



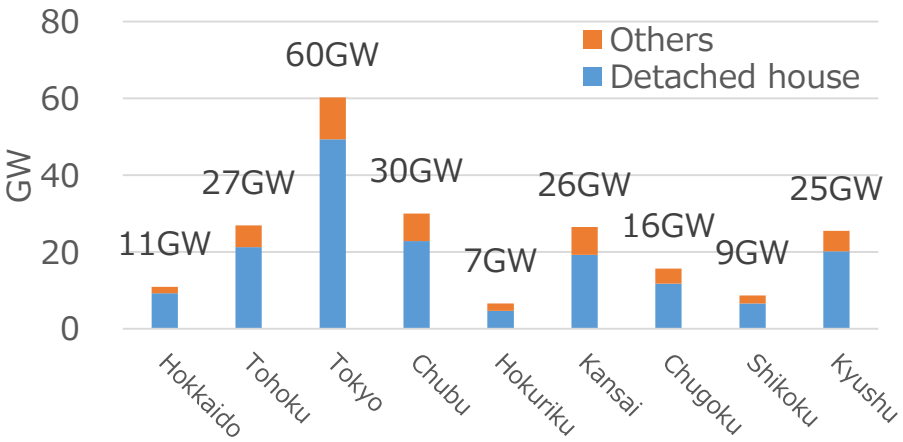
【Reference】 Conditions of Network development estimation

Item	Condition
Power demand	Base demand is forecasted based on forecast of future GDP・IIP etc. Electrified demand reflected in addition to the base demand
RE	Maximum installation (up to available potential) determined by whether IRR 8% can be secured from the energy market revenue during its expected operation period (20years) Installation cost 2030 PV: 100,000 JPY/kW wind: 260,000 JPY/kW (Target value shown in the national committee) 2050 PV: 44,000 JPY/kW wind: 190,000 JPY/kW (forecasted value by Bloomberg NEF)
Fuel cost	CIF 121$/b exchange rate 110JPY/ $ (as of 2030 based on outlooks of IEA,EIA)
Interconnectors	Reinforcement of the following are considered Hokkaido - Tohoku 300MW（2019.4～） Tokyo – Chubu 900MW（2021.4～） 900MW（2028.4～） Tohoku – Tokyo 500MW（2020.4～） 3830MW(2027.11～）
Electrification	Energy costs of “power” and “non-electrified” demand of categories according to their use (Industrial, Commercial, Household) and fuel type (for “non-electrified”: Coal, Oil, Gas) are estimated respectively ※Power cost＝Nation-wide average of power tariff / Efficiency of electrified equipments Non-electrified cost＝Fuel purchase cost / Efficiency of non-electrified equipments （Equipment costs are not considered in the above-mentioned costs) Nation-wide amount of electrification determined by the cost competitiveness analysis of Power vs non-electrified, and distributed to each area in proportion to the past result of area-wise non-electrified energy consumption (as of 2017)
Deployment of EV	40 million vehicles in 2050 (Equivalent to all owner-driven cars) 5kW, 60kWh/vehicle, round-trip efficiency 70% 30% of the vehicles are assumed to be connected to the grid at all hours

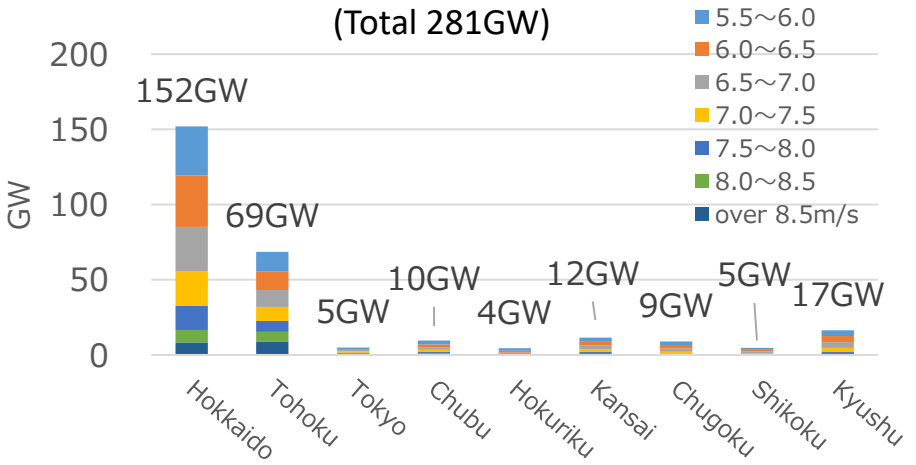
【Reference】 Area-wise Potential of Renewables

- The potential of PV of the country as a whole is approx. 360GW
- That of wind (on and off-shore) is approx. 1620GW

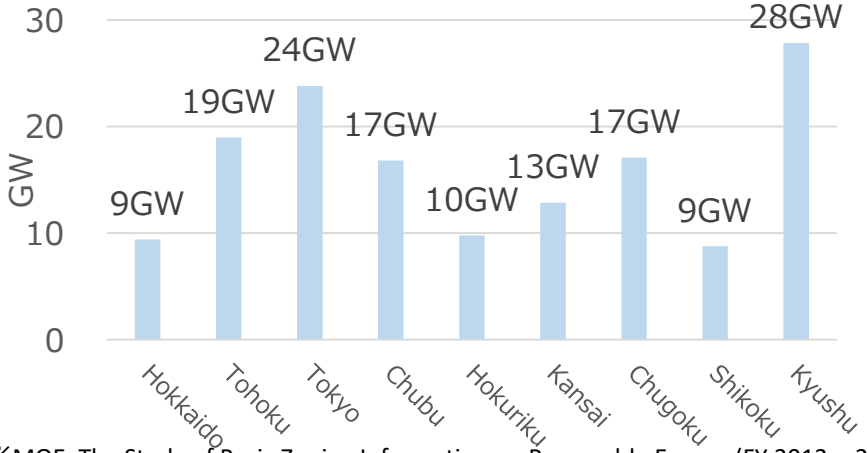
Potential of PV in Households etc.
(Total 211GW)



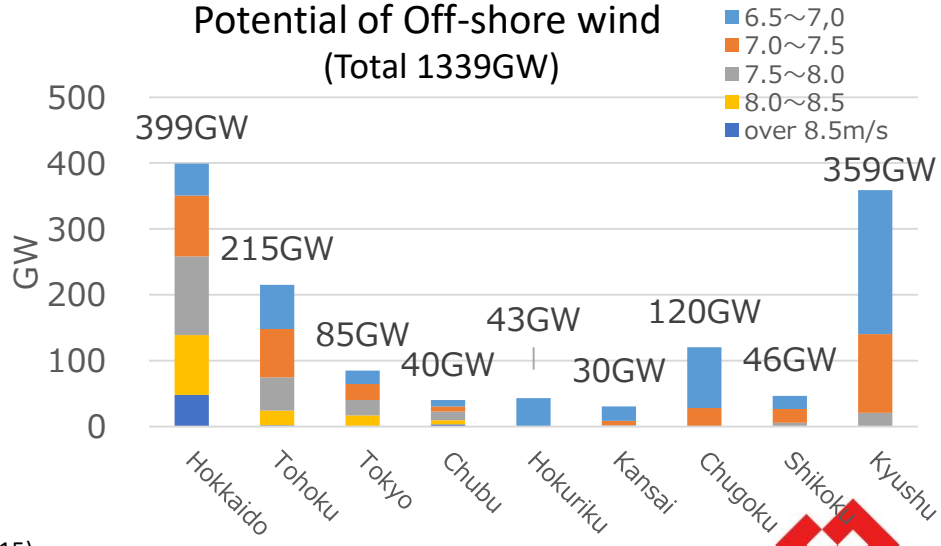
Potential of On-shore wind
(Total 281GW)



Potential of PV in Public facilities etc.
(Total 145GW)



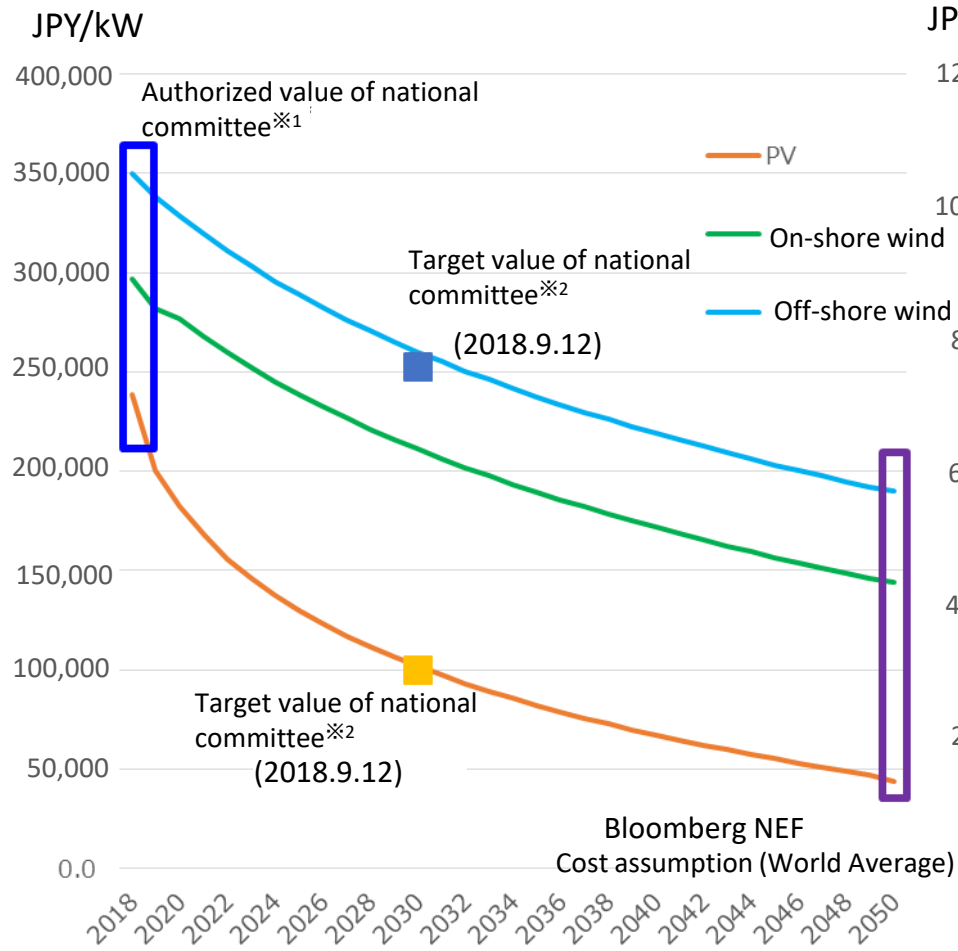
Potential of Off-shore wind
(Total 1339GW)



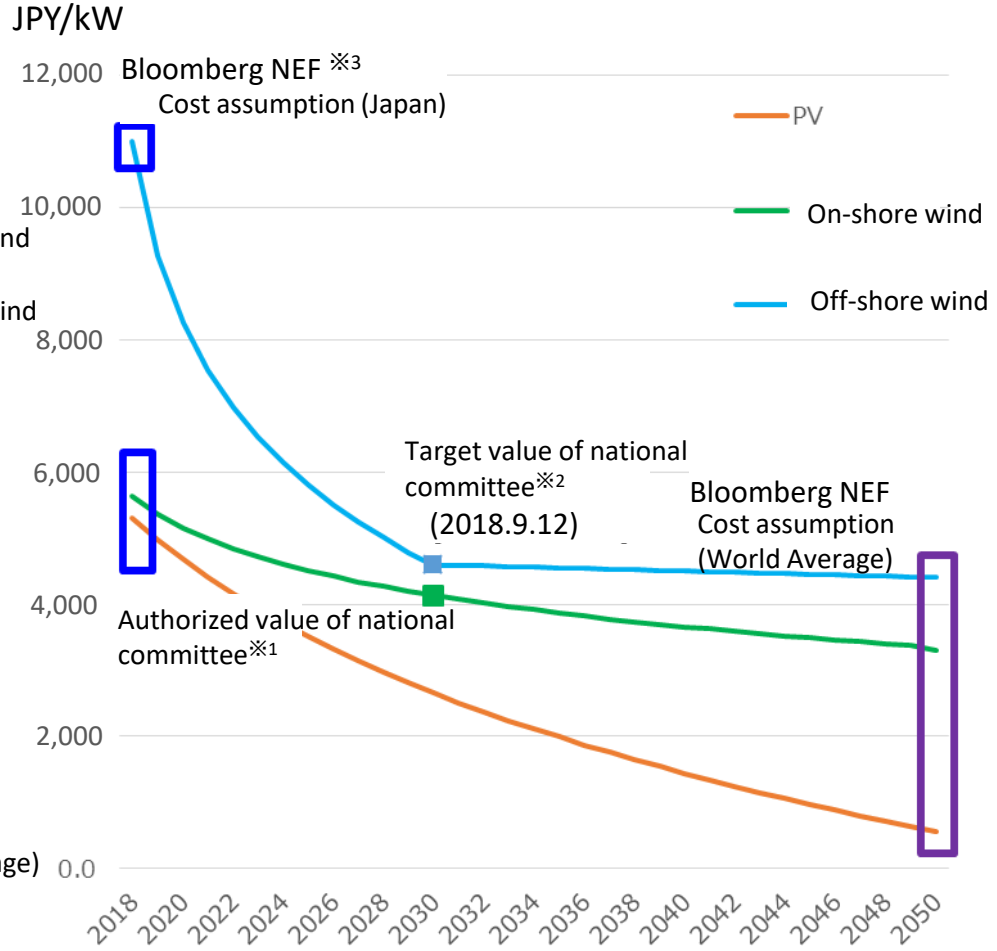
※MOE, The Study of Basic Zoning Information on Renewable Energy (FY 2012～2015)

【Reference】 Cost of Renewables

Capital cost assumption



O&M cost assumption



※1 Procurement Price Calculation Committee

※2 Subcommittee on Mass Introduction of Renewable Energy and Next-Generation Electricity Networks

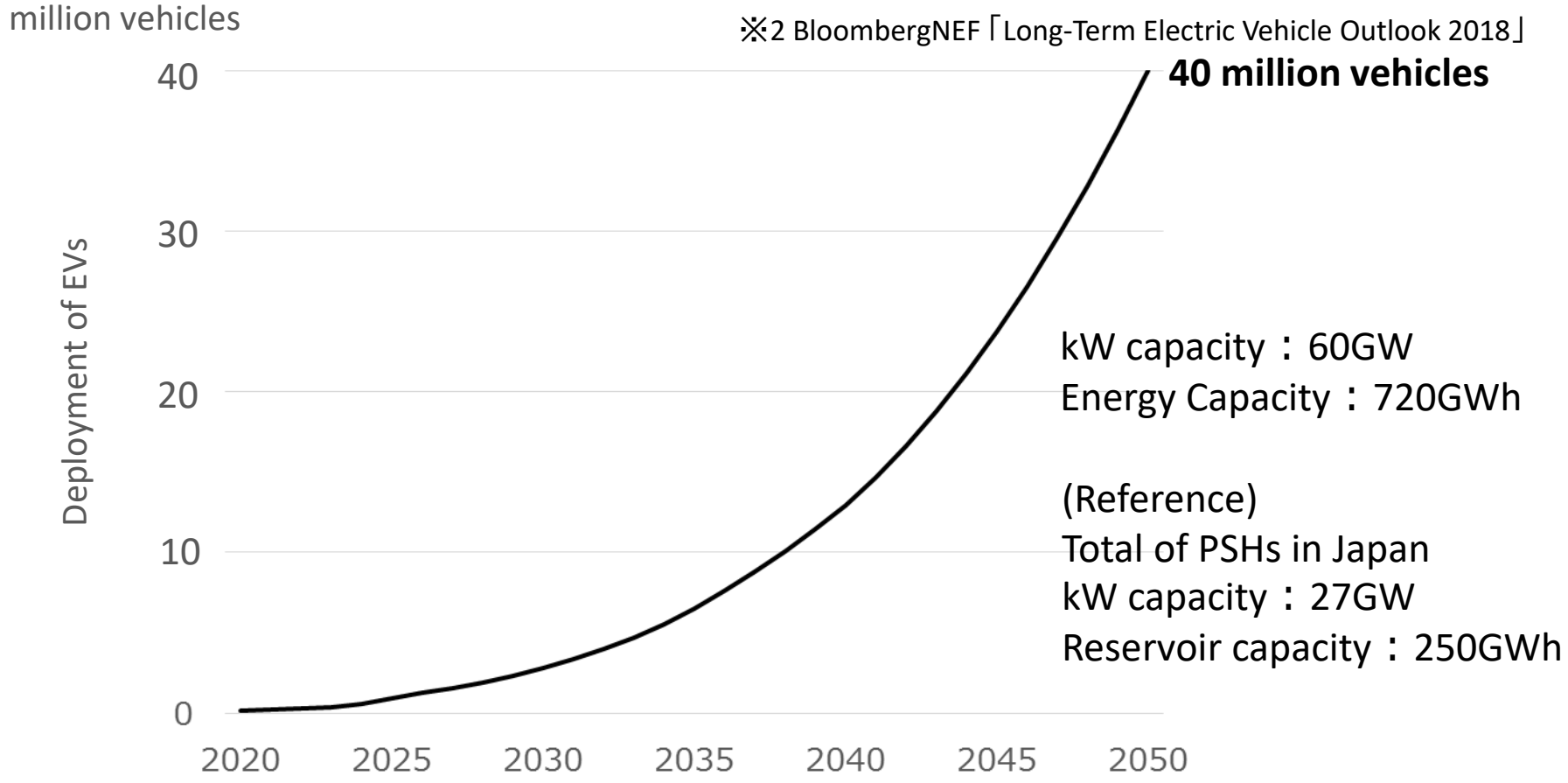
※3 BloombergNEF 「2H 2018 LCOE - Data Viewer」

【Reference】 Deployment of EVs

- Assuming 40 million EVs in 2050 (virtually all owner-driven cars are EV)※1 , transition of deployment was assumed referring to EV outlook of Bloomberg NEF ※2

※1 Okamoto et al., Utility 3.0: Game change in energy industry 2050 (2017)

※2 BloombergNEF「Long-Term Electric Vehicle Outlook 2018」



【Reference】 Potential of Electrification (country as a whole)

- Future final energy demand was assumed based on the energy balance table of EDMC※
- Ingredients of chemical industry (naphtha & LPG) are excluded in this study, since their CO2 emissions are not related to energy industry

※The Energy Data and Modelling Center, The Institute of Energy Economics, Japan