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German-Japanese Energy Transition Council

Japanese long-term scenarios

- Overview of Japan's "Strategic Energy Plan"-

25th November 2021

The Institute of Energy Economics, Japan (IEEJ)
Prof Tatsuya Terazawa

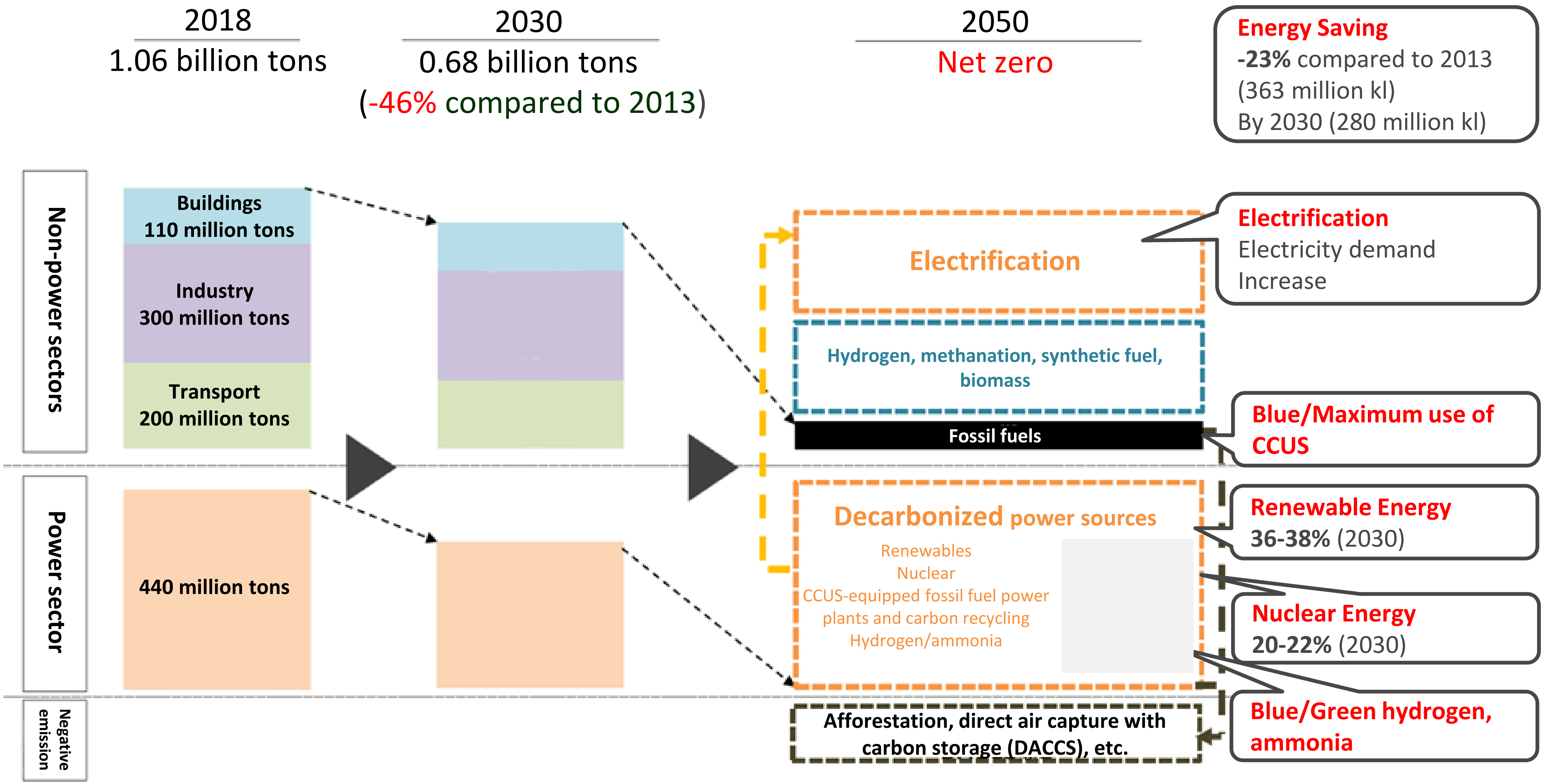
Japanese "The Strategic Energy Plan"

- In Oct 2021, "6th The Strategic Energy Plan" (the Plan) was published by GOJ. The plan describes major direction of strategy on energy demand and supply into 2030 and 2050. Japan's energy sector accounts for over 80% of greenhouse gas emissions and thus the Plan presents key information.

- With assumptions on expected RE installation or demand, the Plan shows concrete energy supply/demand balance and the power sector energy mix in 2030 combined with related policies and measures.

- On the other hand, the Plan does not show a concrete scenario for 2050, but shows broad direction of Japan's energy policy toward 2050, because outlook in 2050 depends on technology innovation etc.. and is uncertain.

Transition toward carbon neutrality in 2050

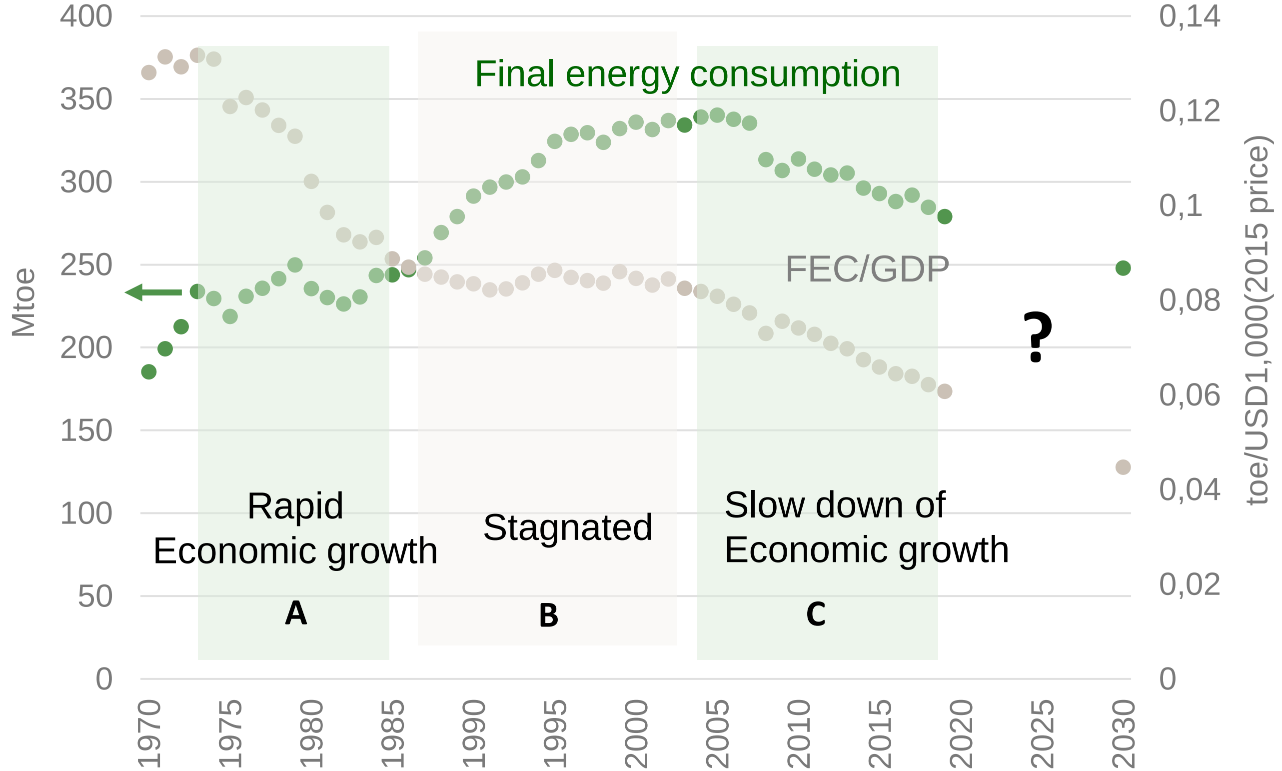


Source) METI, Green Growth Strategy Through Achieving Carbon Neutrality in 2050, December 25, 2020 (Some parts of figure are revised)
* Figures represent references for deepening discussions. Multiple scenarios should be considered.
* tons represent CO2 emissions from energy consumption

Key issue in demand side

In every sectors, improving energy efficiency is essential.
Industry: Innovation of manufacturing process. Establishing efficiency target.
Transport: Transformation to xEVs. Optimizing fleet traffic.
Building: Increase Zero-Emission House/Building.

Trend of final energy consumption and its intensity to GDP in Japan



A: Significant energy efficiency improvement despite rapid economic growth.

B: Efficiency improvement stagnated to increase final energy consumption.

C: Modest improvement of efficiency partly thanks to slow down of economic growth.

Key issue in supply side

Upmost effort to increase renewable energies	Opportunity in offshore wind. Integration of power grids (technology / market design). Coexistence with communities. (Distributed energy system, public acceptance and economic stimulus of communities.)
Uncertainty in nuclear power	Resume operation of existing reactors. Extension of operating life. New development.
Creation of hydrogen supply chain	R&D for cost reduction. Team-up with Asian neighbors. Create initial demands to address “Chicken-and-Egg” issue.

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- A comparison of modeling strategy in power sector -

25th November 2021

The Institute of Energy Economics, Japan (IEEJ)
Hideaki Obane (PhD)

Policy discussion

Direction of Japan's energy policy was discussed in Strategic Policy Committee.

Summary

Term

July 2020 – August 2021 (18 times)

Main council members

University professors, prefectural governor, members of research institutes, bank, industries etc..
(24 members)

Topics

Scenario analysis
Information session from industries etc..

Strategic Policy Committee

Scenario analysis by organizations

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Some organizations including institutes and a consultant shared their own scenario analysis with the Strategic Policy Committee.

Organizations that showed their own scenario analysis

	Characteristics
RITE Research Institute of Innovative Technology for the Earth	*The Research Institute of Innovative Technology for the Earth (RITE)* Founded by the GOJ to promote innovative environmental technologies worldwide.
NIES	*The National Institute for Environmental Studies (NIES)* A focal point for environmental research since 1970.
自然エネルギー財団	*Renewable Energy Institute (REI)* Non-profit institute, founded by a company owner to promote renewable energy.
Deloitte. デロイト トーマツ	*Deloitte Tohmatsu Consulting* One of the Big Four accounting firms.
IEE JAPAN	*The Institute of Energy Economics, Japan (IEEJ)* World leading research institute on energy and environmental policies

* Besides the above, IGES and CRIEPI also shared their own analyses that are not model results.

Model comparison

Basic approach of each model is similar. These models minimize total energy system costs, while the definitions of "cost" can be different in each model.

Organizations that showed their own scenario analysis

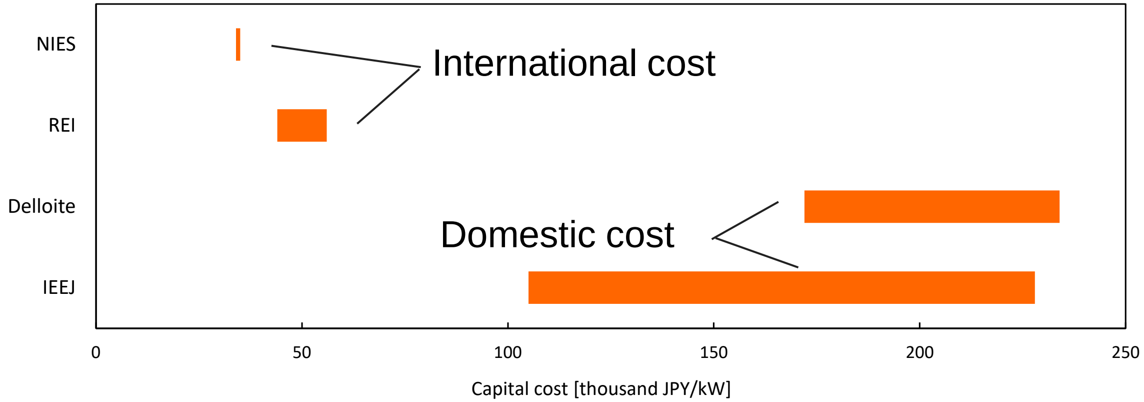
	RITE	NIES	REI	Deloitte	IEEJ
Model	Dynamic New Earth 21+ model	Integrated model (general equilibrium/ Bottom-up/ generation mix)	LUT Energy System Transition modeling	IEA TIMES model	IEEJ-NE model (NE: New earth)
Objective	Minimizing total energy system costs (capital cost, variable cost, etc..)*				
Temporal resolution	1 hour	1 hour	1 hour	4 hours per 4 season	1 hour
Spatial resolution	1 Nodes	10 Nodes	9 Nodes	351 Nodes	5 Nodes

* As for NIES's integrated model, energy system cost is minimized in bottom-up and generation mix model.

Assumption – Renewable energy capital cost -

Capital costs are different depending whether domestic or international costs are assumed. Currently, there is a gap due to technical measurement of typhoon or earthquake.

PV system capital cost[thousand JPY/kW]



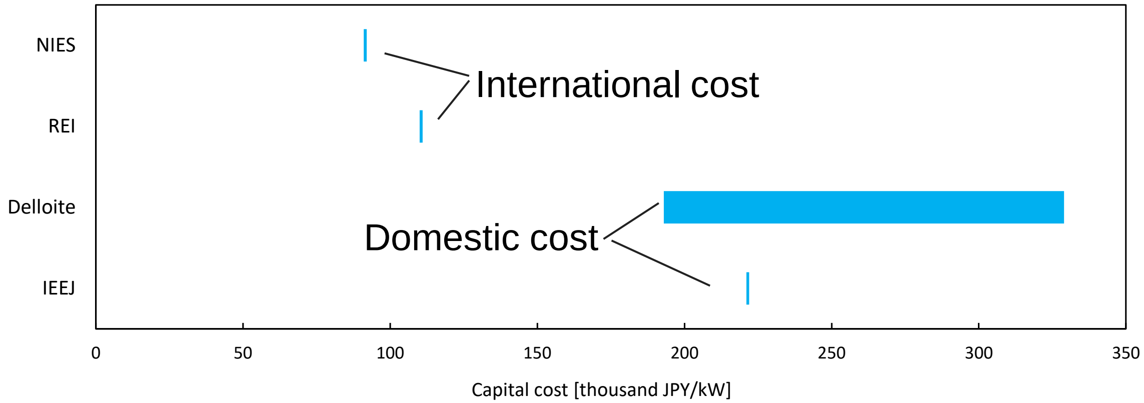
Ref: IRENA

Ref: ETIP-PV / Vartiainen (Learning rate: 40%)

Ref: Japanese cost WG

Learning rate: 21%(Module)

Onshore wind capital cost[thousand JPY/kW]



Ref: IRENA

Ref: E3 for PRIMES and EC

Ref: Japanese cost WG

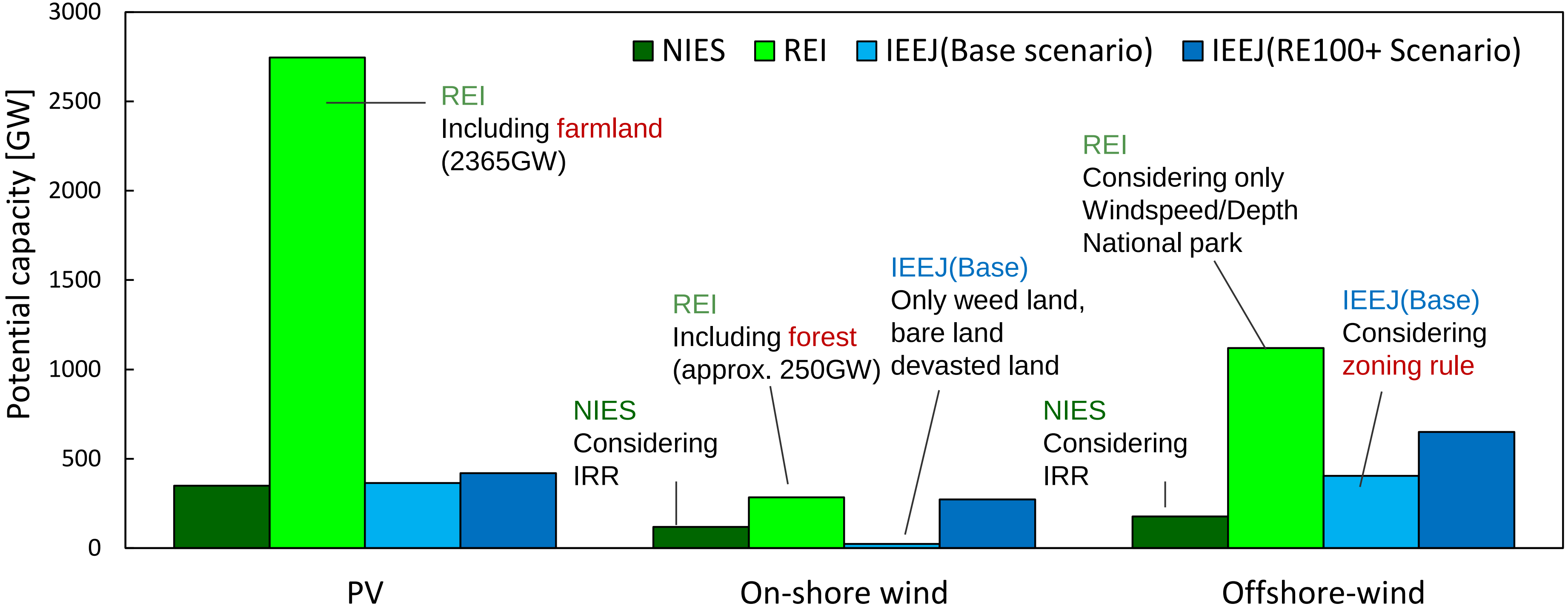
Learning rate: 8%(Turbine)

* 100 thousand JPY ≒ 77 EUR
* RITE shows LCOE(PV: approx. 50-150 USD/MWh, Wind: 70-180 USD/MWh) instead of capital cost.

Assumption – Solar and wind energy potential -

In Japan, solar and wind energy potential is a key factor to influence energy mix.
The assumed potentials are different depending on installation sites.
(Farmland, Forest, Zoning rule for offshore wind, etc..)

Assumed solar and wind energy potential [GW]

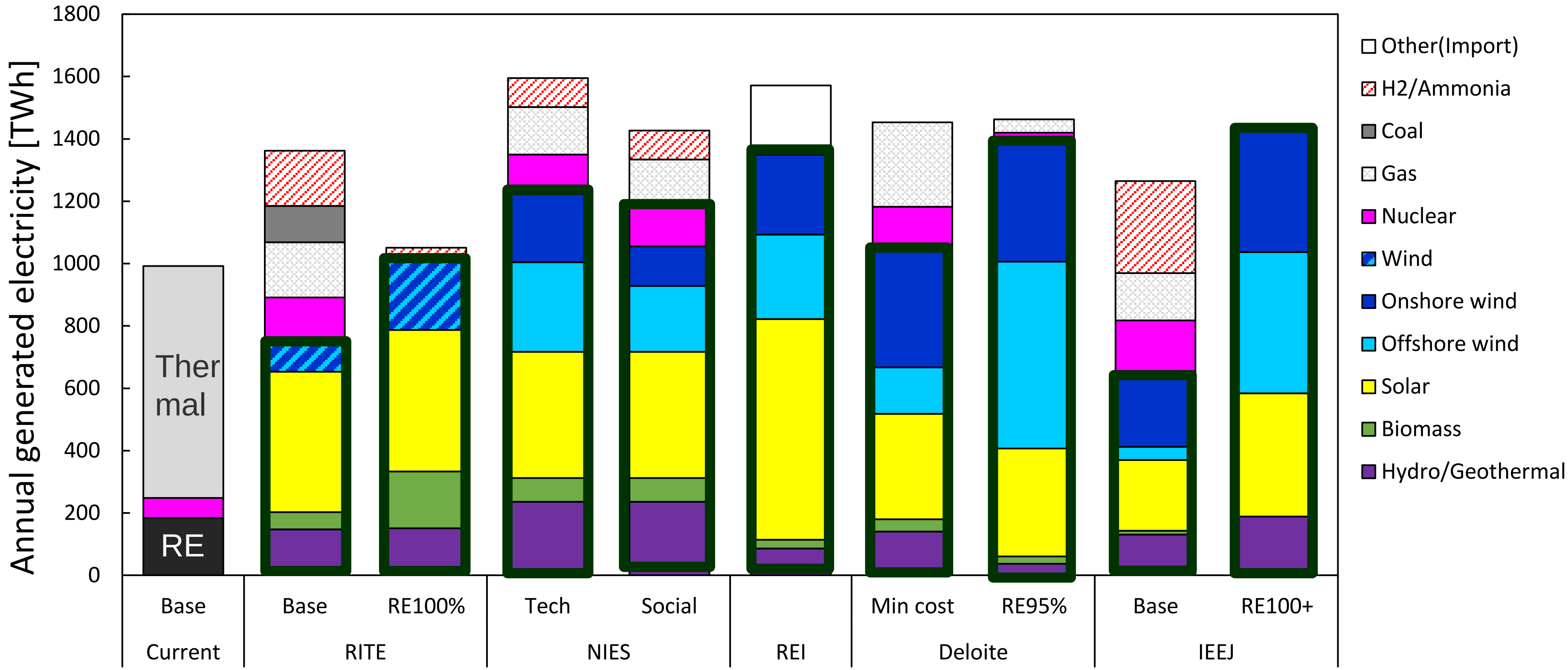


* RITE shows generated electricity-base potential (PV: approx.750TWh/yr, Wind: approx. 200 TWh/yr).
* NIES / REI refers to report by Ministry of Environment
* IEEJ refers to H.Obane et al (Renewable Energy Vol 160 pp.842-851) /Marine Policy Vol 129)

Result – Energy mix in 2050

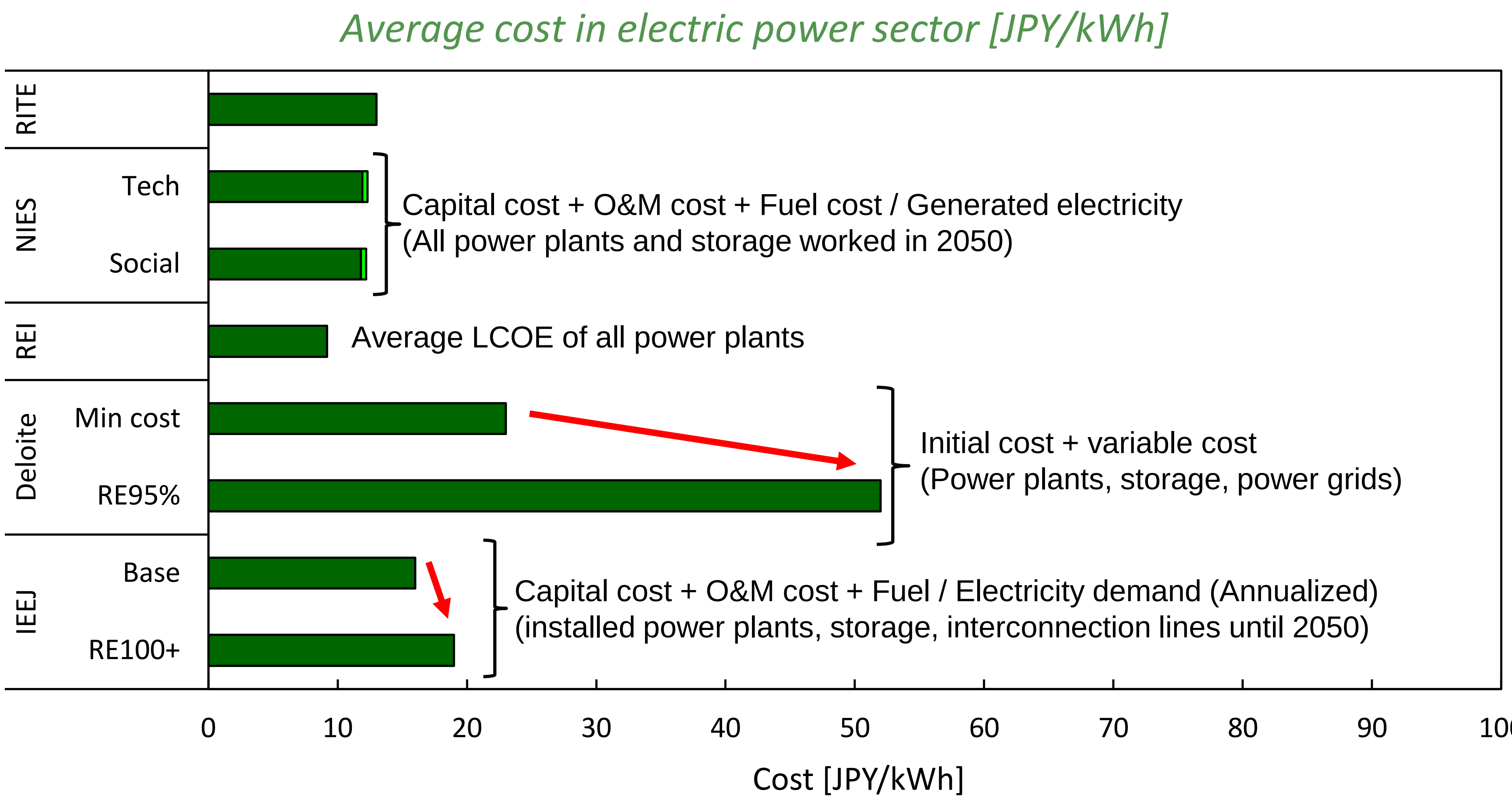
In all scenarios, the percentage of RE is over 50%.
Although some scenarios show high-percentage of RE,
RE is assumed to be in restricted areas (farmland, forest etc..) in such scenarios

Generated electricity in 2050 [TWh]



Result – Average cost in electric power sector

Average cost tends to increase as the percentage of RE increases.
It should be noted that the definition of average cost is different among models.



Main implication of each organization

While some organizations stressed the difficulty of achieving carbon neutrality in the power sector and the need for various technologies, others implied that decarbonization may give positive impact.

	Main implication
RITE (Research Institute of Innovative Technology for the Earth)	Toward carbon neutrality, various technology innovations are necessary (H_2, Ammonia, CCUS etc..). Policy support for several field is necessary.
NIES	Decarbonization may suppress losses of national wealth. Social transformation may ensure decarbonization.
自然エネルギー財団	By utilizing renewable energies, decarbonization is possible not only in electric use but also in thermal or fuel use.
Deloitte. デロイト トーマツ	For realizing carbon neutrality, percentage of renewable energy in electric generation is 71%, electricity prices may double from current price levels.
IEE JAPAN	Toward carbon neutrality, various options should be utilized. (Nuclear, H_2, Ammonia, CCUS etc..). Balanced energy mix is required.

Conclusion

- While basic approach of each model is similar (minimizing total system cost), model assumptions may be significantly different, especially in renewable energy cost or renewable energy potential.

- Although some organizations implied decarbonization is possible by massive installation of renewable energy, it should be noted that the analysis can use optimistic assumption (e.g., lower RE cost, higher RE potential)

- Some organizations implied the difficulty to achieve carbon neutrality and the necessity of various technologies (e.g., H_2, Ammonia, CCUS etc..) .

In a country where renewable energy potential is limited, model results can vary based on assumptions. Hence, it is important to examine assumptions and compare the results in each model.