Status of the national transmission grid to integrate variable renewable electricity generation

September 6, 2022

OCCTO :

Organization for **C**ross-regional **C**oordination of **T**ransmission **O**perators

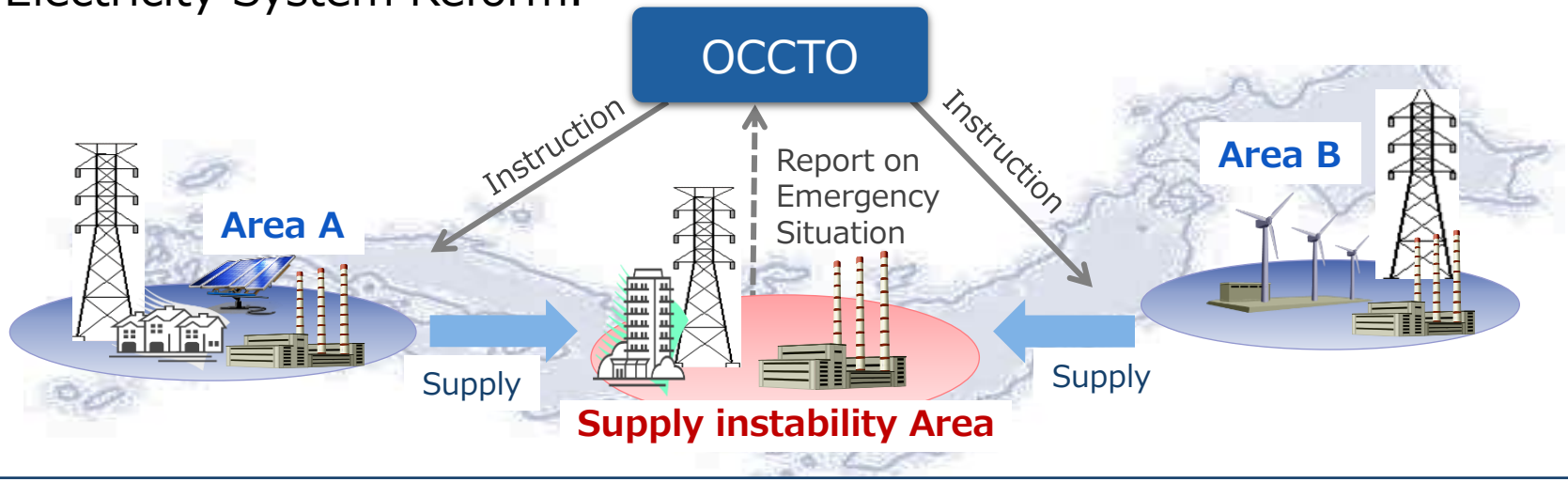
1 Overview of OCCTO

2 Connect and Manage applying in Japan

3 Master Plan of Transmission System Expansion
<under discussion>

OCCTO's Background

- In the Great East Japan Earthquake, there were power shortages in eastern Japan, despite of redundant energy remained in western Japan.
- So as to allow dispatch of energy nationwide and enhance power system resilience, OCCTO was established as an authorized organization (approved by the government) in April 2015 based on the 1st step of Electricity System Reform.



Process of Electricity System Reform (ESR) - ESR to be advanced toward 3 goals by 3 steps

3 goals

1. Securing stable electricity supply
2. Suppressing electricity rates to the maximum extent possible
3. Expanding choices for consumers and business opportunities

3 steps

1st Step (Apr., 2015)
- Establishment of OCCTO

2nd Step (Apr., 2016)
- Full liberalization of entry to electricity retail business
- Introduction of functional licensing system

3rd Step (Apr., 2020)
- Legal unbundling of transmission / distribution sector

OCCTO's Mission

- OCCTO plays a broad role in promotion of "Cross-regional Management of Electrical Businesses"

1. Secure Short-term to Mid to Long-term Stable Supply

- Contribute to efficiency improvement and activation of Electricity Market (capacity market and balancing market)
- Formulating "Long-term Development Policy of Cross-regional Network" and "Cross-regional Network Development Plan" and take initiative in reinforcing required facilities
- Securing Stable Electricity Supply by "Aggregation of Electricity Supply Plans"

2. Promote Fair, Equitable and Efficient Use of Transmission and Distribution equipment Facilities

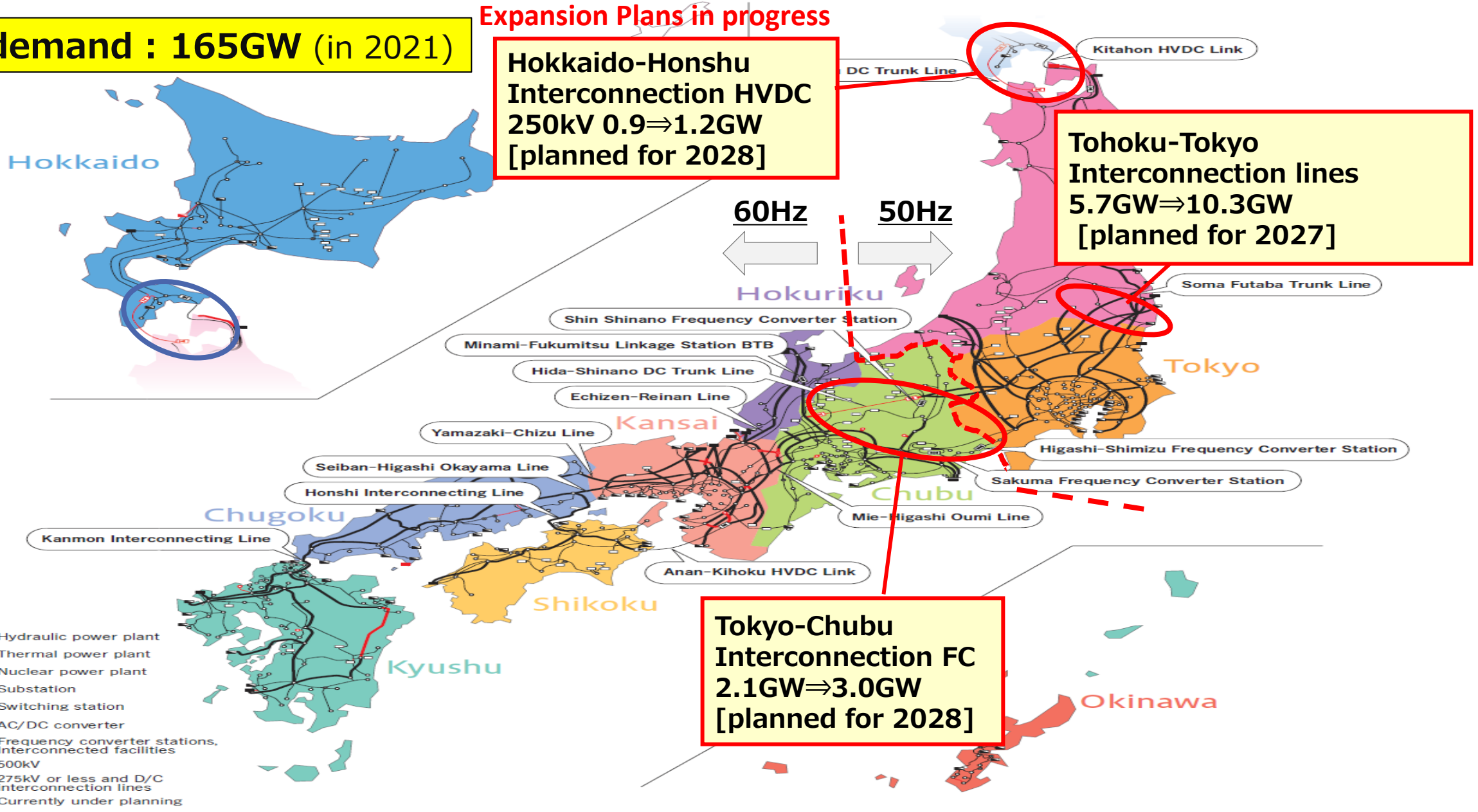
- Formulate rules for all electricity power companies to comply
- Introduced new usage method of interconnection lines (Indirect auction)
- Accept system impact studies of generation facilities
- Make efforts to maximize utilization of existing network
  (Connect and Manage applying in Japan: N-1 Inter-trip scheme, Non-firm access)

3. Monitor Nationwide Conditions of Supply-Demand and Network System Operation

- Monitoring nationwide conditions, 24 hours a day, 365 days a year
- Grasping situation of nationwide supply-demand balance by plan management through the Cross-regional Operation System
- Instructions for improvement of supply instability situation to Electricity companies

Transmission System in Japan

Peak demand : 165GW (in 2021)

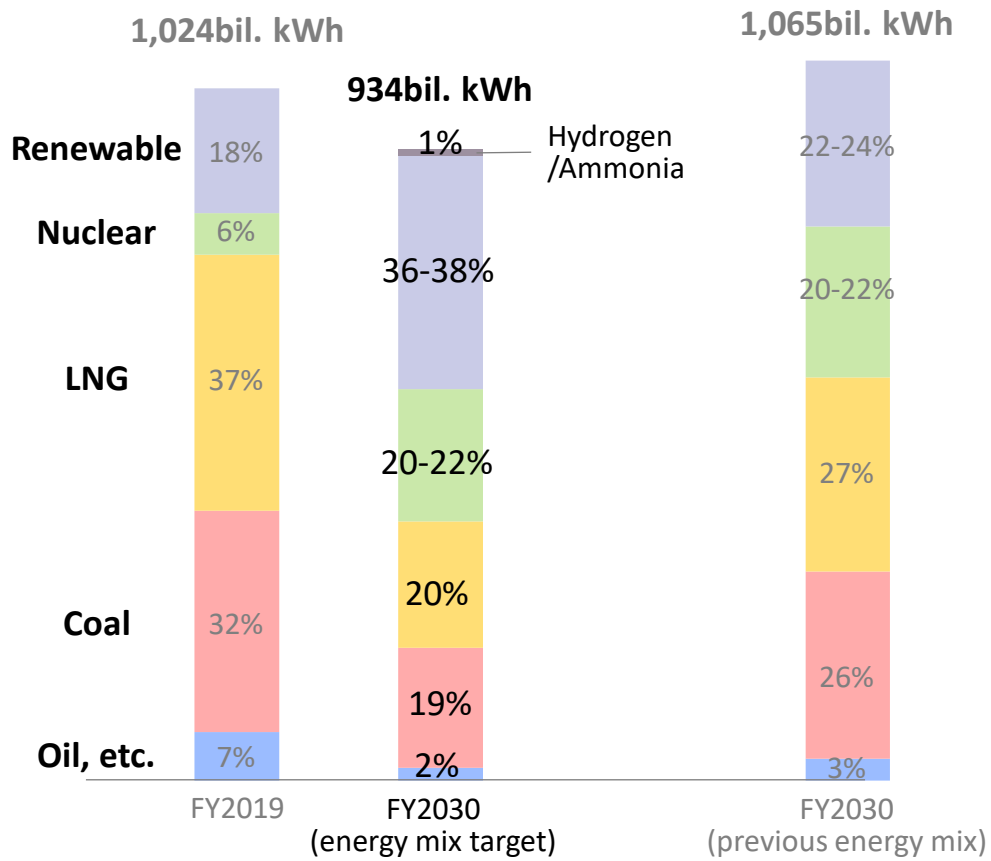


OCCTO

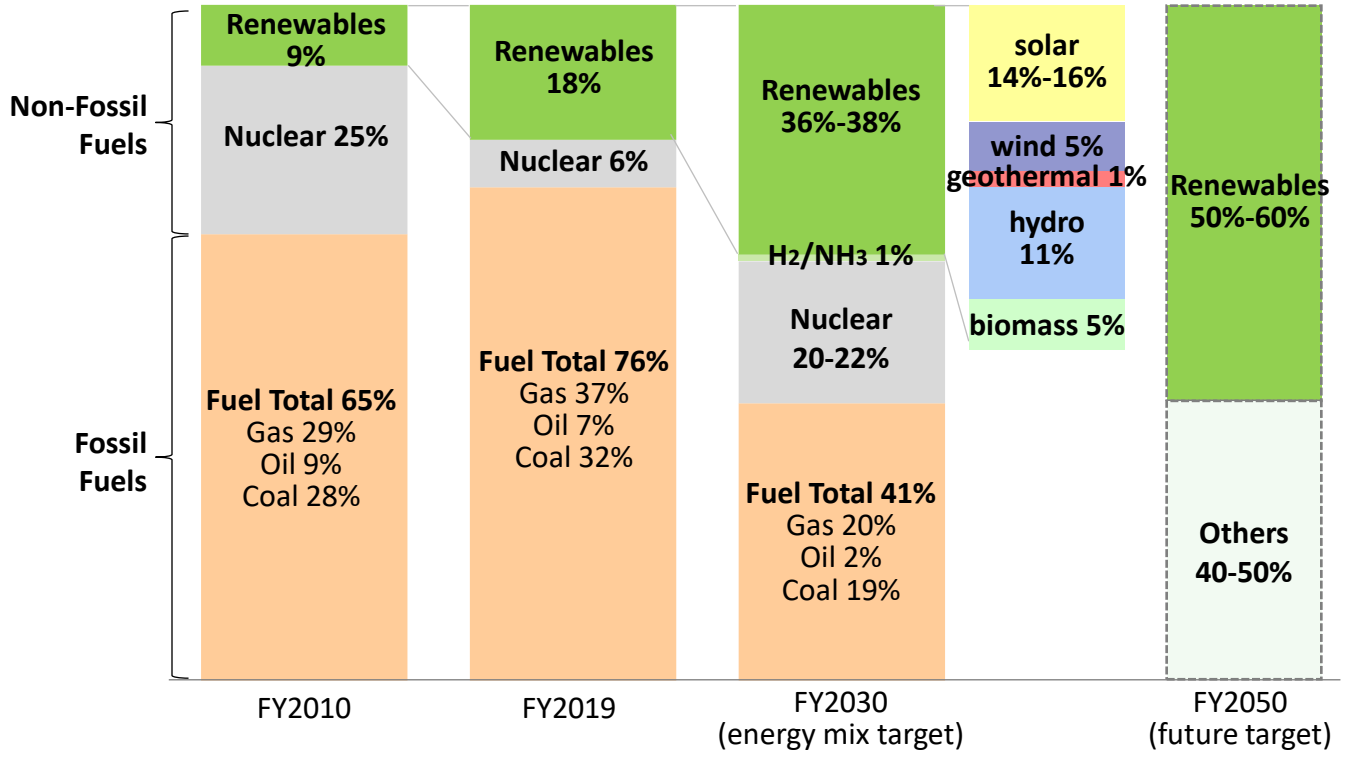
Power generation mix (ambitious outlook) in the 6th Strategic Energy Plan

- In the 6th Strategic Energy Plan, Japan aims to further expand RES percentage up to 36-38% by 2030.
- To achieve the carbon neutrality in 2050, it faces the challenge of introducing maximum amount of RES and solving various issues related to lack of transmission capacities.

Power Generation Mix



Increase of Renewable Energy Resources



Source : METI

1 Overview of OCCTO

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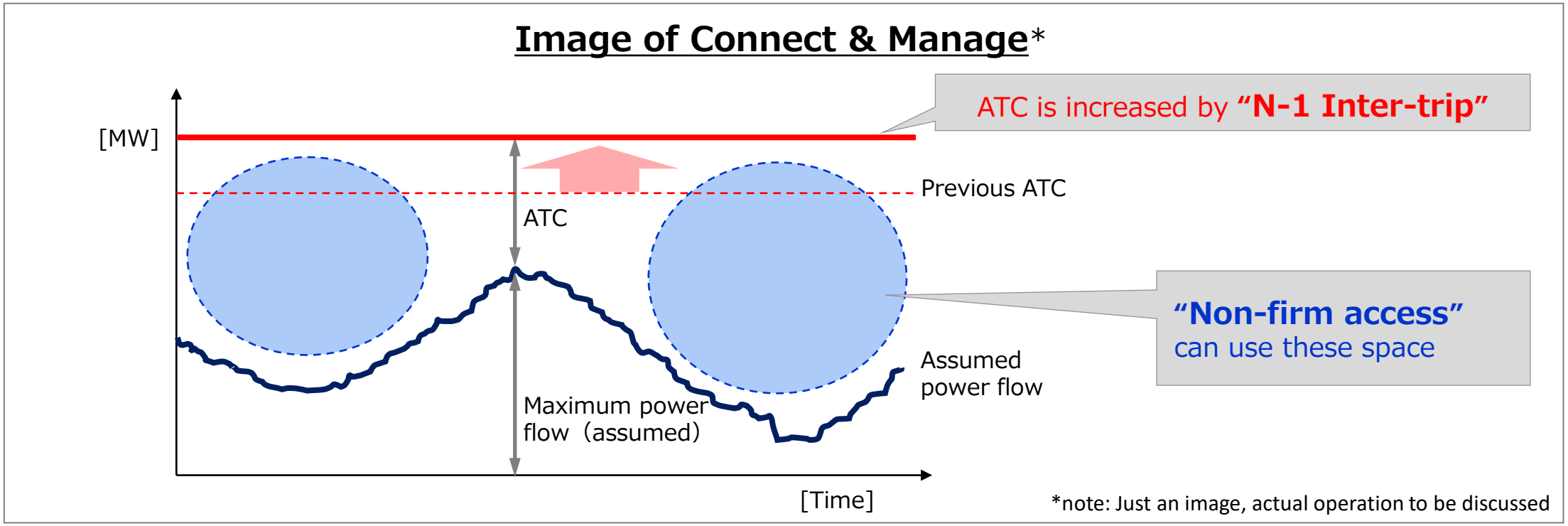
3 Master Plan of Reinforcement Network
<under discussion>

The general overview of Connect & Manage in Japan

- OCCTO makes efforts to maximize utilization of existing network, for example to make a rule of Connect and Manage.

N-1 Inter-trip scheme
- Increased capacity by applying N-1 inter-trip scheme can be used for new generator interconnection.

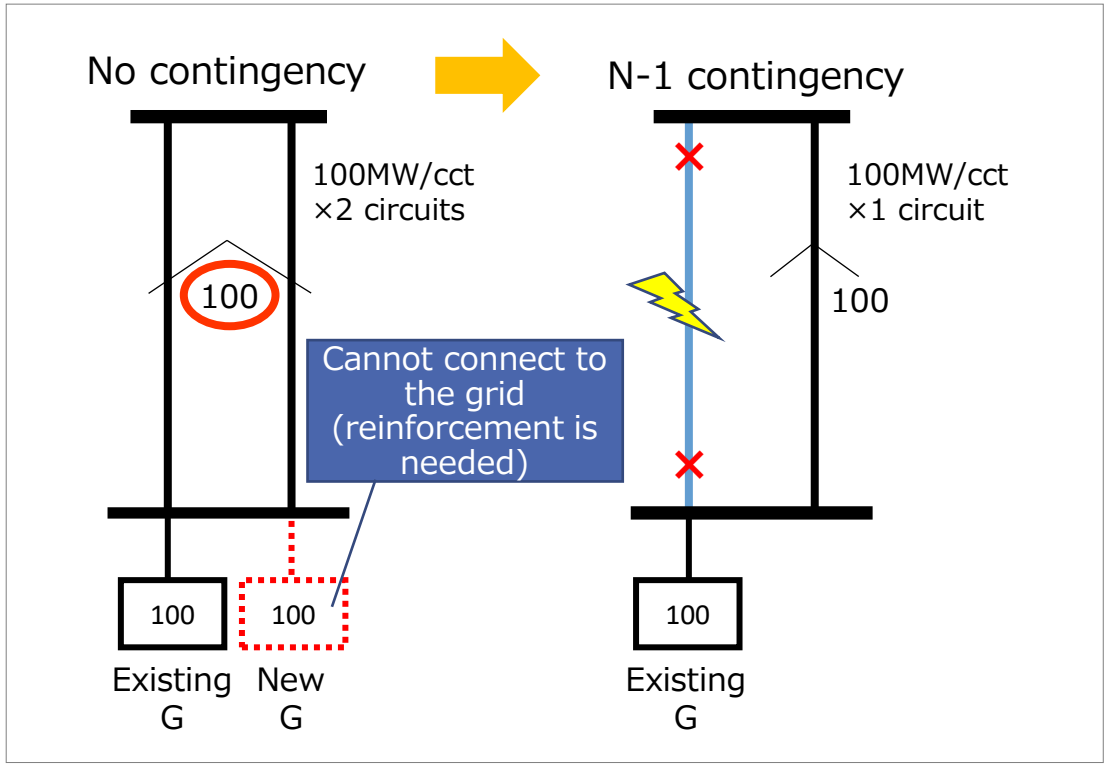
Non-firm access
- Regardless of ATC, new generator can connect to the grid and operate within operational capacity. (in case of excess it, the generators have to be curtailed)



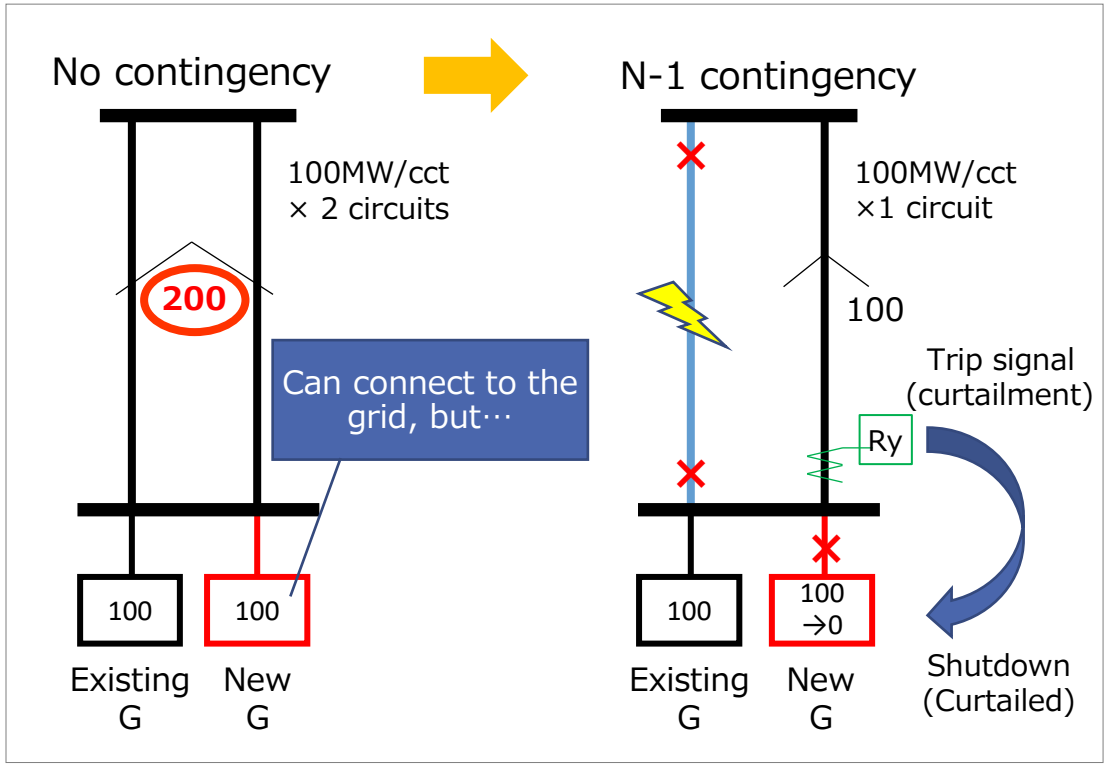
Outline of N-1 Inter-trip Scheme

- From a viewpoint of reliability of power system, N-1 criteria shall be maintained in case of N-1 contingency.
- N-1 generation inter-tripping system needs quick response after occurring N-1 contingency. Therefore, the protection relays need high reliability.

Present Operation



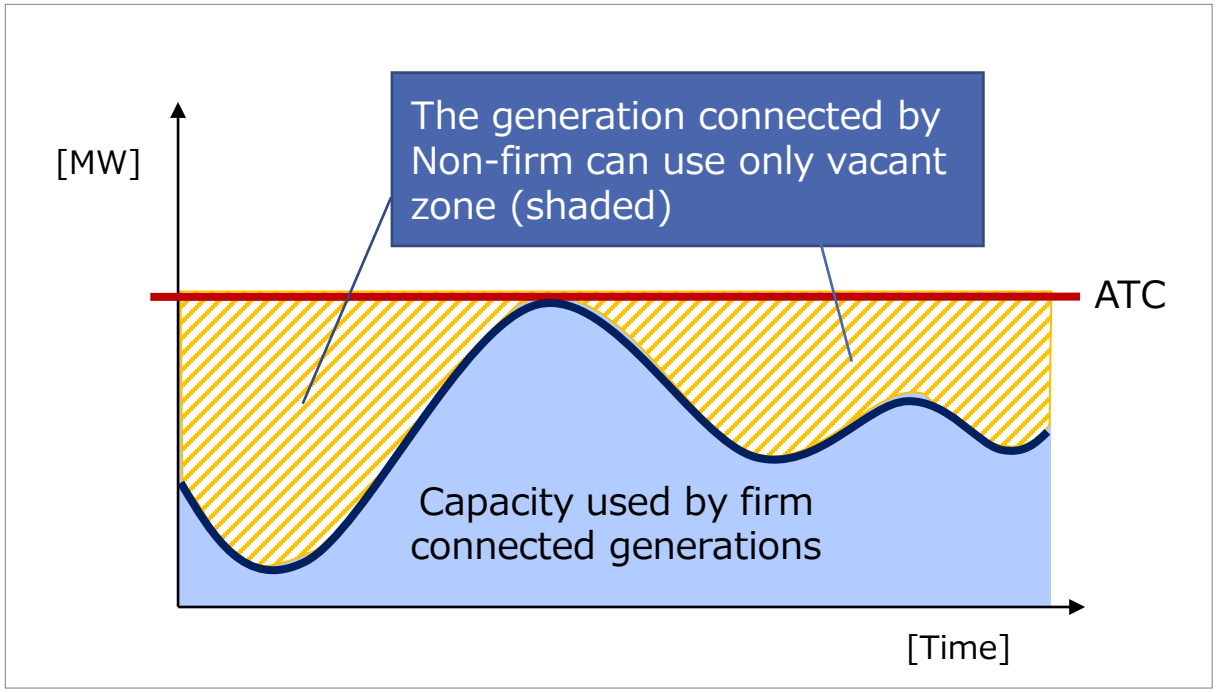
Applying N-1 inter-trip scheme



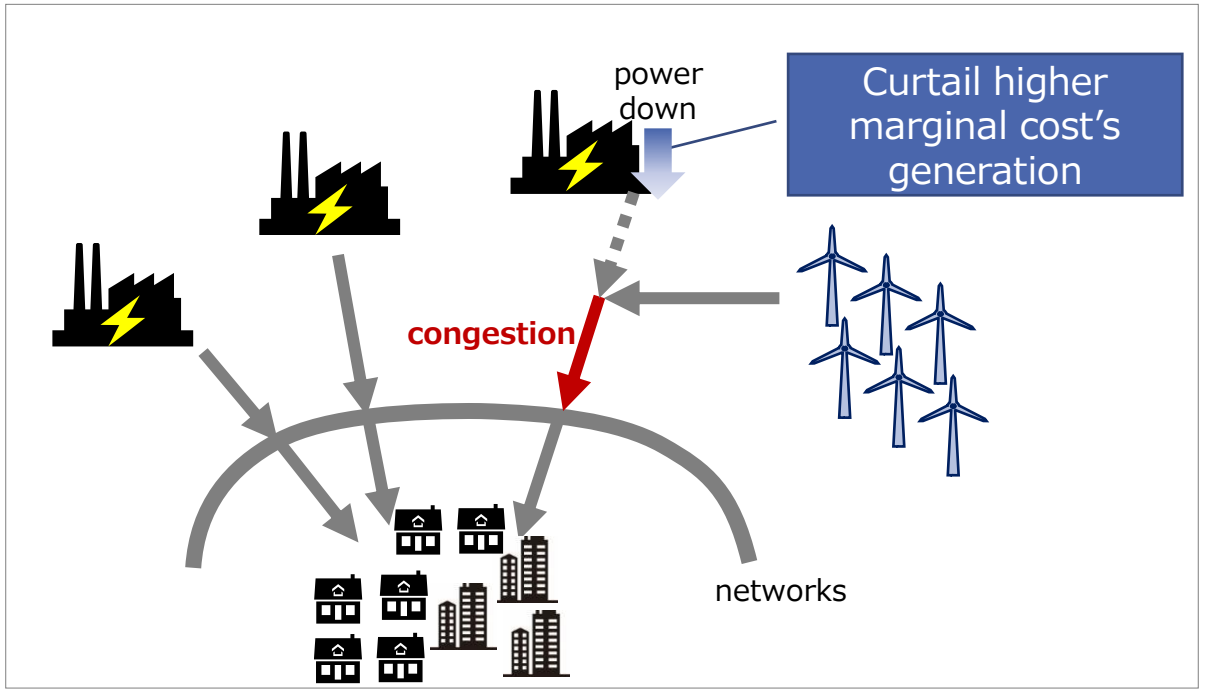
Outline of Non-firm access and Re-dispatching

- Non-firm access is a method of connecting generations only by using vacant capacity of transmission and equipment (in case of excess ATC, the generators have to be curtailed).
- Re-dispatching is a method of congestion reducing that curtail higher marginal cost's generations in sequence.

Grid availability by Non-firm access



Re-dispatching method



1 **Overview of OCCTO**

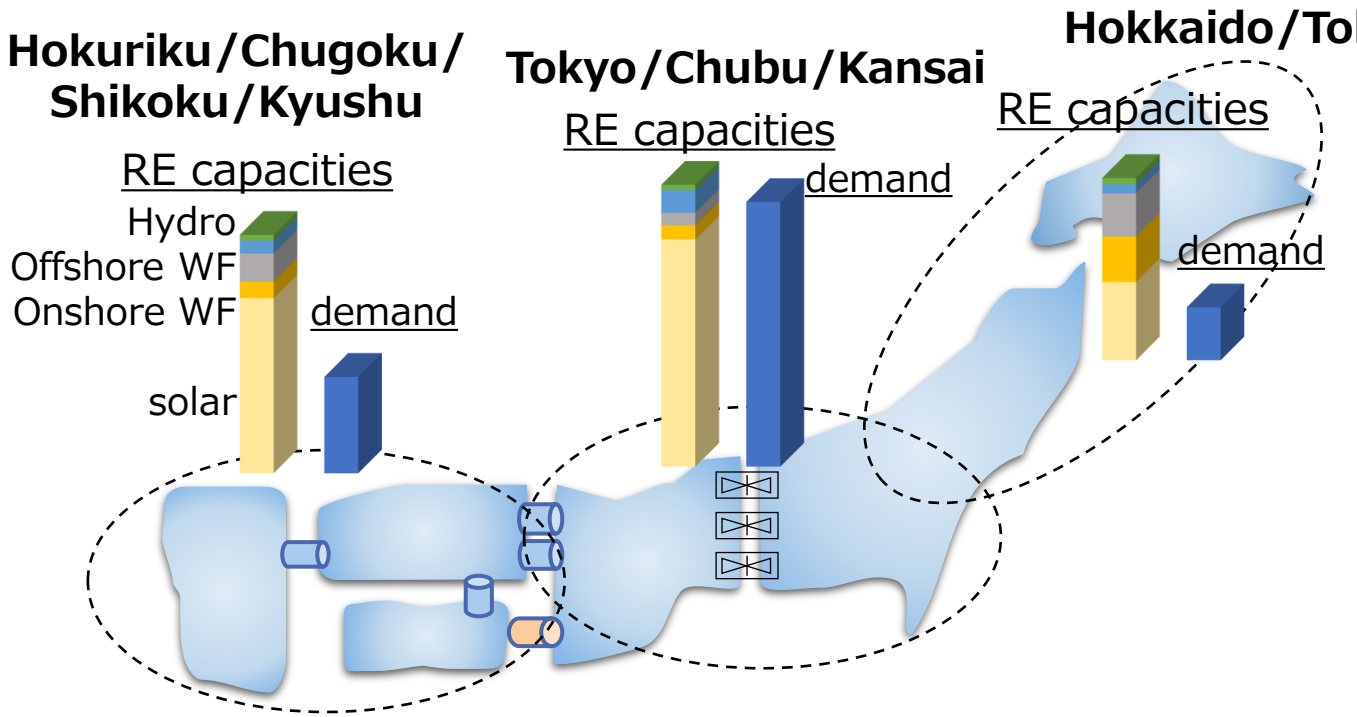
2 **Connect and Manage applying in Japan**

3 **Master Plan of Transmission System Expansion**
<under discussion>

The example of future scenario in Master Plan

- A major key to achieving carbon neutrality in 2050 is to fully utilize the renewable energy potential and to transmit its electricity to large demand areas.
- To discuss Master Plan, it is important not only renewable energy potential but also future demand assumption to achieve carbon neutrality in 2050.

Scenario to carbon neutrality in 2050*

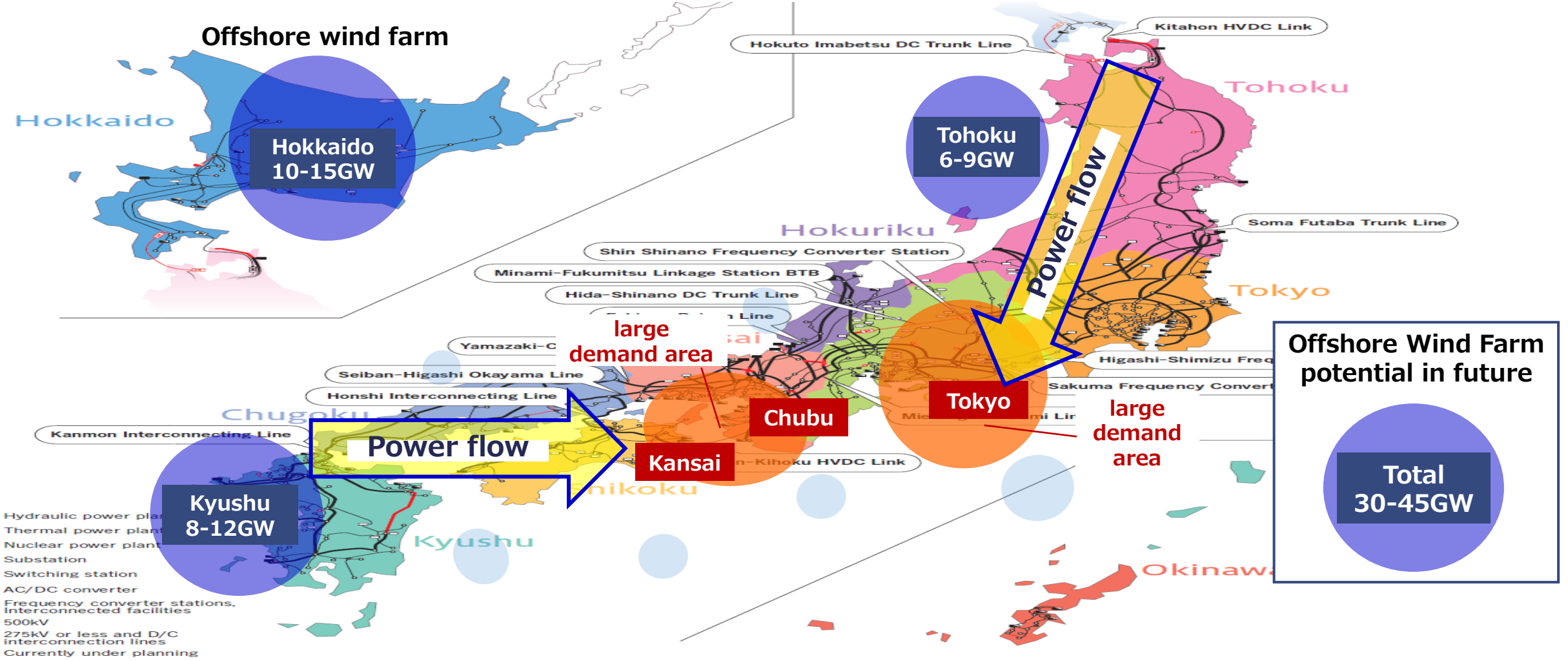


Demand	**250GW**
RE installed amount	**380GW**
RE generation ratio [as a % of total generation(kWh)]	**50%**

demand | Solar | Onshore WF | Offshore WF | Hydro | Others

The Potential of Renewable Energy and Power Flows

- The potential of renewable energy, especially offshore wind farm, is concentrated in north (Hokkaido / Tohoku) and west (Kyushu) of Japan.
- Electric power flows increase from the north and the west regions to the central demand sites. It occurs a shortage of transmission capacity in the bulk power system.



Master Plan of Transmission System Expansion <under discussion>

- In order to install 45GW of renewable energy by 2050, it is estimated that approx. 3,800 to 4,800 billion yen will be required for investment in the transmission system expansions.

Demand	250GW
RE installed amount	380GW
RE generation ratio [as a % of total generation(kWh)]	42%
RE curtailment	4%

One case of the future transmission expansion plans

Hokkaido-Tokyo
Newly construction of HVDC 8GW
¥1,500-2,200 billion

Tohoku-Tokyo
Operational capacity measures
¥700 - 810 billion

Tokyo area
Reinforcing network in area
¥380 – 530 billion

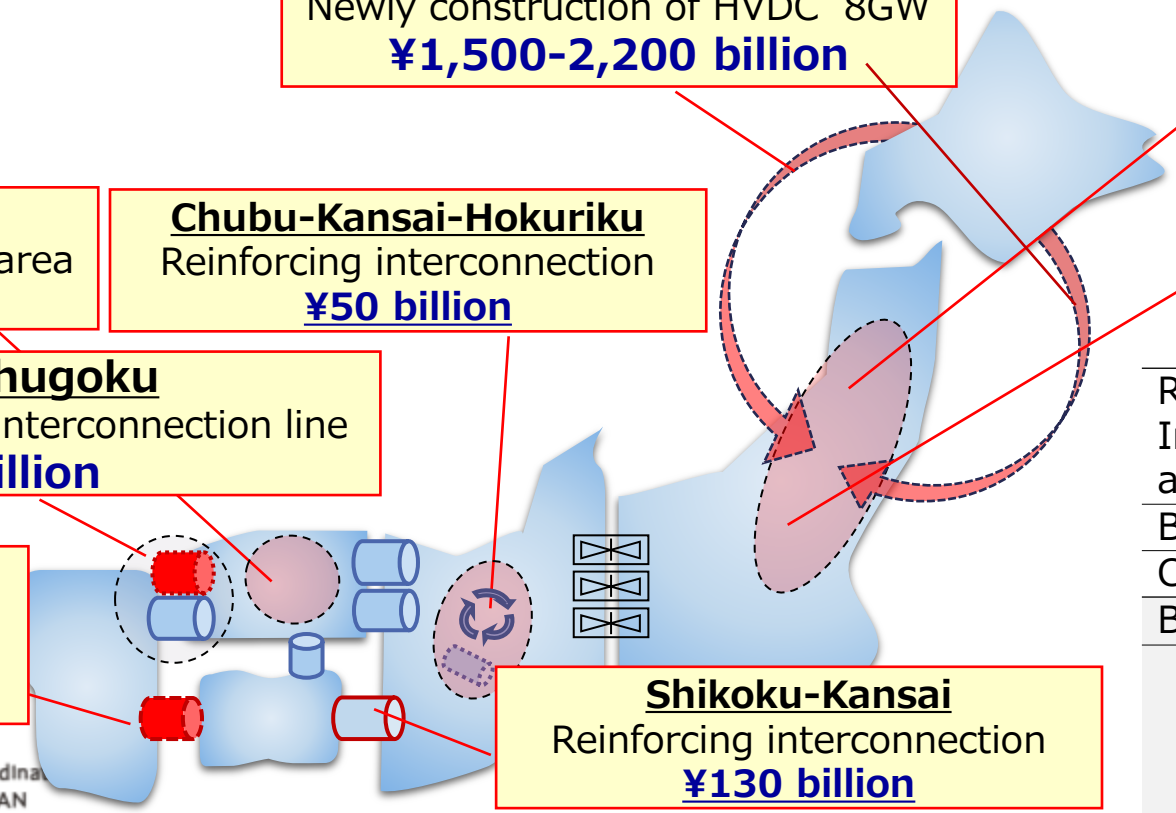
Chugoku area
Reinforcing network in area
¥100 billion

Chubu-Kansai-Hokuriku
Reinforcing interconnection
¥50 billion

Kyushu-Chugoku
Newly construction of interconnection line
¥360 billion

Kyushu-Shikoku
Newly construction of interconnection line
¥580 – 640 billion

Shikoku-Kansai
Reinforcing interconnection
¥130 billion



Required Investment amount	**¥3,800 – 4,800 billion**
Benefit-cost ratio	1.13 - 1.44
Cost per year	¥360 - 450 billion / year
Benefit per year	¥510 billion / year
Fuel cost reduction	¥444 billion / year
CO2 measure cost reduction	¥66 billion / year
CO2 reduction: approx. 12 million ton / year	

Summary

- OCCTO has been performing its duties in accordance with the purpose to maintain a stable supply of electricity and render power supply systems as efficient as possible from a neutral and impartial position.
- Accommodating the growing adoption of renewable energy is also an urgent matter to be addressed in order to achieve carbon neutrality in the future.
- We will proceed with various efforts that show the ideal figure of electricity network and realize it based on Mid to Long-term perspectives.

Thank you for your attention

https://www.occto.or.jp/en/