METI
Ministry of Economy, Trade and Industry

System Resilience Against Major Earthquakes
~Learnings from the Hokkaido Blackout~

May 14th 2019

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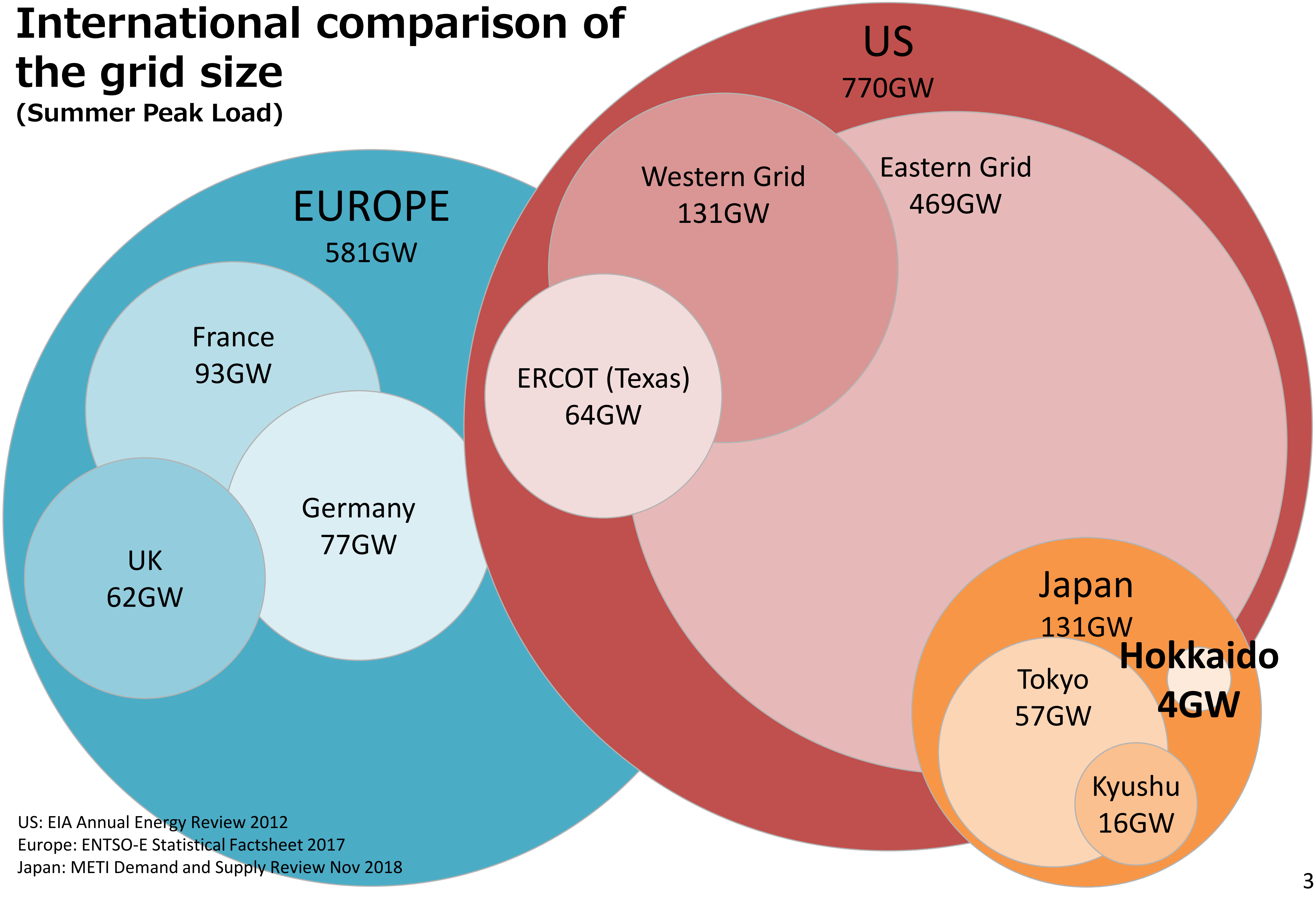
Where Hokkaido is

International comparison of the grid size

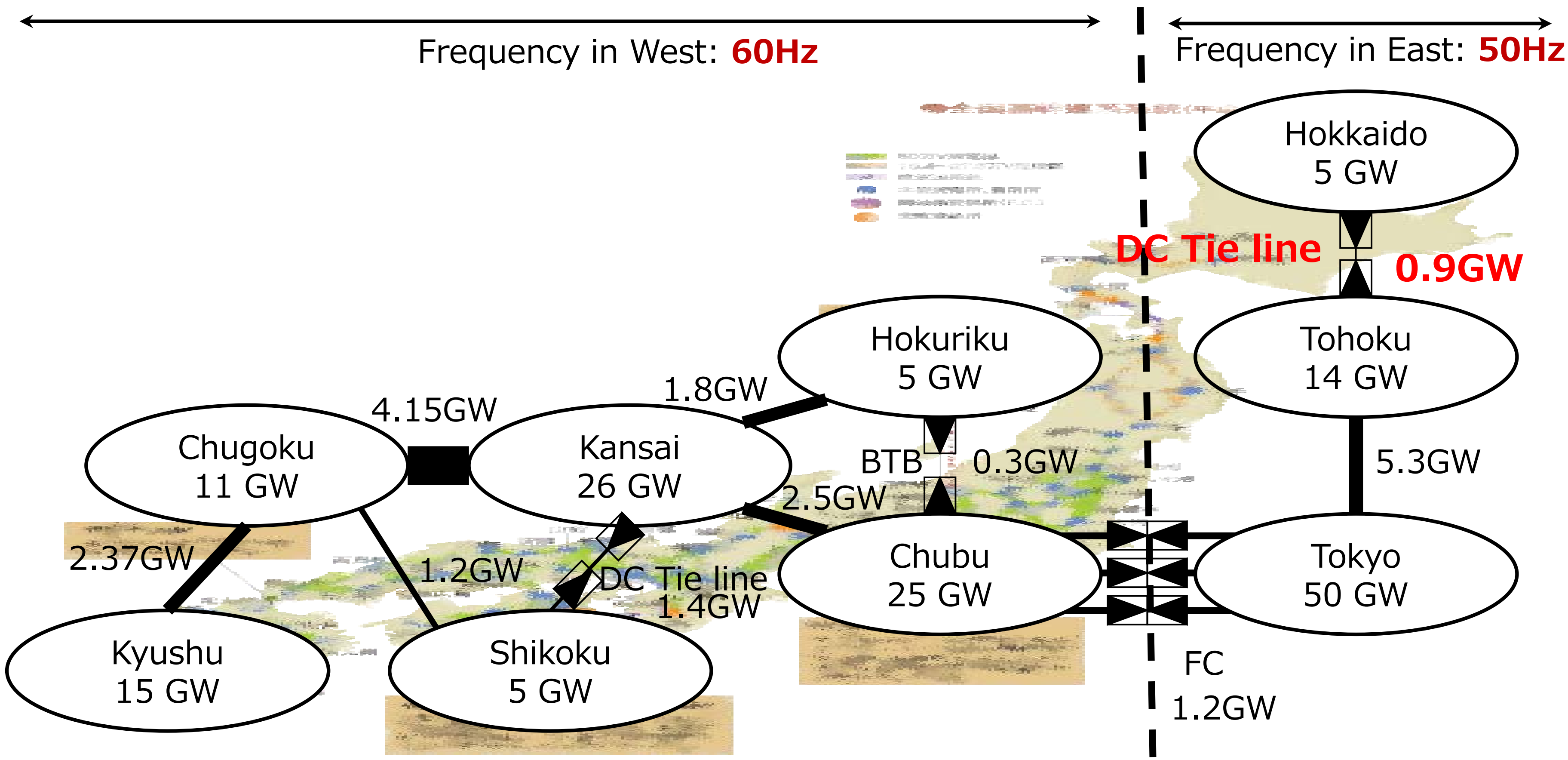
(Summer Peak Load)



US: EIA Annual Energy Review 2012
Europe: ENTSO-E Statistical Factsheet 2017
Japan: METI Demand and Supply Review Nov 2018

Interconnection between control areas

- Japan has limited interconnection capacity between the 9 control areas.



*DC: direct current, FC: frequency conversion

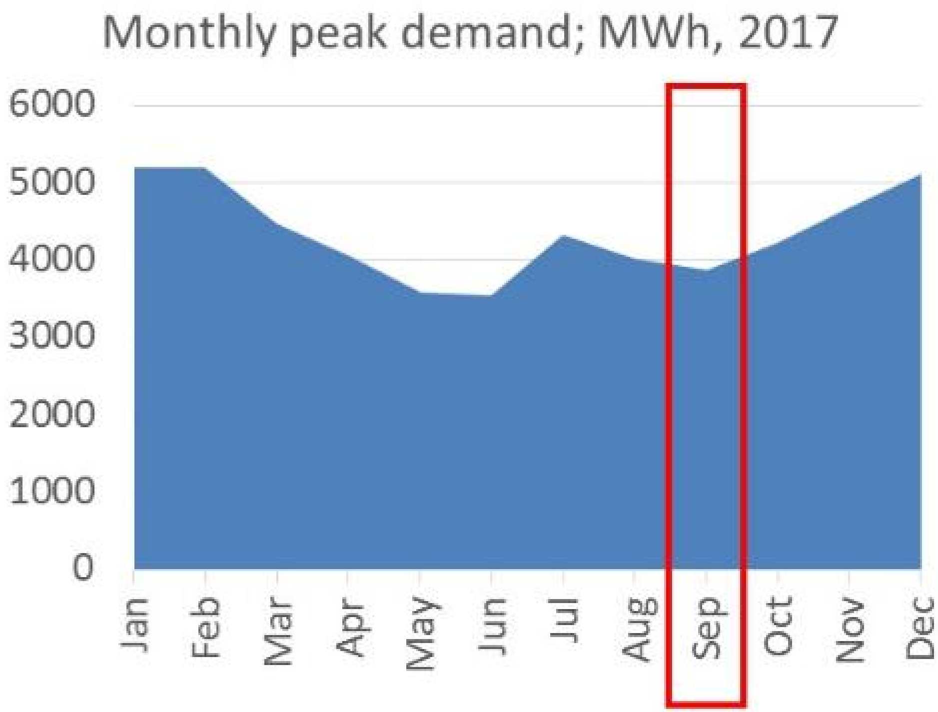
1. Background

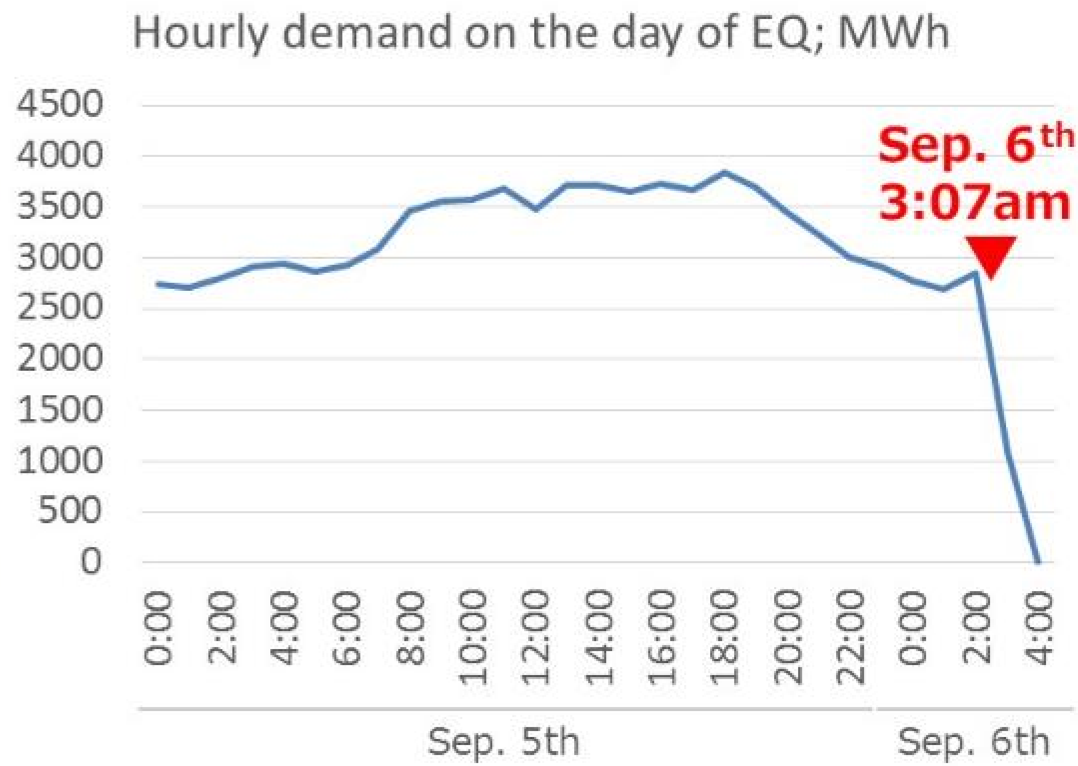
2. Fact-sharing

3. Implication

Demand scale when the earthquake hit

- The earthquake hit Hokkaido when the demand was relatively small

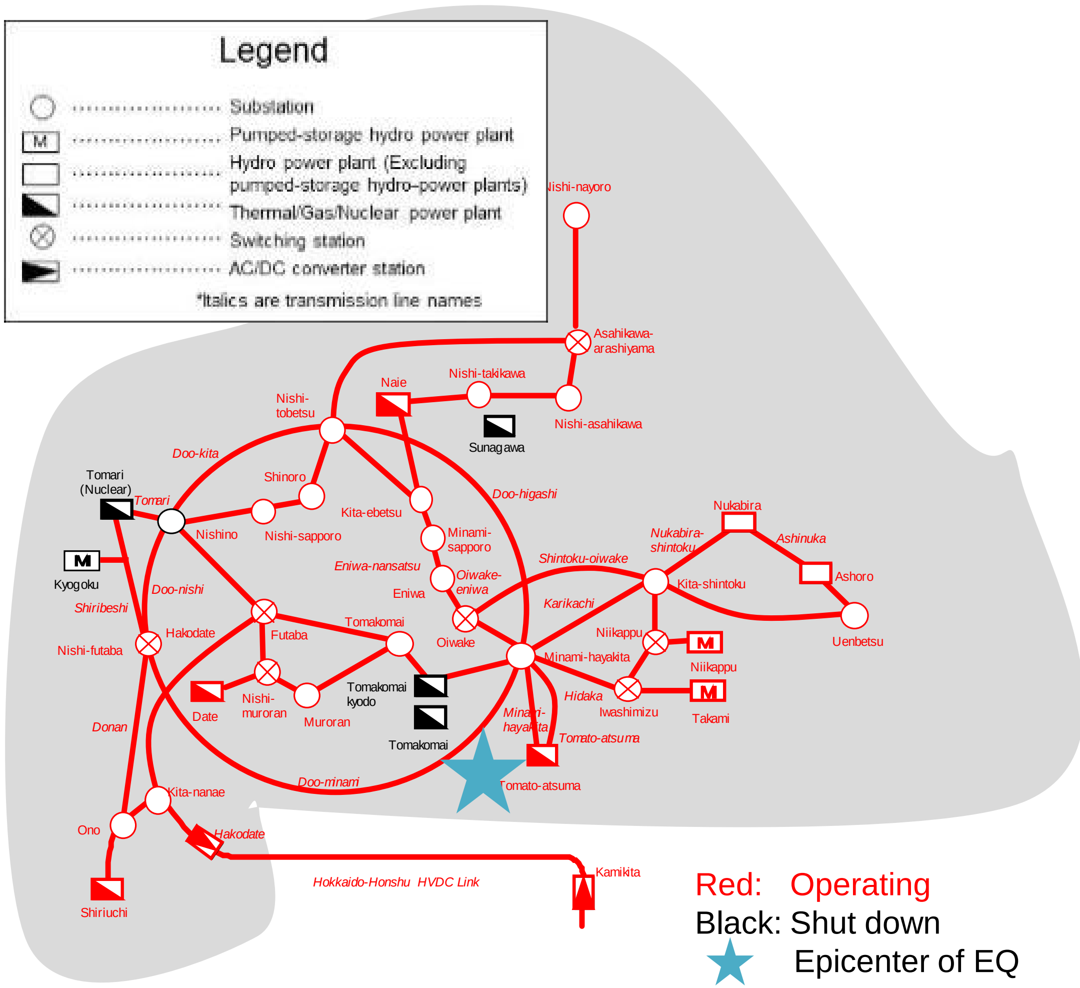




The epicenter of the earthquake

- The epicenter was close to Tomato-Atsuma thermal power plant

Grid map of Hokkaido



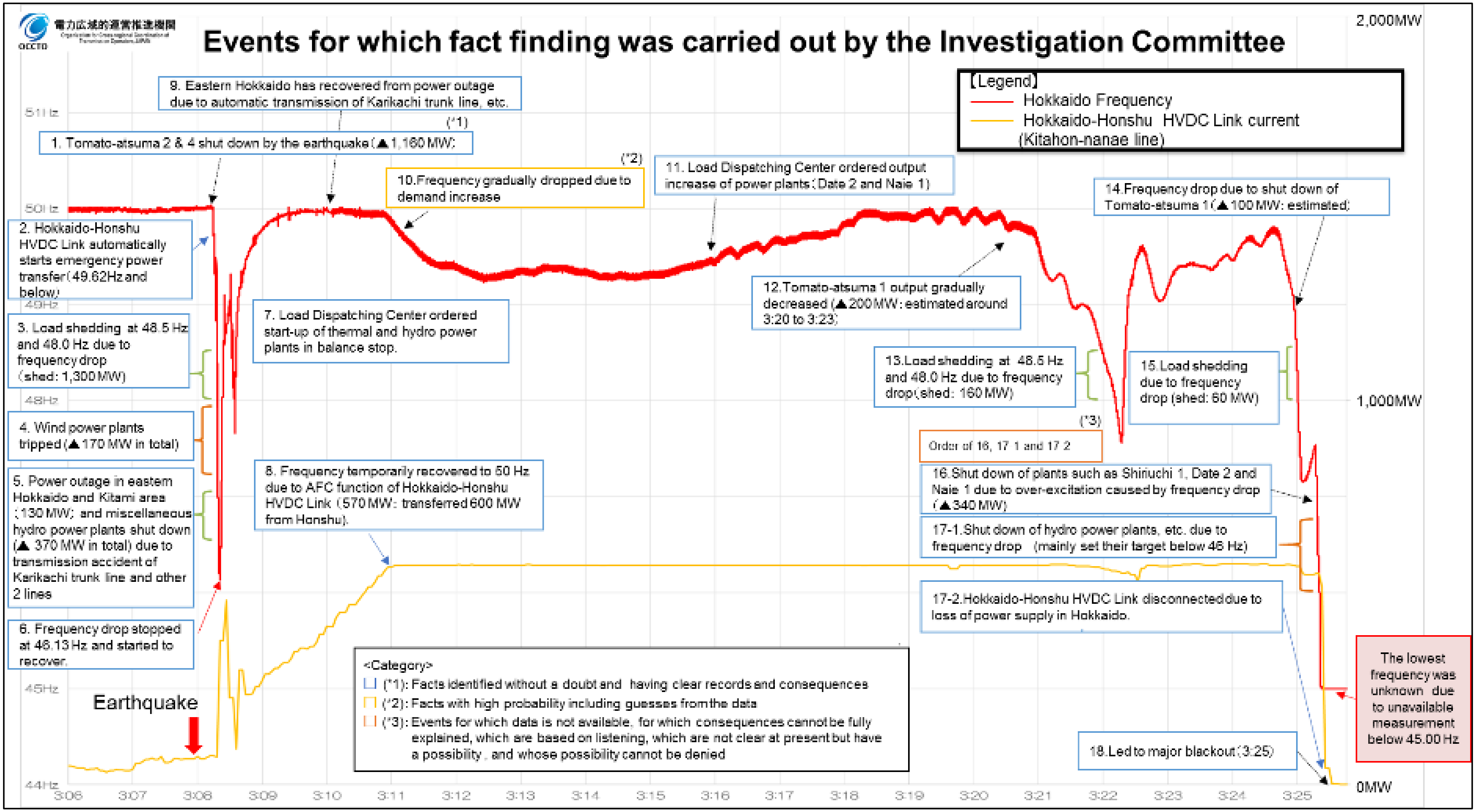
Source of supply before the EQ

Generation type	Output (MWh)	Share
Thermal	1,725 (1,492 from Tomato-Atsuma)	56%
Hydro	780	25%
Wind	166	5%
Solar	0	0%
Interconnection	72	2%
Others	344	11%
Total	3,087	

Sequence of events that led to the blackout

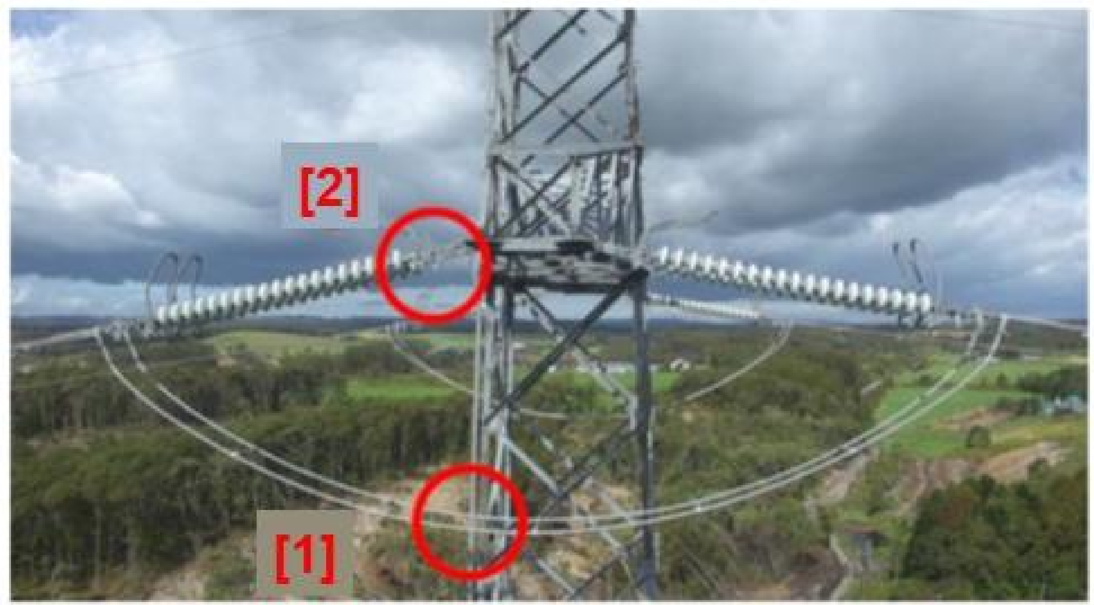
- 3 units at Tomato-Atsuma (N-3) shut down
- 4 power transmission lines (N-4) were damaged by ground fault.
- The UFR* and interconnection were insufficient to sustain the frequency

*UFR: Under Frequency Relay



Tomato-Atsuma power plant

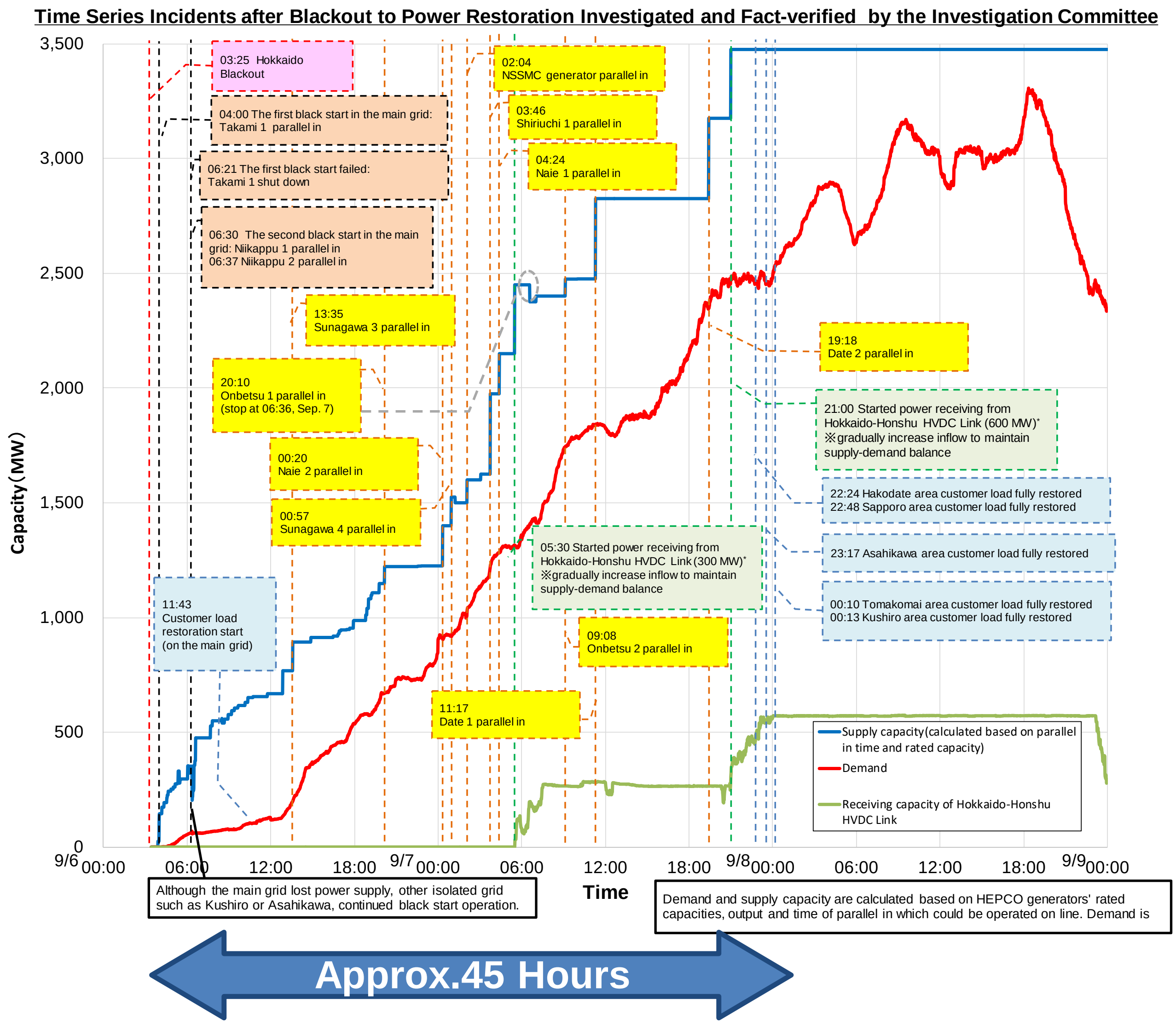
Transmission accident



Earthquake vibrations caused the [1] jumper wire to come in contact with the [2] tower body

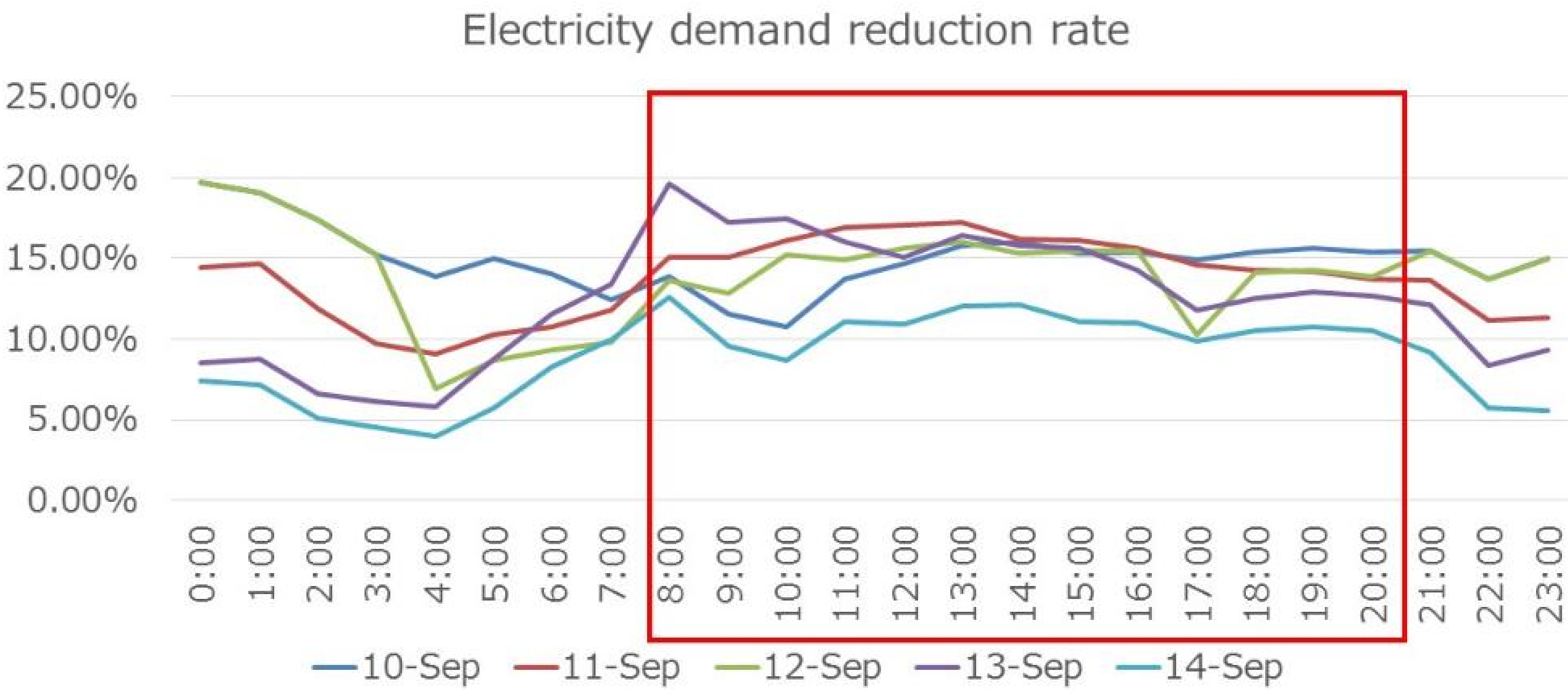
Recovery from the blackout

- It took approx. 45 hours to supply power to nearly the entire area



Voluntary power saving

- METI asked the citizens of Hokkaido to cut back electricity demand from 8:30 to 20:30 and 10~20% of reduction was achieved



*Demand is measured against the peak demand during Sep.5th, the day before EQ

Measures to be taken

- ☑ **Expansion of the interconnection capacity**
- ☑ **Addition of load shedding capacity** (UFR: Under Frequency Relay)
- ☑ **Ensuring resource adequacy**

1. Background

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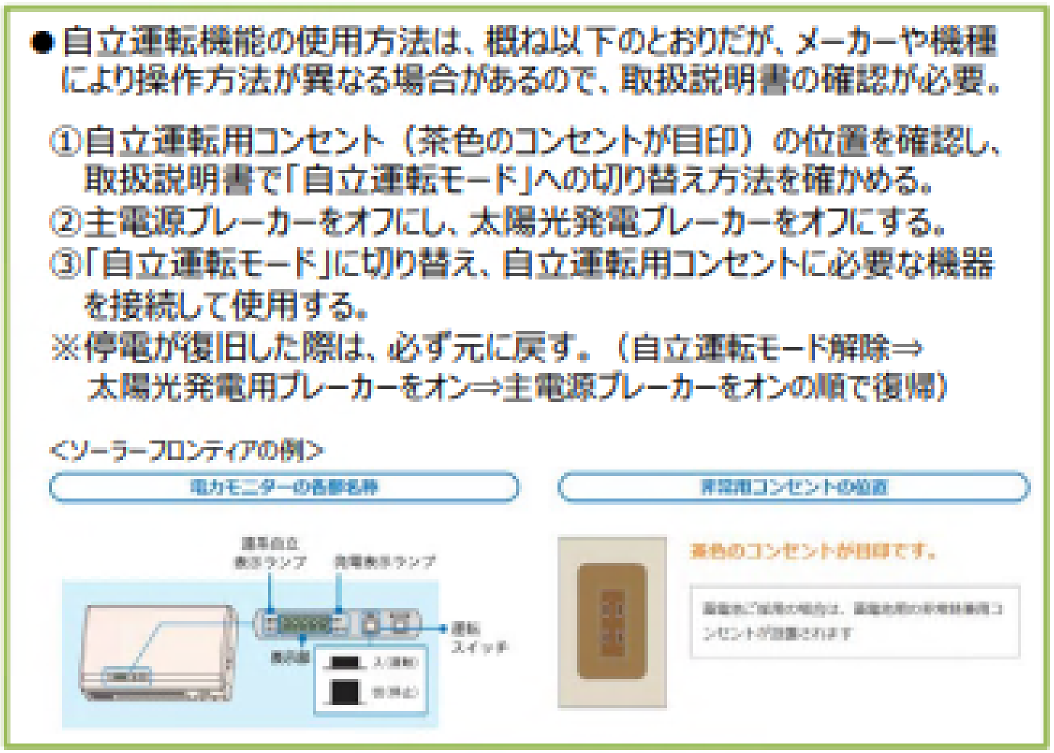
Implication to Renewable Energy Sources (RES)

- ☑ **On-site PV contributed** to support household demand. **Educating the citizens** on how to modify the device setup is important
- ☑ **Clear grid code** is required to make RES more resilient to frequency changes
- ☑ **Sufficient balancing capacity** is required for RES to re-connect to the grid after blackout

Contribution of on-site Solar Photovoltaic (PV)

- METI announced how to modify the device setup to run in power from the on-site PV

Announcement from METI

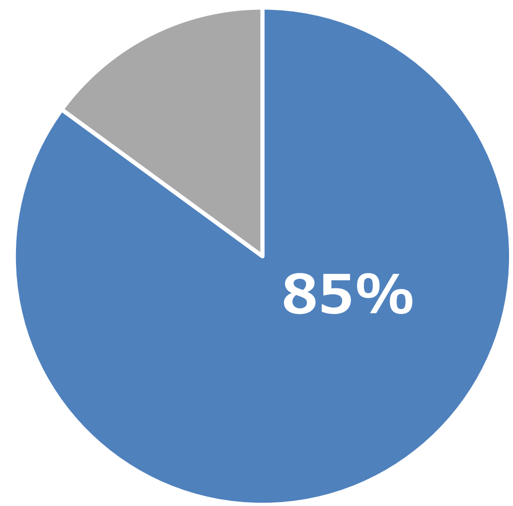


- 自立運転機能の使用方法は、概ね以下のとおりだが、メーカーや機種により操作方法が異なる場合があるので、取扱説明書の確認が必要。

①自立運転用コンセント（茶色のコンセントが目印）の位置を確認し、取扱説明書で「自立運転モード」への切り替え方法を確かめる。
②主電源ブレーカーをオフにし、太陽光発電ブレーカーをオフにする。
③「自立運転モード」に切り替え、自立運転用コンセントに必要な機器を接続して使用する。
※停電が復旧した際は、必ず元に戻す。（自立運転モード解除⇒太陽光発電用ブレーカーをオン⇒主電源ブレーカーをオンの順で復帰）

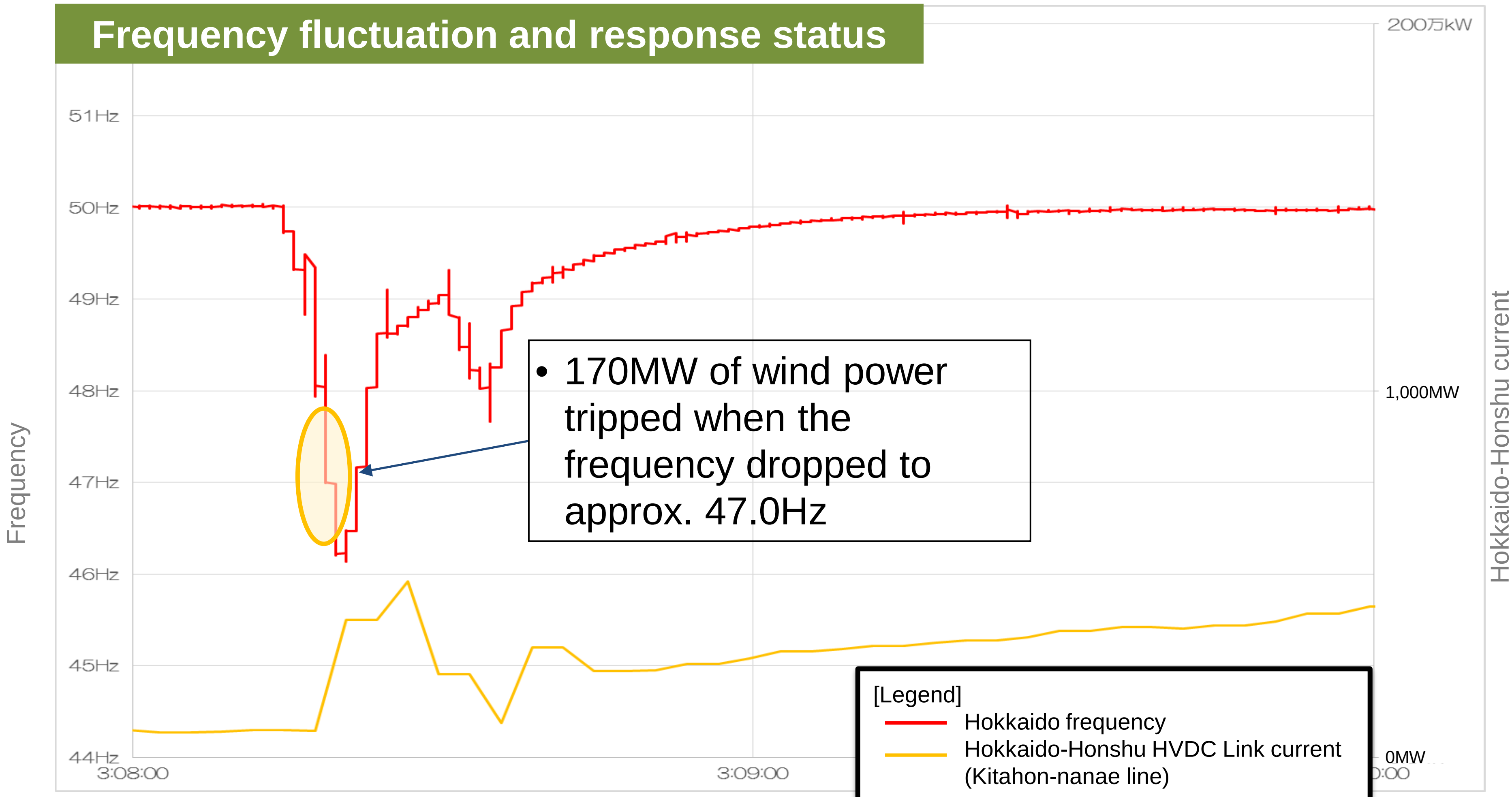
<ソーラーフロンティアの例>

Share of households utilized on-site PV during the blackout



Resilience against frequency changes

- Due to mechanical configuration, 170MW of wind power tripped all at once when the frequency dropped below approx. 47.0Hz.



Recovery of RES

- It took a week for RES to recover to full operation due to lack of balancing capacity