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IEA WIND TEM#101: Hybrid power plants challenges and opportunities

Hybrid power plants in Japan

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Outline

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1. About our company
2. Difficulties in wind development in Japan
3. Case studies: hybrid power plants in Japan
4. Summary

1. About our company

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We provide one-stop solutions covering engineering, products and services

2-1. Difficulties in wind development in Japan

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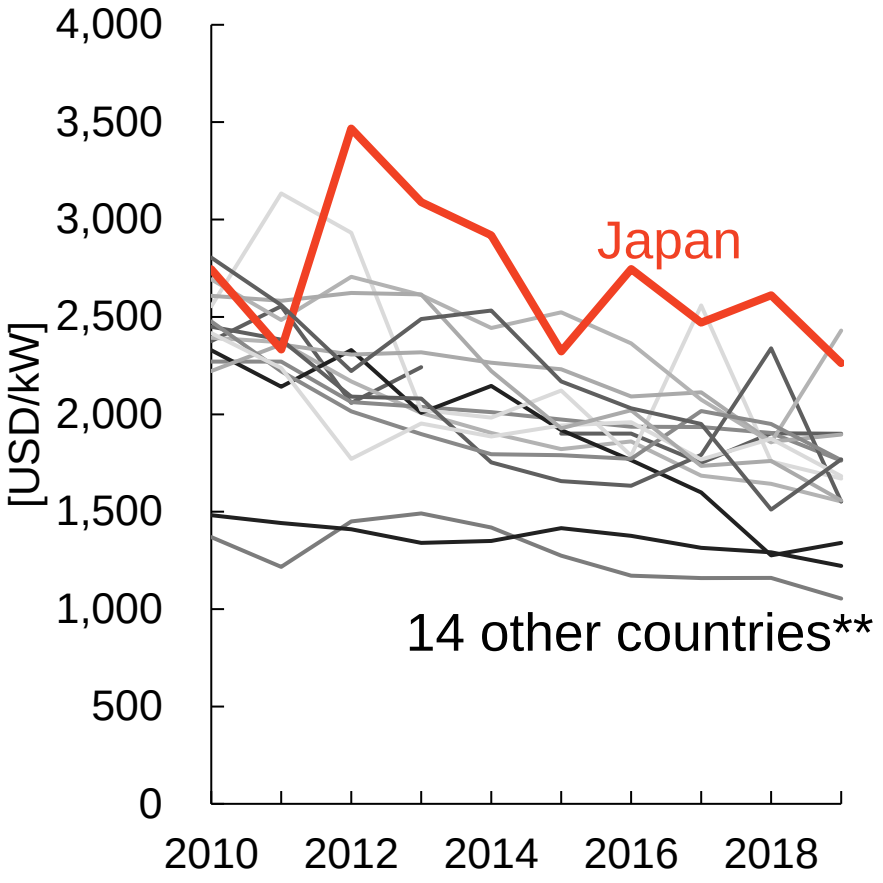
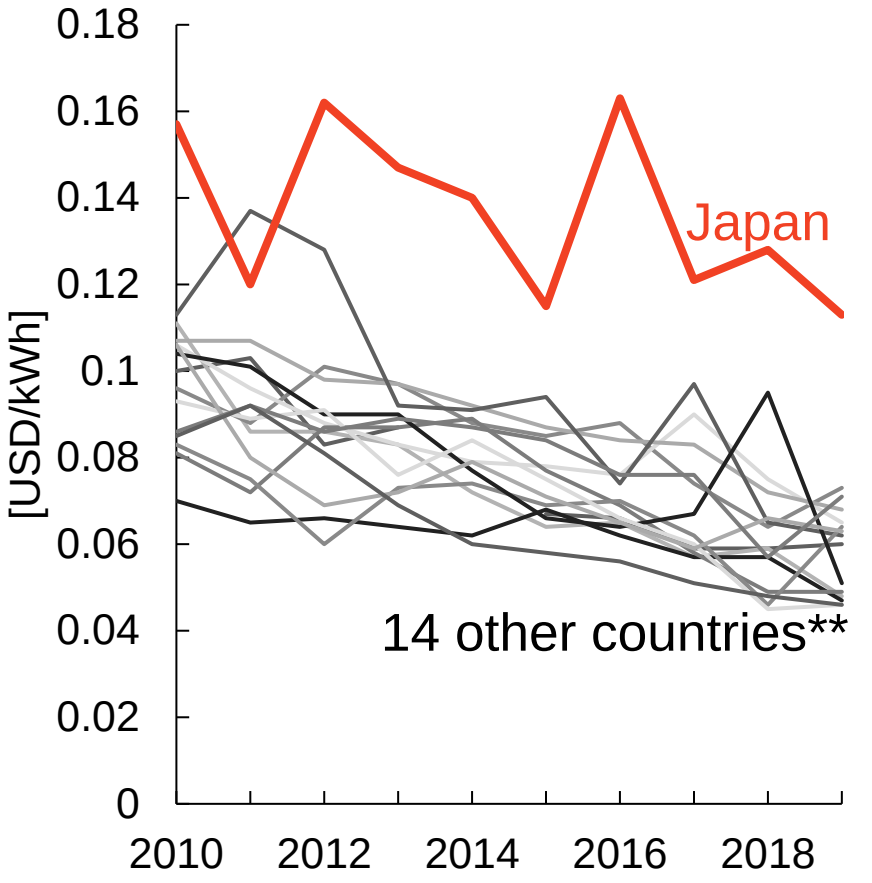
Total installed costs and LCOE are worse than others

Total installed costs*



LCOE*



*IRENA, *Renewable Power Generation Costs in 2019*, (2020)

**Denmark, Brazil, Canada, China, France, Germany, India, Italy, Mexico, Spain, Sweden, Turkey, U.K., U.S.

2-2. Difficulties in wind development in Japan

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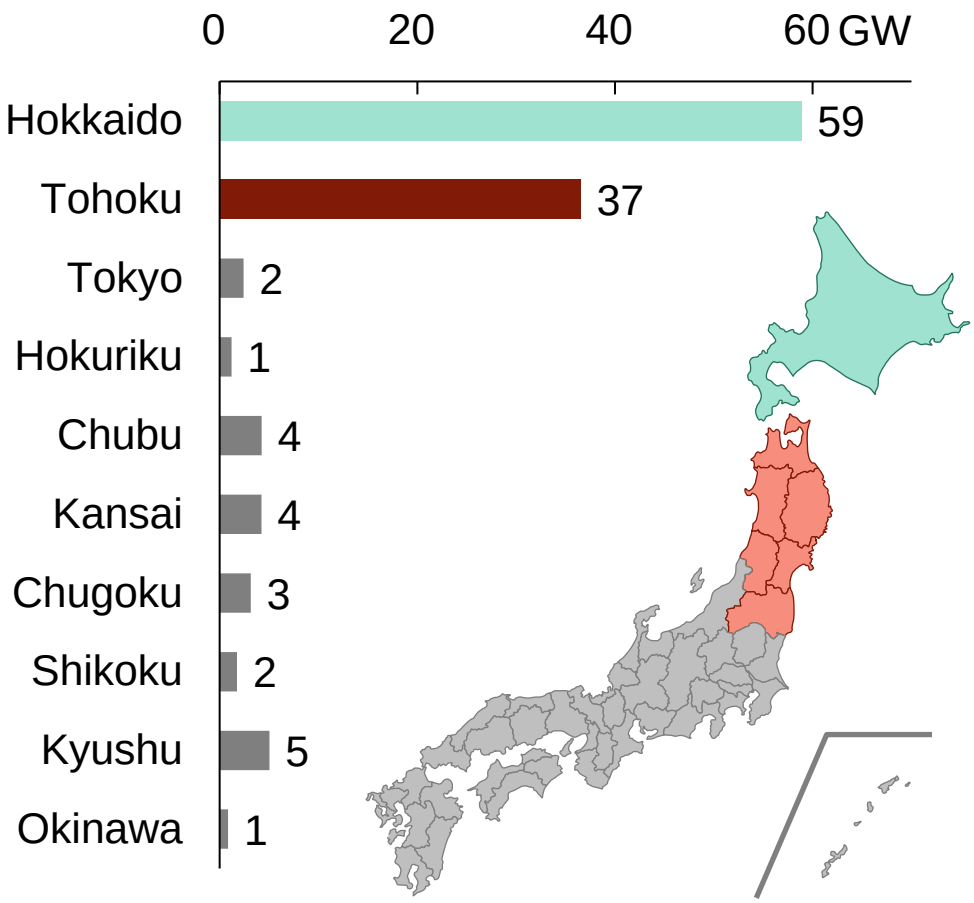
Wind resources are unevenly distributed in Japan

Wind development potential without considering grid capacity*



Insights

Difficulties:

-Wind resources are abundant in Hokkaido and Tohoku

-Grid capacity is limited in these regions

Research directions:

1) Create additional benefits
2) Develop areas where grid capacity is limited

*Ministry of Environment, Japan, (2020); Those above is based on 17JPY/kWh scenario

3-1. Case studies: HPP in Japan

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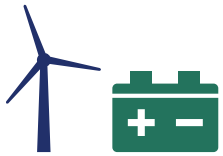
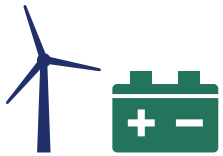
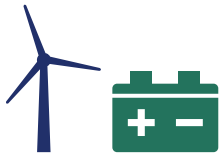
			Research directions / Concepts	
No.	**Comm. Operation**	**Components**	**1) Create additional benefits**	**2) Develop areas where grid capacity is limited**
1.	2002- Okinawa		Reduce fuel costs of island grid	-
2.	2010- Tohoku		-	Mitigate wind power fluctuation
3.	2015- Tohoku		Emergency power supply	Mitigate wind power fluctuation
4.	Under dev. Tohoku		-	Co-location with PV

3-2. Case(1) HPP for island grid

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Storage mitigate wind power fluctuation; HPP reduces fuel cost of island grid

Project overview

Site: One of islands in Okinawa, Japan

Context: Power was supplied by DEG; they suffered from increase in fuel costs

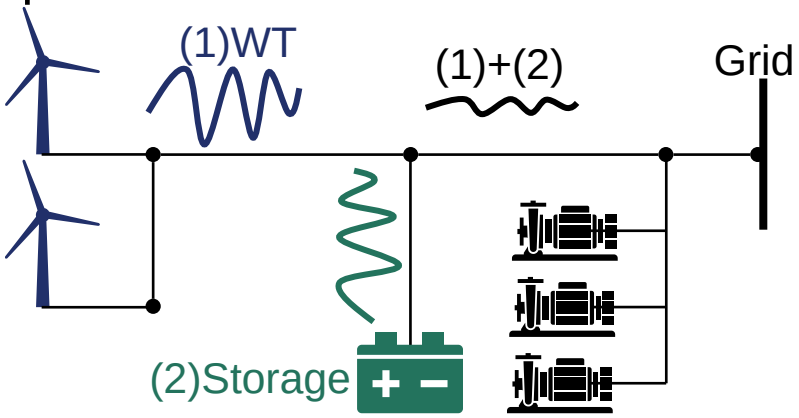
Components: WT (600kW)x2 and Storage (300kVA)x2

Comm. operation: 2002

Partners: Okinawa Electric Power Company, Inc.

System

-Storage mitigate power fluctuation caused by WT
-Avoid unnecessary wind power curtailment



Additional Benefits: Supply 70% of total demand in the island by wind power

3-3. Case(2) HPP to mitigate power fluctuation

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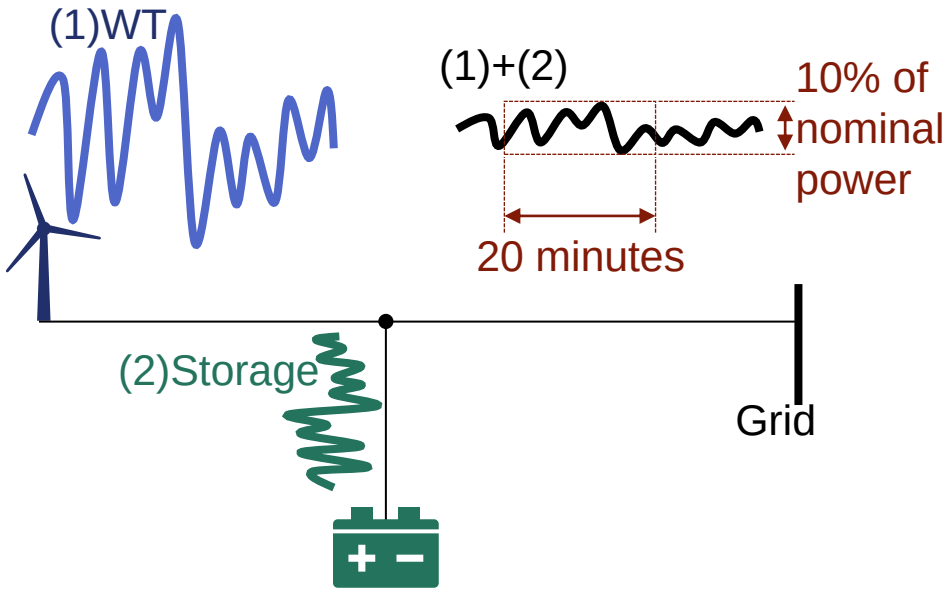
Some TSOs require WT to mitigate power fluctuation

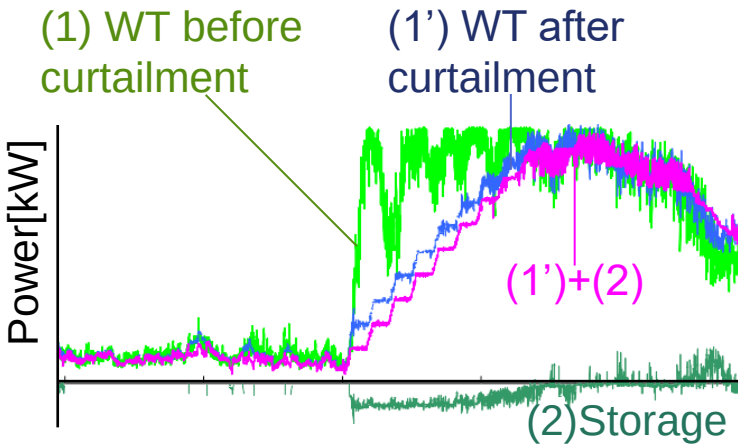
Project Overview

Requirements imposed by TSO*:
Differences between max. power and min. power within 20 minutes should be less than 10% of nominal power



Sites: nine sites already operated

Track records



-Wind power (1) increases suddenly; mitigated power (1')+(2) is moderate.
-Wind curtailment (1)-(1') seems waste of energy; it can help reduce storage capacity.

*Tohoku Electric Power Co., Inc

3-4. Case(2) HPP to mitigate power fluctuation

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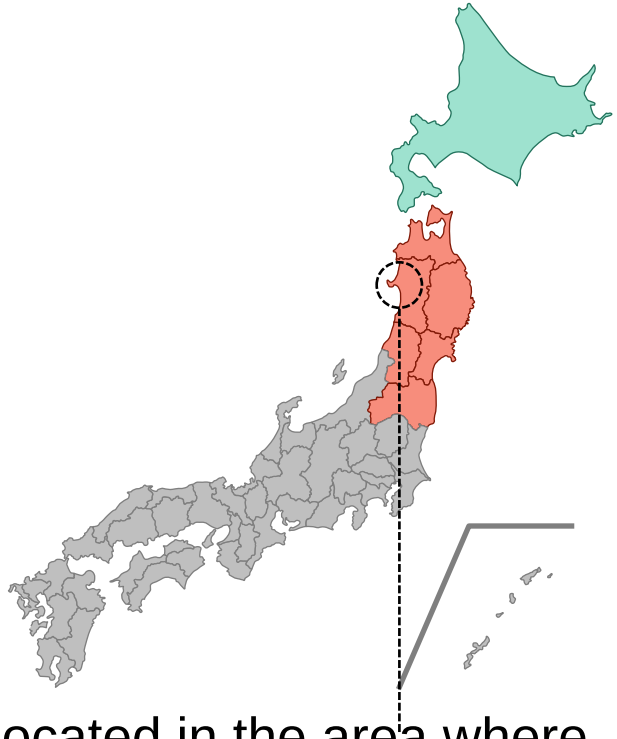
The HPP enables wind developers to develop difficult areas

Site photos

Lead-acid battery

Remote control room

Site location



Located in the area where wind resource is abundant but grid capacity is limited

3-5. Case(3) HPP with multi-purpose storage

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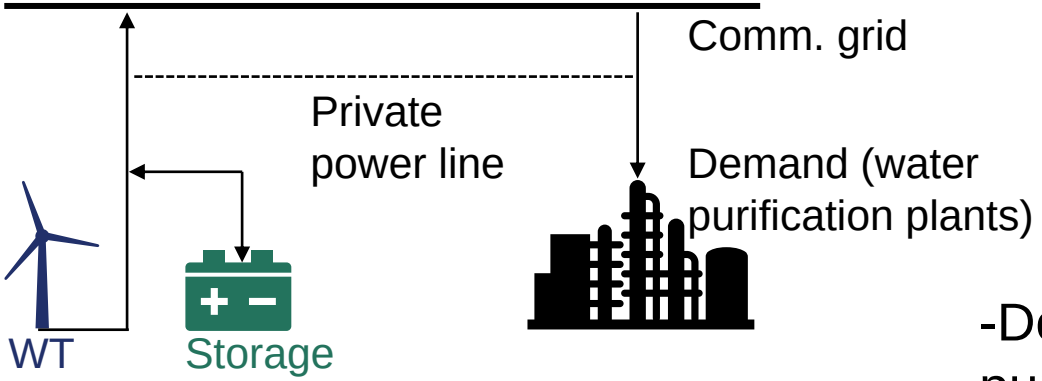
The mitigation sys. is also served as emergency power supply

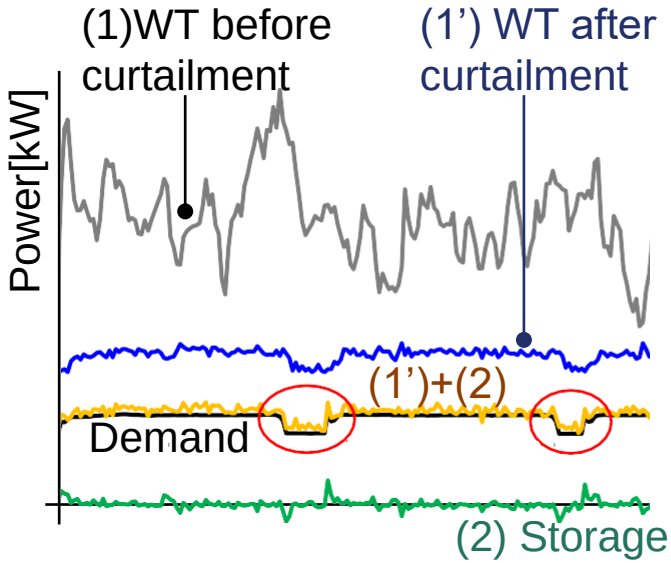
Project overview

Technical requirements:
-Mitigate power fluctuation (TSO)
-Emergency power supply (Water purification plants)



Area: Tohoku, Japan
Comm. operation: 2015
Components: WT (1,870kW)x4 and storage (500kVA)x5

Demo.



-Demand changes suddenly when pumps starts/stops
-Successfully control (1')+(2) as fast as demand changes

Additional Benefits: Emergency power supply will last 2.5 hours

3-6. Case(4) HPP for connecting grid at existing PV

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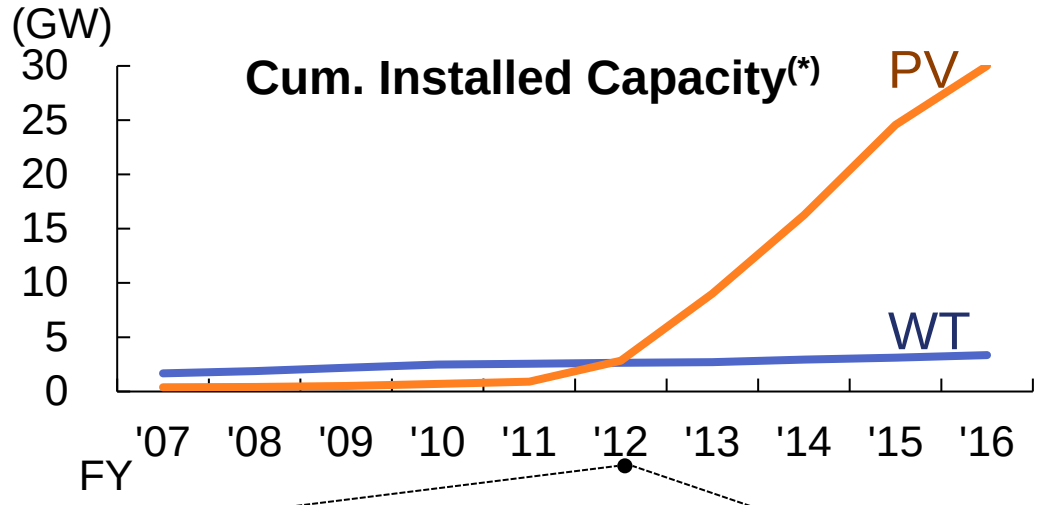
WT delayed in development; Research on WT control to connect existing PV

Impact of laws on installed capacity



Feed-In-Tariff
-July 2012
-both PV and WT

Environmental Impact Assessment Act
-October 2012
-PV: Not required
-WT: Mandatory or highly recommended

Insights

-PV had no obligation to obey EIA when FIT was enforced in Japan
-PV had occupied grid capacity even in the area where wind is abundant

-Research on WT control to connect existing PV (not vice versa)

*Ministry of Economy, Trade and Industry, Japan, *Annual Report on Energy*, (2018); Excluding Rooftop PV

3-7. Case(4) HPP for connecting grid at existing PV

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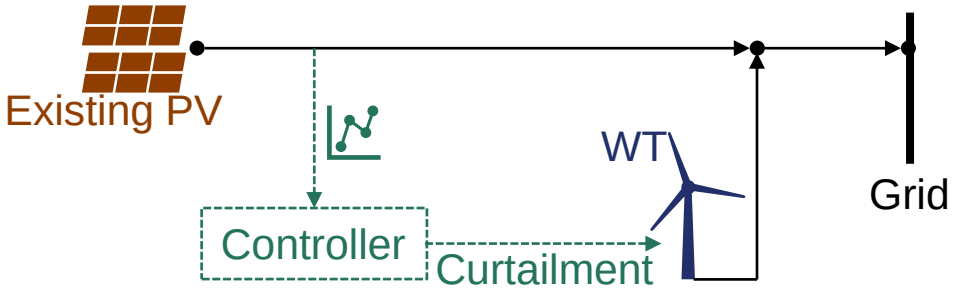
Requirements for co-location with PV are satisfied by rapid curtailment of WT

Project overview

Technical requirements:
-Total power is not allowed to exceed over existing PV nominal power (TSO)
-Curtail only WT (Existing PV)



Site: Demonstrated in Tohoku, Japan

Demo.

Successfully curtail wind power as rapidly as PV power changes, even on cloudy days

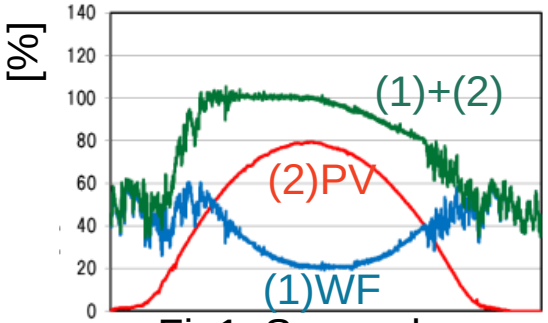


Fig1. Sunny day

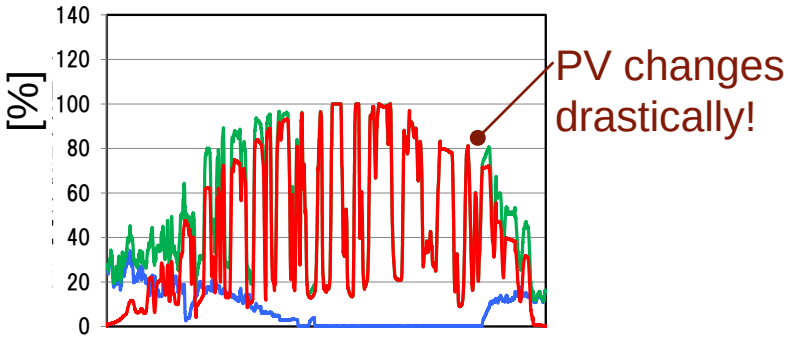


Fig2. Cloudy day

4. Summary

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We have almost 20 years of experience in developing HPP

There are two difficulties in wind development in Japan:
-Costs of installing WT is higher
-wind resources are unevenly distributed

Our research directions are:
-to create additional values
-to develop areas where grid capacity is limited.

Four cases explained.

Opportunities: HPP may enable wind developers to develop areas where wind is abundant and grid capacity is limited.

Challenges: Rapid WT control helps save storage capacity and reduce HPP installation costs, but not enough.