

11th IERE Webinar: Grid-Forming Inverter (GFM)

R&D Activities on Grid-Forming (GFM) Inverters in Ja

October 16, 2026

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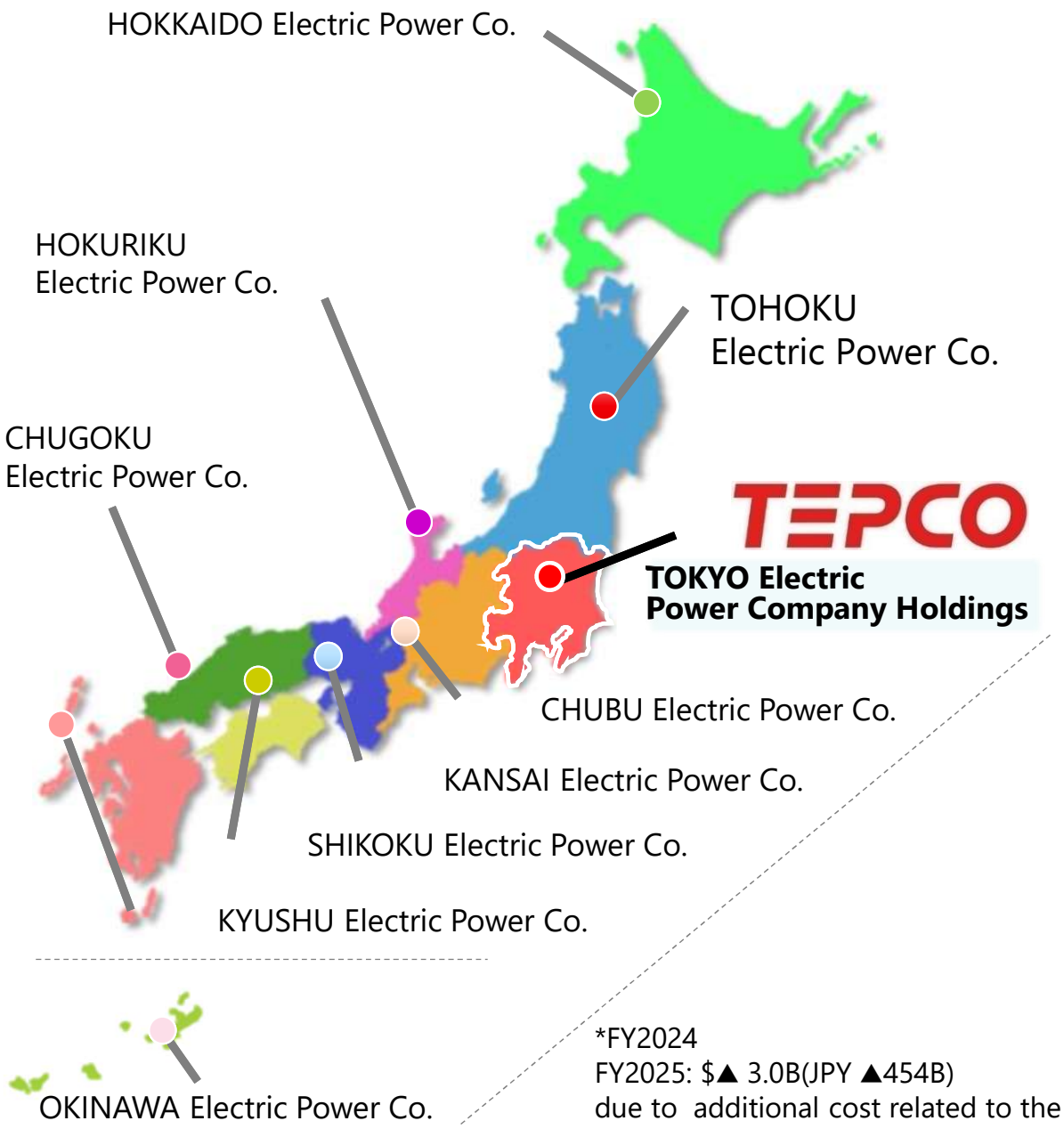
TEPCO Research Institute

Tokyo Electric Power Company Holdings, Inc.

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TEPCO Overview



Item		JAPAN	TEPCO
Service Area Population		120 million	**44 million**
Installed Capacity		350 GW	**18 GW (JERA 59 GW)**
Annual Generation		1000 TWh	**11 TWh (JERA 227 TWh)**
Composition	Gas	86 GW 338 TWh	**0 GW (JERA 47 GW)**
	Coal	55 GW 330 TWh	**0 GW (JERA 10 GW)**
	Nuclear	94 GW 331 TWh	**8 GW 0 TWh**
	Renewable	131 GW 242 TWh	**10 GW 11 TWh**
Electricity Demand		806 TWh	**210 TWh**

TEPCO Financial Information (FY2025)		
Revenue	$ 42.0B	JPY 6300B
Operating Income	$ 2.3B	JPY 340B
Net income*	$ 1.1B	JPY 160B
Capital	$ 9.3B	JPY 1400B
Employees	38,000(Consolidated)	

*FY2024
FY2025: $▲ 3.0B(JPY ▲454B)
due to additional cost related to the Fukushima Daiichi decommissioning

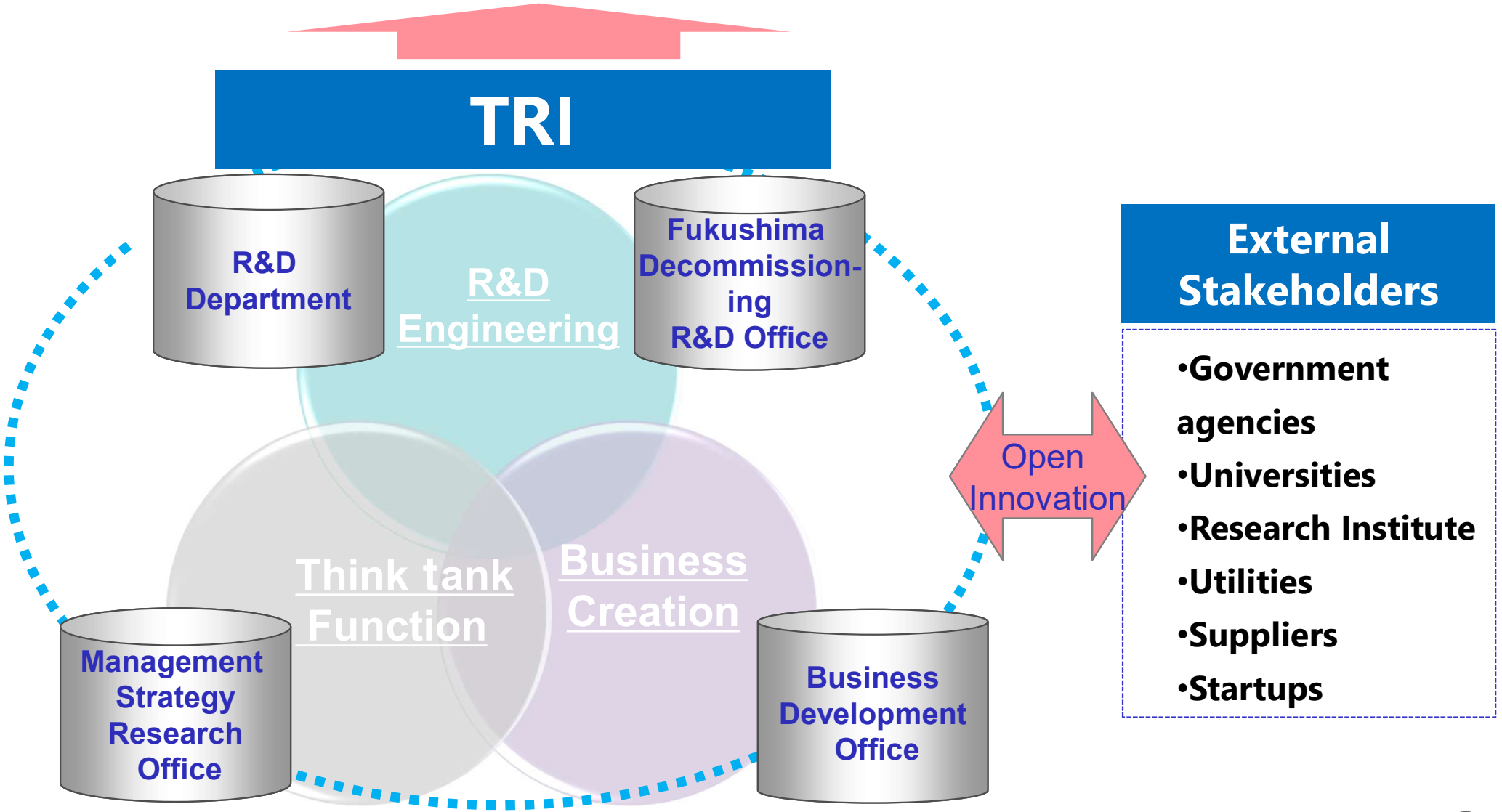
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Role of TEPCO Research Institute （TRI）

TEPCO
Main Holding Company

TEPCO Group Companies

TEPCO Fuel & Power
TEPCO Power Grid
TEPCO Energy Partner
TEPCO Renewable Power



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Background and Objective

Background

- Countermeasures are required to address the decline in grid inertia caused by large-scale integration of renewable energy.
- In Japan, GFM inverter technology is still at an early stage; therefore, practical development is being conducted under national projects (NEDO program).

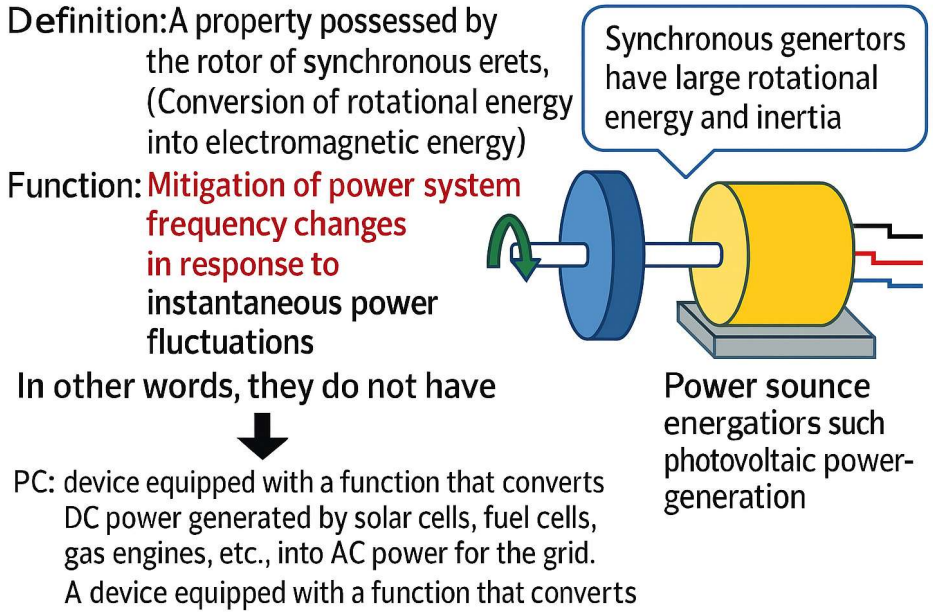
Objective

- To establish practical solutions for reduced grid inertia.
- To develop GFM inverters for high-voltage grid interconnection.

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Purpose of National project

- Japan's Seventh Strategic Energy Plan (2025) promotes large-scale renewable integration toward 2040. This transition reduces the number of synchronous generators and decreases overall grid inertia. Reduced inertia degrades frequency stability and increases the risk of widespread outages during disturbances.
- This project addresses the reduction in inertia by implementing synthetic inertia in power converters. Synthetic inertia is implemented in high-voltage, grid-connected converters to:
- Suppress frequency deviations
- Enhance system stability



Inertia in Power Systems

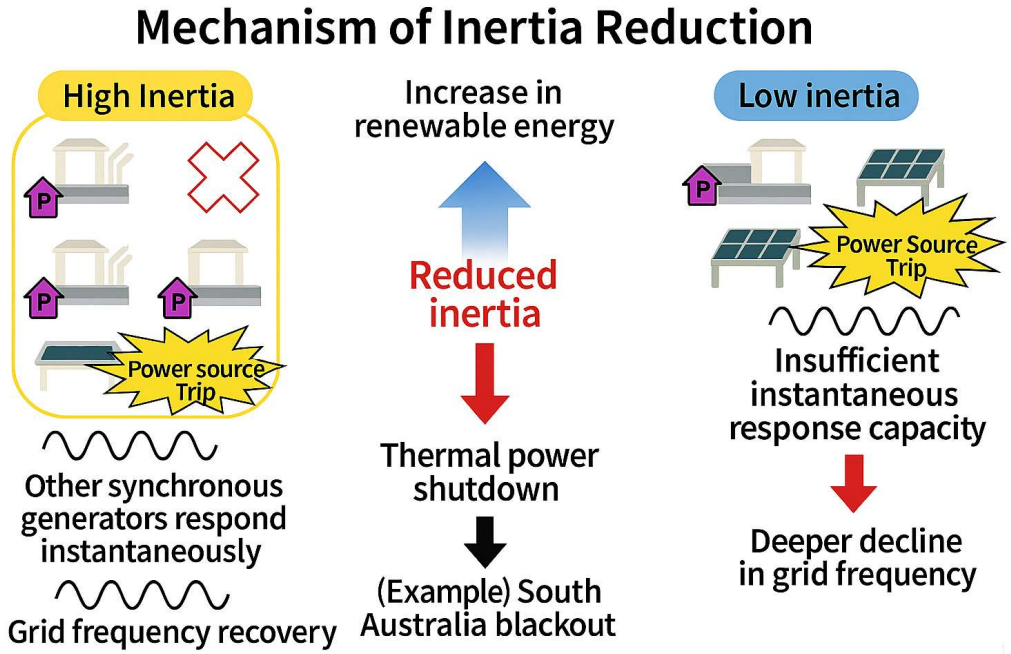
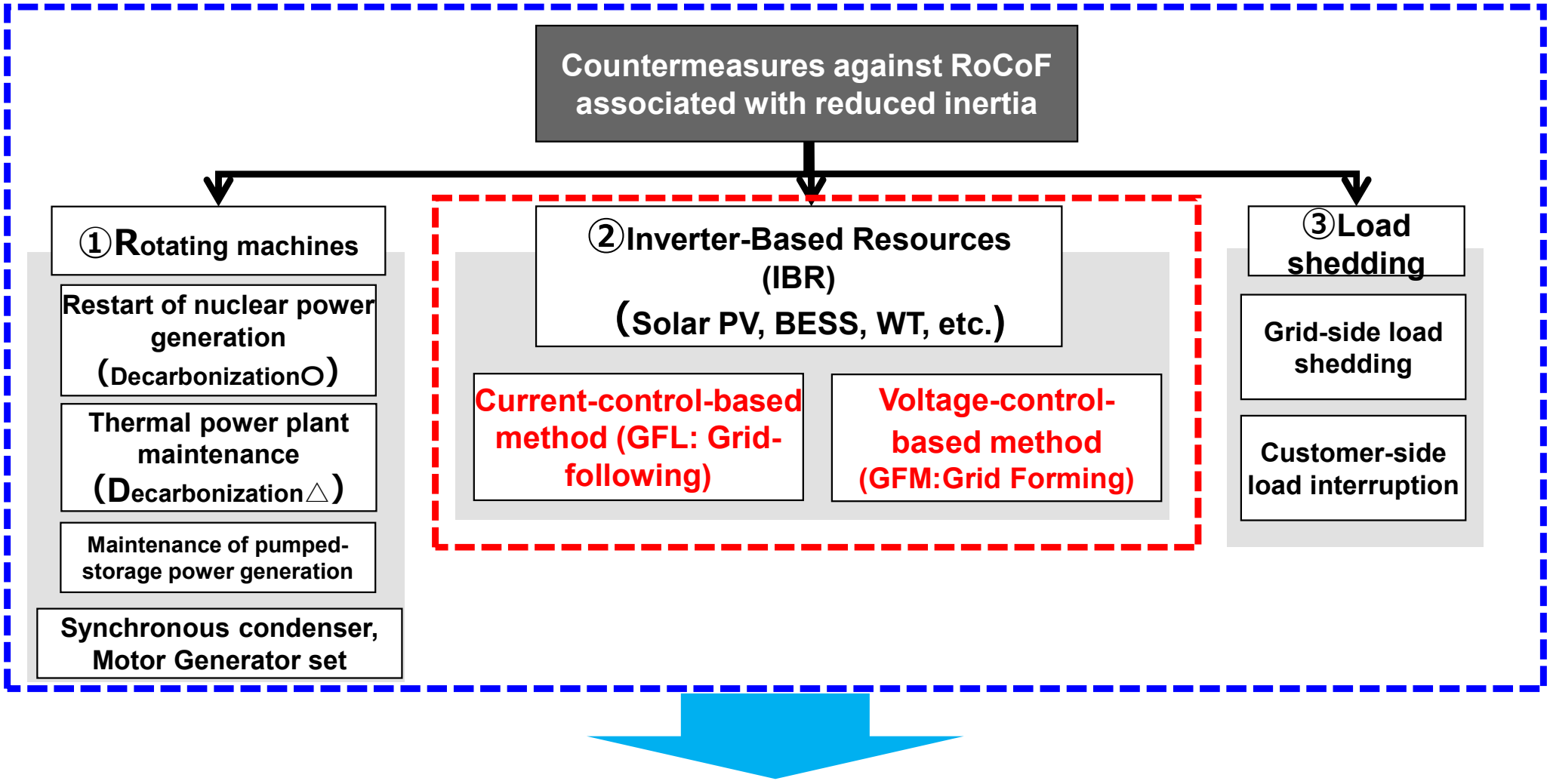


Illustration of the Effects of Inertia Reduction

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Measures to address inertia reduction



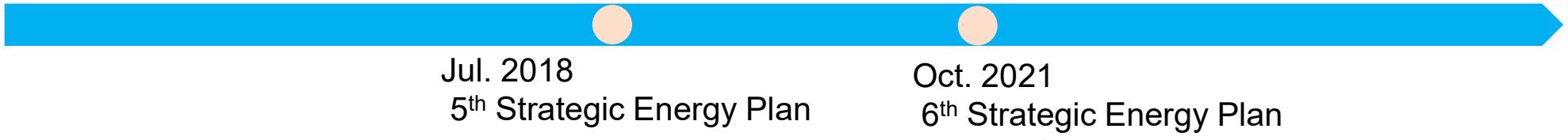
Research Objective:

Establish countermeasures using IBRs to achieve:

Renewable energy as a primary power source, Decarbonization, Cost-efficient system operation

Schedule of the National Project

Japanese Government Policy of 7th Strategic Energy Plan



Promote technological development and regulatory framework considerations for introducing inverters with synthetic inertia functions, etc.

NEDO project

Next-Generation Power Network Stabilization Technology Development for Large-Scale Integration of Renewable Energies

- Development of basic technology to cope with decreases in inertia

Phase A: initial study for synthetic inertia

(FY2019～FY2021)

Future-generation power network **S**tabilization **T**echnology development for utilization of **R**enewable **E**nergy As the **M**ajor power source (STREAM)

- R&D for applying inverter-based synthetic inertia technology

Phase B: implementation of synthetic inertia

(FY2022～FY2026)

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R&D Framework

NEDO Project Manager: Mr. Hokazono (NEDO)

Structure includes:
Main contractor and subcontractors
Collaborative discussions across stakeholders

discussion

1. Project Leader: Mr. Uemura (CRIEPI)
2. Sub-Project Leader: Prof. Baba (The University of Tokyo)

TEPCO Tokyo Electric Power Company Holdings
AIST
UTokyo
WASEDA University
TEPCO Power Grid
HIROSHIMA UNIVERSITY
Environment and Energy Technology Research Institute Co., Ltd.
CRIEPI Central Research Institute of Electric Power Industry
HOKKAIDO UNIVERSITY
National Institute of Technology (KOSEN), Kure College
JET

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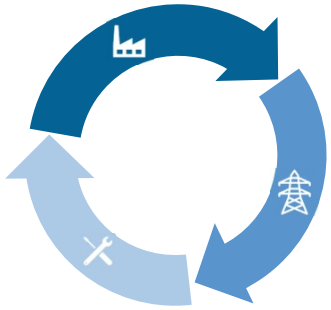
Project Overview

WP1 Development of Inverters

- Requirement definition and specification design
- Design and development of prototypes
- Collaboration with multiple vendors

WP2 Validation and testing

- Equipment-based study, e.g., Lab/Field testing and conformance of GFM.



Laboratory testing

- Development of test procedures for certification.
- Impact assessment of new functions using PHIL testing technologies
- Demo field testing
- Testing on full-scale distribution systems
- Additional testing not covered in laboratory testing

Prototype improvement

- Grid interconnection testing and conformance to requirements
- Revision of inverter requirements

Lab testing: Smart System Research Facility, AIST



Demo field testing: Akagi testing Center, CRIEPI



WP3 Power System Stability analysis

- Simulation-based evaluation of system stability
- Assessment of GFM contributions under future scenarios

Output

- Proposals and supporting data for standardization.
- Data and report for revision of Grid Code

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WP1 Development of Inverters

Item	A Company	B Company	C Company
Application	BESS	BESS	BESS
Capacity	50kVA	50kVA	50kVA
Control Function	GFM/GFL	GFM	GFM/GFL
GFM type	VSG	VSG	Droop
GFL type	Δf	–	df/dt+Δf
Q control	Fixed PF	Fixed PF	Fixed PF
Overload Capacity	300%-1s	150%-1s	250% continuous
One photo per prototype			

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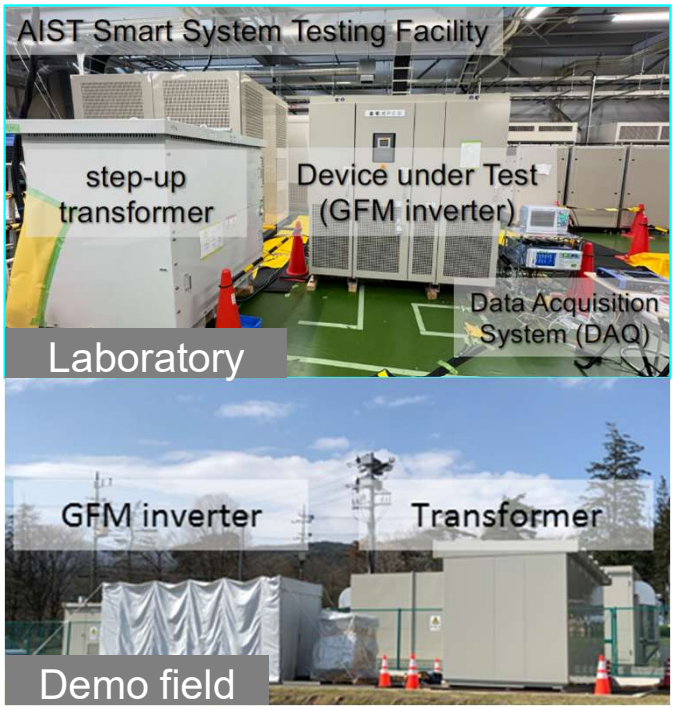
WP2 Validation and testing

Laboratory Testing

- Development of test procedure achieving certification.
- Impact assessment of new function with Virtual(HIL) testing technologies.

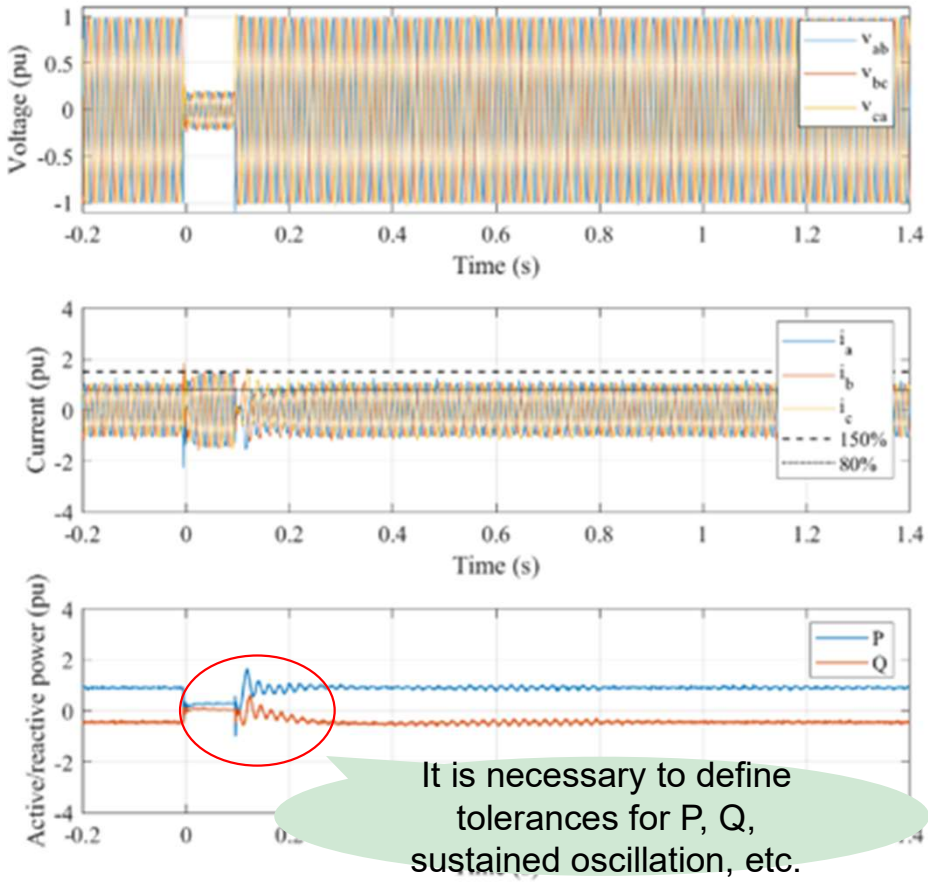
Demo field Testing

- Testing on full-scale distribution systems.
- Tests not covered in laboratory testing.



GFM inverters should keep operating during short disturbances, and after the disturbance is cleared, should oscillate and be suitably damped. It is necessary to define acceptable operating behavior.

Sample Test Result of LVRT Response



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WP3 Power System Stability analysis

Background

- For a grid dominated by inverter-based resources (IBR), the contribution of GFM inverters to grid stability needs to be assessed to solve the issue associated with low inertia.

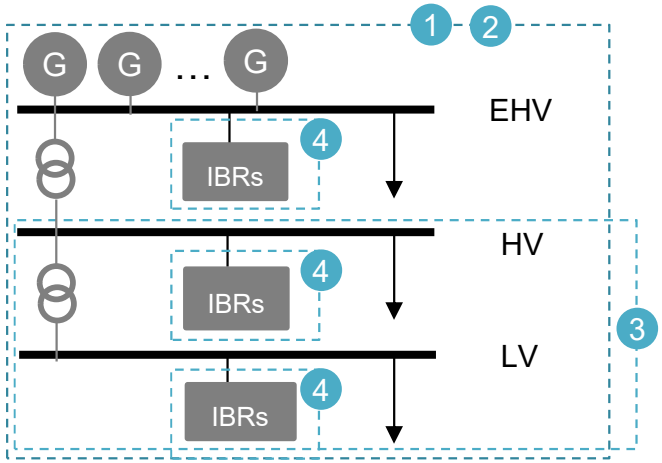
Object

- Development of stability analysis technologies for the grid including GFM inverters, and evaluation of the effect of GFM inverter introduction based on future scenarios.

R&D items

Issues Various issues associated with low inertia

1. The future of power supply are not clear.
2. EMT simulation imposes a heavy computational burden.
3. Distribution system models with many GFMs are complicated.
4. Contribution to grid stability of GFM hasn't been fully clarified.



A Study of future scenarios
-Demand and supply scenario considering GFM implementation

THE UNIVERSITY OF TOKYO

-Verification of effectiveness of GFM based on scenarios

WASEDA University

Issues: 1 2 4

B Analysis technology development and validation
-R&D of model reduction technologies for GFM

HOKKAIDO UNIVERSITY

-R&D of RMS model for GFM

HIROSHIMA UNIVERSITY

National Institute of Technology (KOSEN), Kure College

Issues: 2 3 4

C Fundamental characteristics analysis
- EMT-based stability simulation

AIST

Issues: 4

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Summary

Summary

- Large-scale renewable integration reduces grid inertia
- This creates frequency stability challenges
- GFM inverters provide synthetic inertia and are a key solution

Project Achievements

- WP1: Development of GFM inverter specifications and prototypes
- WP2: Establishment of testing and validation methods
- WP3: Quantitative evaluation of system stability impacts

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