新しい時代を元気にします
Empower for new days

MEIDEN

Aalborg 2015 Microgrid Symposium
September. 27 – 28, 2015

# Construction of Wide-area Operation System for Intermittent Power Sources

Meidensha Corporation
Takayuki TANABE

# Contents

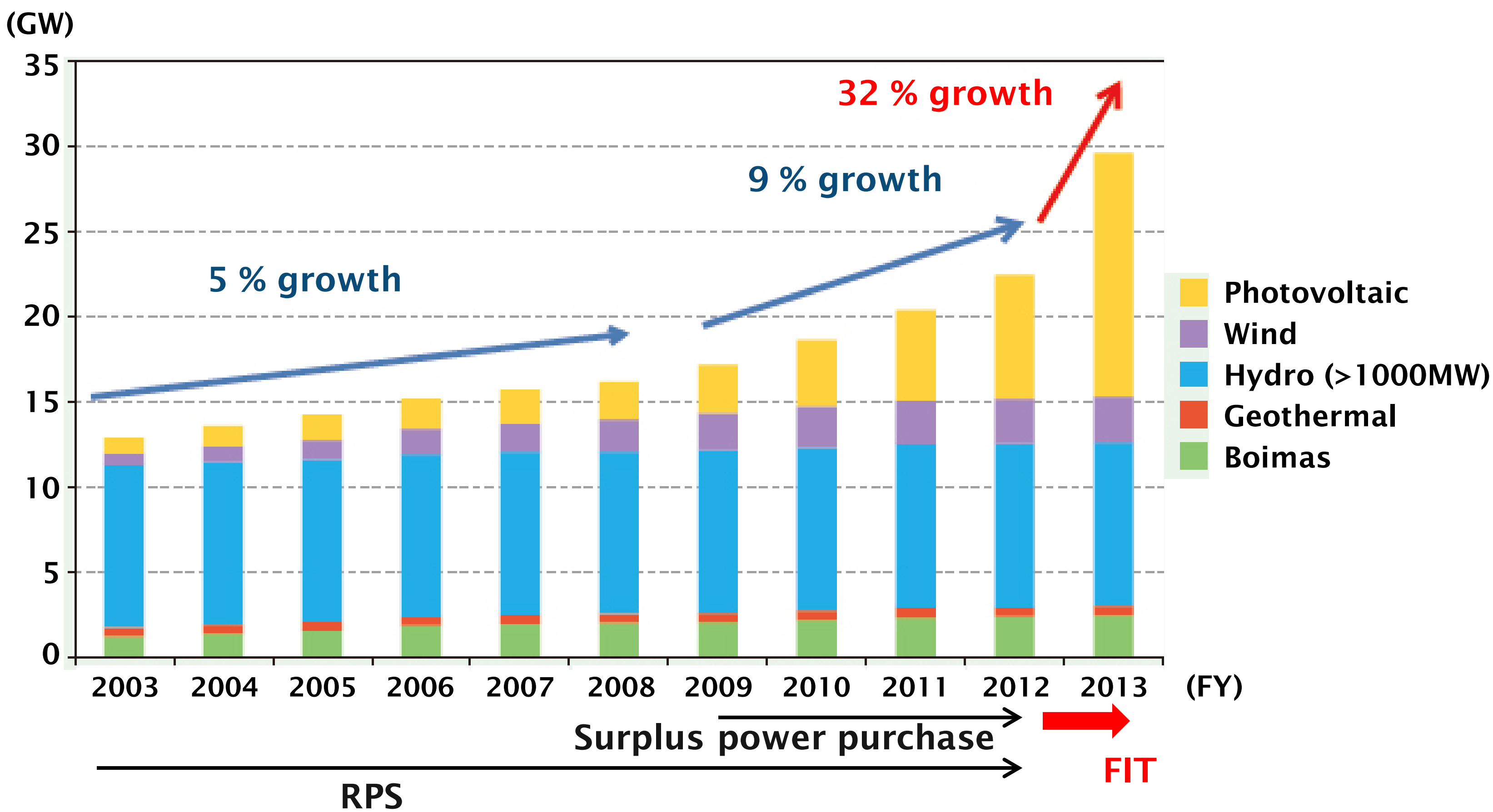
1. Backgrounds
2. Demonstration Project of the Wide-area operation systems
3. Technical theme and results.
   - Generation power forecasting
   - Wide-area operation system
   - Control algorithm

# 1. Backgrounds

# 1-1. Expansion of Renewable Energies in Japan

## Backgrounds

- FIT had been started at July 2012.
- PV system is rapidly growth because installation is easy and purchase price is very high.

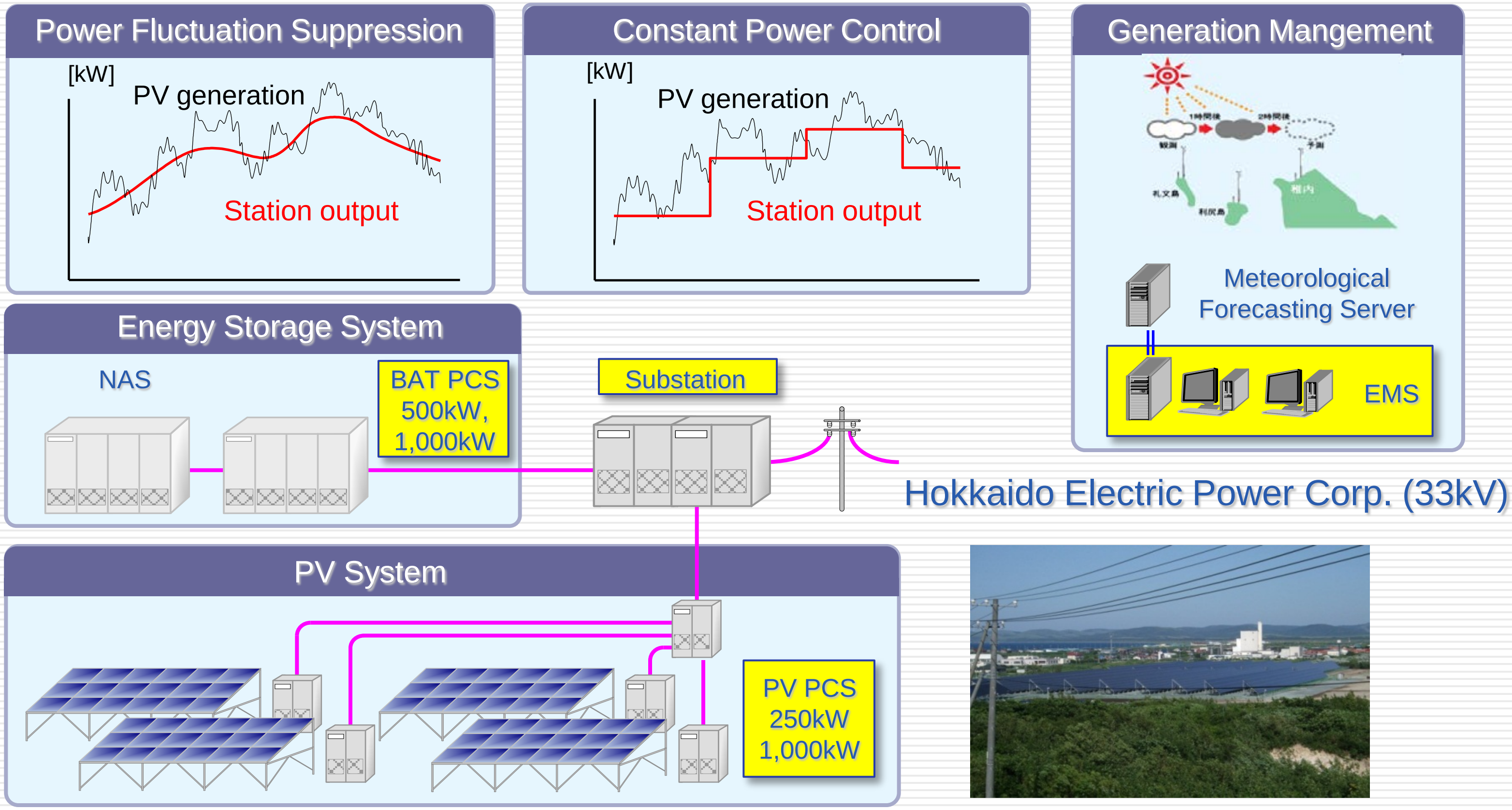



Ministry of Economy and Industry of Japan

# 1-2. Countermeasure for intermittent generations

## Conventional Project

- Wakkanai Mega Solar Project supported by NEDO (FY20056– FY2010)
- Generation planning and constant power control based on meteorological forecasting.
- Smoothing fluctuation
- Islanding operation by only PV and NAS

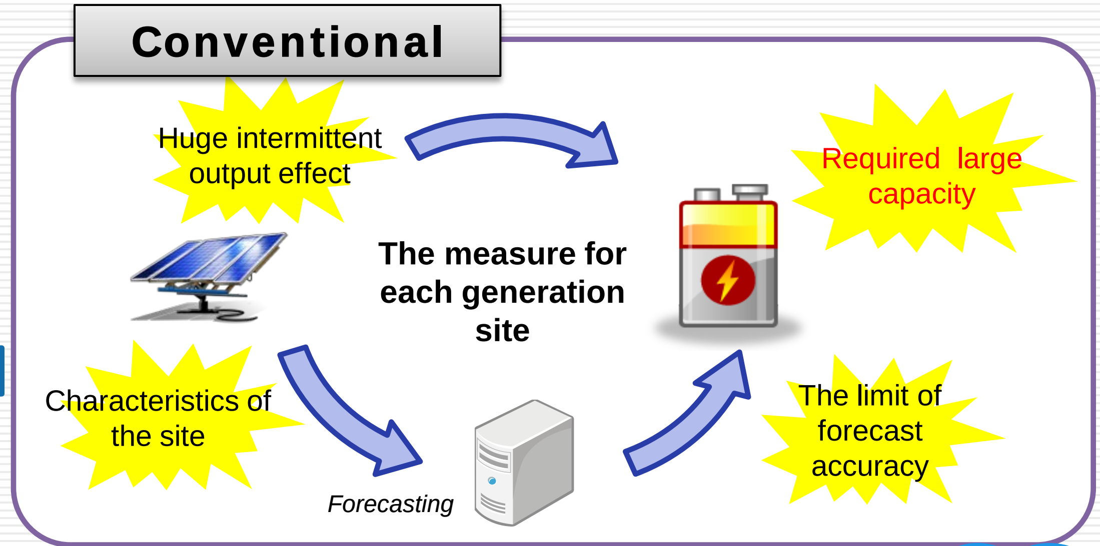


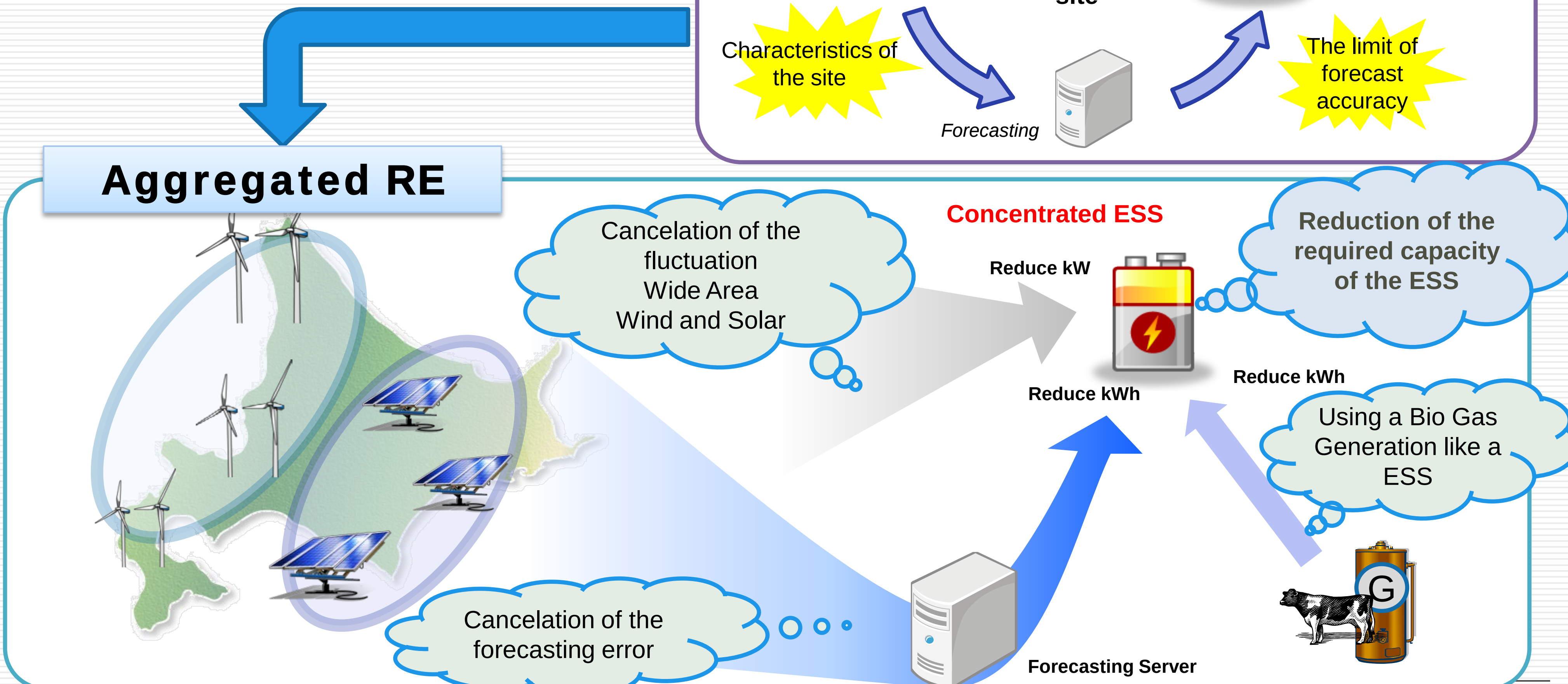
# 1-2. Countermeasure for intermittent generations

MEIDEN

## New Concept of operation

- Forecasting error reduction.
- Battery capacity reduction.
- Realize a real time control through an information network



# 2. Demonstration Project
# of the Wide-area operation system

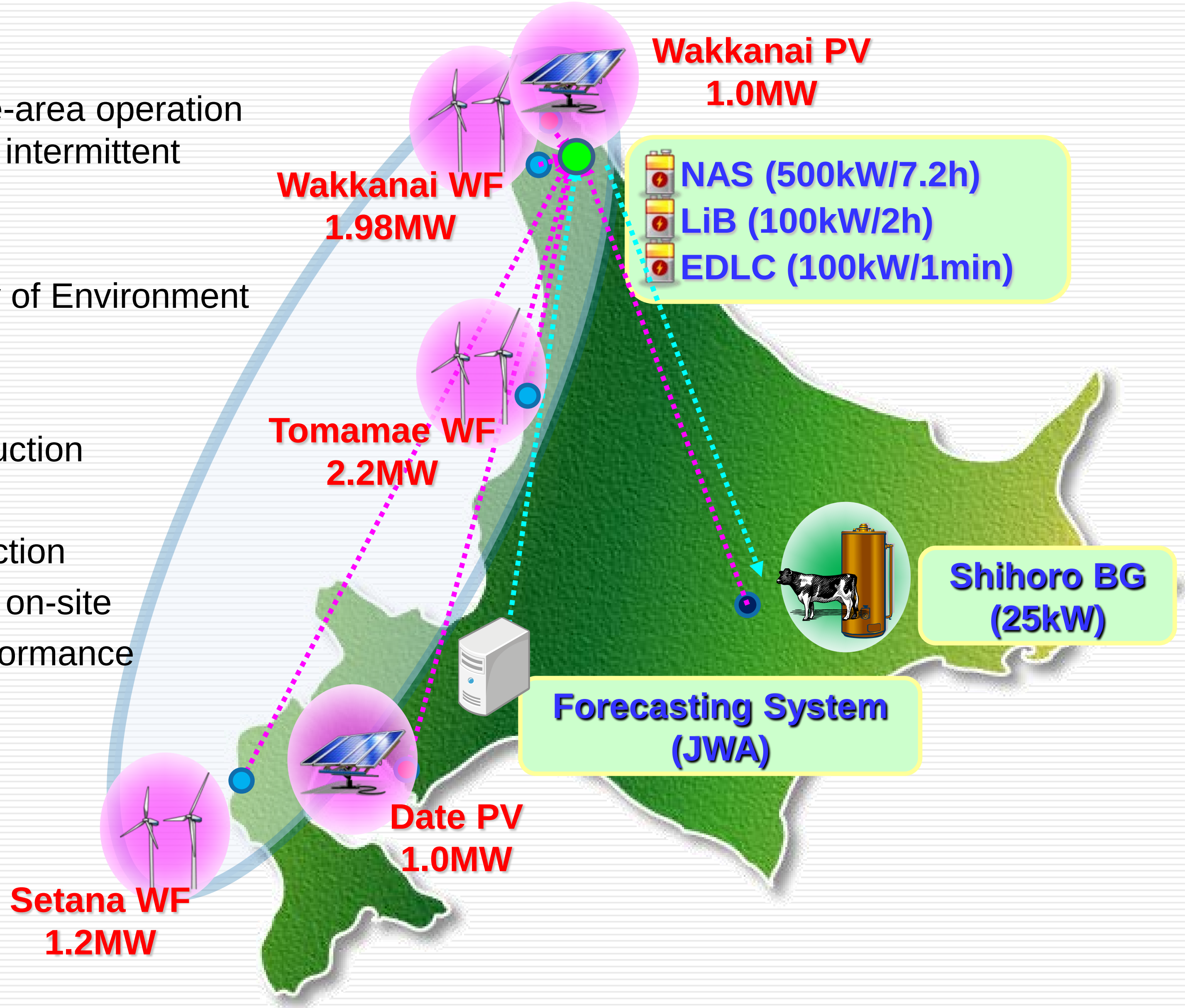
# 2-1. Project of Wide-area operation system

## Project outline

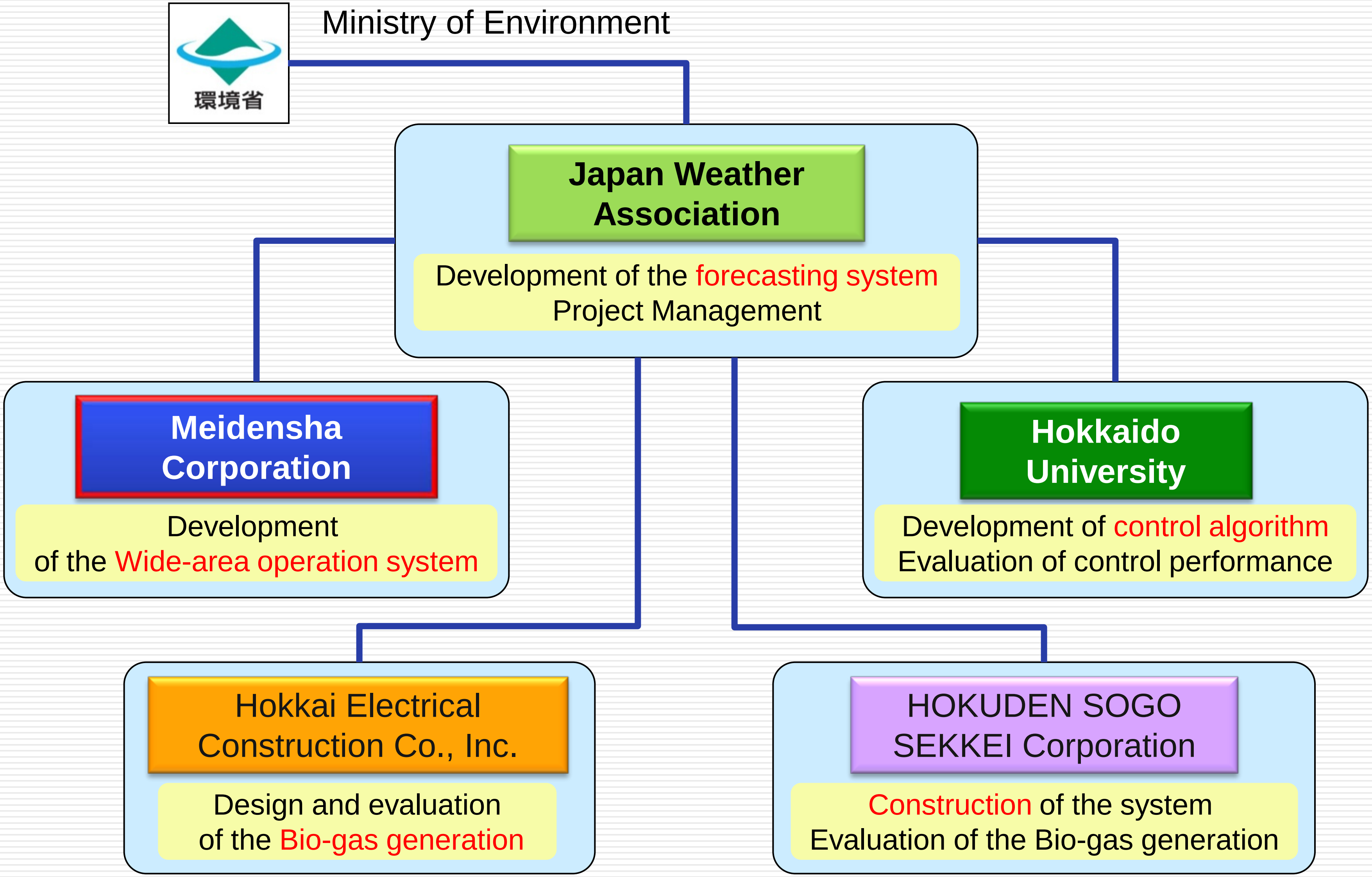
- "Research of the wide-area operation system for distributed intermittent generations"
- FY2012 – FY 2014
- Supported by Ministry of Environment (MOE).

## Target

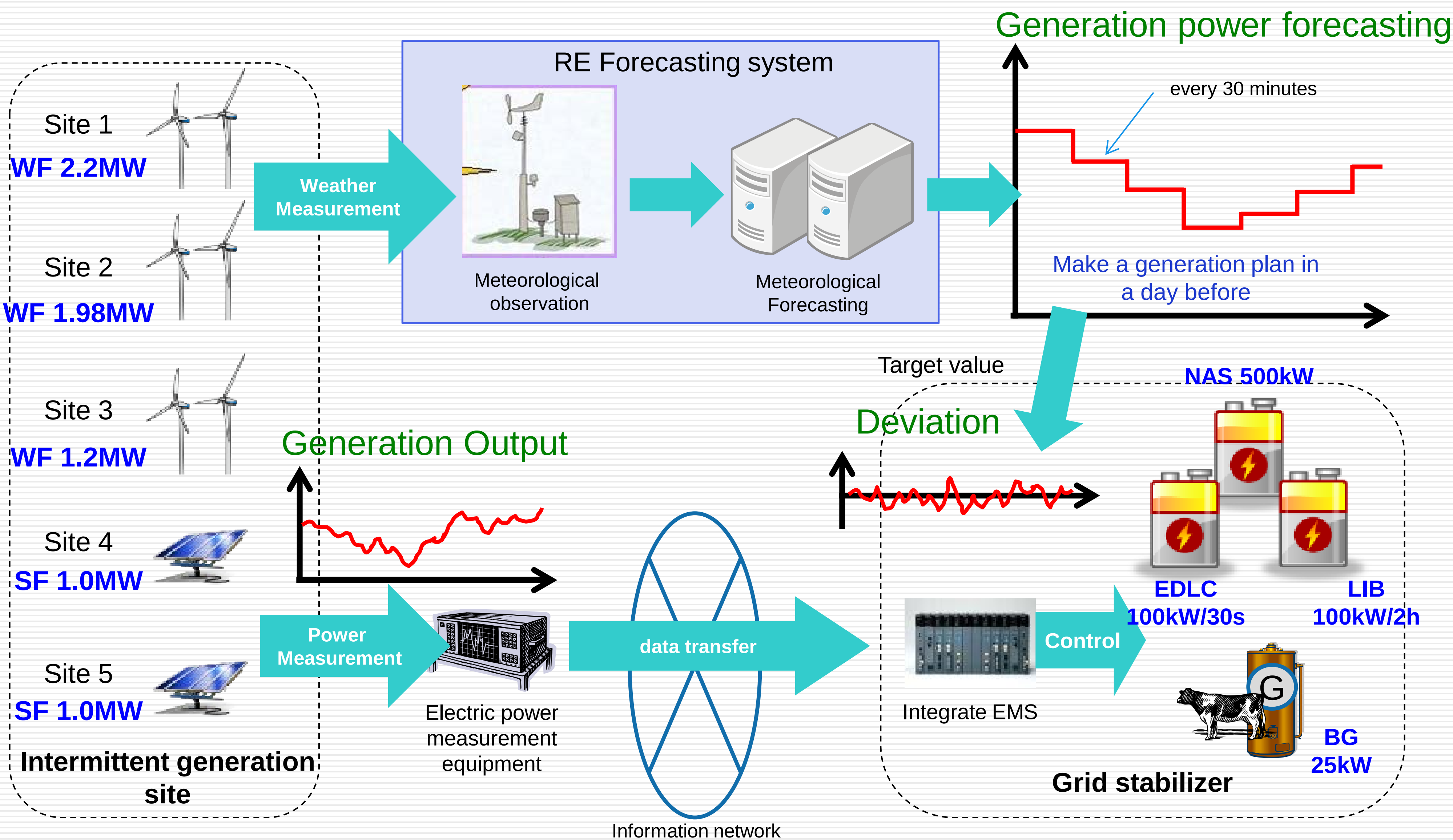
- Forecasting error reduction
  Error < 10%
- Battery capacity reduction
  50% reduction from on-site
- Real-time control performance
  delay < 100ms



# 2-2. Project Scheme



# 2-3. System Configuration



# 2-4. Target of the Performance

MEIDEN

## Typical target of this project

| Items of the target | Company | Targets |
|---|---|---|
| Generation power forecasting | JWA | Error of whole site < **10 %** |
| High speed measurement | **Meidensha** | Transfer delay < **100 ms** |
| Accuracy of the synchronization | **Meidensha** | Accuracy < **10 ms** |
| Delay of the control | **Meidensha** | Response < **500 ms** |
| Performance of constant power control. | Hokkaido Univ. | Error of kWh < **5 %** |
| Performance of fluctuation suppression control | Hokkaido Univ. | Error of kW < **3 %** |
| Battery capacity reduction | Project | On-site X **50%** |

# 2-5. Evaluation method

## Generation power forecasting

- Using the estimated generation power in accuracy evaluation of WF, because it is difficult to estimate operation status of the stopping by some trouble.
- Accuracy of forecasting was evaluated by summation of whole generation power in one year.

## Wide area operation system

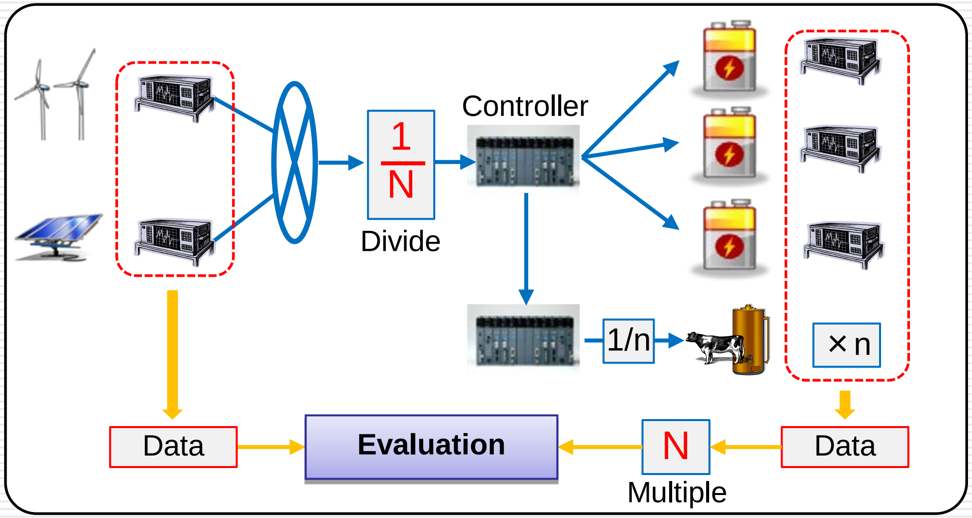
- Delay of the wide area operation system was evaluated under actual provided service.
- Measurement data was synchronized by IEEE1588 protocol and this performance was evaluated.

## BESS Controller

- Performance of the control algorithm was evaluated in digital simulation by using actual measurement data and forecasting data.

## Demonstration

- Capacity of BESS was adopted small size.
- Using a capacity ration N between BESS and generator.



# 3. Technical theme and results

# 3-1-1. Forecasting System (JWA)

MEIDEN

## Specifications

- Generation Site

| RE Site | Rated generation power | Target of forecasting |
|---|---|---|
| Wakkanai WF | 1,980kW (660kW×3) | Generation power of WF |
| Tomamae WF | 2,200kW (600kW×2, 1000kW) | |
| Setana WF | 1,200kW (600kW×2) | |
| Wakkanai PV | 1,000kW | Generation power of PV |
| Date PV | 1,000kW | |

- Delivery of Forecasting Data

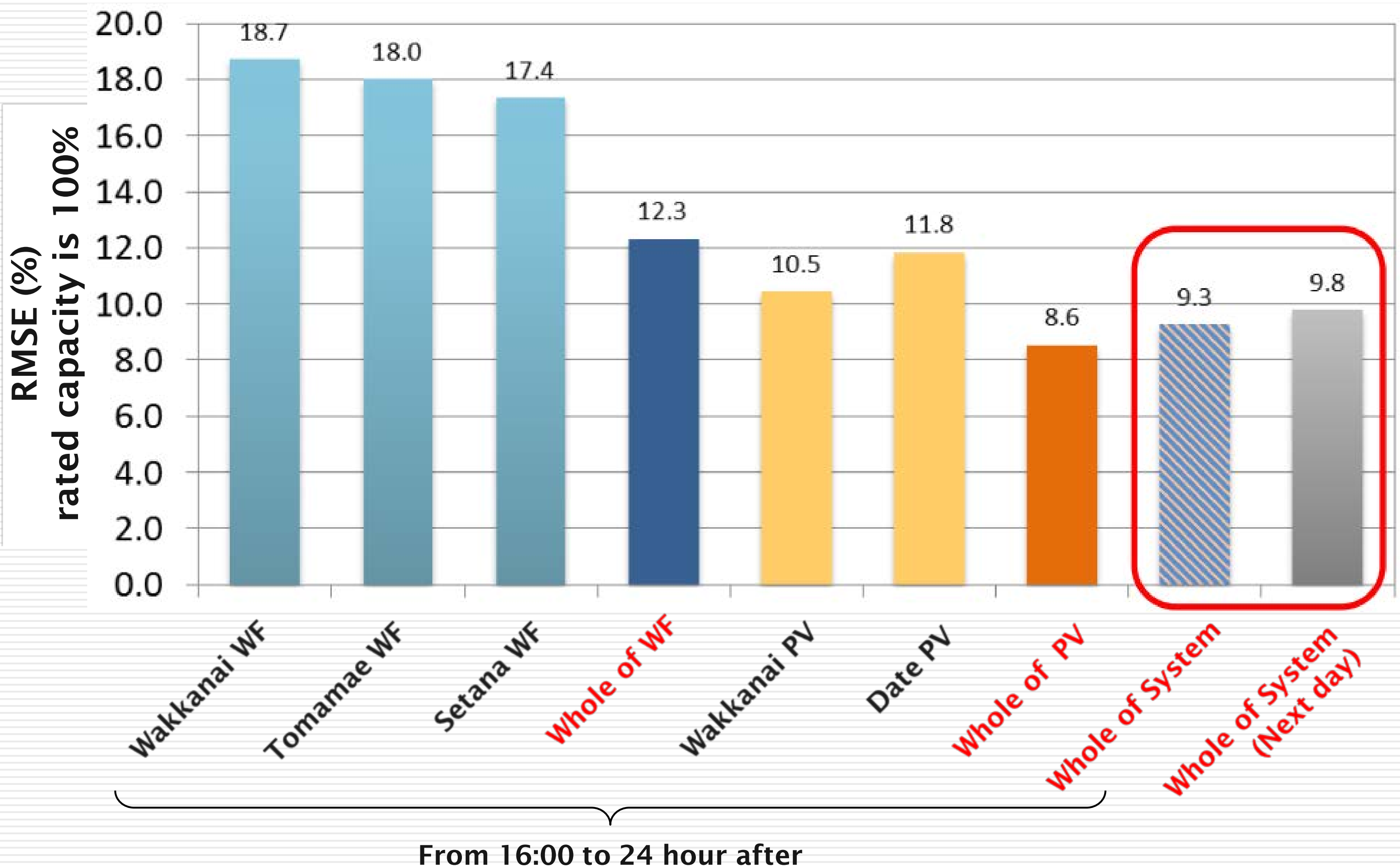
| Kind of Forecasting | Time | Forecasting target | Period |
|---|---|---|---|
| Short time destination | 5 minutes before of every hour | 6 hours destination | 30 min |
| Day before | 10:00 | From 3:00 of that day to 3:00 of 2 days future (48 hours) | 30 min |
| | 16:00 | From 12:00 of that day to 12:00 of 2 days future (48 hours) | |

# 3-1-2. Forecasting System (JWA)

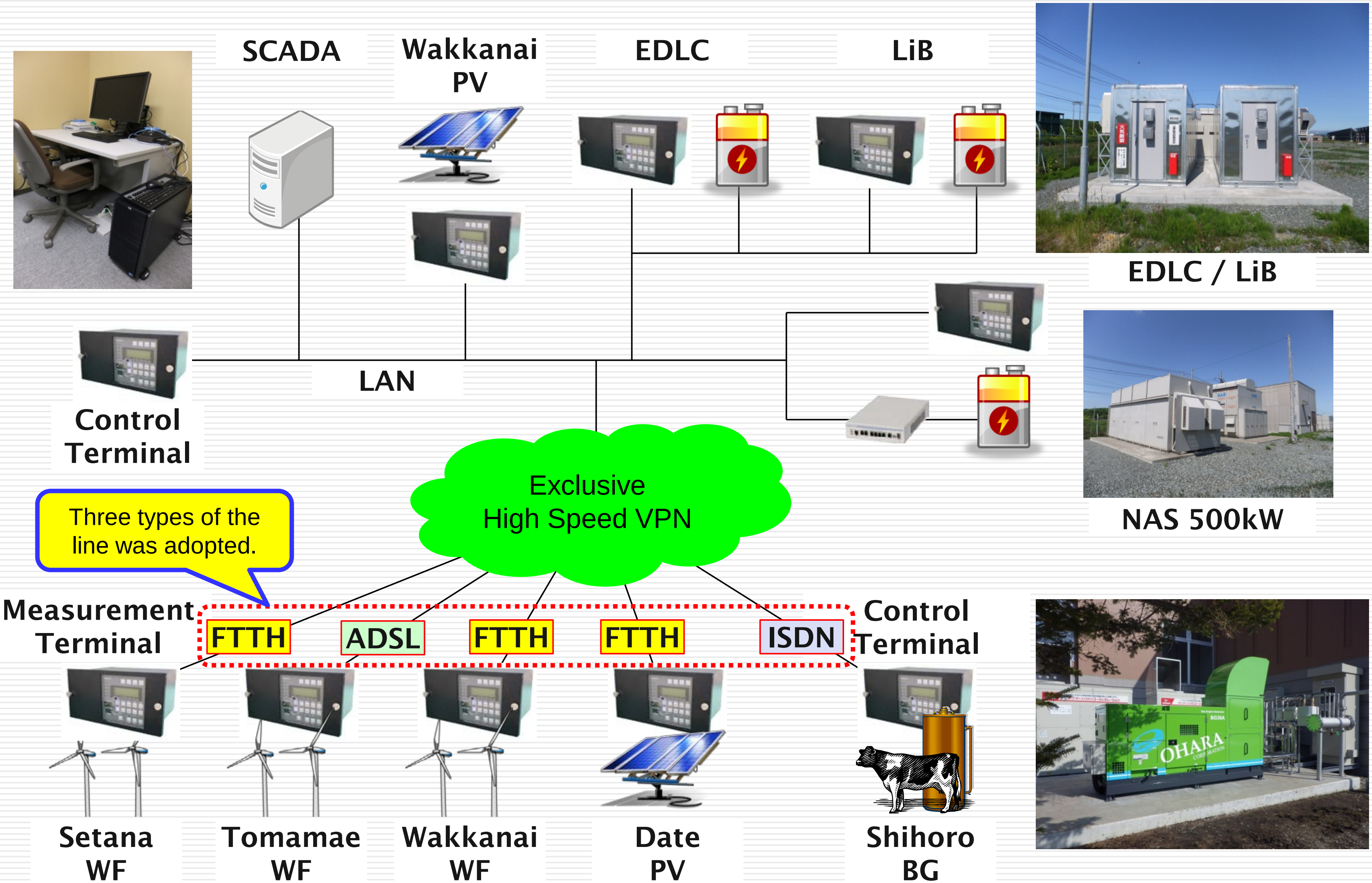
MEIDEN

## Typical evaluation result

- Forecasting accuracy of whole site summation is 9.3% from Sep. 2013 to Aug. 2014.
- Forecasting accuracy was improved because error was cancelled each other

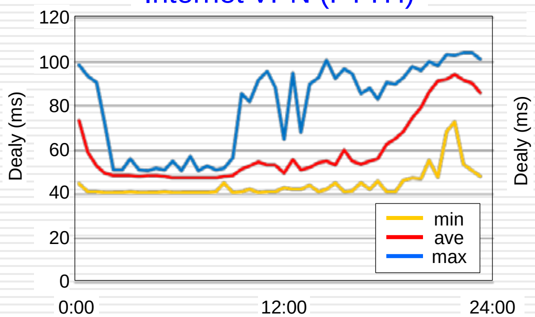


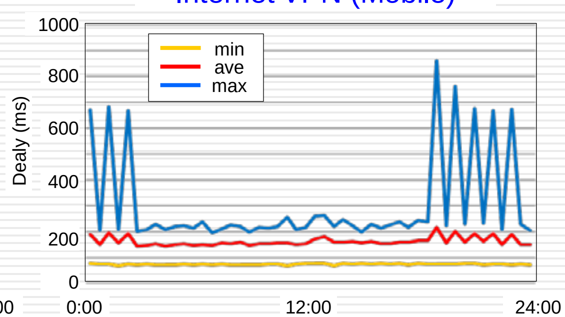
# 3-2-1. Wide-area Operation System and facilities

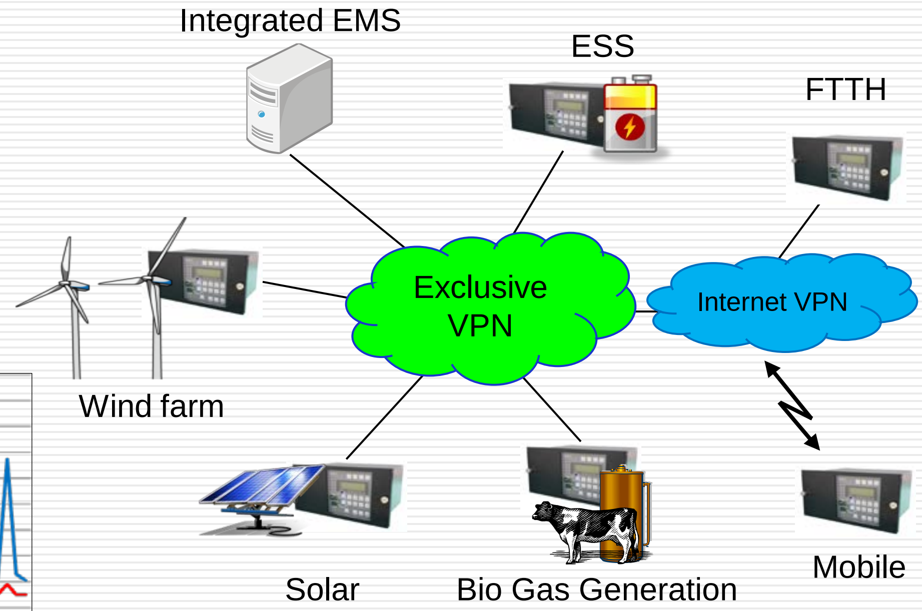


## Real time control performance

- Real time control is realized with good performance.
- Internet VPN is instable than a exclusive VPN, but it is cheap.



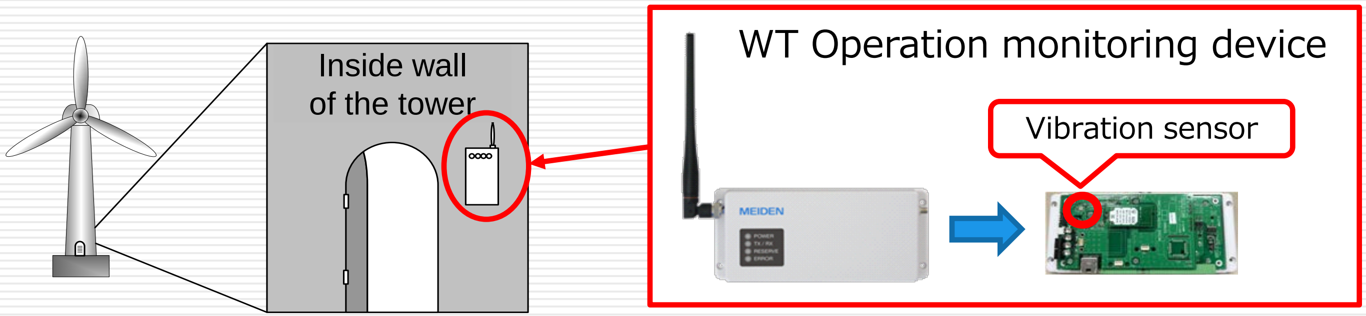



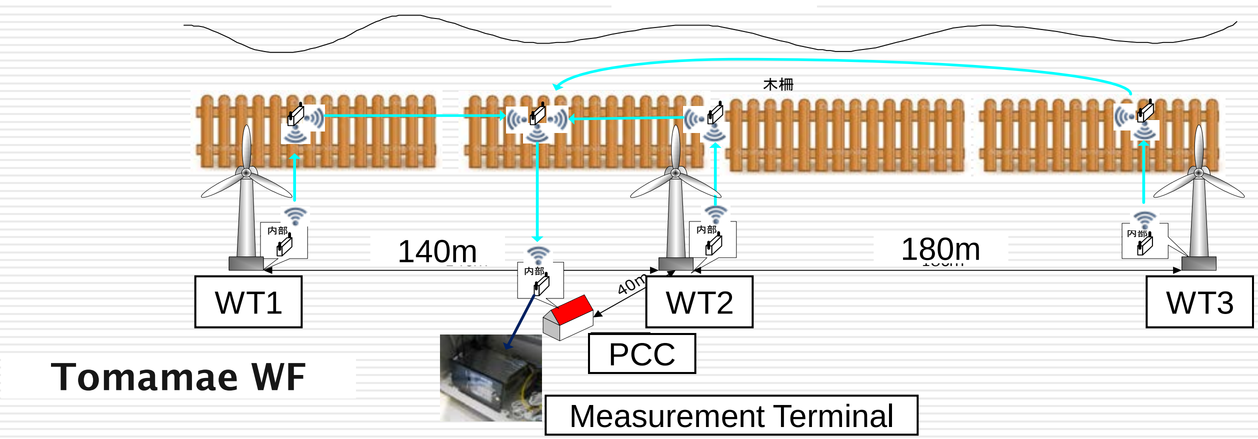




| Information Network | | Sync. accuracy (IEEE1588) Target < 10 ms | Control Delay Target < 50ms | Evaluation |
|---|---|---|---|---|
| Network | Line | | | |
| Exclusive High Speed VPN | FTTH | ±0.3 ms | 10 ms | OK |
| | ADSL | ±0.7 ms | 16 ms | OK |
| | ISDN | ±8.0 ms | 38 ms | OK |
| Internet VPN | FTTH | ±7.0 ms | 25 ms | OK |
| | Mobile | ±17.0 ms | 102 ms | **Measures are necessary** |

## Objective

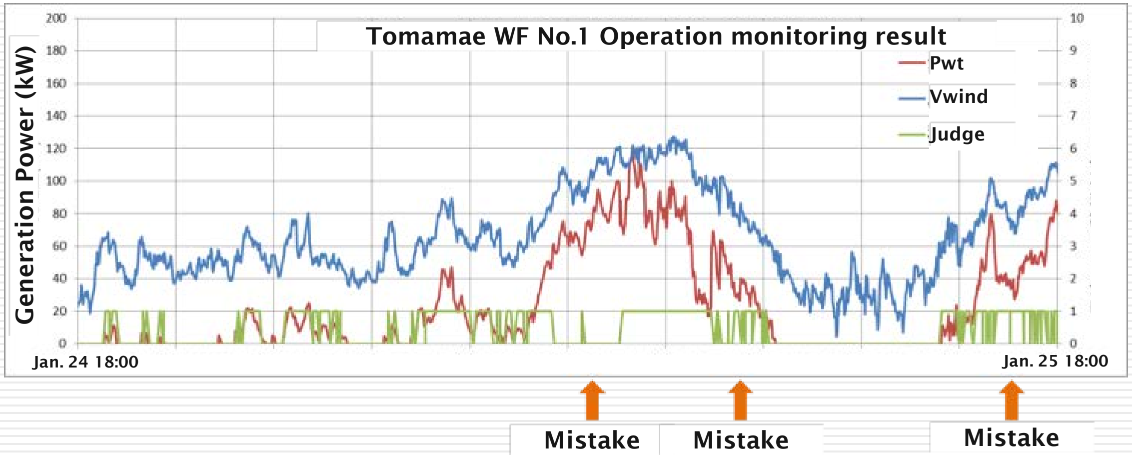
- Small wind turbine site did not has a SCADA.
- Wind turbine is sometimes stopped long term by a mechanical trouble.
- Forecasting accuracy was affected by wind turbine operation status.
- It is necessary to develop a monitoring system of wind turbine operation status.
- We had adopted a vibration acceleration sensor and multi-hop wireless communication.

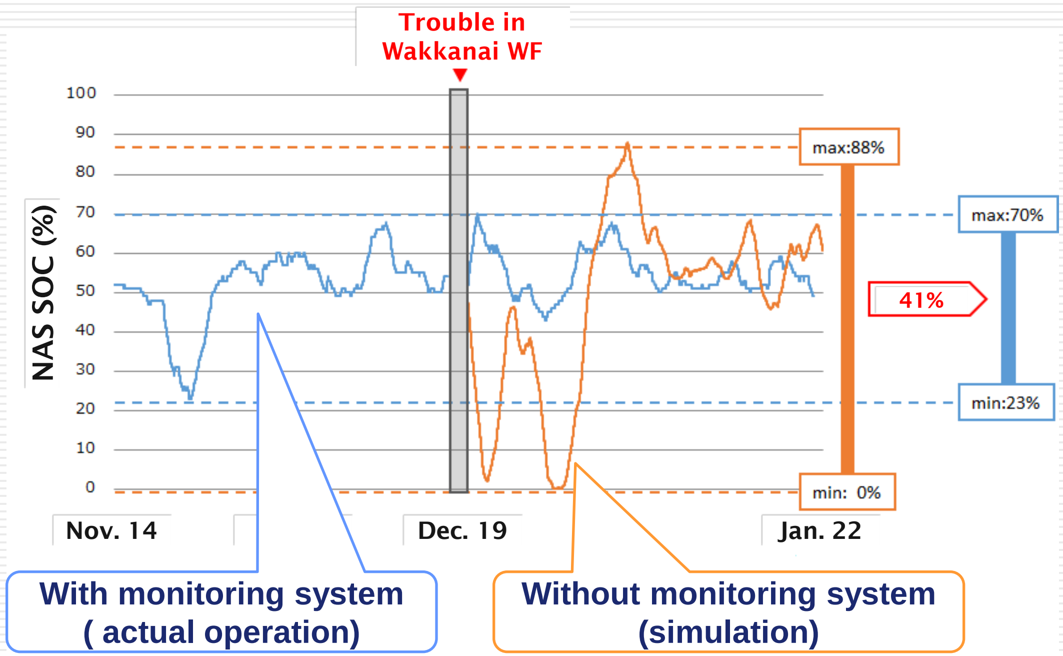


## Result

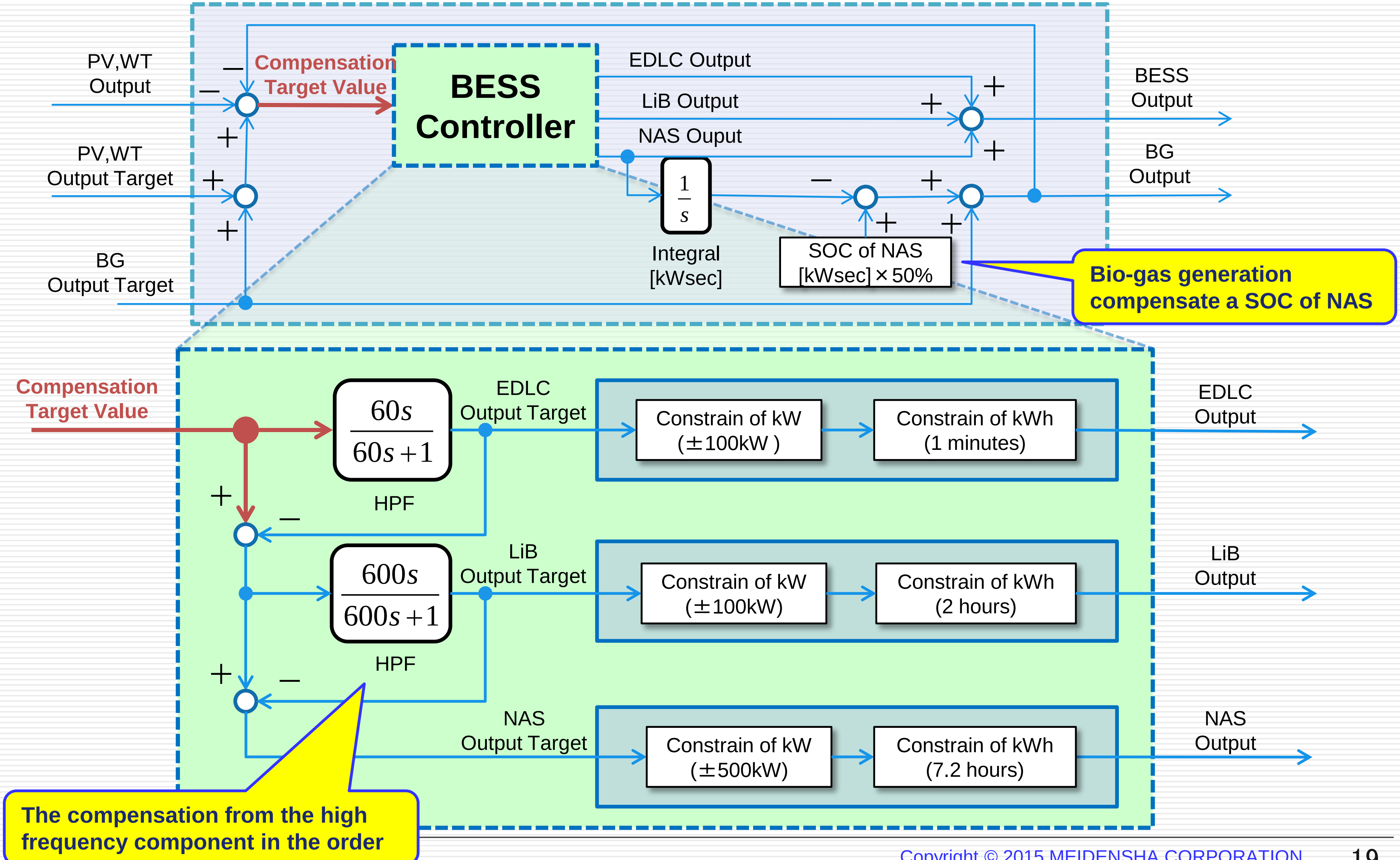
- It has been found that it is possible to determined operation status of WT by the vibration measurement.
- There were few mistake but it is not fatal.
- Operation monitoring system is very effective to improve a prediction accuracy and to reduce a battery kWh capacity.



# 3-3-1. Control Algorithm (Hokkaido Univ.)

MEIDEN



# 3-3-2. Evaluation of Hybrid BESS (Hokkaido Univ.)

## Simulation conditions for the hybrid BESS

| Case Name | BESS to be used | | | |
|---|---|---|---|---|
| | NAS | EDLC | LIB | B.G. |
| Case N | ✓ | | | |
| Case E | ✓ | ✓ | | |
| Case L | ✓ | | ✓ | |
| Case B | ✓ | | | ✓ |

- The required capacity of the NAS is as parameter.
- The capacity of EDLC, LIB and B.G. are 0.5 p.u., and base capacity is defined as generation power of whole system

## Simulation results

- The capacity of the NAS is reduced in hybrid BESS case.
- Although effectiveness of capacity reduction is small.
- There is a tendency that the capacity of the NAS becomes excessive, because generation planning had been decided from forecasting in day before.

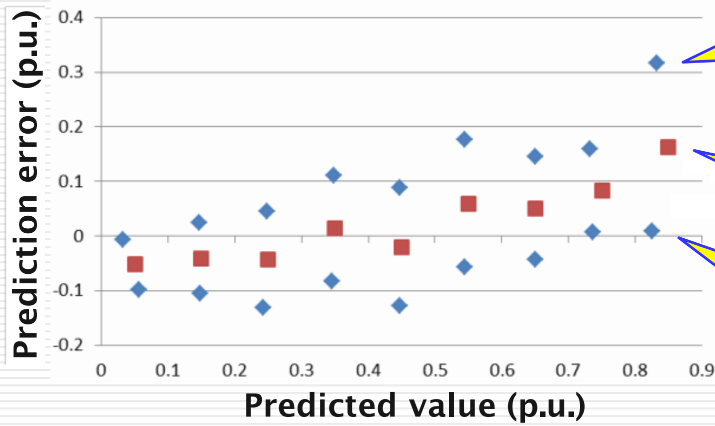
| Case Name | Required Capacity of NAS | Charge and Discharge Loss |
|---|---|---|
| Case N | 0.795 p.u. | 0.049 % |
| Case E | 0.794 p.u. | 0.260 % |
| Case L | 0.713 p.u. | 1.460 % |
| Case B | 0.408 p.u. | 0.0004 % |

# 3-3-3. Evaluation of Capacity Reduction (Hokkaido Univ.)

MEIDEN

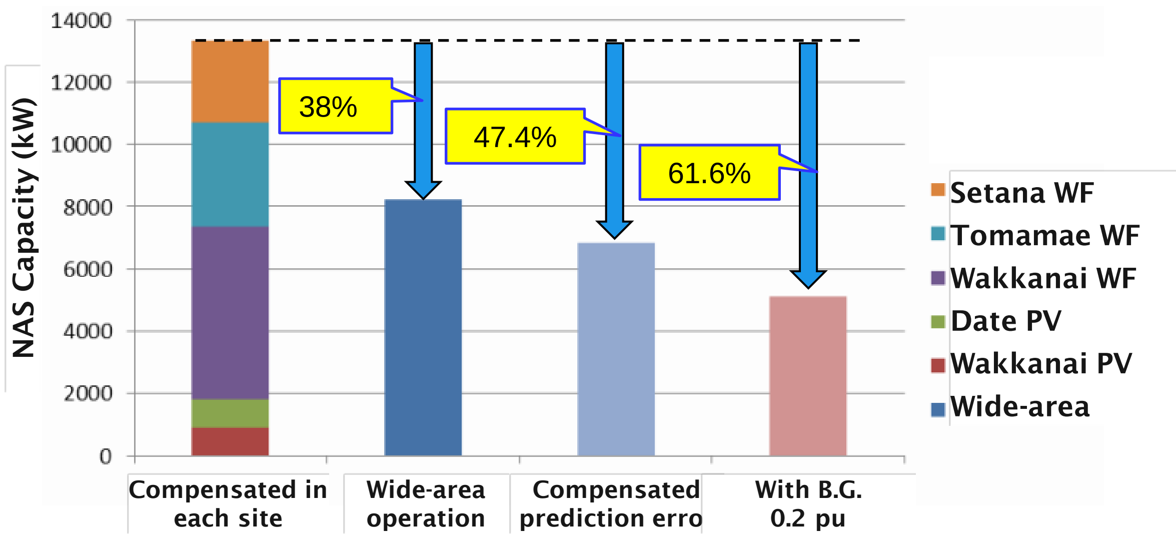
## Improvement of the control algorithm

- There was a tendency that prediction error is lower side.
- Implementing a compensation of the statistical error of the generation power forecasting.




## Evaluation result

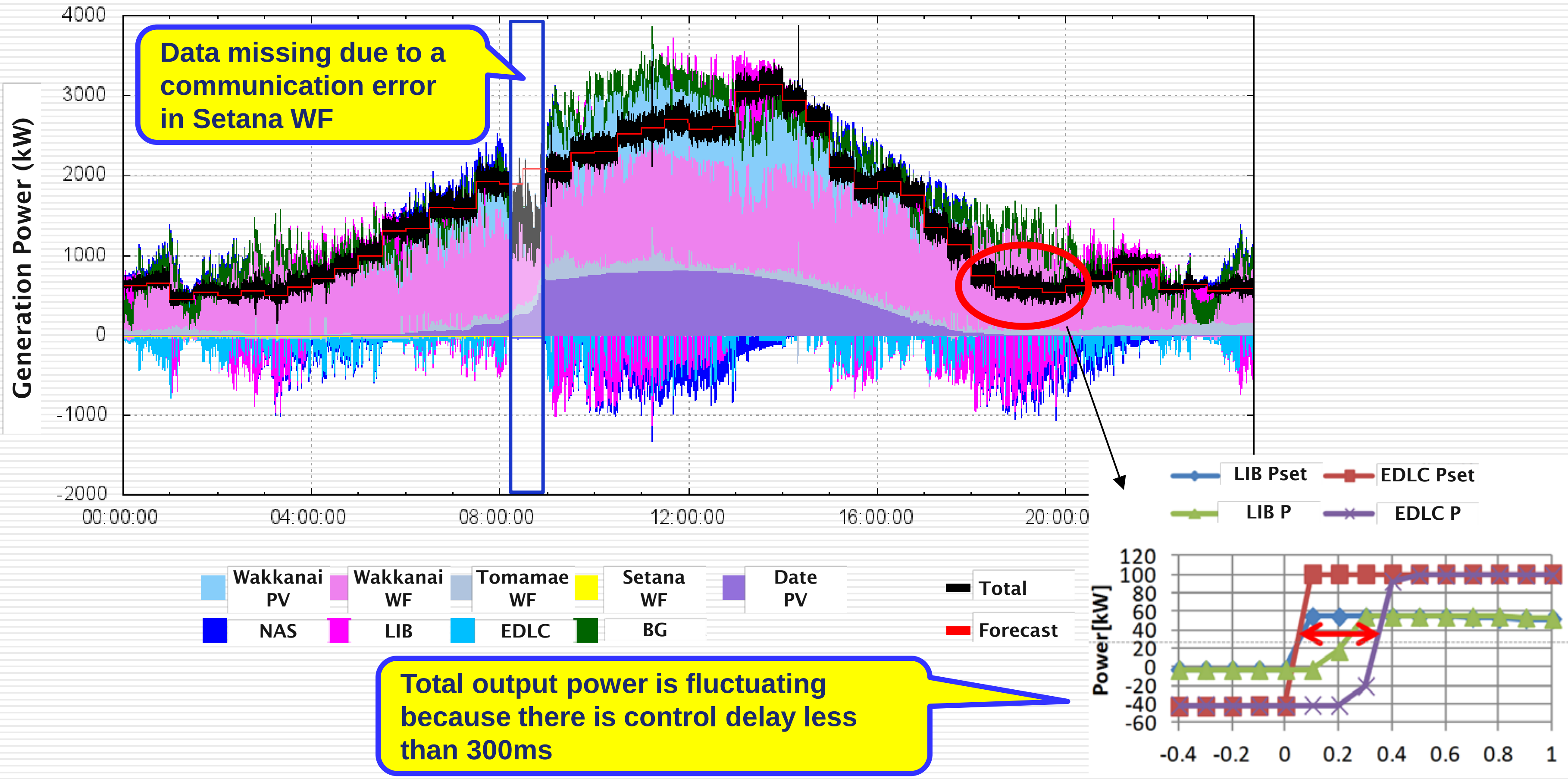
- Project target of BESS capacity reduction was achieved.
- Bio-gas generation is very effective in order to reduce a required capacity of BESS
- EDLC and LiB is not effective in operation of generation plannning.



MEIDEN

## Results

- Wide-area operation system had been evaluated by actual facilities.
- Communication error is a important issue in these system.
- Data transfer delay cause a high frequency fluctuation of total output power.



# 4. Conclusion

# 4. Conclusion

## Generation power forecasting

- Target of this project, forecasting error less than 10%, is achieved
- An operating status of generation site is important factor to improve a accuracy.

## Wide-area operation system

- Performance of data transfer delay (<100ms) and of control delay (<500ms) is achieved.
- Synchronization accuracy (<10ms) is achieved. It is important factor to evaluate a wide-area operation system.
- Operation monitoring system is very effective to improve a prediction accuracy and to reduce a battery kWh capacity.

## Control performance

- Required capacity of BESS is decreased 47.4% than conventional system.
- Furthermore, required capacity of BESS is decreased 61.6% with using a bio-gas generation.
- Bio-gas generation is better solution to decrease a BESS capacity, because it is clean.

***Thank you for your attention***

MEIDEN