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Power to Heat Technology
Demand-side Contribution to Balancing

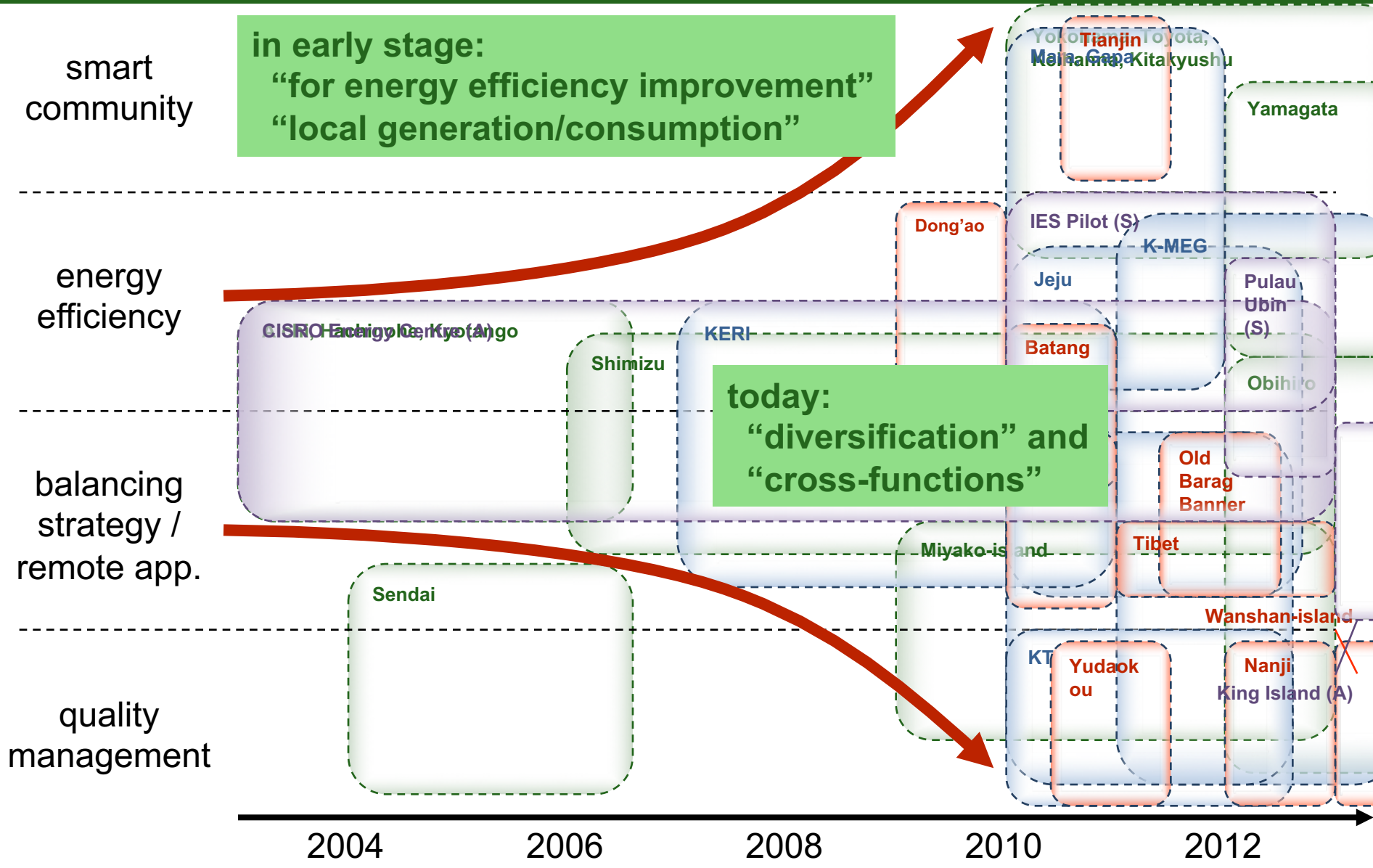
Ryoichi HARA

HOKKAIDO UNIVERSITY

Motivations for MG (presented at Chilecon 2013)

- Total energy efficiency improvement
  - introduction of RER driven generation systems
  - combined heat and power (CHP) supply
  - shortening the transmission distance (local production, local supply)
- Harmonization between distributed generations and bulk system
  - compensation for intermittency of PV, WT (being a *Good Citizen*)
- Reliability improvement
  - enhancement in the autonomy of local system
  - against huge disaster such as earthquake/tsunami

Summary of Asian projects (presented at Chilecon 2013)



Ambition for renewables in Japan

- Totally 236.6 - 251.5 TWh (approx. 22-24%) in 2030
- Growth of variable/intermittent generations
  - would enlarge mismatch of demand and supply
  - occupy the share of legacy generators with regulation capability (coal / gas / oil)
- New balancing capability is needed !

(in TWh/yr)

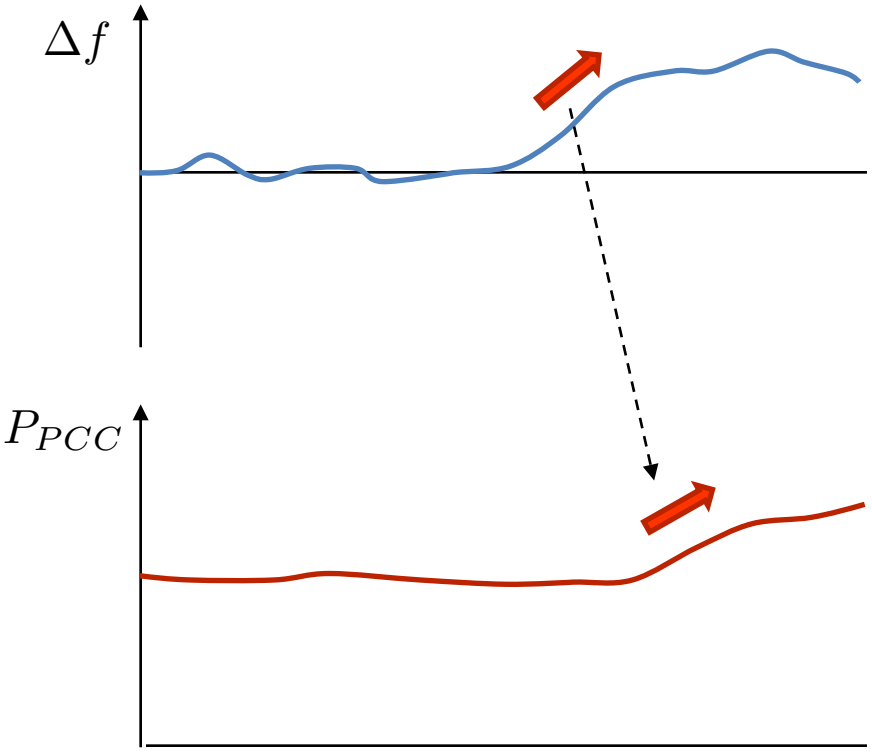
Type	Production in 2013	in 2030
geothermal	2.6	10.2 - 11.3
biomass	17.6	39.4 - 49.0
hydro	84.9	93.9 - 98.1
photovoltaic	11.4	74.9
wind	5.2	18.2

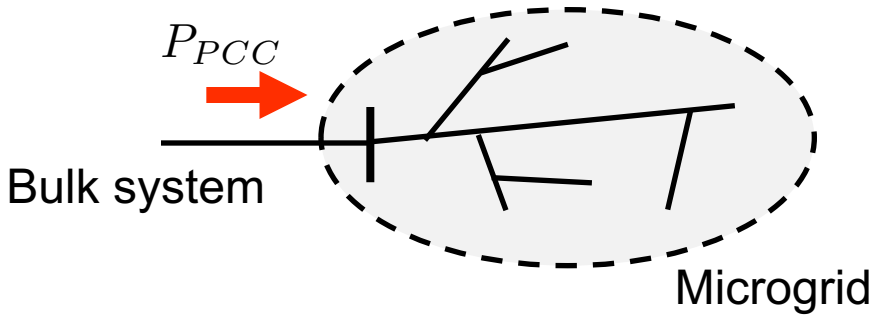
Motivations for MG

- Total energy efficiency improvement
  - introduction of RER driven generation systems
  - combined heat and power (CHP) supply
  - shortening the transmission distance (local production, local supply)
- Harmonization between distributed generations and bulk system
  - compensation for intermittency of PV, WT (being a *Good Citizen*)
  - contribution to demand/supply balancing in the bulk system
- Reliability improvement
  - enhancement in the autonomy of local system
  - against huge disaster such as earthquake/tsunami

Contribution of Microgrids

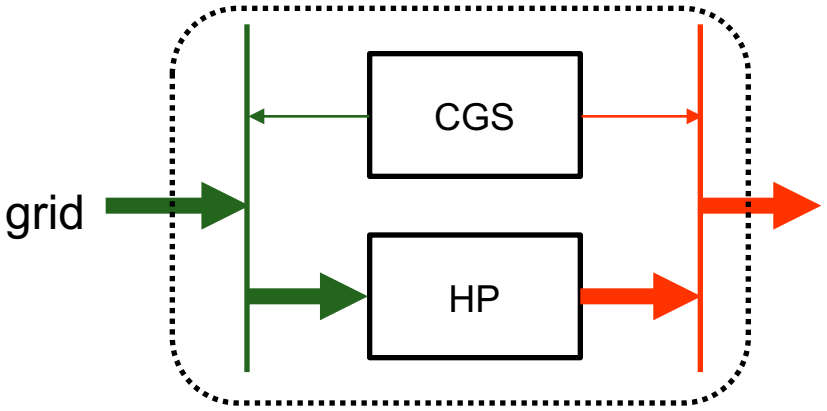
- Active control of power-flow at the PCC by means of
  - charging / discharging of battery systems
  - demand control (including EV), and/or,
  - control of distributed generators



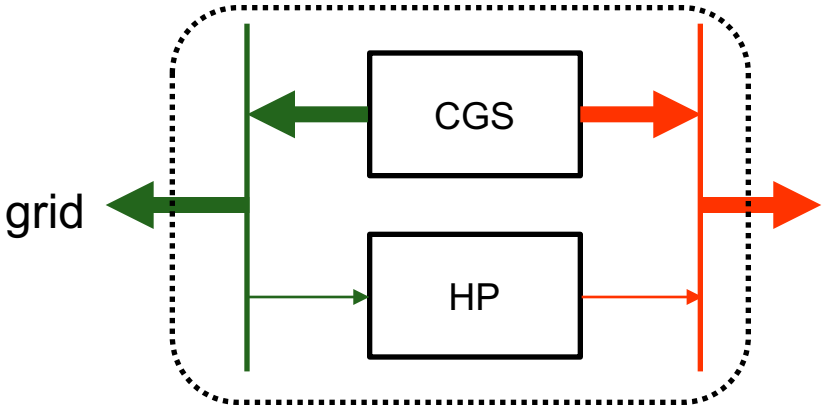


Power To Heat (P2H) technology

- Apparent energy storage function by combining cogeneration system (CGS) and heat pump (HP)



✓ charging mode
- HP is mainly used



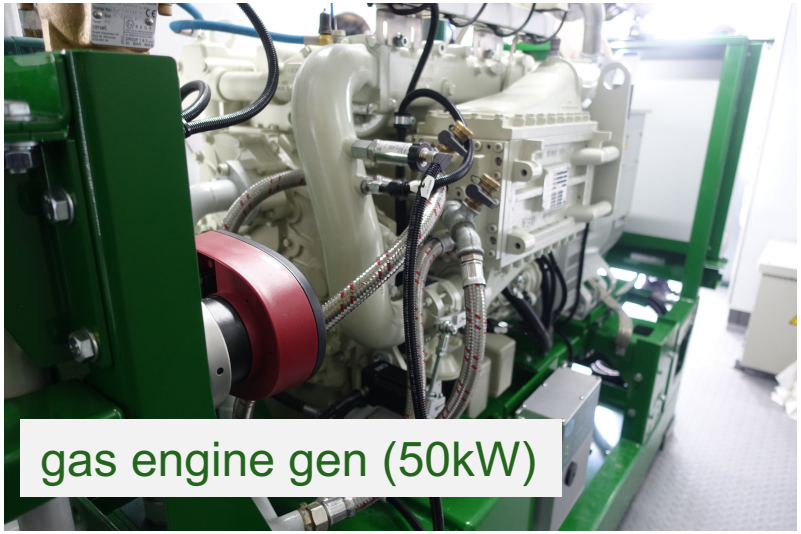
✓ discharging mode
- CGS is mainly used

Demonstration site (NEDO project)

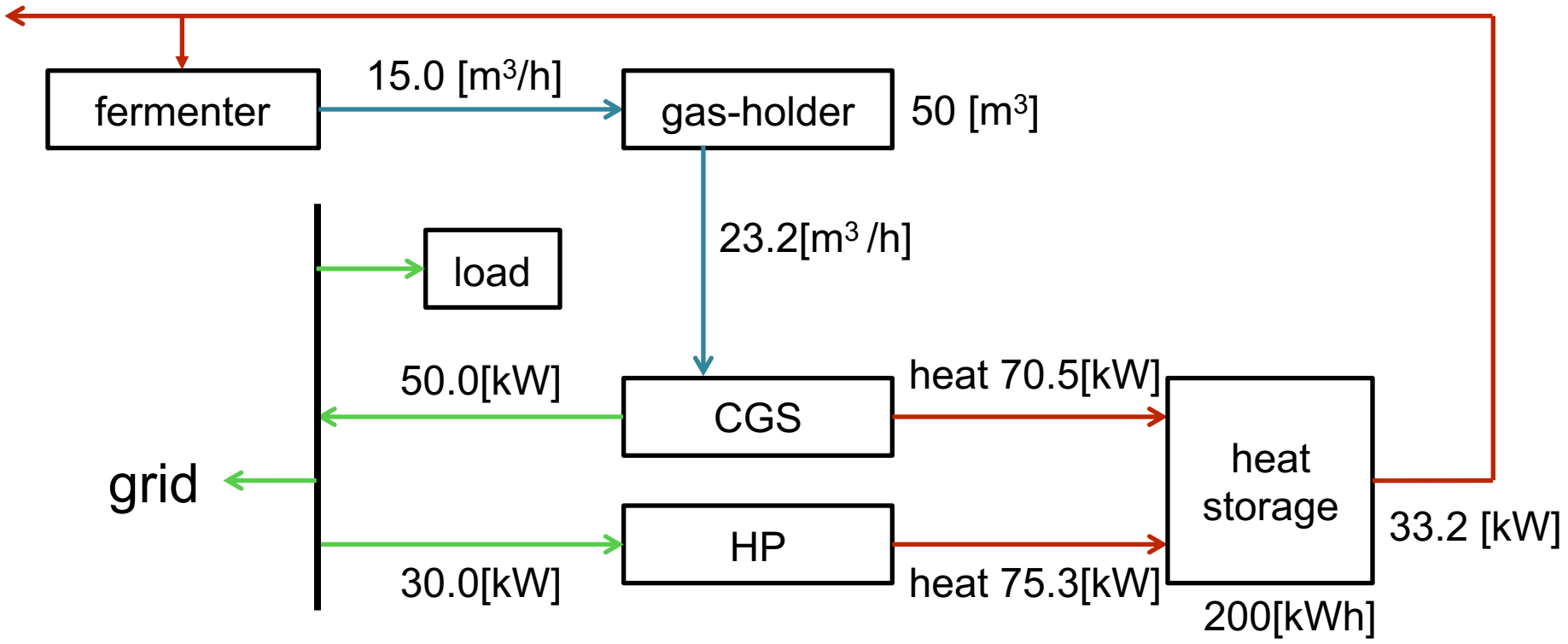
- In Rakuno-Gakuen University @ Ebetsu-city, having a diary farm
- Bio-gas plant is located adjacent to the livestock barn
- Thermal energy is used for fermentation (gas production)
- In operation since April 2016


fermenter

heat pump units (10kW x 3)


gas engine gen (50kW)

System diagram

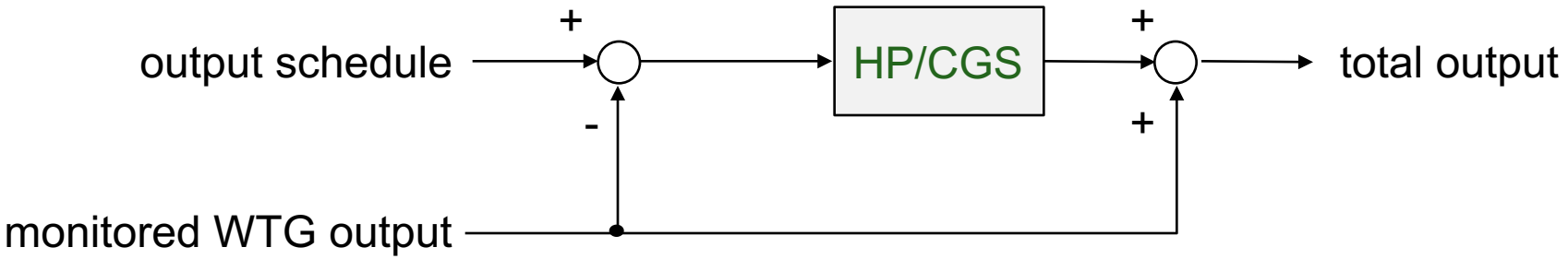


- Equivalent kWh capacity : 164kWh
- Equivalent kW capacities :
  30.67kW (discharge) / 49.33kW (charge)

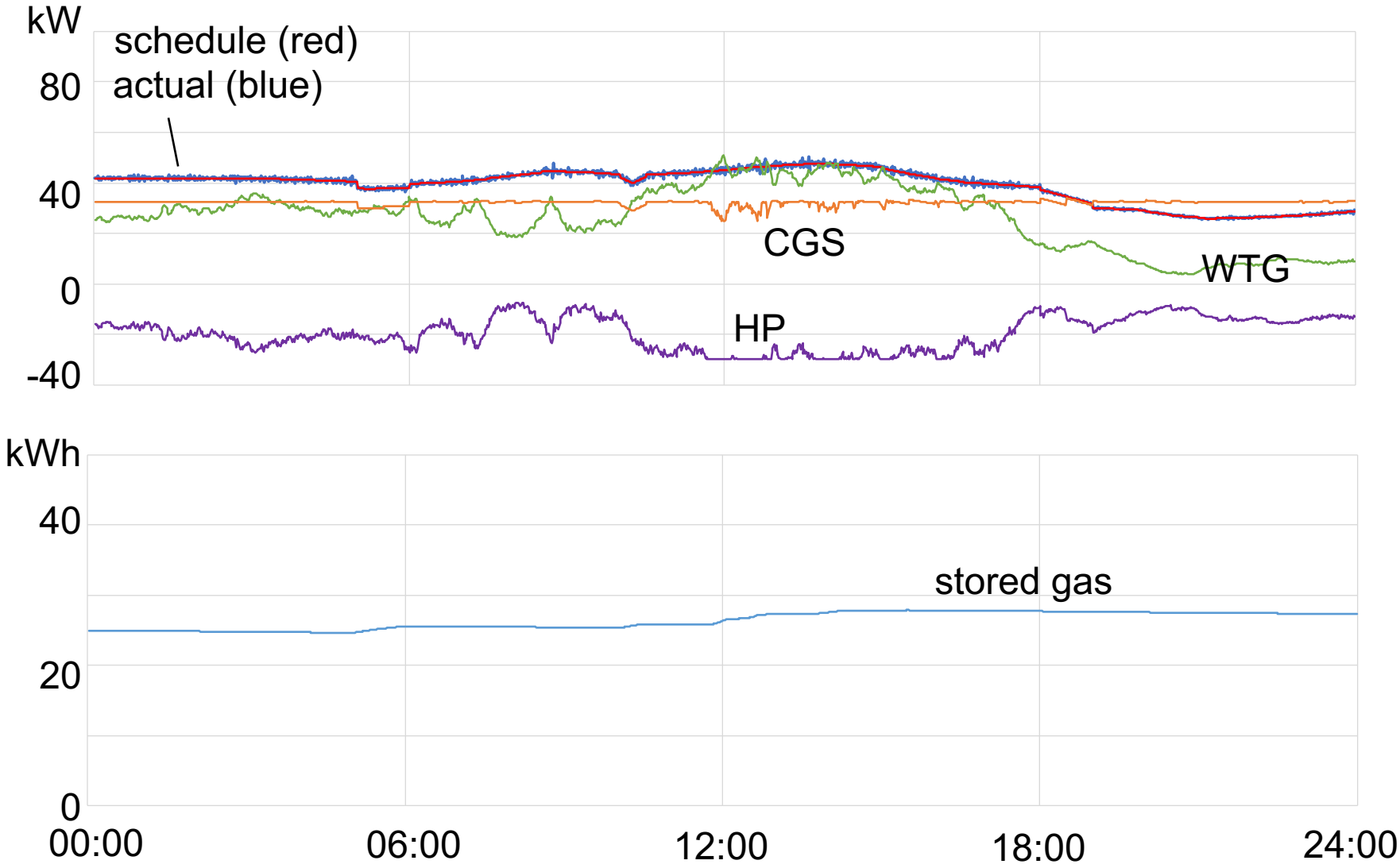
*** specs in this slide are not based on the actual measurement ***

Case Study

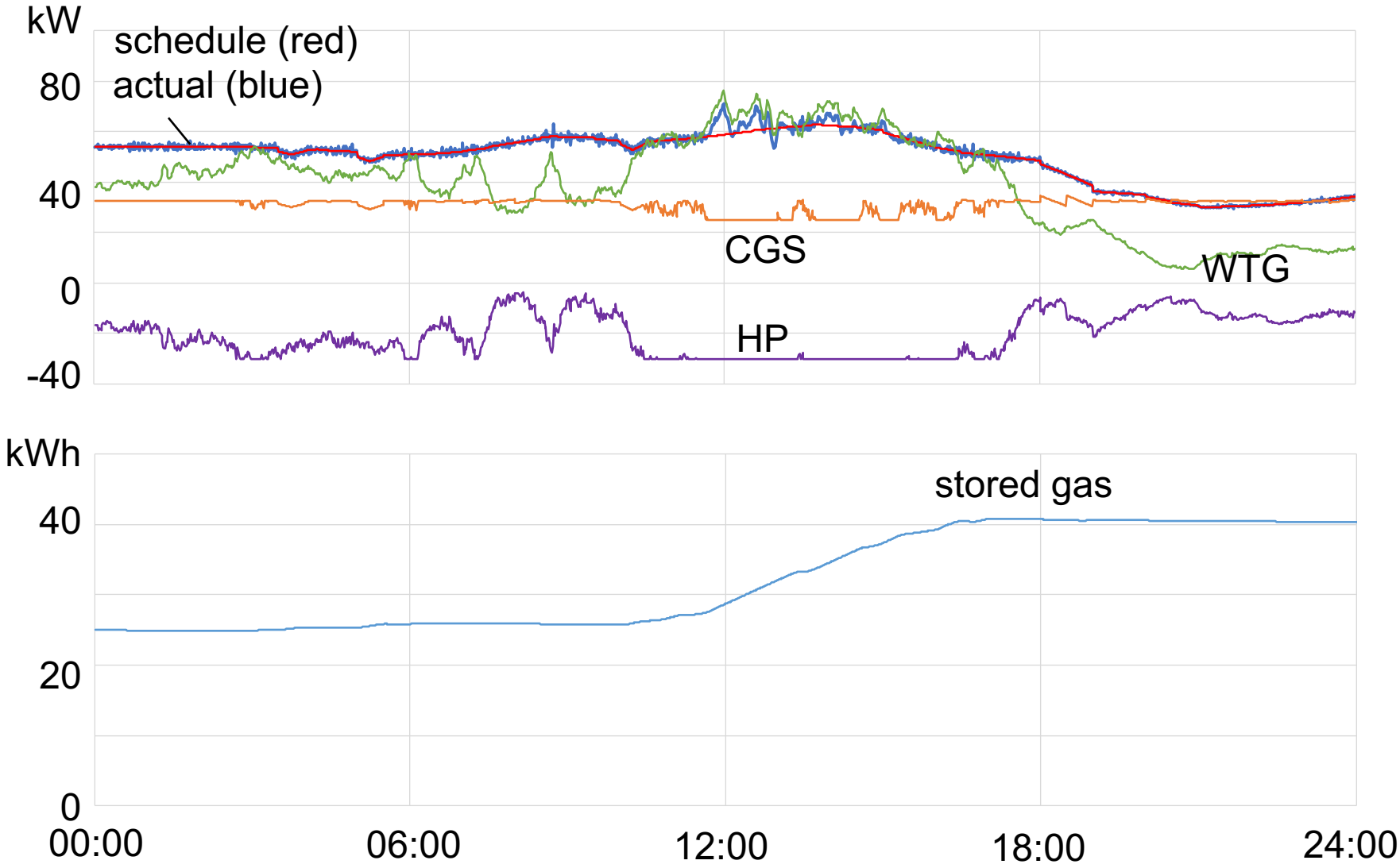
- Proposed HP/BG system is tested for "scheduled generation by WTG + HP/BG"
- Assumed WTG capacities: 80kWp / 120kWp



Simulation results (for 80kWp)



Simulation results (for 120kWp)



Comparison with battery system

- Lower investment cost
  - only by adding HP and extra-spaces in gas-holder and heat storage
    - bidirectional electricity flow
    - widen the range of regulation
      CGS only : +25kW(50%) ~ +50kW(100%)
      CGS + HP : -30kW (HP 100%) ~ 50kW (CGS 100%)
    - stable thermal supply
- Complicated control and system design
  - management of two energy storages (gas holder and heat storage)
  - handling of ON/OFF control
  - agreement of thermal demand size and gas production volume is necessary