Energy Storage Applications in Microgrids

Newcastle symposium on microgrid (29-30, Nov. 2017)

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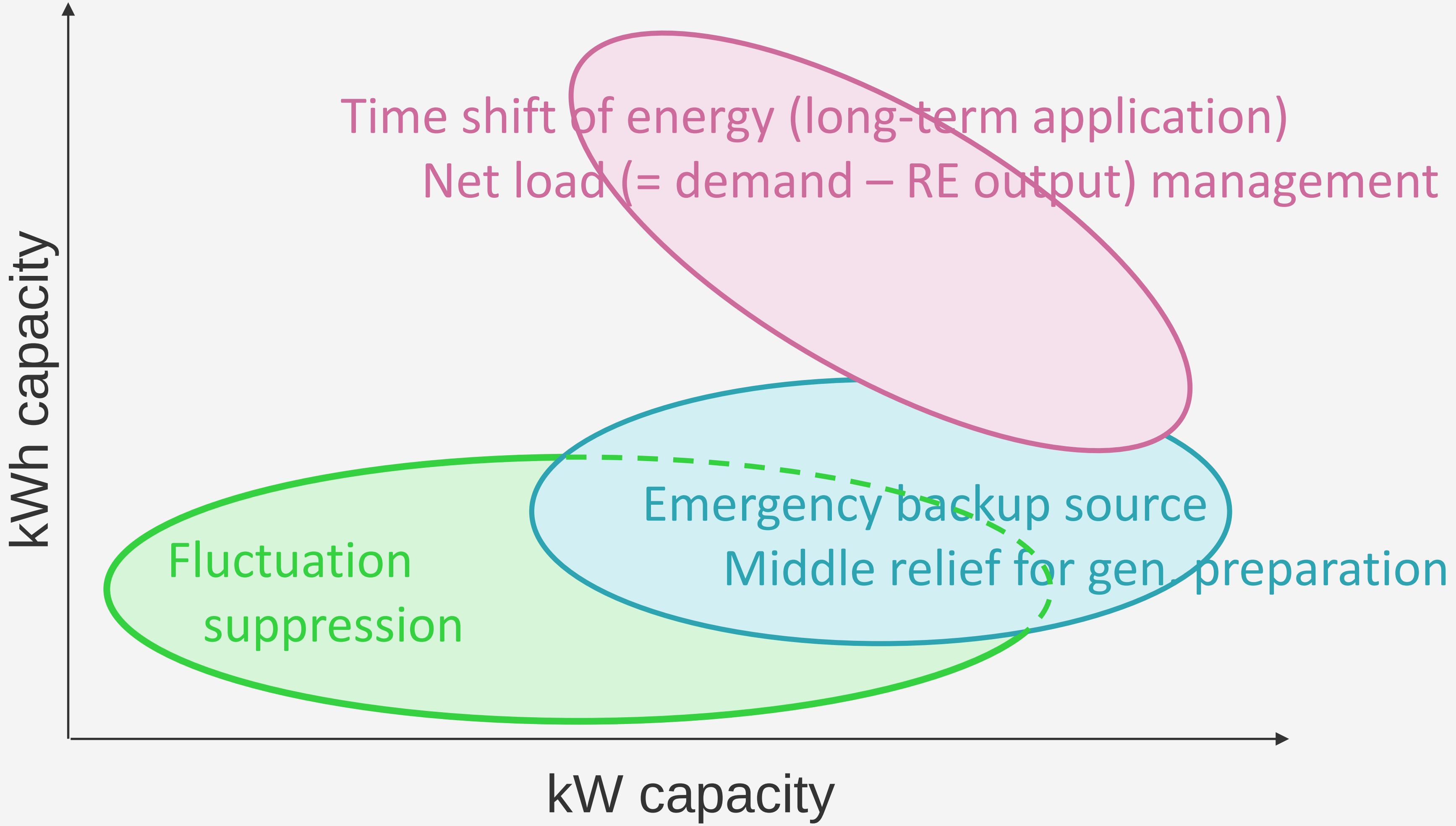
Roles of energy storage in microgrids



Advantages and disadvantages of battery

Advantages

- Good in controllability
- Good in scalability
- Well-developed technology

Disadvantages

- Expensive installation cost
- Round-trip efficiency (~80%)

→ Development of alternating technologies

Possible alternatives

Electric vehicle (EV)

- Primarily, charging speed control is available
- Discharging (V2G) might be available

Demand response (DR)

- Demand shift of demand side apparatuses such as air-conditioner, hot-water heater, chiller, etc.
- Relatively slow response

Power to Heat technology (P2H)

- >> see the PPT in Niagara symposium on microgrid 2016

Hydrogen production process (power to gas, P2G)

Power to Gas (P2G)

Background

Conversion of excess electricity from renewables to H_2 (by electrolyzer) - easy to store

Increasing hydrogen demand in the world for mobility (FCV) and for CGS (residential use)

Difficulties

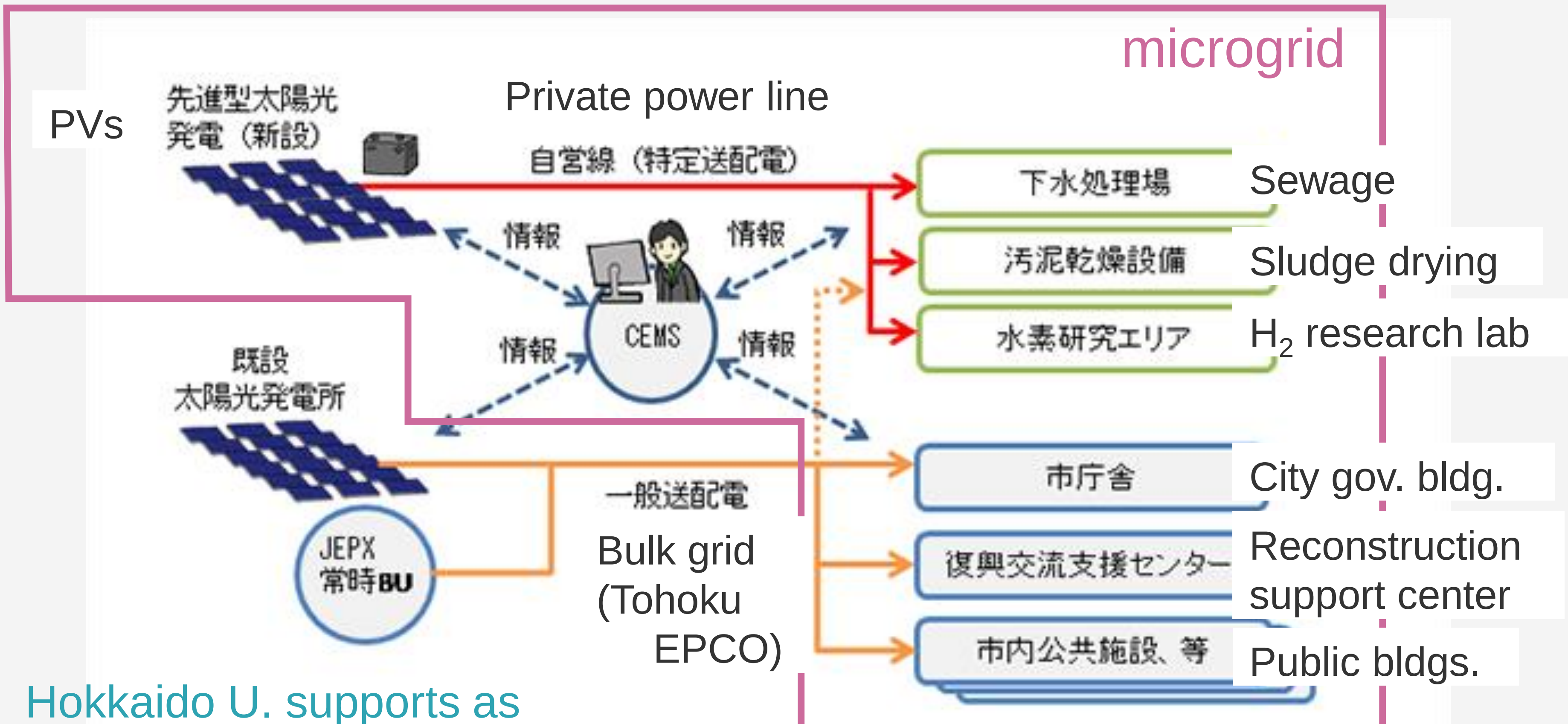
Low conversion efficiency (50%-70%) in electrolysis

Does “re-conversion” to electricity make sense? (~40%)

Ramp-speed performance is ”not” well studied yet

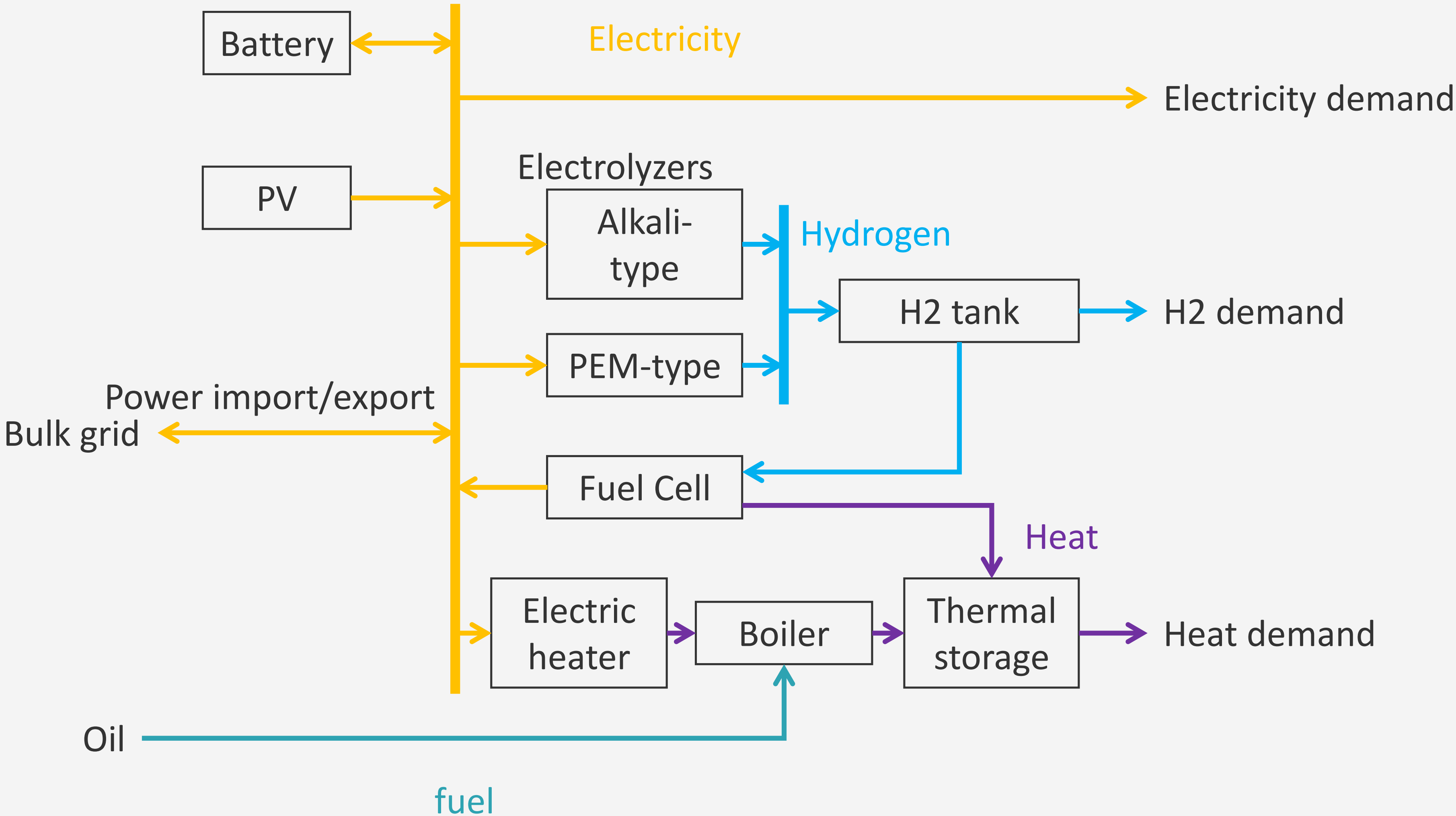
MG with H2 production process

Project begins in 2017 at Soma-city, Fukushima, Japan as a part of reconstruction and development program by *Reconstruction Agency*, Japan



Hokkaido U. supports as
a technical advisor

Energy flow model



Alkali-type: good in efficiency

Polyelectrolyte multi-layer type : good in controllability

Three purposes

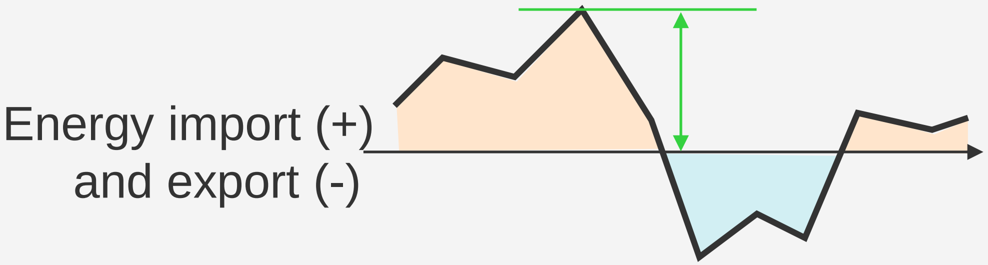
For energy efficiency

Minimization of importing energy (electricity and oil)

For self-supply ability

Minimization of “net” importing energy

(Net import = Import – Export)



For disaster-resistant

Minimization of “peak” import energy

Preliminary study (energy efficiency)

Elec-A

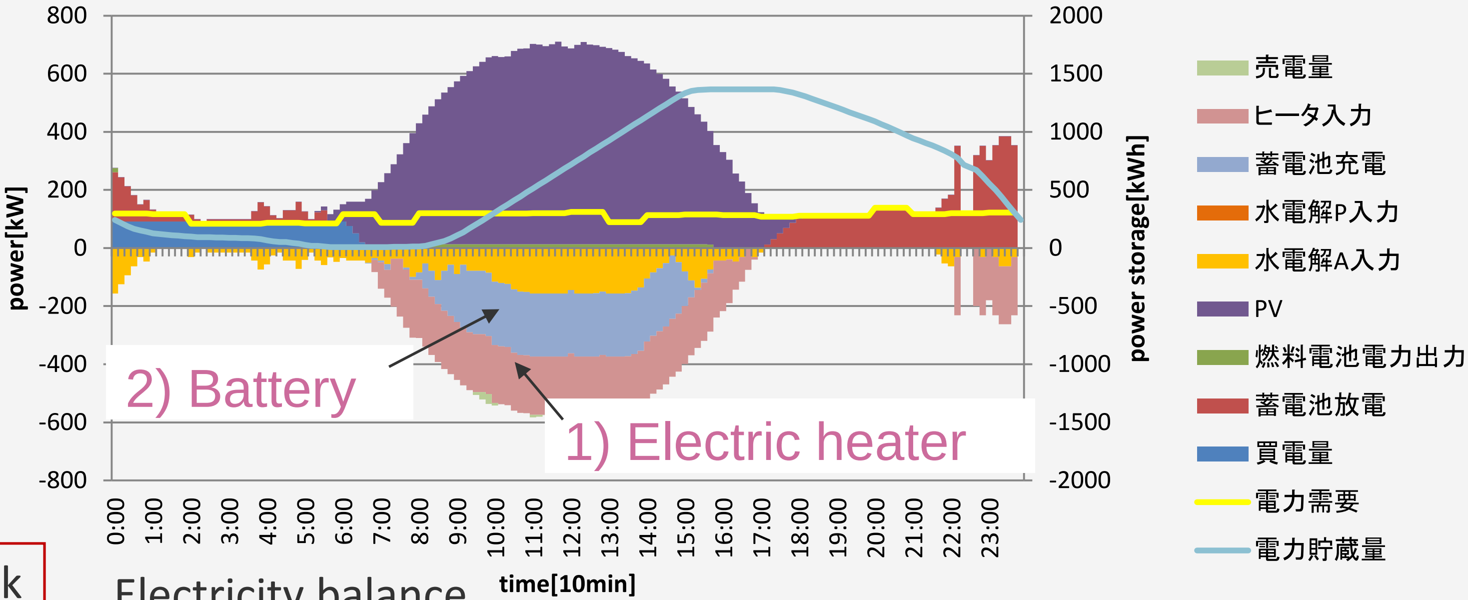
Bat

Heater

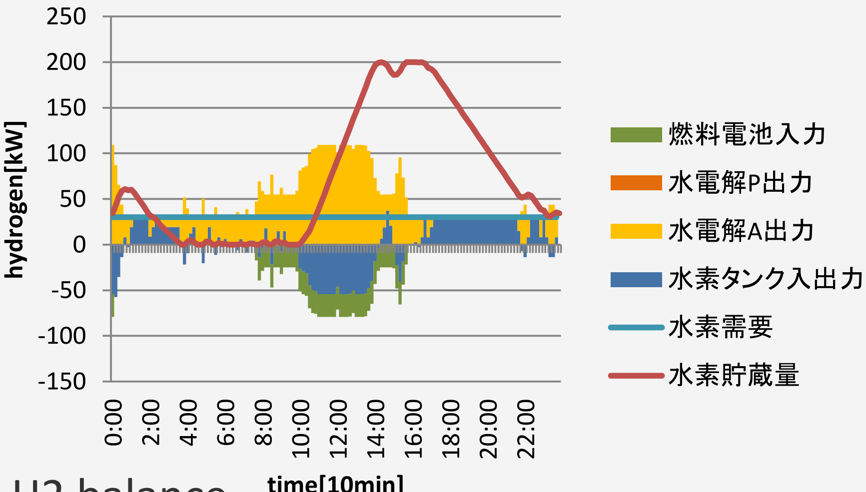
Fuel Cell

H2 Tank

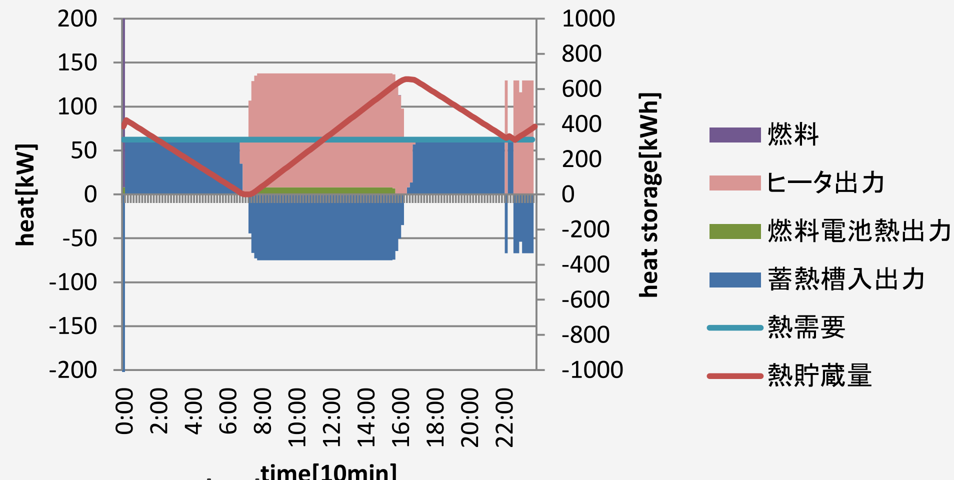
Thermal Tank



Electricity balance



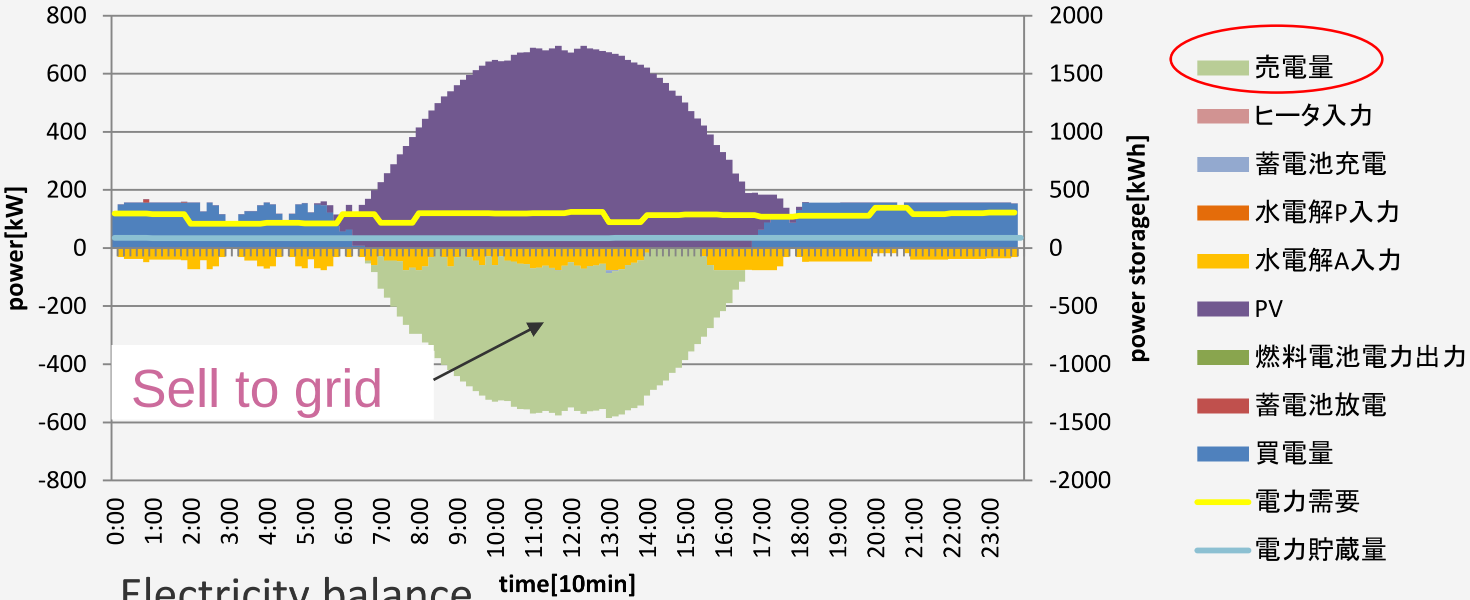
H2 balance



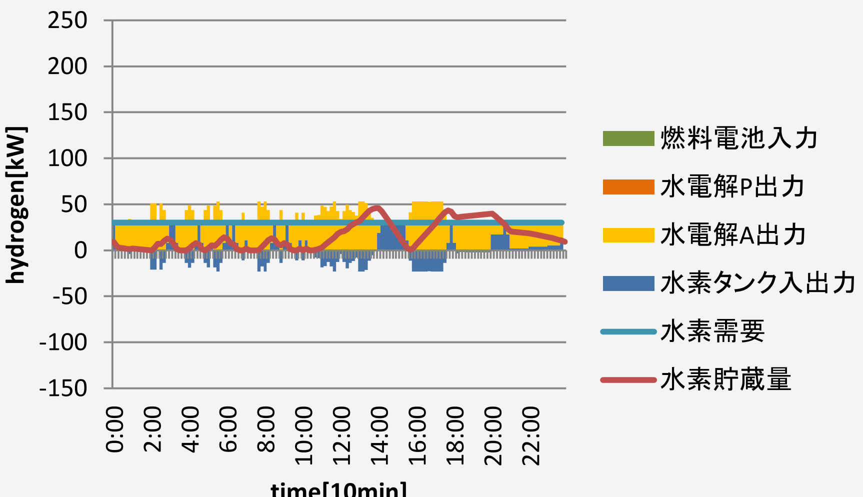
Heat balance

Preliminary study (self-supply)

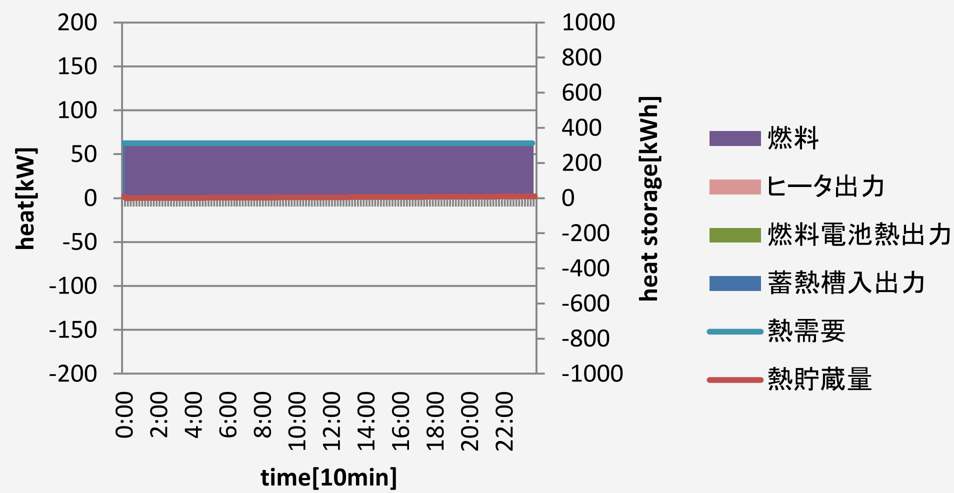
Elec-A



Electricity balance



H2 balance



Heat balance

Preliminary study (disaster-resistant)

Elec-A

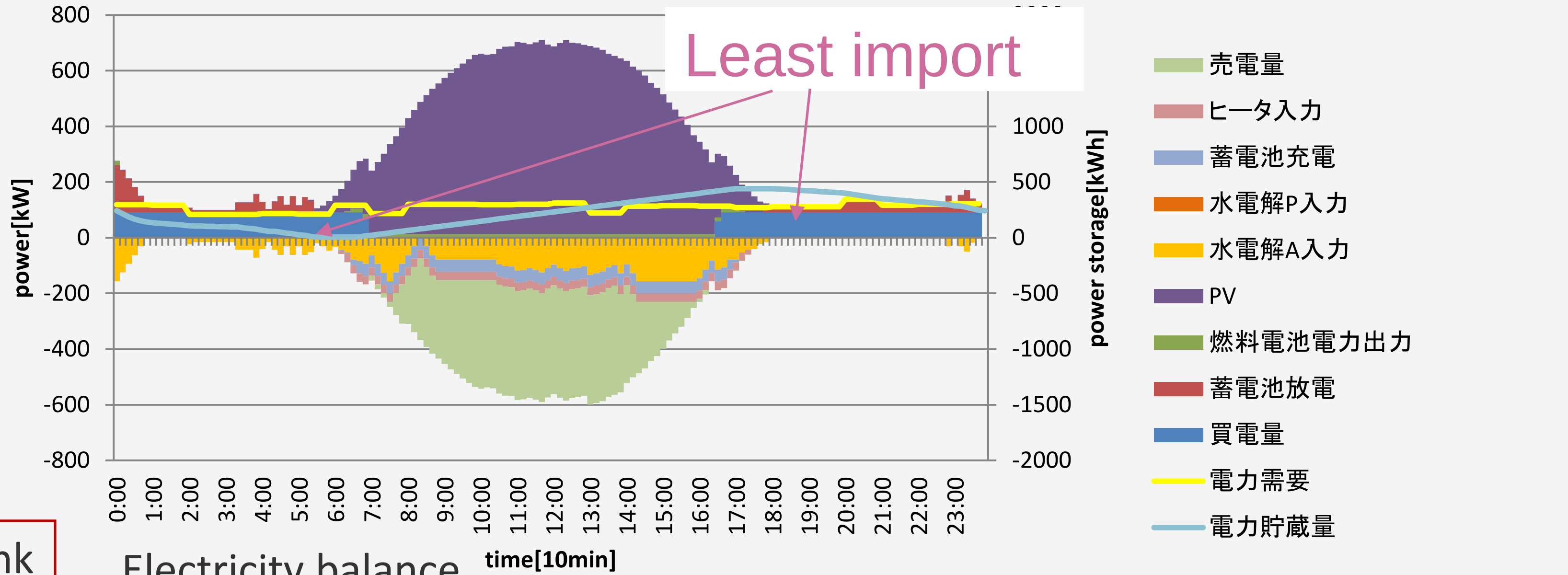
Bat.

Heater

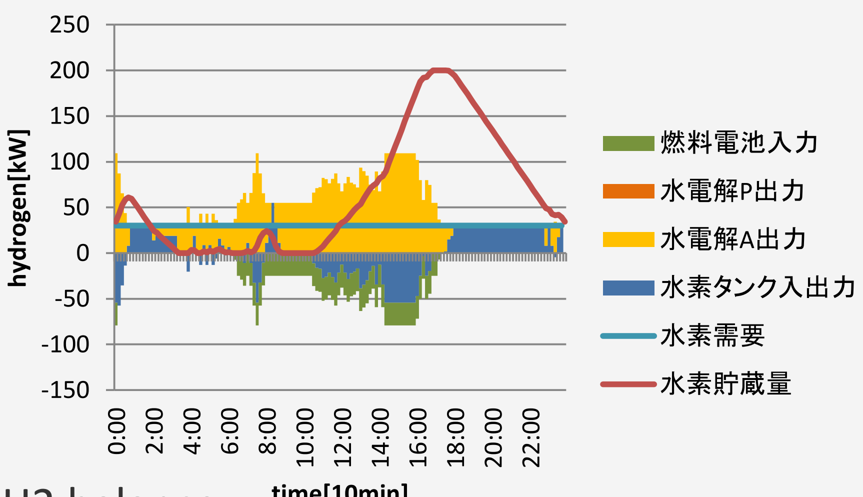
Fuel Cell

H2 Tank

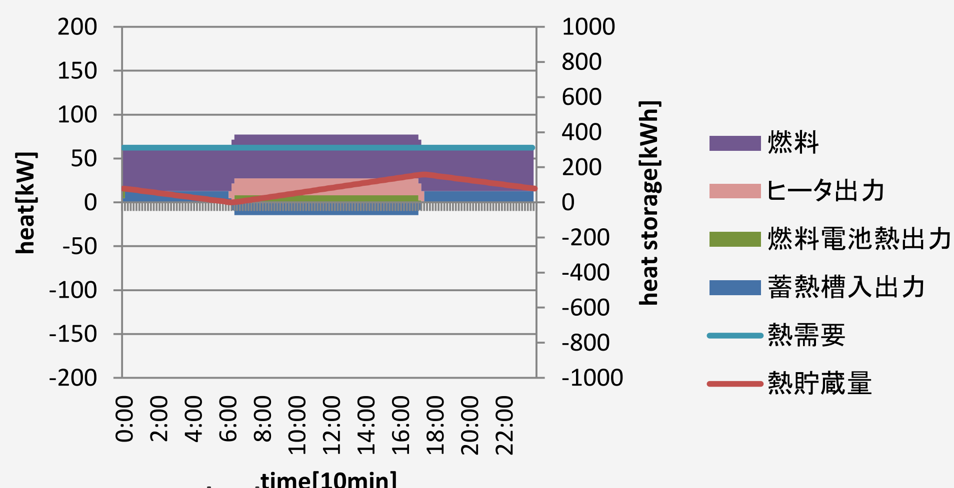
Thermal Tank



Electricity balance



H2 balance



Heat balance

Conclusions

Status of project

- Currently, in system-design process
- New demonstration set-up will be in operation next year

Technical challenges

- Demonstration of electrolyzers’ performance in
  - conversion efficiency (especially in partial load condition)
  - controllability (response time)
- Development of EMS
  - management of electric/thermal/gas storages

Other issues

- Estimation and stimulation of hydrogen demand