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# What environmental and social dimensions need to be considered for residential battery storage applications for renewables?

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# Topics

- In how far can residential battery storage technologies with solar PV systems transform the electricity grid?
- What would be the environmental (and possible economic/security) implications of a large scale penetration of residential battery storage applications combined with solar PV systems?
- What is the role of consumers and consumer acceptability?
- Which regulation and policy are needed to support the deployment of residential battery applications for renewables?

# In how far can residential battery storage technologies with solar PV systems transform the electricity grid? (In Japan)

- The purpose of residential battery

  1.Cost saving by utilization of cheaper electricity in night time

  2. Cost saving by utilization of surplus electricity from PV system

  3.Continual electricity usage in case of emergency

- Considering the purpose, it is really far…
  - The economic efficiency is not good.
  - The consciousness of emergency options has fade by time after the earthquake.

# The economics of residential battery

- In case using cheaper electricity in night time
  - Saving money 2,500yen/month (25$/month)
    - Daytime/Nighttime 30/10yen/kWh (0.30.1$/kWh)
    - Battery available capacity 5kWh
    - Charge and discharge efficiency 85%
  - Lease price 50$/month (w/o subsidy) (One energy)
  - Purchase price 9,000$ (Panasonic) *1800$/kWh*
    - Payout time 30 years (longer than lifetime)

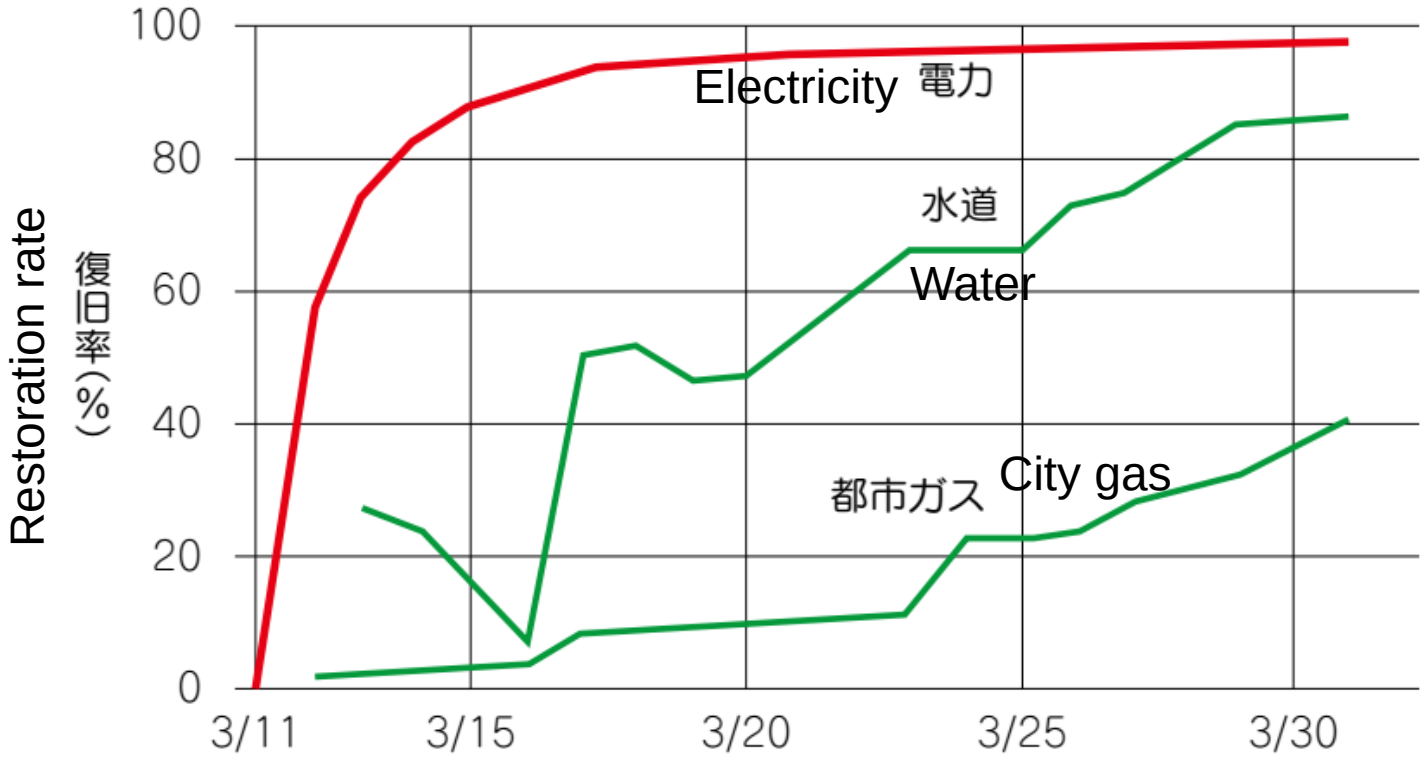
1/2 to 2/3 cost reduction should be needed.

# The economics of residential battery

- In case using solar electricity
  - There is no incentive to store the solar electricity because of high feed-in tariff for PV in Japan.
    - Surplus electricity can be sold at 37 yen/kWh during 10 years (up to 10kW) (37 US cents/kWh)
    - Generated electricity can be sold at 32 yen/kWh during 20 years (more than 10kW) (32 US cents/kWh)
    - Average residential electricity price : 25 yen/kWh (25 US cents/kWh)
  - In Germany
    - FIT price 12.88 euro cents/kWh (June 2014, rooftop solar),
    - Average residential electricity price : 29 euro cents/kWh (2014)
    - Price gap between the two prices : 16 euro cents /kWh is almost same as the price gap between the night and the day time price in Japan (20 US cents/kWh) and is not enough to recover the initial cost of residential battery.

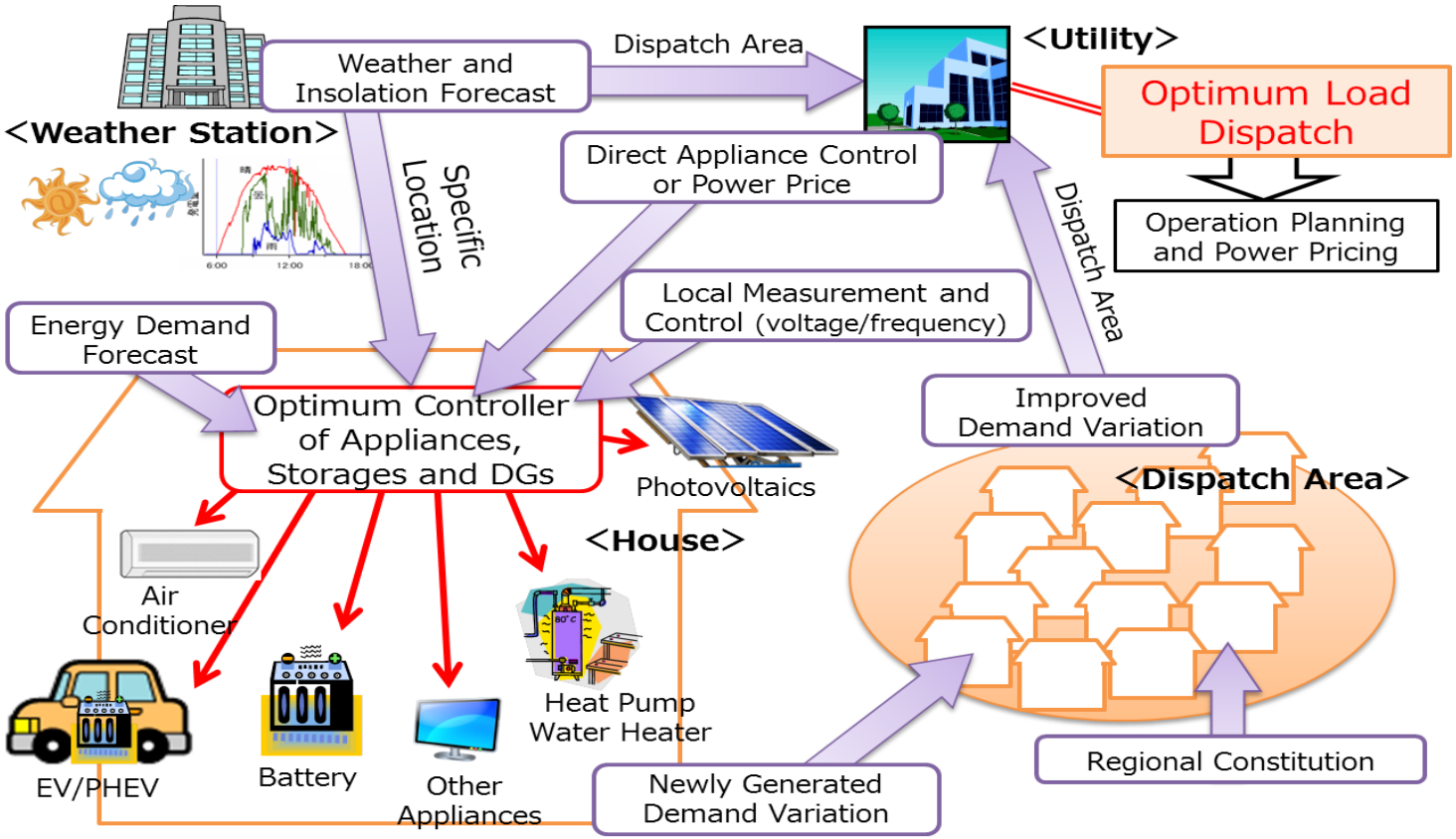
# Continual electricity usage in case of emergency

Restoration period of electricity, city gas and water after the Great East Japan Earthquake in 2011 (*Japan Society of Civil Engineers*)




The restoration period of electricity is shortest.
Small needs for residential battery except for rich and cautious households.

# Implications of residential battery storage applications combined with solar PV systems




Cooperative energy management system

# Which regulation and policy are needed to support the deployment of residential battery applications for renewables?

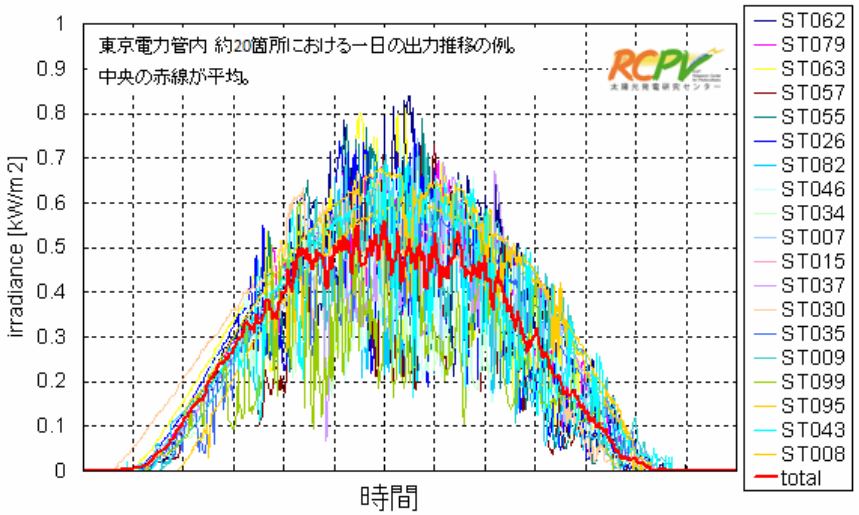
- New pricing mechanism
  - Dynamic pricing mechanism
  - Capacity or ancillary service market
- Electric vehicle is more promising.
  - Nissan LEAF is equipped with 24 kWh battery.

(30,000$ for a vehicle and 3400$ for a power station allows V2H electricity utilization (including subsidies)) *< 1,000$/kWh*

# The value of stationary residential battery

- For customer
  - The barrier to establish of the market of stationary batteries is high. (cost, customer needs)
    - Battery can contribute to energy only (indirect utility).
    - Significant cost reduction and suitable pricing mechanism
  - EV battery has a chance to be used instead of stationary batteries.
    - EV can provide direct utility, “driving”
- For power system
  - Local problems including voltage constraint can be solved by residential battery.
  - Larger batteries such as power station level are more efficient because of smoothing effect of renewable power and demand.

# Smoothing effect

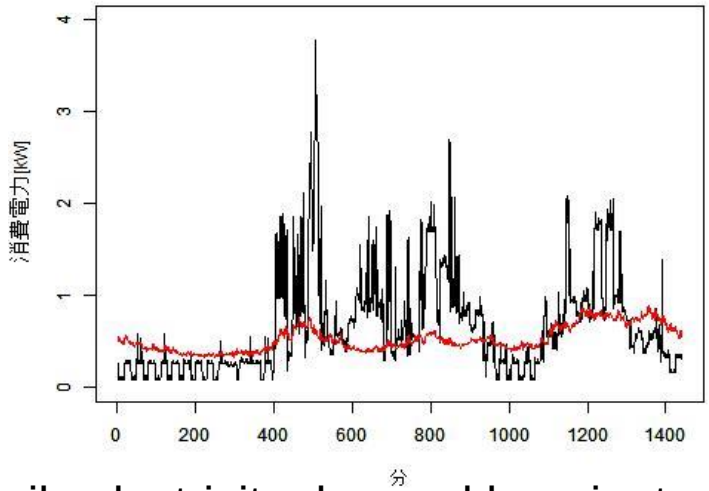



・雲の通過で、個々の出力は激しく変動

・数km以上離れると、互いに打ち消し合う
→合計ではずっと小さな割合の変動に

・実際には数十万、数百万箇所に導入される
→これよりずっと滑らかに

Daily PV generation at 20 points in TEPCO area (red line: average)
(*National Institute of Advanced Industrial Science and Technology*)




Required battery capacity can be smaller when treating the smoothed load and generation.

Daily electricity demand by minute in 1 house (black) and 40 houses average (red)