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Microgrids for resilience and recovery from a disaster

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Microgrids improve resilience

- Proved by Sendai microgrid at
  Great East Japan Earthquake (GEJE)

- Government subsidized many projects after GEJE
  - Support project of penetration of smart community concept 2011 (METI)
    Iwate: Kuji City, Ohtsuchi Town, Kamaishi City
    Miyagi: Kesennuma
    Fukushima: Minami-soma, Costal area
  - Encourage project on introduction of smart community concept 2012 (METI)
    Iwate: Miyako City, Kamaishi City, Kitakami City
    Miyagi: Kesennuma, Ishinomaki, etc.
    Fukushima: Aizu-wakamatsu

etc

(IEEE PES Magazine, 13-3)

Higashi-matsushima City

- Location
  - 40 km north-east from Sendai

- Damages of by Great East Japan Earthquake
  - Casualties 1,109 + 24 missing
  - Population 43,000 → 40,000
  - Residential dwellings 14,581 (97%)
  - Economic damage 66.9 BJPY
    (Income of FY2017: 15.3 BJPY)

Higashi-matsushima Smart Disaster prevention Eco-town

- Budget and funding

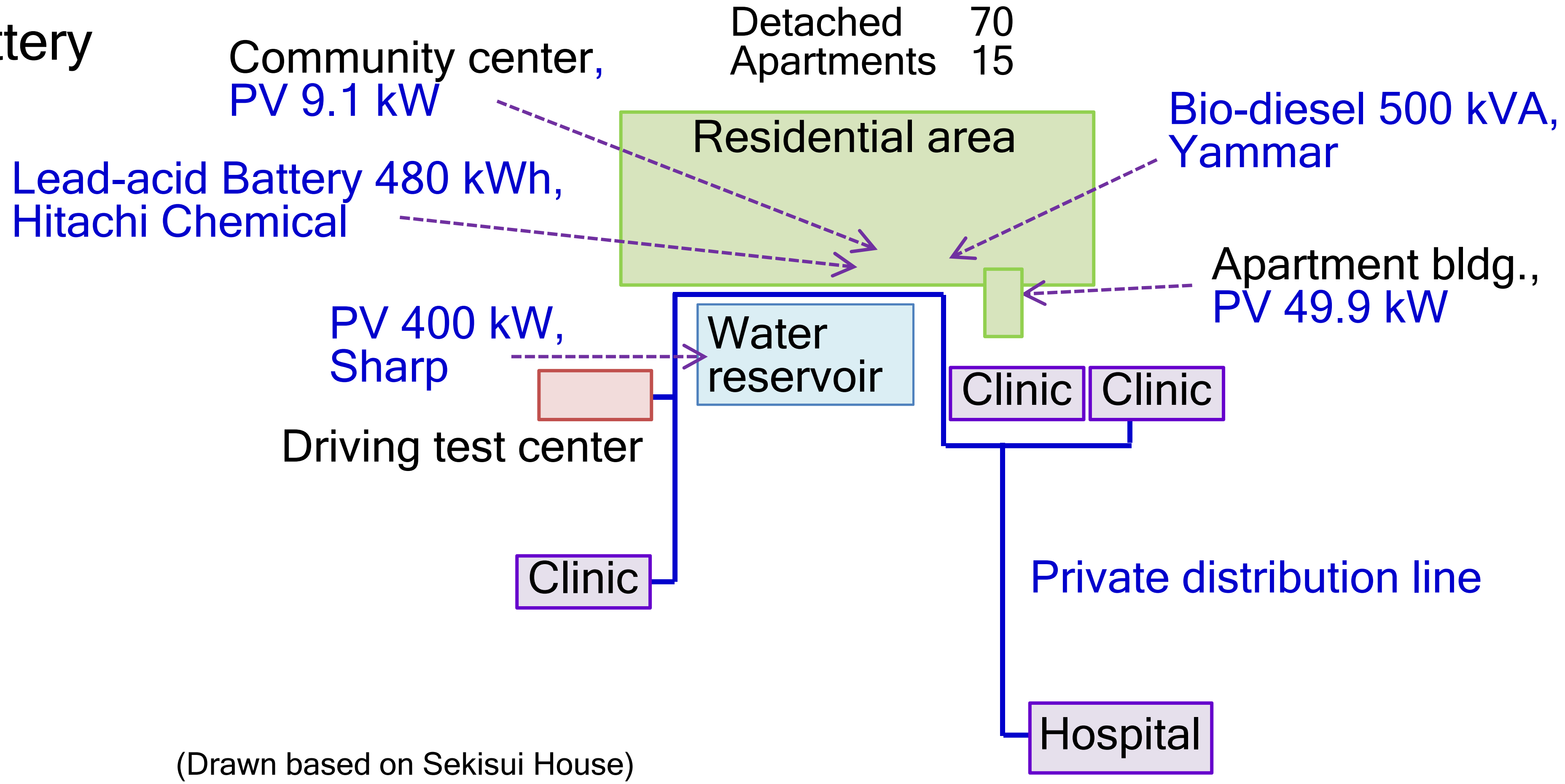
  0.5 billion JPY, 3/4 was subsidized by Ministry of Environment (MOE)

- Project operator

  Higashi-matsushima Organization for Progress and Economy, Education, Energy (HOPE)

Electrical system

- Private distribution line + back-up by an utility
- PV + DG + Battery



(Drawn based on Sekisui House)

Electricity supply

- PPS (HOPE) supplies all electricity via private distribution line + back-up by an utility

- PV supplies 50% of total demand
  - Battery is used to store excess electricity, no reverse flow to external grid
  - 50%: PPS purchases electricity from JPEX market

- PPS business of the operator support economics
  - Sales in FY2017: 20.8 GWh (94% high volt.), not only the microgrid
  - CO_2 emission is not low (0.527 t-CO_2/MWh, TEPCO: 0.474, Tohoku: 0.548)

Japanese Red Cross Ishinomaki Hospital

- Best practice to learn resilience of medical facilities
  - BCP considered (back-up gens, etc)
  - All stakeholders worked for business continuity

    Hospital staff (MD, nursing staff, etc)
    Gas utility, oil utilities, municipal government officers
    MDs of other hospitals
- Showed importance of operation

INVITED PAPER

Demand-Side Resiliency and Electricity Continuity: Experiences and Lessons Learned in Japan

This paper discusses the experiences and lessons learned from Japan using demand-side resources to improve electricity continuity.

By Hirohisa Aki

ABSTRACT | In March 2011, Japan suffered devastating damage from the Great East Japan Earthquake (GEJE) and accompanying tsunami, which caused massive blackouts affecting 8.5 million customers. Damage to power stations, including Fukushima Daiichi Nuclear Power Station, caused a long-term, nationwide power shortage. Other infrastructure and customer facilities were damaged as well. Demand-side resiliency means the availability of electricity to consumers, which is an important factor that affects business continuity. Onsite generation and microgrids have been recognized as important measures that improve resiliency; successful real-life applications of these technologies, such as the Sendai Microgrid and Roppongi Hills, have increased after the GEJE. Metrics on the importance of loads or facilities and resiliency are needed to encourage investment by supporting business operators' decision making and enabling quantitative analyses of the tradeoff between cost and resiliency improvement. This paper presents a comprehensive outline of experiences and lessons learned from the GEJE from the viewpoint of demand-side resiliency—or the availability of electricity to consumers. Damage to power systems and power supply capability through power source loss, best practices (including microgrids), and post-disaster responses and lessons learned are all examined.

KEYWORDS | Demand side; disaster; distributed generation; earthquake; Great East Japan Earthquake (GEJE); microgrid; resiliency; tsunami

Manuscript received August 24, 2016; revised November 14, 2016; accepted November 25, 2016. Date of publication January 16, 2017; date of current version June 16, 2017.
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Digital Object Identifier: 10.1109/JPROC.2016.2633780

I. INTRODUCTION

The threats of natural disasters have been increasing around the world [1], and there have been extensive efforts to reduce the impacts of these disasters. Resiliency has thus become an important value in recent years, and the improvement of communities' resiliency, including that of their infrastructures, has been recognized as an important measure for improving preparedness and mitigating the impacts of natural disasters [2], [3].

The main focus in preparing for natural disasters has been making utilities' facilities, such as transmission towers for distribution cables, as strong as possible. The adoption of resiliency gives other options, including fast restoration of services and demand-side measurements. Another important measure of the preparedness of a power system is its "demand-side resiliency," or customers' ability to continue using electricity in a disaster (i.e., the assurance of electricity continuity for customers). The increase in onsite generation has made it possible for customers to become self-sufficient in electricity. Distributed energy resources—including onsite generators, batteries, and microgrids—enable customers to continue electricity use during power outages, thus improving their demand-side resiliency [4], [5], [6].

After the Great East Japan Earthquake (GEJE), which hit Japan in March 2011, it became important to build a more resilient power system. The country suffered devastating damage from the earthquake and subsequent tsunami, and massive blackouts occurred, affecting 8.5 million customers. Damage to power stations, including Fukushima Daiichi Nuclear Power Station, caused a lengthy, nationwide power shortage; rolling blackouts lasted for two weeks and electricity saving campaigns, designed to maintain the supply–demand balance in summer and winter, influenced not only

Vol. 105, No. 7, July 2017 | Proceedings of the IEEE 1443

H. Aki, "Demand-Side Resiliency and Electricity Continuity: Experiences and Lessons Learned in Japan," in Proceedings of the IEEE, 105-7, 1443-1455, 2017.

Conclusions

- Higashi-matsuhima microgrid
  - Developed after GEJE (showed microgrids' value)
- Japanese Red Cross Ishinomaki Hospital
  - Collaboration and operation by all stakeholders are also important
- Next step for resiliency improvement
  - Development operations for disaster, e.g. sharing of limited power