FORT COLLINS 2019 SYMPOSIUM ON MICROGRIDS
PANEL Session: Microgrids for Resilience

Lessons Learned from Sendai Microgrid

2019/08/11

New Energy and Industrial Technology Development Organization
Smart Community Department
Technical Officer

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Colorado State University
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About NEDO, established in 1980

What's NEDO

- NEDO plays an important role in Japan's economic and industrial policies as one of **the largest public research and development management organizations**

NEDO's Missions

- **Addressing energy and global environmental problems**
- **Enhancing industrial technology**

The Sendai Microgrid from LBNL Web Site

BERKELEY LAB

MICROGRIDS AT BERKELEY LAB

GRID INTEGRATION GROUP • ENERGY STORAGE AND DISTRIBUTED RESOURCES DIVISION

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- About Microgrids
- Microgrid Definitions
- Types of Microgrids
- Examples of Microgrids
  - Fort Carson
  - Mesa del Sol
  - Santa Rita Jail
  - Sendai Microgrid
  - Huatacondo
  - Hartley Bay
  - New York University
  - Borrego Springs
  - Fort Collins

The Sendai Microgrid

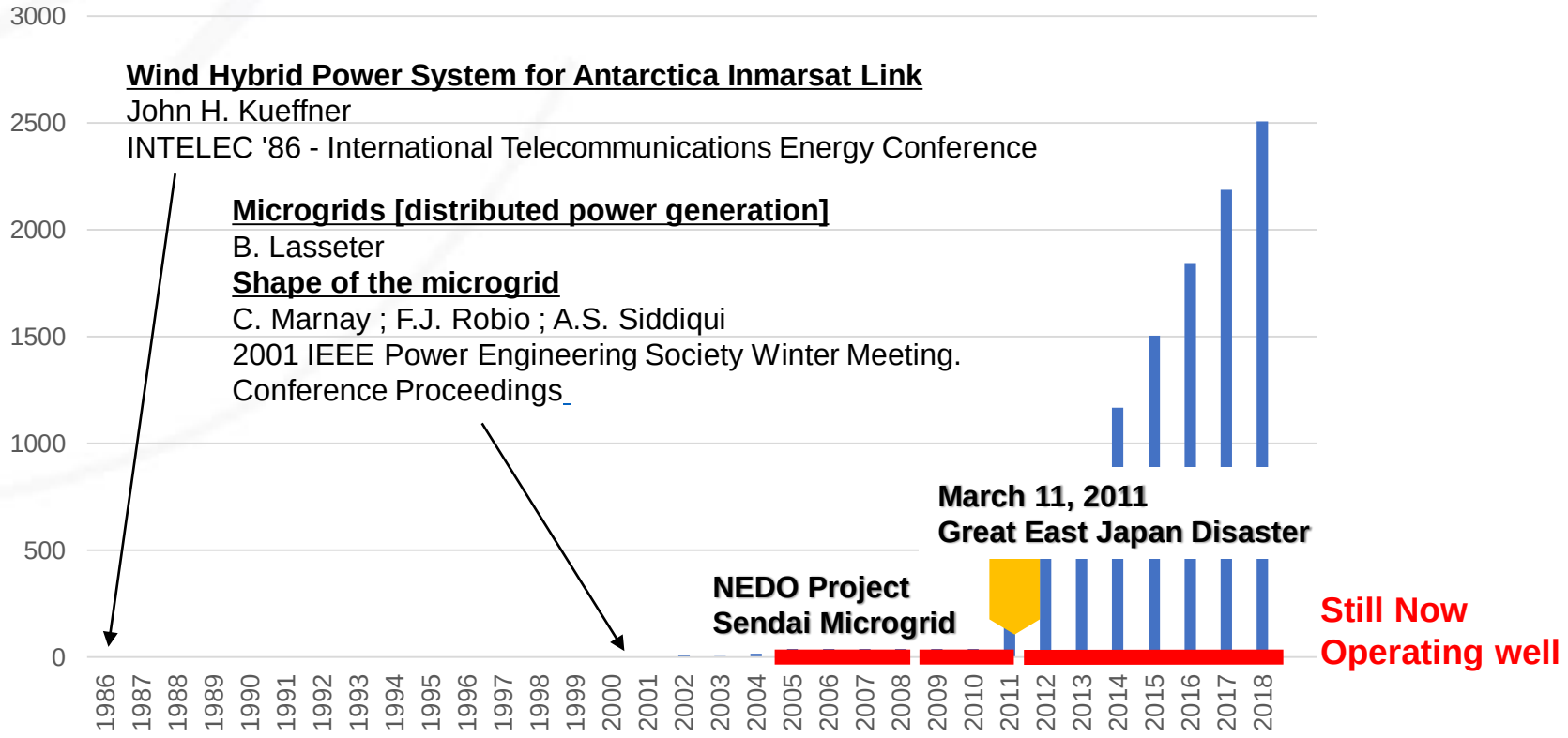
Perhaps the **most well-known microgrid demonstration** on this planet, The Sendai Microgrid Project was one of the four major New Energy and Industrial Technology Development Organization (NEDO) ones carried out in Japan between 2005 and 2008. After some upgrades, this project is still fully operational.

While already highly successful, the project achieved microgrid superstardom because of its **excellent performance during the 2011 earthquake and tsunami**. Following a service loss of a few hours, its engine generators were started and the microgrid supplied the teaching hospital of Tohuku Fukushi University, on whose campus it is located, with both power and heat for the duration of the two-day blackout.

The energy center contains **two 350 kW natural gas fired gensets, 50 kW of PV, and modest battery storage**. Another notable feature of this project are the six varying levels of power quality supplied on various circuits. One of them is a direct DC circuit that supplies the control room, in which all devices, including data racks, are DC to avoid disturbance propagation.

What this graph shows?

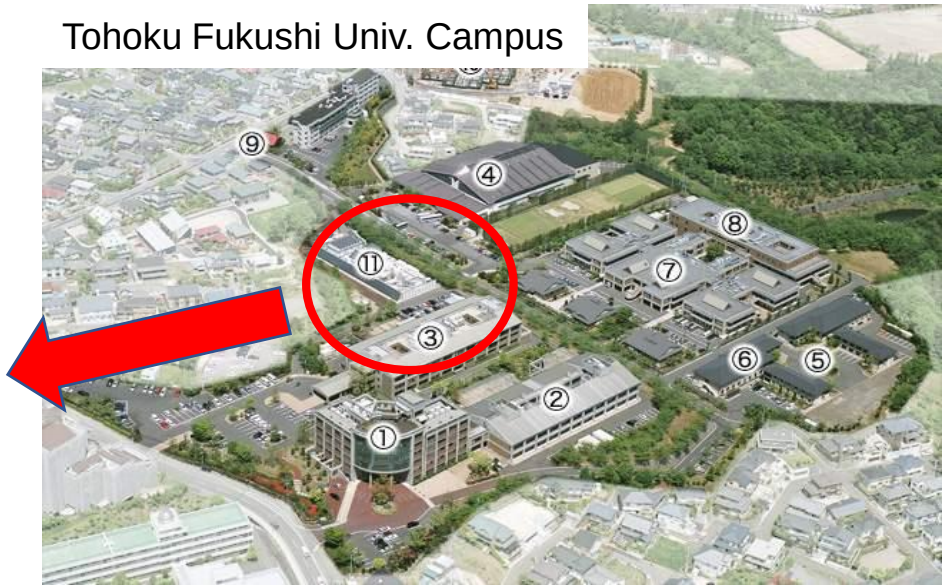
IEEE Xplore Digital Library, Search Resutls
Displaying results 1-25 of 12,270 for "Microgrid + power + system"
Filters Applied: 1986 - 2018, Conferences (9,754), Journals (2,292), Magazines (131), Early Access Articles (56), Standards (19), Books (15), and Courses (3).

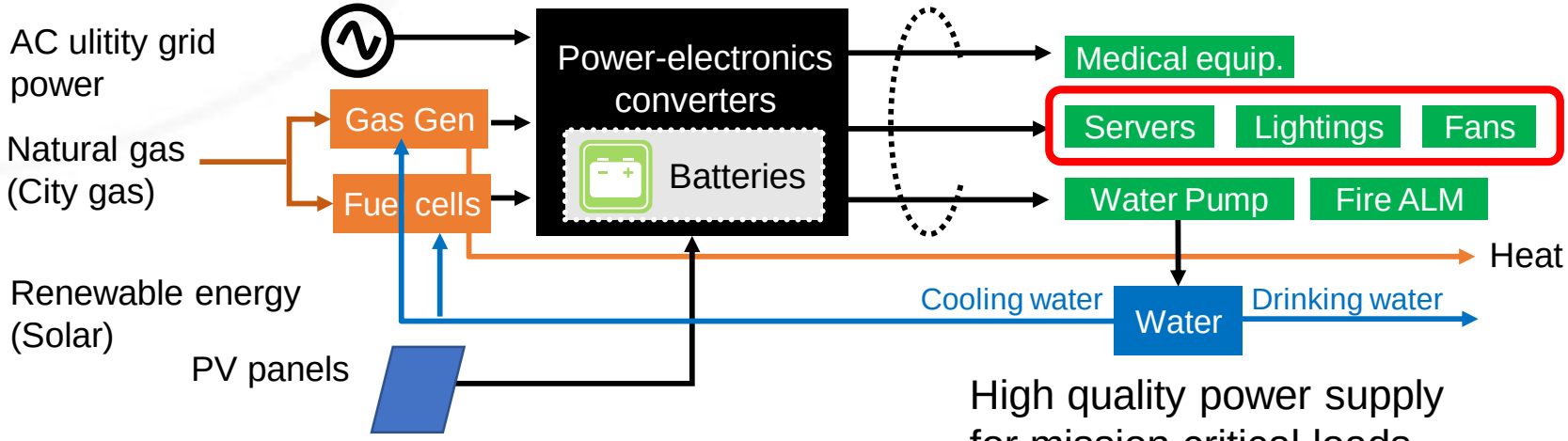


The Sendai Microgrid (2005 – Present)

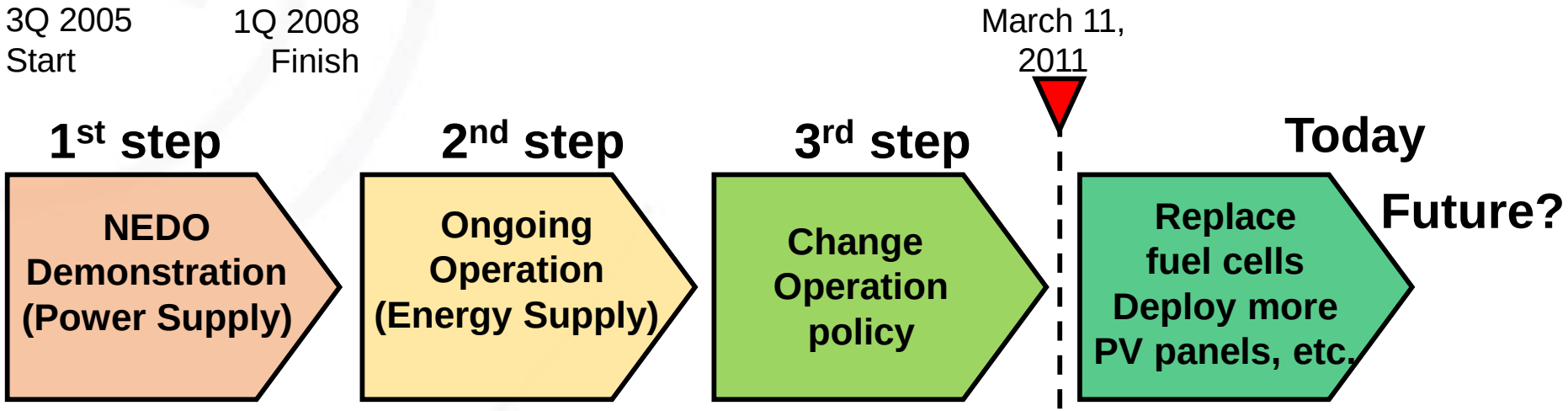
1 mega-watt Microgrid System, Energy Center

Tohoku Fukushi Univ. Campus





Evolution of the Sendai Microgrid



Design/development → Construction → Demo

- Hospital open
- Heat recovery and quality level-C add

- Stop quality level B2
- Disconnect city zone
- DVR remove
- MCFC remove
- Change GE operation policy

- Installation PAFC 100 kW July 2011
- Addition PV panels 160 kW

Evolution from Electric Power to Energy Supply System, and Going Green

Top challenges in measuring resiliency

- To satisfy customers' requirements
  - Demand side management for critical loads/systems
- Optimized system configuration and design
  - INPUT → Multiple energy sources
    - Best mix utility grid power, natural gas, and renewable for risk diversification
  - STORAGE → Short/Long time energy/fuel reserves
    - Battery ⇔ Fuels H2/Gas/Oil/Bio. etc.
  - OUTPUT → Multiple service levels
    - Supply NOT ONLY electricity but also heat, water, telecom/info, etc.
    - Avoid over specification at the same time
- Cost-benefit analysis
  - Maximize the value of microgrid
  - Budget is limited…

Top challenges in enabling resiliency

- Plug-in-play, flexibility of the system
  - DC power is more flexible!
- Best mix of resources: Hardware and Software

  (Microgrid ⇔ Human resources for operation)

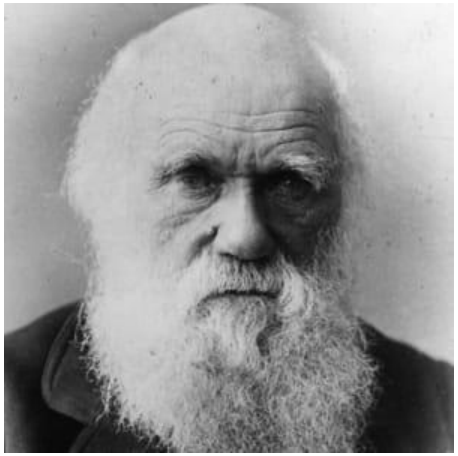
  - Avoid excessive dependence on ICT, Simple is the best
  - Man is the most powerful, than hardware.
  - People can think about what is the most important in case of emergency!
- Plan the Long-term operation and do drill/training/education

short time and long term needs and solutions for enabling resilient system given recent events

- Short time
  - CAPEX: Who invests?
  - Engineering: Tool for design (Cookie cutter)
  - Business model: Asset management, billing, etc.

- Long time, need to plan these changes!
  - OPEX: Fuels, maintenance, over whole, etc.
  - Hardware performance: Aging, malfunctions, availability
  - Load management : Capacity of loads, scalability, fluctuation, change of needs
  - Personnel: Transfer, retile, education
  - Regulation/code/policy

"It is not the strongest of the species that survives, nor the most intelligent, but the one most responsive to change."
Charles Darwin, British naturalist, geologist and biologist



Thank you for your attention

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Example: Fire and Building Codes in Japan