Battery energy storage for microgrids & islands

Four case studies on real-world applications

March 15, 2018

Taylor Sloane: taylor.sloane@fluenceenergy.com

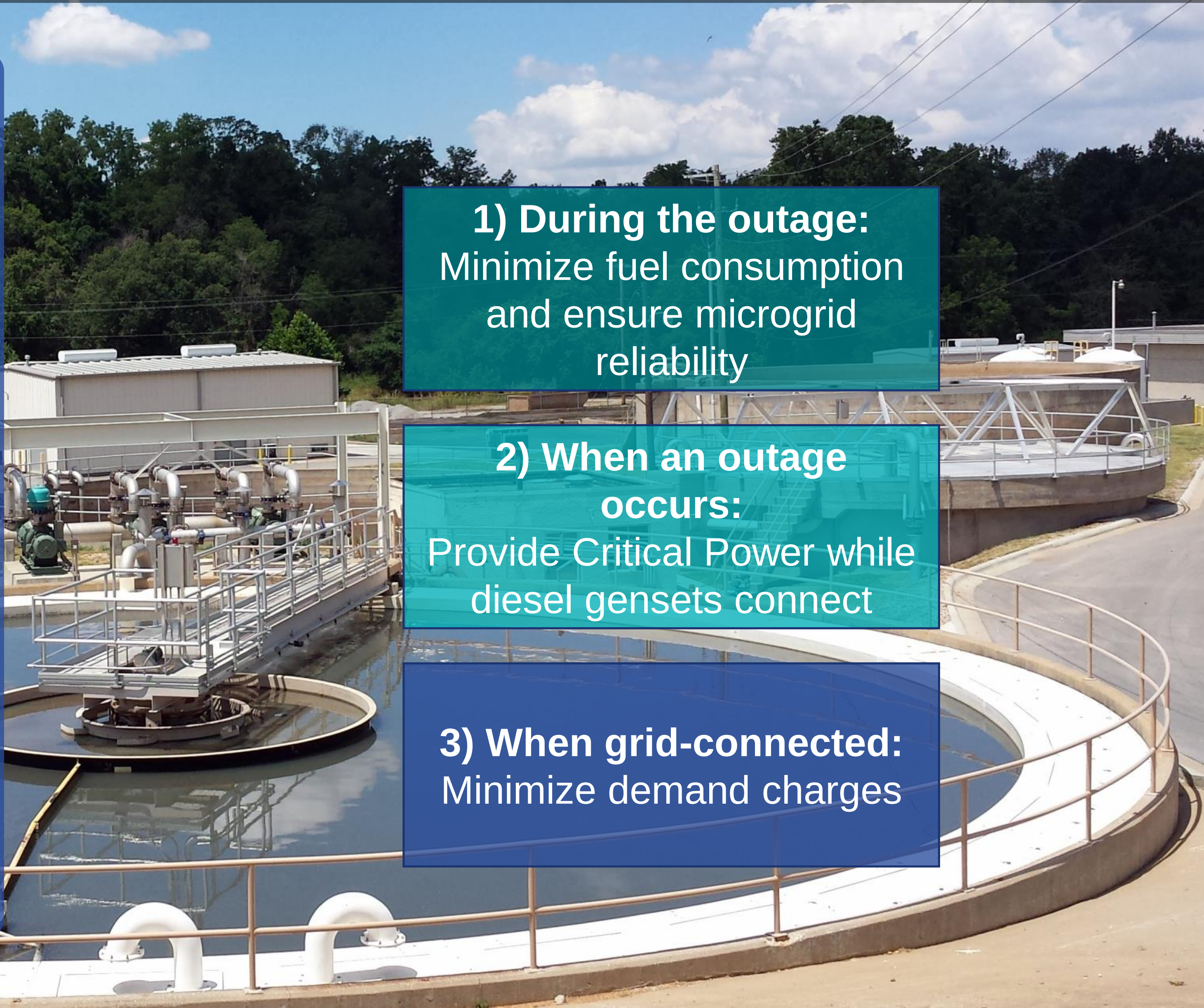
FLUENCE

A Siemens and AES Company

Grid-connected systems are worried about risk management whereas off-grid systems are worried about fuel cost reduction

	Grid-connected	Off-grid
Microgrids (<10 MW)	**1** **Infrastructure:** hospital, water treatment, airports **C&I:** data center, heavy manufacturing	**3** Cell phone tower, remote communities
Islands (>10 MW)	**2** Interconnected island utilities	**4** Island utilities; Remote resource extraction (e.g. oil & gas, mining)

1) Grid-connected microgrid: Key challenge is to provide adequate resilience to a facility or campus, while also being cost effective



Case Study 1:
Grid-connected microgrids
Water treatment plant

Background: A water treatment plant in United States lost power during hurricane and was forced to discharge millions of gallons of untreated sewage into local river.
Challenge: Creating a cost effective microgrid to operate up to 10 days without outside power to prevent sewage discharge.
Solution: Install 896 kW solar and 1 MWh energy storage to augment diesel generators. Provides demand charge reduction, reduces electricity consumption, and extends limited fuel supply when it is islanded.

1) During the outage:
Minimize fuel consumption and ensure microgrid reliability

2) When an outage occurs:
Provide Critical Power while diesel gensets connect

3) When grid-connected:
Minimize demand charges

2) Grid-connected island: Key challenge is to provide adequate resilience to an island, while also being cost effective

Case Study 2:
Grid-connected Island
European Island

Background: A European island is interconnected to the European grid with one subsea cable. The island has on-island generation, but it takes several hours to bring online.

Challenge: Creating a cost effective solution to prevent island blackouts if the subsea cable is interrupted.

Solution: Install energy storage to provide uninterrupted power for critical loads when subsea cable goes down. Arbitrage electricity import price differences when grid-connected and extends limited fuel supply when it is islanded.

1) During the outage:
Minimize fuel consumption and ensure Island grid reliability

2) When an outage occurs:
Provide Critical Power while diesel gensets connect

3) When grid-connected:
Minimize demand charges

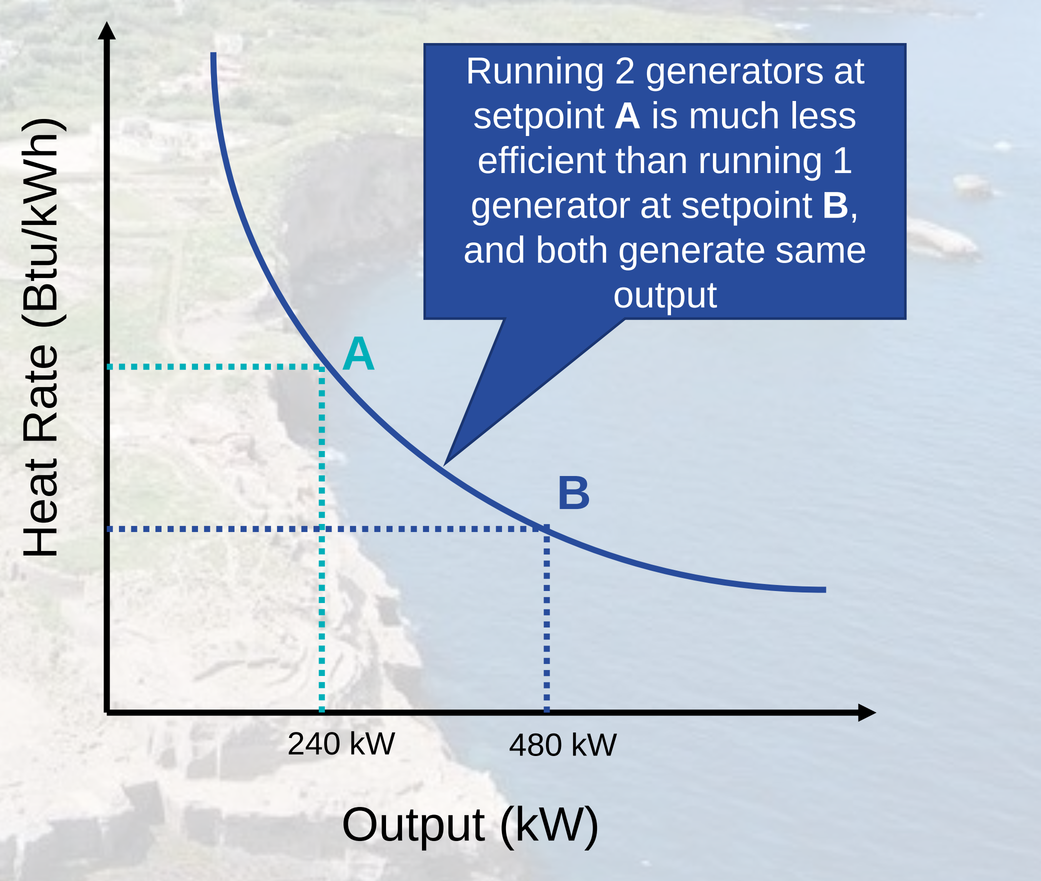
3) Off-grid microgrid: Key challenge is to minimize fuel cost

Case Study 3:
Off-grid microgrid
Diesel + solar PV + battery

Background: A European island with 700 inhabitants is 46 km away from the coast. Island operates four 480 kW diesel generators and 90 kW of solar.

Challenge: Microgrid operator must run multiple generators at low, inefficient set points to cover short-term peaks, which increases fuel consumption.

Solution: Install 500 KW / 600 kWh energy storage to flexibly charge and discharge to allow diesel genset(s) to operate steadily at maximum efficiency. Storage also mitigates solar intermittency issues.

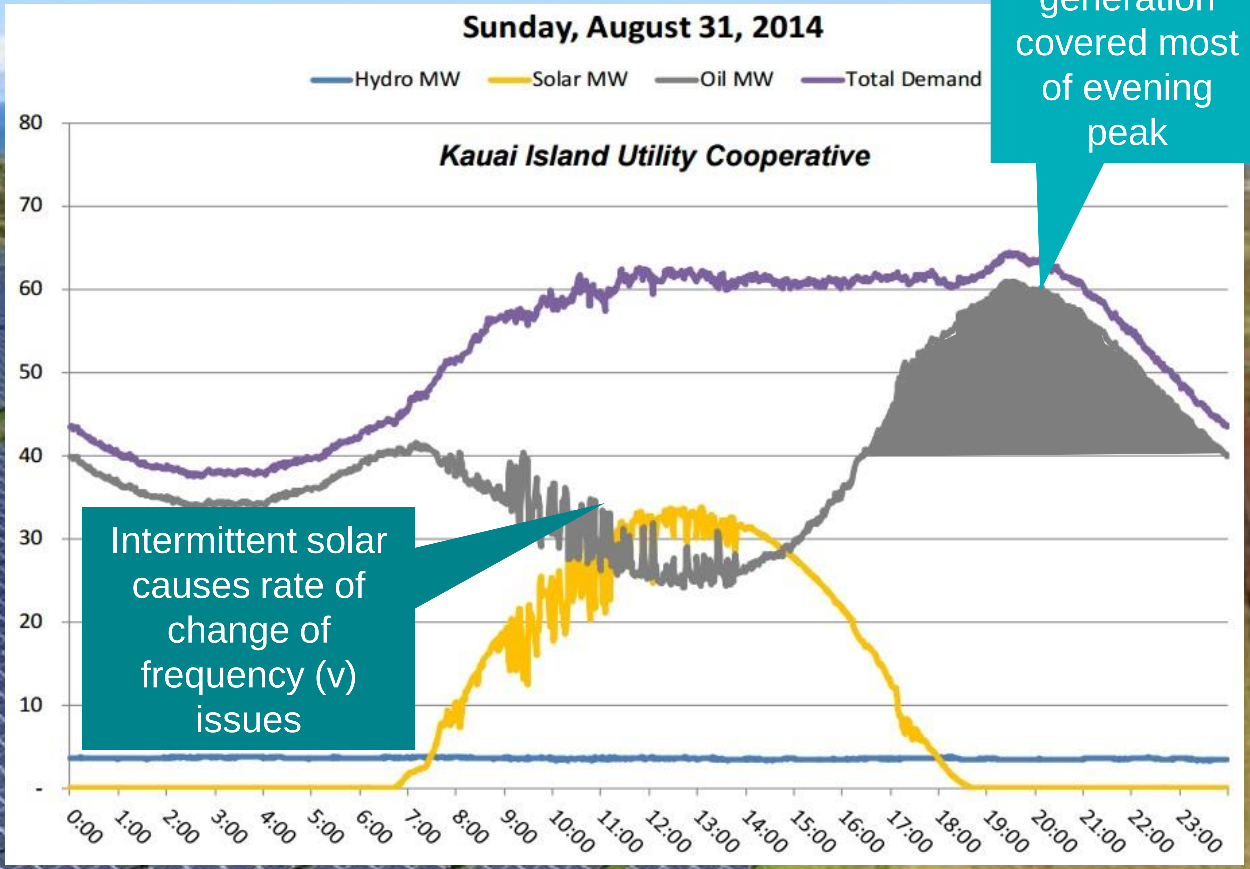


4) Off-grid island: Key challenge is to minimize fuel cost AND ensure reliability

Case Study 4: Off-grid island

Renewable firm power for island utility

Background: The island of Kauai in Hawaii has a population of 66,000 and a 80 MW peak demand.
Challenge: The average household pays about 33 cents per kWh, or $330/MWh, and the utility often uses expensive fossil fuel generators to cover peak load (***see right***)
Solution: A 28 MW solar + 20 MW, 5 hour (100 MWh) energy storage solution provides power during the peak demand from 5 pm to 10 pm each day. The PPA is $110/MWh, which is significantly less than the cost of oil-fired power.



Expensive oil generation covered most of evening peak

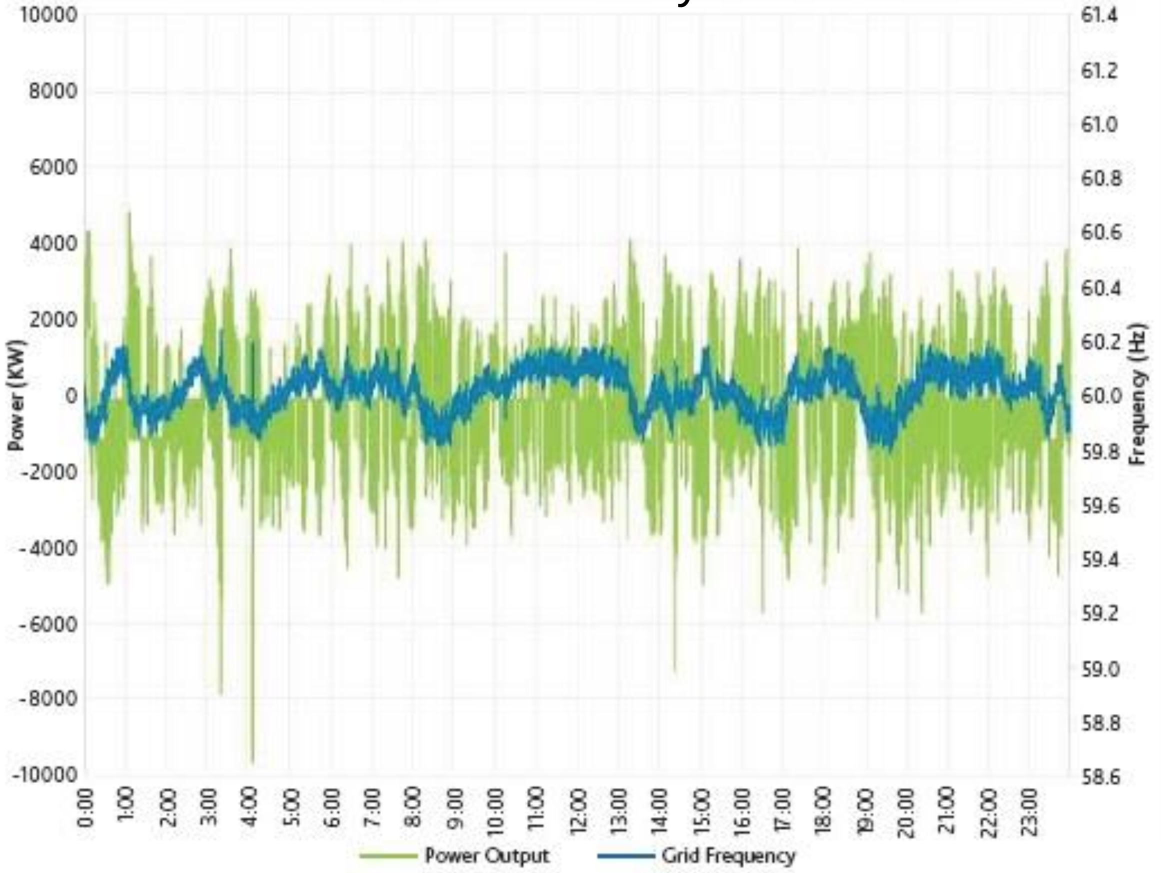
Intermittent solar causes rate of change of frequency (v) issues

Credit: DOE solar DG presentation

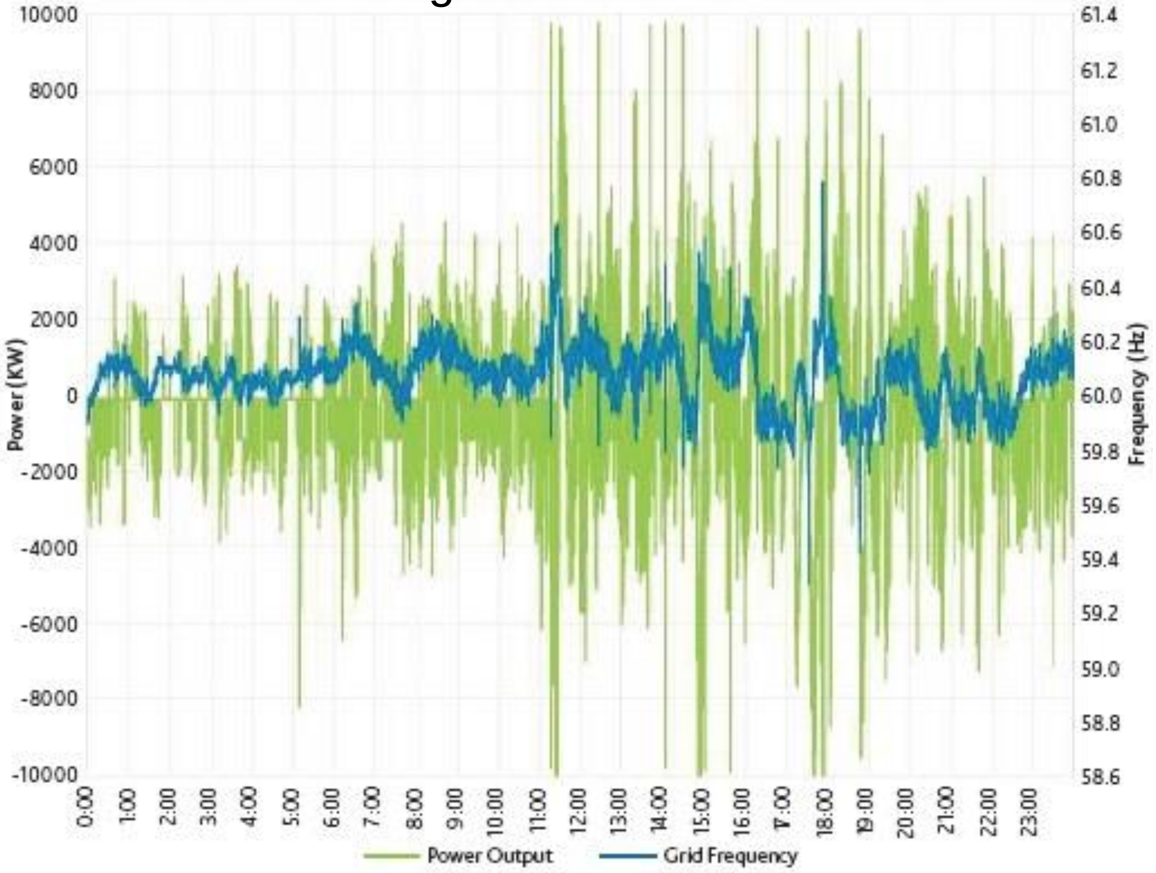
Added bonus: energy storage can maintain frequency during hurricanes when generators and loads are disconnecting

Energy storage system in Dominican Republic had to discharge 57% more energy than normal to balance grid

Normal day



During Hurricane Maria



Actual operating data from energy storage in the Dominican Republic during Hurricane Maria

When will the economics of energy storage work?

If these conditions are present, energy storage will likely be economically viable

Off-grid microgrids

1) Very expensive fuel
2) Grid stability issues caused by solar intermittency

Grid-connected

1) High cost of power outage (critical loads that cannot be interrupted)
2) Susceptibility to extended outages
3) Demand charges/time of use charges (optional)

Islands

1) Running engines at suboptimal heat rates
2) Expensive fuel
3) Expensive electricity
4) Grid stability issues caused by solar intermittency (RoCoF)

Thank you

Taylor Sloane, Market Applications
taylor.sloane@fluenceenergy.com
Fluence, A Siemens and AES Company
http://fluenceenergy.com/

Puerto Rico vision