The Objectives of Energy Management in Microgrids

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About the Presenter

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Eric Gallant has been involved in the power and energy sectors for more than 25 years. His experience ranges from nuclear reactor testing and operation for the Department of Energy (DoE) and the United States Navy (USN) through mission critical facility design and operation. He recently joined GS Battery to develop new opportunities in the areas of microgrids, renewable energy and battery based energy storage systems.

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Agenda

- What is a Microgrid?
- What are the objectives of energy management in a microgrid?
- Case Studies
  - Shetland Islands
  - Haiti
  - Ecuador
- Summary and Questions

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What is a microgrid?

- Definition:

  "A group of interconnected loads and distributed energy resources (DERs) with clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode."

What is a microgrid?

- Components and Features
  - *group of interconnected loads*
  - *distributed energy resources (DERs)*
  - *clearly defined electrical boundaries*
  - *acts as a single controllable entity with respect to the grid.*
  - *can connect and disconnect from the grid*
  - *operates in both grid-connected or island-mode.”*

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What are the Objectives?

- Energy Security/Energy Independence
  - Ability to operate islanded from grid
  - Improved ability to integrate renewable energy sources
- Increased Energy Reliability and Resiliency
- Increased Demand Side Energy Management Opportunities
  - Peak Demand Reduction
  - Time of Use Shifting
- Improved grid resilience

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Case Study: Shetland Islands

- Energy Resources
  - Fossil Fuels (North Sea, Shetland Basin)
  - 1968-2008
  - 8 Billion barrels of oil
  - Landed at Sullom Voe

Case Study: Shetland Islands

- Energy Resources
  - Renewable Energy (Wind)
  - 2000-Present
  - Burradale Wind Farm
    - 3.68MW
    - World Record Capacity Factor (57.9 in 2005)
  - Viking Wind Farm (PLANNED)
    - 370MW

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Case Study: Shetland Islands

- Energy Resources
  - Renewable Energy (Tidal)
  - 2014-Present
  - Nova Innovation 30
    - 30kW
    - World's First Community Tidal
  - Shetland Tidal Array (CONSTRUCTION)
    - 100kW

Case Study: Shetland Islands

- 1MW Battery Project, Shetland
  - Primary Objective
    - Add Energy Storage to Reduce Peak Demand at Lerwick Power Station
  - Secondary Objectives
    - Renewable generation constraint avoidance
    - Reduction of power station fossil fuel consumption
    - Stability control
    - Provision of ancillary services

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Case Study: Shetland Islands

- Project Technical Approach
  - Battery Plant

Battery System Configuration	
Batteries per Rack	24
Racks per String	11
Cells per String	264
Nominal Voltage	528VDC
Parallel Strings	12
Total cell count	3168
System Power	$1MW_{AC}$
System Energy	3MWh

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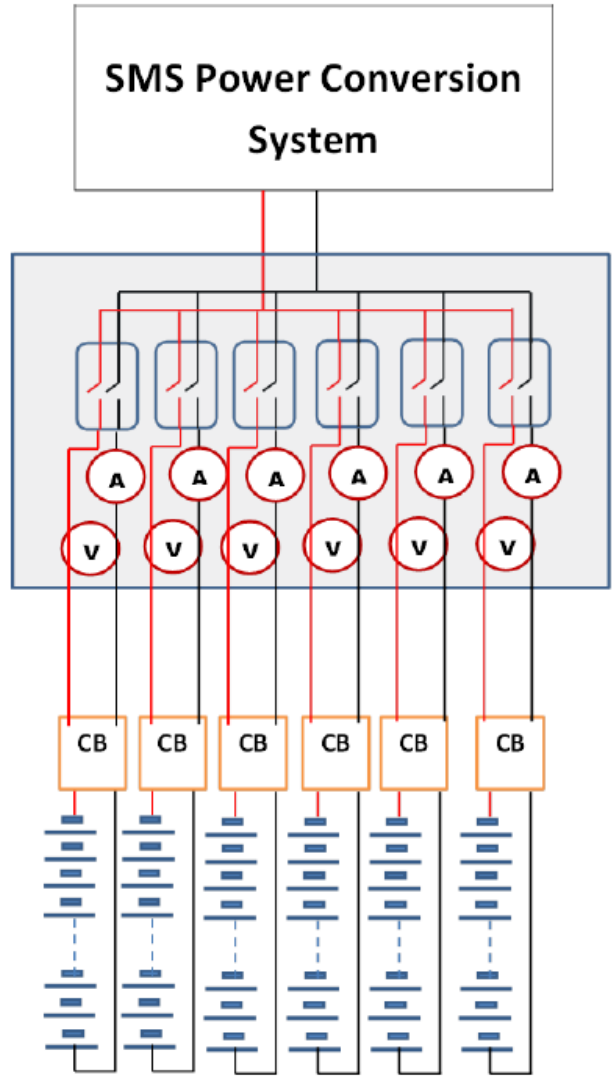
Case Study: Shetland Islands

- Project Technical Approach
  - Power Conversion

Power Infrastructure Data	
Transformer Room	11kV grid connection
Power Conversion Room	2x 500kW AC-DC converters
Battery Room	1MW/3MWh VRLA storage
Store Room	Fire suppression and spares



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Case Study: Shetland Islands

- Project Technical Approach
  - Monitoring and Control Systems

Control Systems
SCADA
Active Network Management Platform
Battery and Power Conversion System Controller
Local Interface Controller
Battery Management Monitoring and Management System

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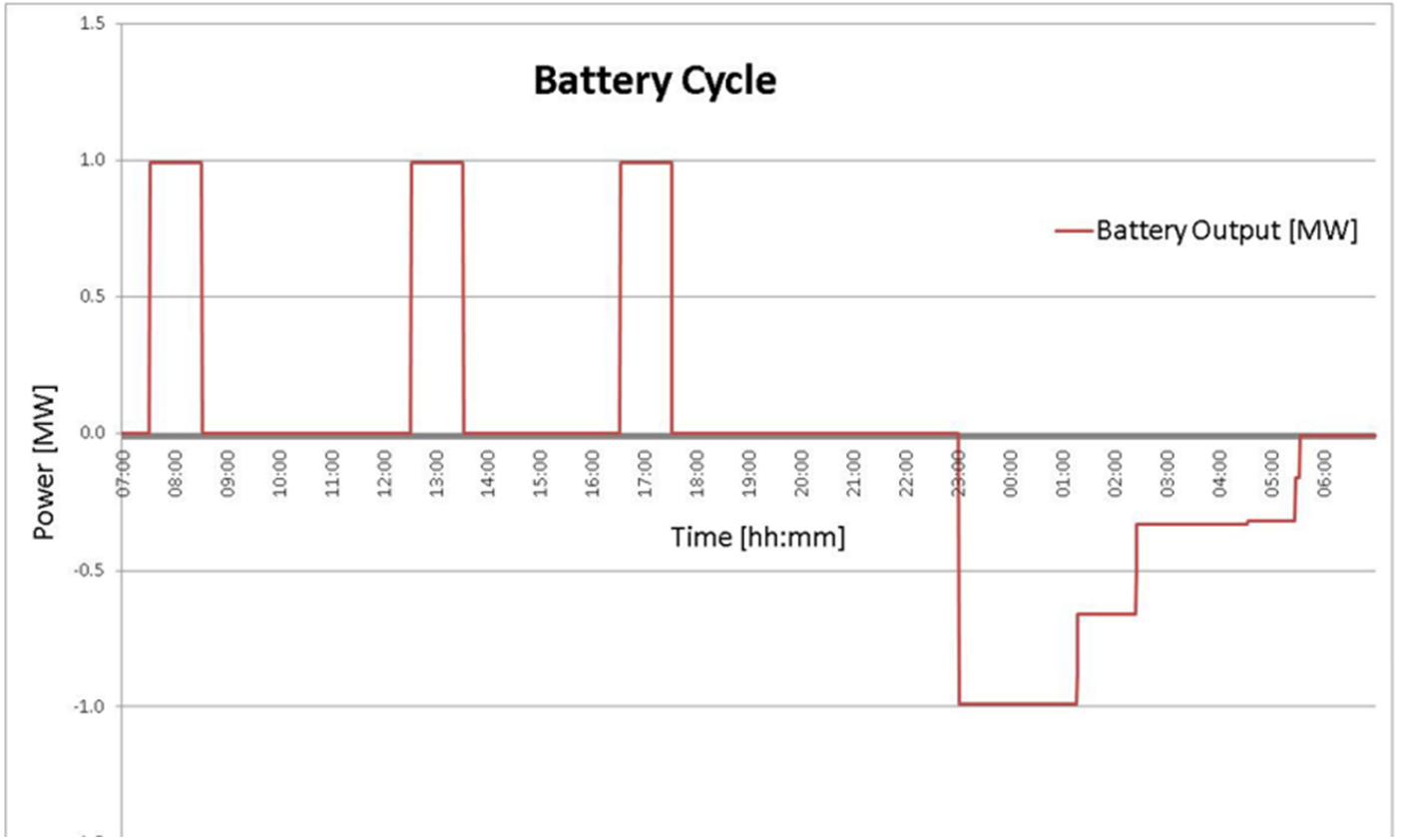
Case Study: Shetland Islands

- Battery Charging/Discharging
  - 3 discharge cycles/day
  - Corresponding to shifts
  - Charging off peak via renewables



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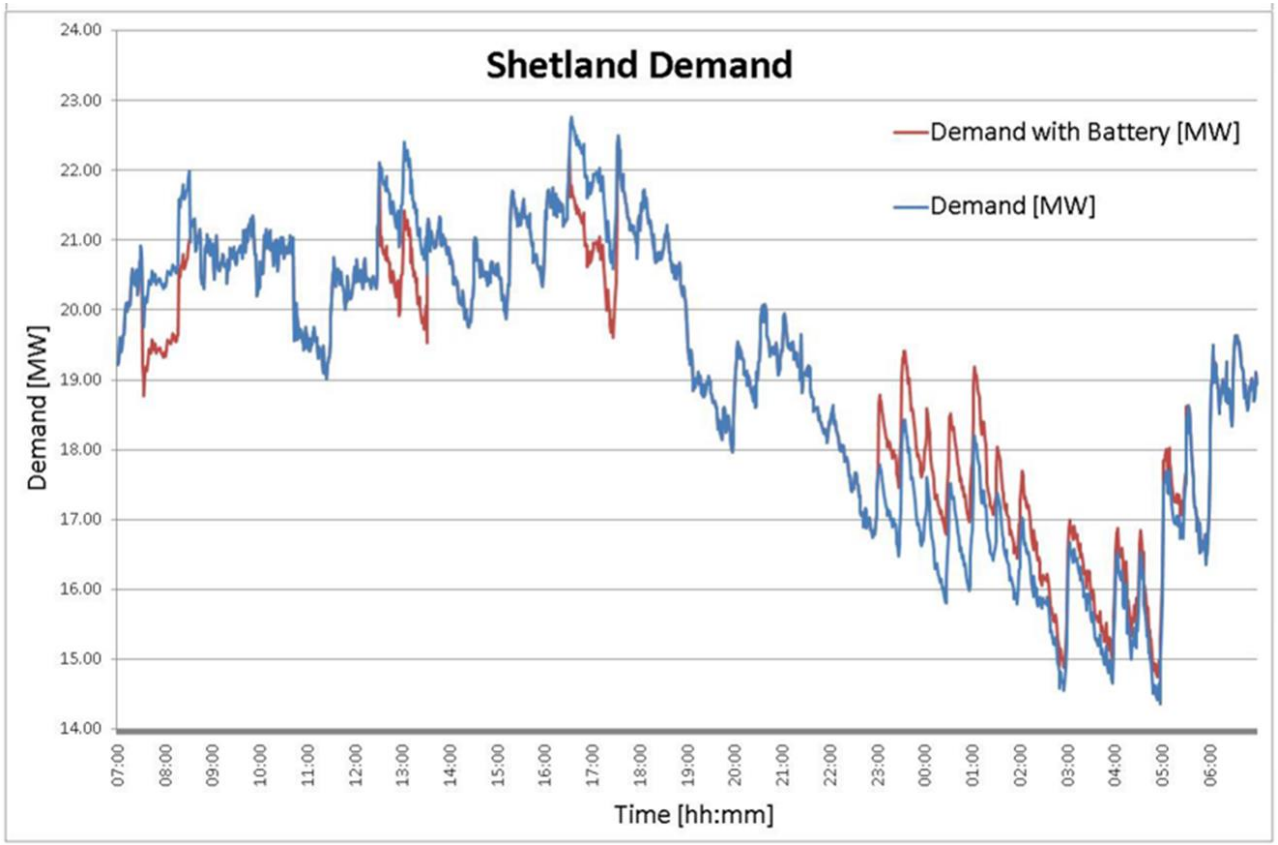
Case Study: Shetland Islands

- Peak Demand Reduction
  - Elimination of generator starts
  - Reduction in diesel fuel consumption
  - Elimination of maintenance costs
  - Increased utilization on renewables



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Case Study: Shetland Islands

- Outcomes
  - Project reduced peak demands
  - Project reduced OpEx and delayed CapEx
  - Reduction in fossil fuel emissions
  - Project facilitated the integration of increased renewables
  - Reduction in diesel fuel consumption
  - Elimination of maintenance costs
  - Increased utilization of renewables

Case Study: Bonne Fin, Haiti

- Energy Resources
  - Unreliable Grid
  - Small Scale Hydro
    (Rainy Season Only)
  - Diesel Generators
  - Renewable (PV)

Case Study: Bonne Fin, Haiti

- 192 kWh Battery Project Haiti
  - Primary Objective
    - Improve site power quality and resiliency
  - Secondary Objectives
    - Renewable integration
    - Reduction of fossil fuel consumption
    - Extend hours of operation
    - Reduce OpEx related to energy

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Case Study: Bonne Fin, Haiti

- Project Technical Approach
  - Battery Plant

Battery System Configuration	
Batteries per Rack	24
Racks per String	1
Cells per String	24
Nominal Voltage	48VDC
Parallel Strings	4
Total cell count	96
System Power	500kW
System Energy	192kWh

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Case Study: Bonne Fin, Haiti

- Outcomes
  - Improved Power Quality
  - Improved Quality of Patient Care and Medical Capability
  - Project reduced OpEx and delayed CapEx
  - Reduction in fossil fuel emissions
  - Project facilitated the integration of increased renewables
  - Reduction in diesel fuel consumption
  - Elimination of maintenance costs
  - Increased utilization of renewables

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Case Study: Kapawi Lodge, Ecuador

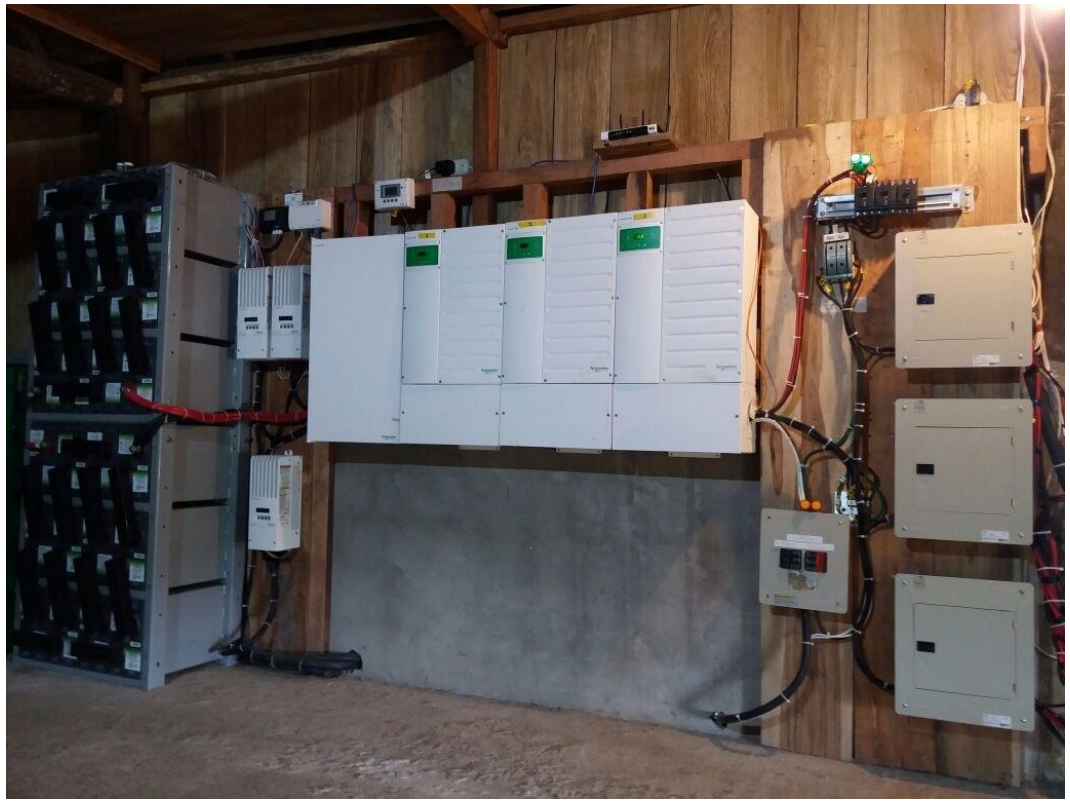
- Energy Resources
  - Diesel Generators
  - Renewable (PV)

Case Study: Kapawi Lodge, Ecuador

- 48 kWh Project Ecuador
  - Primary Objective
    - Reduction of fossil fuel consumption
  - Secondary Objectives
    - Renewable integration
    - Improve site power quality and resiliency

Case Study: Kapawi Lodge, Ecuador

- Project Technical Approach
  - Battery Plant



Case Study: Kapawi Lodge, Ecuador

- Outcomes
  - Improved Power Quality
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  - Project facilitated the integration of increased renewables
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  - Elimination of maintenance costs
  - Increased utilization of renewables

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Summary

- Microgrid Objectives
  - Each project achieve multiple objectives. Create a “value stack”
  - Any Scale

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Questions