DER Portfolio Optimization and Dispatch, Tertiary Control/Monitoring Strategies

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Three Pillars of a Microgrid System

Mixed Generation Assets

- Wind, Solar, other RES
- GT, ST, CHP, Fuel Cell, Diesel Gen-sets
- Battery, UPS, Other ESS

Microgrid Loads

- Critical vs. Non-Critical
- Controllable vs. Non-Controllable
- Sheddable vs. Non-Sheddable

Modes of Operations

- Grid-Connected vs. Off-Grid
- Black start
- Re-synchronization to the Grid

Microgrid Control Hierarchy

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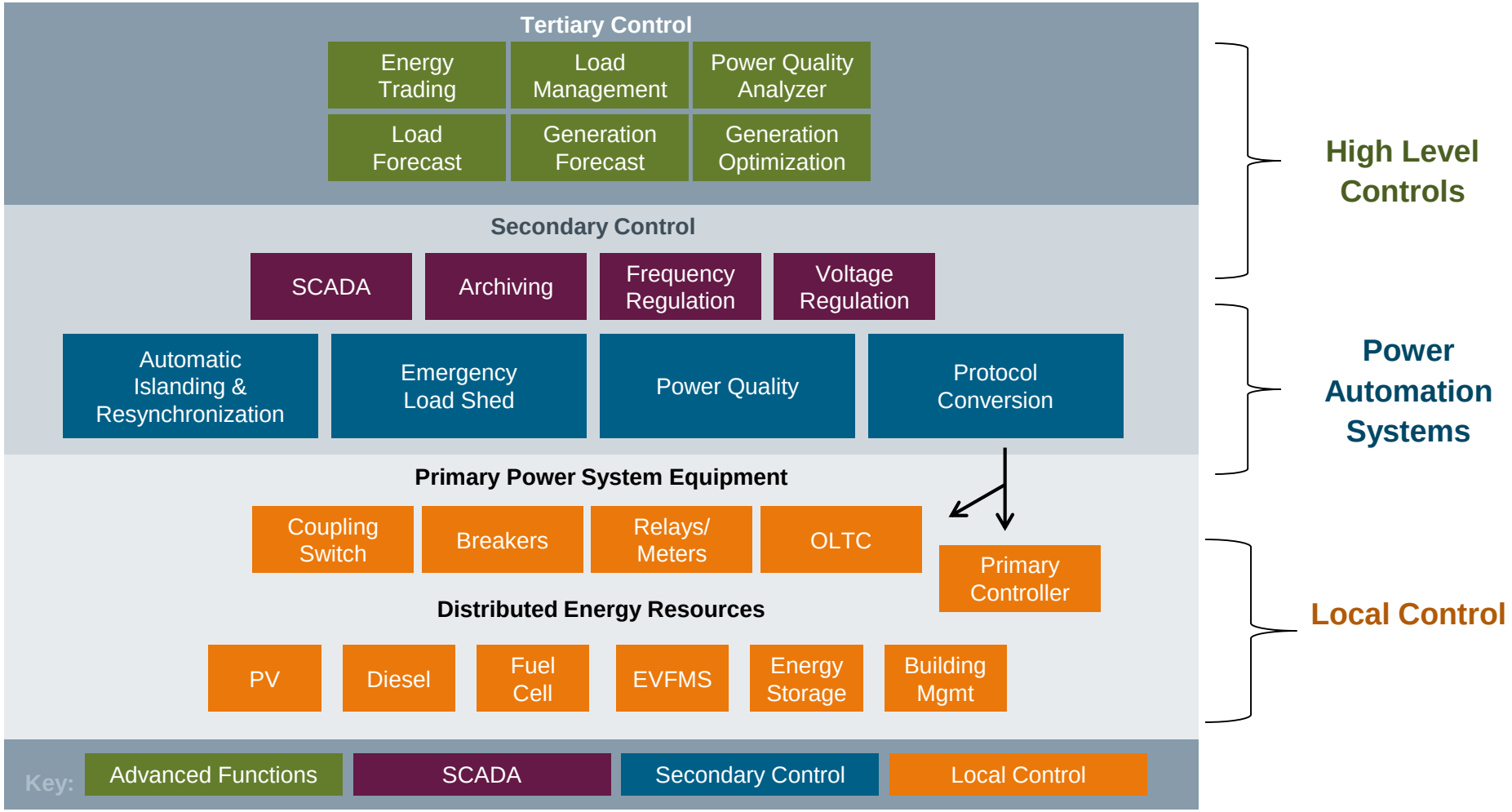

Why Tertiary Control?

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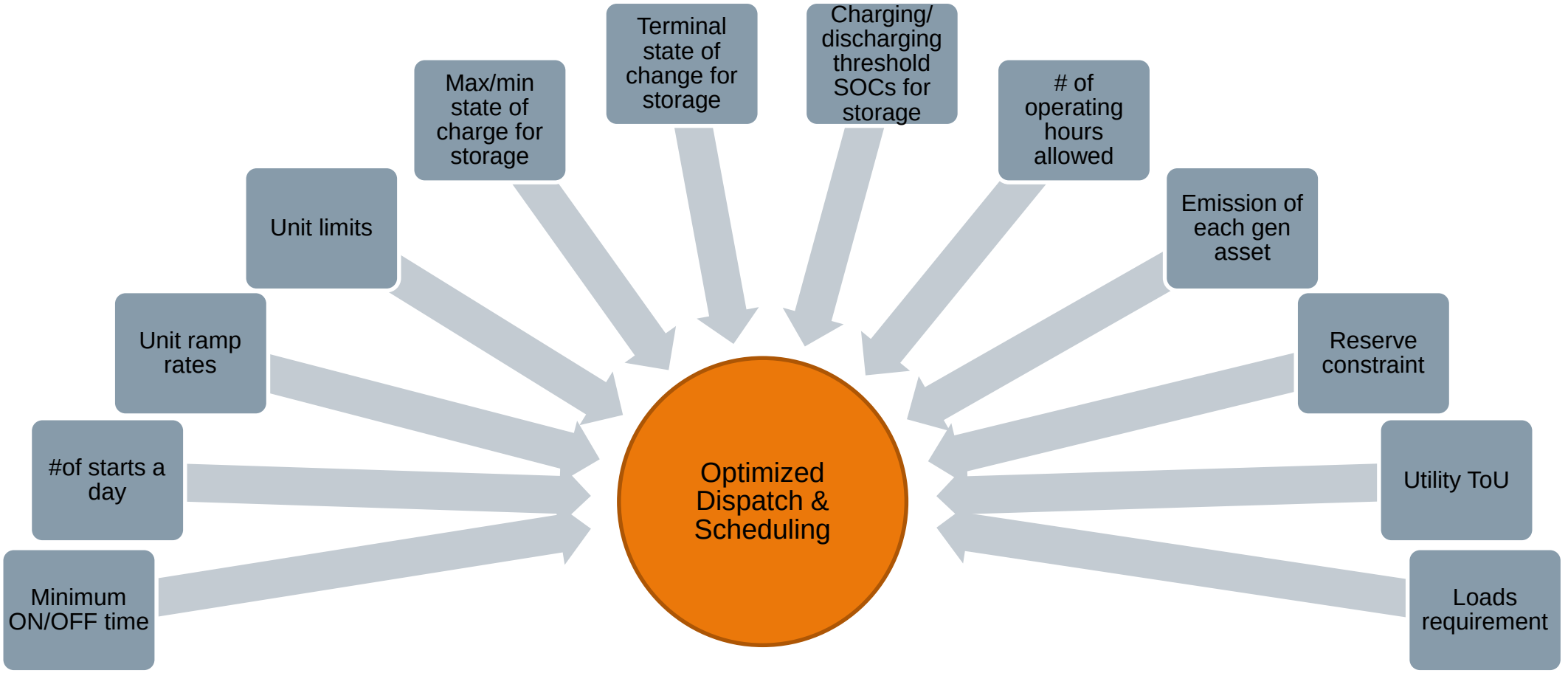
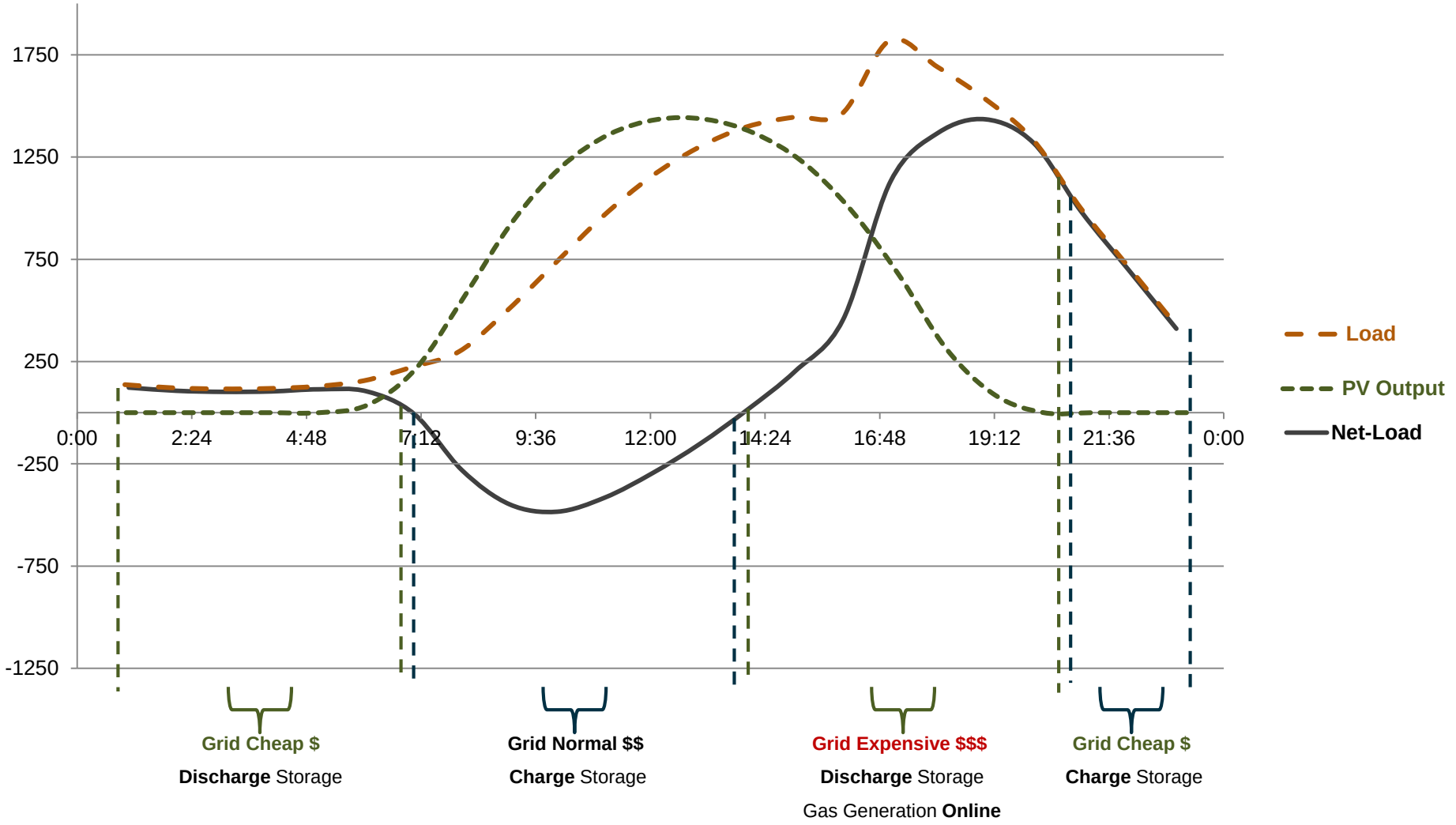
Tertiary Control Functions (What, When, Why, How) -

- Complement microgrid design
- Achieve higher level business objectives
- Present an abstract view of microgrid to higher hierarchy
- Enable coordination with transmission and distribution grid
- Help realize business value of the microgrid
- Reconcile business and physics
- Connect the dots
- Complete the big picture

Constraints to be Considered for Optimization



Day-ahead Forecast and Scheduling based on Optimization



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DER Portfolio Optimization – Blue Lake Rancheria Microgrid

BLR Microgrid Intro Video

Project Partner:

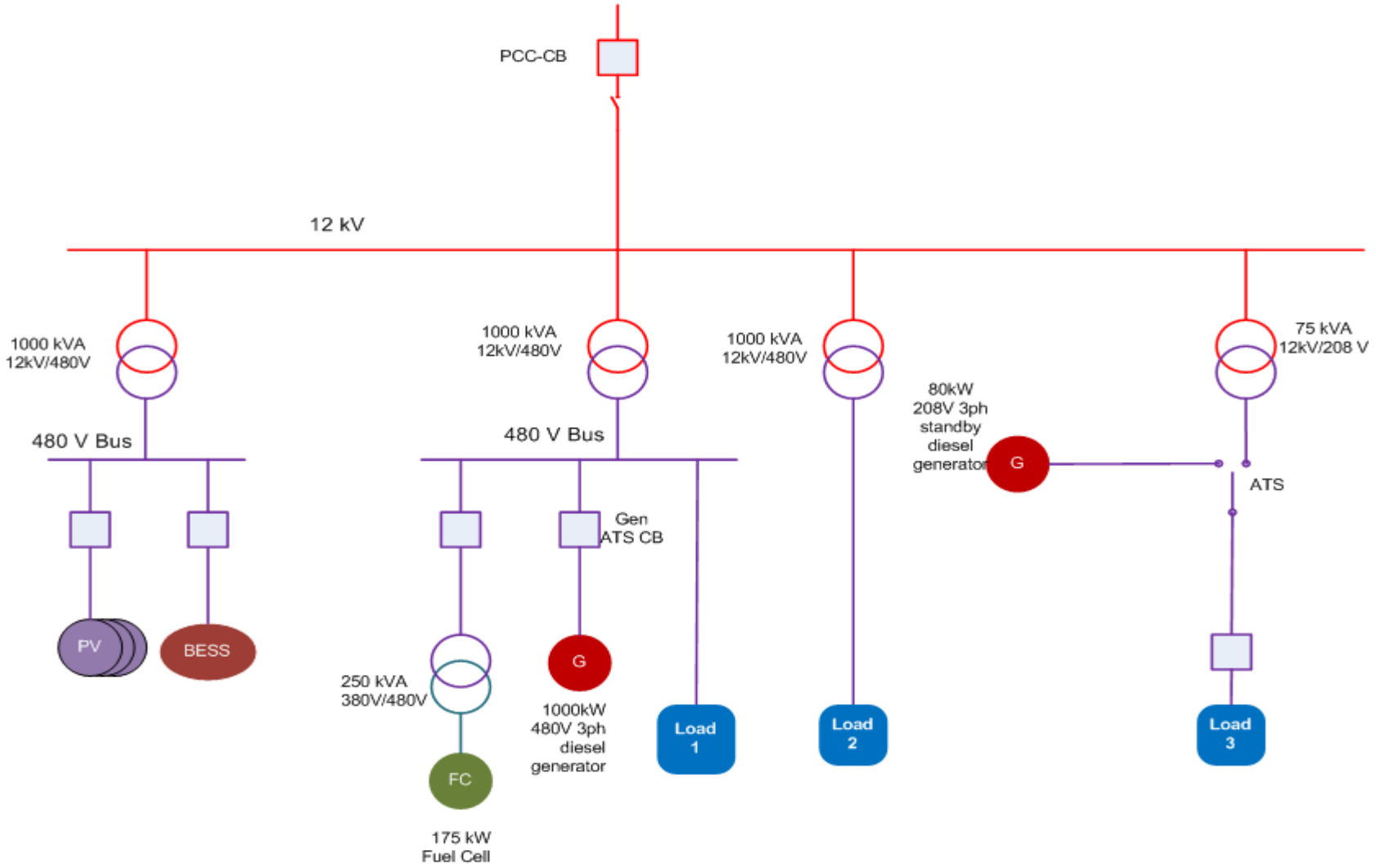
PG&E, Idaho National Lab, Tesla, REC solar, Humboldt University Schatz Energy Research Center, California Energy Commission

http://www.pgecorp.com/corp_responsibility/reports/2016/videos.jsp

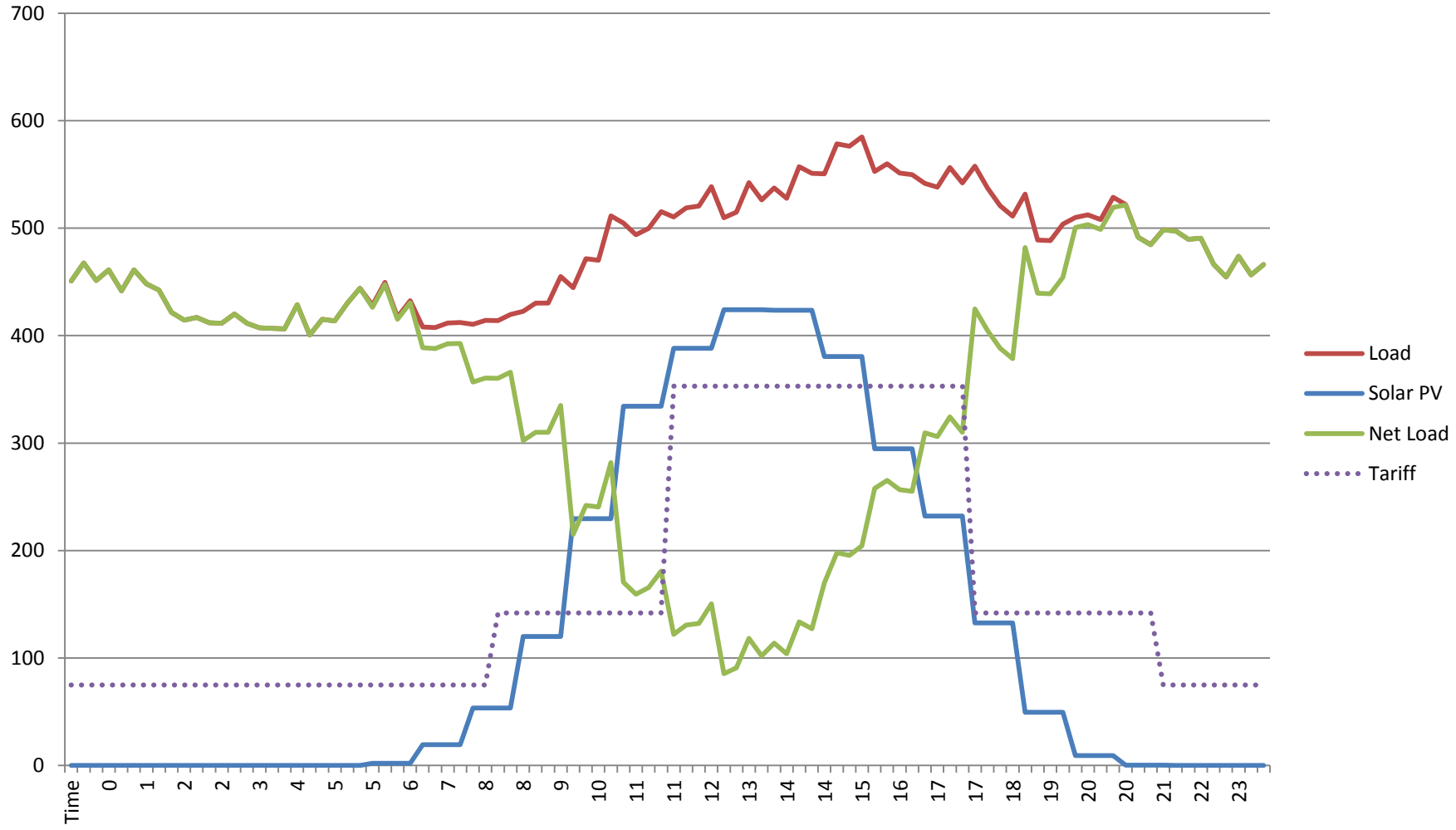
BLR Microgrid Assets

- Backup Diesel Generator – 1000 kW
- Biomass Fuel Cell: 175 kW
- Solar PV: 430 kW peak
- Battery Energy Storage: 500 kW/1000 kWh
- Generator ATS
- Point of Interconnection circuit breaker
- Four controllable load groups
- Uninterruptible Power Supplies
- Office backup generator

Microgrid Schematic



Microgrid Load Profile



Objectives of Normal Operation

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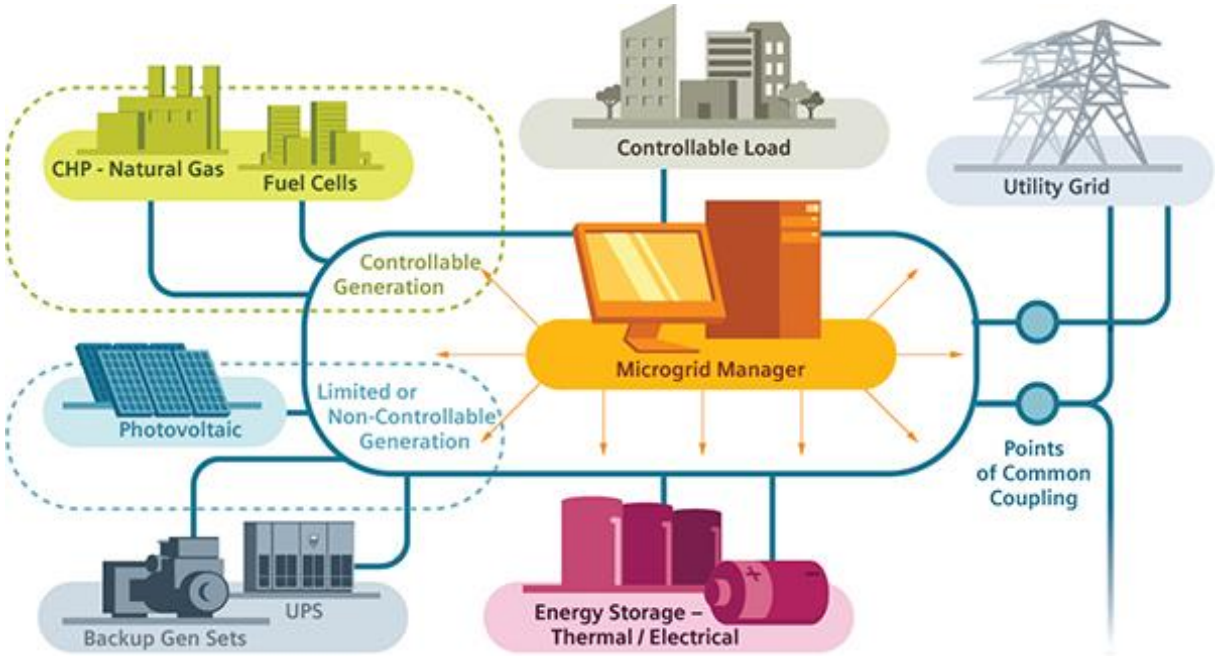
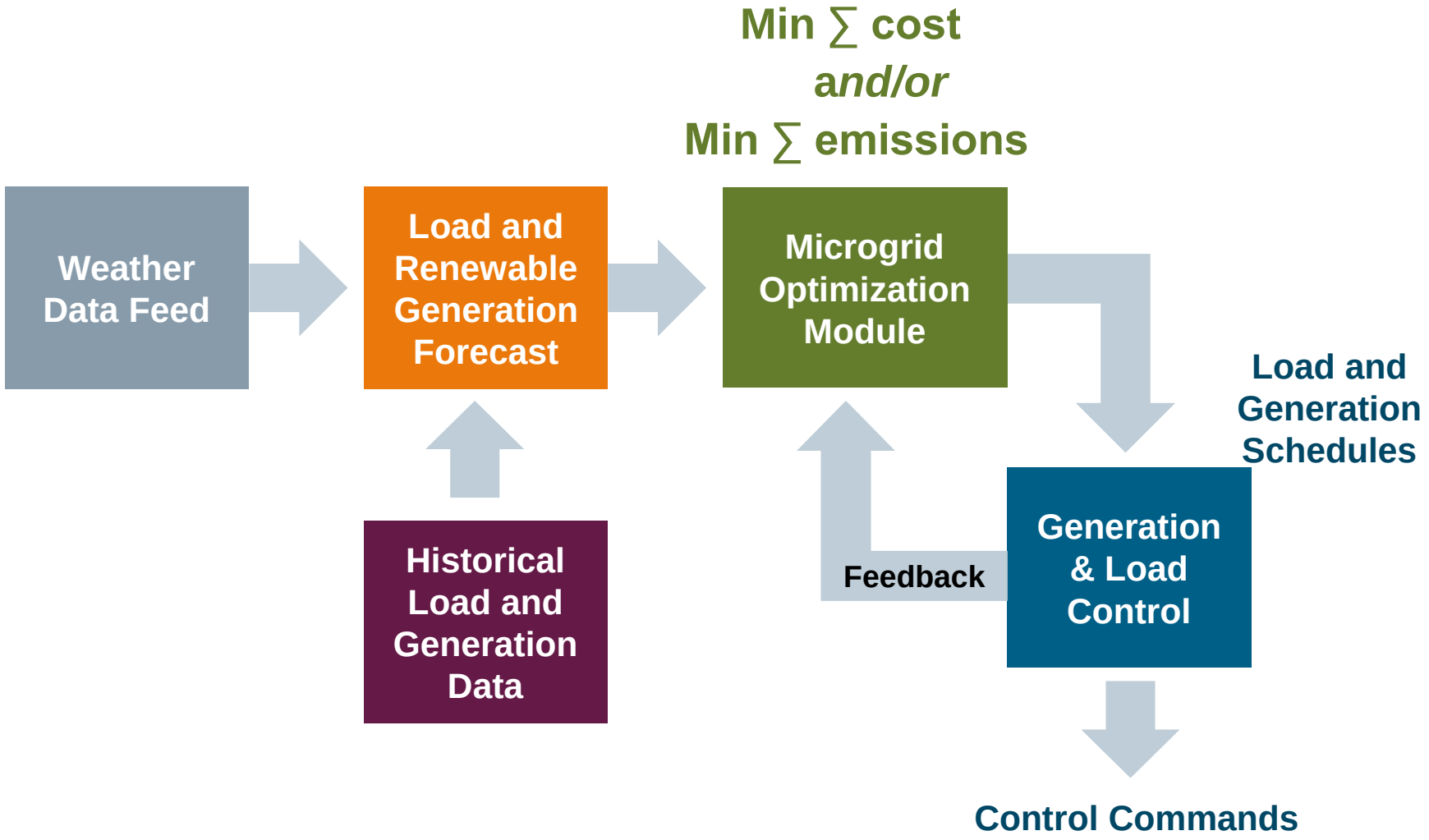
Maximize Economics & Efficiency

- Minimize Energy Consumption Charges
- Minimize Peak Demand Charges
- Introduce Additional Revenue Stream by participating in Demand Response



Workflow of Normal Operation



Demand Response Programs

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Base Interruptible Program

- 30 min notice
- 4 hrs/event, 1 event/day, 10 events/month, 180 hrs/year, any day
- Incentive: $8/kW/Month {$0.20 to $0.80 /kWh}
- Penalty: $6 to $8.40 /kWh for shortfall
- Compulsory once enrolled
- Self participation

Demand Response Programs (continued..)

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Demand Bidding Program

- Minimum reduction of 10kW for 2 consecutive hours
- Day ahead notification
- Submit day ahead load reduction bid for each hour
- 6am to 10 pm; 1 event/day; 4rs – 8hrs; Weekdays
- Incentive: $0.50/kWh capped to 150% of reduction bid
- No penalty

Objectives of Islanded Operation

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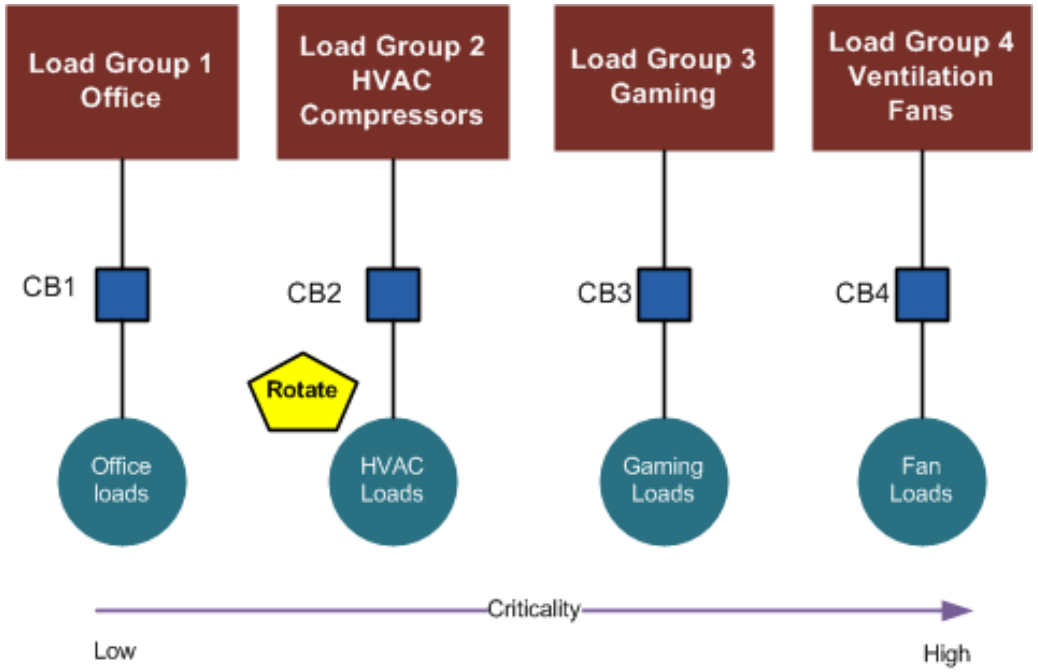
System stability while using renewable generation

- Maintain microgrid stability and power quality
- Renewable energy smoothing
- Manage nuisance outages with BESS
- Minimize use of Diesel Generator
- Maximize use of renewable energy
- Maximize fuel conservation during natural disaster event
- Minimize cost of energy while maintain system stability

Load Management

- Load shed allowed in islanded mode
- Load shed allowed in emergency situation
- One load group allows preconfigured rotation
- Same load group provides soft start during black start
- Ventilation fans are most critical to maintain user comfort level



Microgrid Operation - Islanding

- Planned
  - Non critical loads, if any, are shed
  - Generation including grid forming generation is started and ramped up to balance the load in microgrid
  - Open PCC breaker
  - PCC breaker relay communicates breaker status to the grid forming generation controller
  - Grid forming generation controller switches to F, V mode
- Unplanned (scenario 1)
  - Microgrid blacks out
  - Black start sequence is started to restore microgrid in islanded mode
- Unplanned (scenario 2)
  - Fast load shed trips breakers of non critical loads (< 50 mSec)
  - Energy storage switches to F, V mode (< 50 mSec)
  - Generation is started and islanded mode operation restored

Black Start Features

- Intelligent selection of energy storage or conventional generation, or both for black start
- Smart load restoration with soft start of HVAC loads
- Smooth transition from energy storage to conventional generation (or vice versa) when needed

Seamless Grid Resynchronization

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- Comply with utility requirement not to parallel diesel generation with grid
- Handover from diesel generator to energy storage for seamless resynchronization
- Intelligent use load shed during seamless transfer

“Do More with Less!” with Tertiary Control

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- ✓ Maximize economic benefit through operational optimization
- ✓ Minimize fossil fuel use during grid outages
- ✓ Maximize renewable generation use in islanded operation
- ✓ Maximize asset utilization
  - Increase economic efficiency beyond deployment of renewable energy sources
  - Perform black start with relatively modest energy storage in comparison to load
  - Greater demand flexibility
  - Faster demand response through distribution utility or market interface

Siemens Commitment

Challenge

- Optimize campus energy costs through the lowest cost generation mix
- Achieve campus-level energy efficiency leveraging existing building automation
- Enable advanced Microgrid functionality such as islanding from the grid, and ancillary programs such as demand response

Proposed Solution

- Siemens Spectrum Power Microgrid Management System (MGMS) will be installed to integrate, control and optimize 4 MW cogen, 10 kw solar, battery, Electric Vehicles, utility metered electricity, and more
    - MGMS enables use of the most cost efficient energy mix creating savings for the end customer
    - Islanding mode including load shedding and management
    - Interface with Siemens' Building Automation system enabling BAS optimization in Microgrid controller decisions
    - Integration and optimization of renewables
    - Enable student research and learning

Benefits

- Provides resilience through black start capability
- Enables potential savings of $200k* per year for 20 years (microgrid energy center)

*Note: Based on Siemens value estimation tool

Project Profile

- Algonquin College, Ottawa, Ontario, Canada
- Educational Institution
- Peak demand: 4,656 kW

ALGONQUIN COLLEGE

Thank You!

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