Solar + Storage: From Concept to Implementation

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MIPSYCON

CONNEXUS®
Your Community Energy Partner
Connexus Energy

Anoka County Project

Athens Project
Outline

- Project Overview
- Use Case
- Siting
- Interconnection Configuration
- Operational Rules
- Interconnection Study
- Operation
Project Overview – Solar + Storage

- **10 MW of Solar**
  - 2 sites
  - ~60 acres of land

- **15 MW of Storage for Demand Response**
  - 30 MWh (15 MW for 2 hours)
  - Lithium-ion Technology
Connexus Energy Use Case

at MW Scale
on distribution grid
demand response design
Solar + Storage Value Propositions

1. Improve renewable economics
2. Reduce peak demand
3. Support state energy policies
4. Green the grid without increasing rates
5. Create pollinator habitat
6. Grid modernization
7. Enhance grid resiliency and event response
8. Defer distribution investment
Site Identification Considerations

- **Interconnection quantification**
  - MW of solar
  - MW of storage
  - Costs
- **Land costs ($/acre)**
- **Zoning/Permitting**
  - Permitting requirements vary from pro-solar to specifically prohibiting community solar
Challenge
No ordinances allowing utility-scale solar

No ordinance = No permit

Potential Solutions
1. Proactive interaction with communities to create ordinances
2. Educate - setback requirements, screening and decommissioning assurances
3. Understand property value impact
Deal Structure

- **Pay as You Go**

- **Solar – Power Purchase Agreement**
  - 25-year term
  - Only pay for the energy received

- **Storage – Storage Service Agreement**
  - 25-year term
  - Only pay for the service received
Ramsey Site – 3.4 MW Solar & 6 MW Storage
Athens Site – 6.6 MW Solar & 9.0 MW Storage

- Feeder IST02
- Connexus existing OH line
- DER Interconnection tap points
- Feeder CPC03
Interconnection – Basic 1-line

PV Array

Inverter

Step up Transformers– 600 VAC/12.5 KV

AC Disconnect

PV Recloser

Point of Interconnection (POI)

Interconnection Master Switch (padmount recloser)

Interconnection Feeder Tie (PMH or OH Disconnect)

Delivery Meter

Solar – Storage Direct Coupling Point

ES Array

Inverter

ES Meter

ES Recloser

AC Disconnect

Ownership

ES
PV
Interconnection Provider

Interconnection Meter M1

Distribution System Interconnecting Feeder

Concept for equipment label & ownership

PV ES One-Line Diagram
15 MW Storage....developed by NextEra

**Ramsey Site**
- 6 MW / 12 MWh
- 1,260 batteries – Lishen
- Lithium Iron Phosphate
- 54 string inverters
- 0.5 acres
- 2,697 homes (equivalent demand)

**Athens Site**
- 9 MW / 18 MWh
- 1,890 batteries – Lishen
- Lithium Iron Phosphate
- 81 string inverters
- 0.7 acres
- 4,045 homes (equivalent demand)
Battery Storage System

Each Enclosure

- 1 MW / 2 MWh
- 210 batteries – Lishen
- Lithium Iron Phosphate
- 9 string inverters
- 450 homes (equivalent demand)
Solar string inverters: 
125 kW each

Athens Site
- 40 acres
- 27,189 modules
- 56 Inverters

Ramsey Site
- 16 acres
- 13,851 modules
- 27 inverters
Operational Requirements

- Solar – continual operations when irradiance available
- All stored energy must come from solar
- Batteries maintained at 50% SoC at rest
- SoC > 50% < 24 hours
- Maximum no. charge/discharge 75 cycles / yr
- Battery operation schedule day in advance via SCADA
- No reverse power into transmission system
Interconnection Study

- Capacity
- Protection / Sectionalizing
- Voltage Excursions
- Harmonics

Internal Study – Windmil

Independent by Consultant - Synergy

Validate Process & Results
Retain Knowledge

Flicker – variation in output
Steady State – full output
Voltage Control - VAR Compensation

Power Flow:
- 24 MW
- 16 MW

Substation:
- 126
- 124.5
- 123.2

Voltage Control - VAR Compensation:
- 127.5
- 125
- 118

PV
- 2.0 MW
- 3.4 MW

ES
- 6.0 MW
- 6.0 MW

95% Power Factor, Leading 1.97 MVAR
Virtual Microgrid

- PV Array
- Inverter
- Delivery Meter
- Interconnection Meter
- ES Array
- Inverter
- ES Meter

Point of Interconnection (POI)

Ownership:
- ES
- PV
- Interconnection Provider

Very smart inverter controller

Charging power from PV

PV ES One-Line Diagram
Concept for equipment label & ownership

Distribution System Interconnecting Feeder
Control Center SCADA Screen
Clean operation (June 6)
- Solar
- Storage charge/discharge
Recharge & discharge (June 7)
Recharge to 50% (June 8)
Operational Success & Challenges...

✓ Virtual Microgrid battery charging
✓ Solar generation
✓ Reverse power curtailment (both solar & storage)
✓ Voltage control
✓ “day of” scheduling changing (recent enhancement)

- Battery controls – “balancing”
- Communications systems
- Inverter controls
- Learning control center protocol
- Mega snow – February 2019
It takes a team...

Engineering
- System study
- Equipment/Materials
- Design

SCADA
- DER monitor/control
- Grid monitor/control

Core
- Legal & Contracts
- Land / Governmental
- Power Supplier
- Interconnection – Plan, PM, Operations

IT/Communications
- Site LAN
- WAN (microwave)
- Security

C&M
- Construction

“DSO”
- Operations
- DR coordination

Executive / Corporate Sponsor

Solar Developer

Storage Developer

Metering

Solar Developer

Core

IT/Communications

Executive / Corporate Sponsor

Engineerings

SCADA

C&M

“DSO”