Renewable and Resilient Microgrids

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Life Is On Schneider Electric


The New Energy Landscape
for California Communities
The necessity,
opportunity and
capability is now here
Life Is On
Schneider
Electric

While serious challenges are driving us today… they can also accelerate us towards sustainable, resilient and cost effective solutions

Centralized Generation

Transmission & Distribution

End-Use Consumption

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Each city has a unique path towards that energy future….and distributed energy resources will be a huge part of that transition

Centralized Generation

Transmission & Distribution

End-use Consumption

Distributed Energy Resources and Prosumers

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What are those key facilities and services in your city?

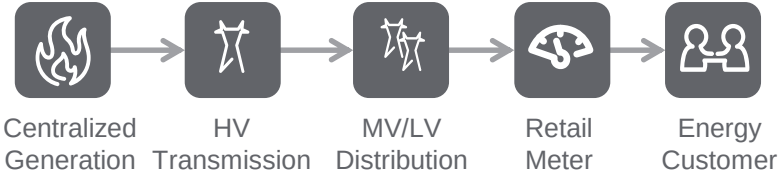
- City Hall
- Police, Jail, Fire, EMS Facilities
- County Healthcare MOB Facilities/Departments/Hospitals
- Surface water treatment or wells
- Wastewater treatment and Stations
- Water Treatment Plants and Stations
- Traffic Signalization
- Senior Care or Youth Facilities
- Schools
- Essential Retailers (Fuel/Food/Pharmacy)
- Essential Logistics and Operations

Distributed Energy Resources and Prosumers

Energy Megatrends – 3D+E has set the stage

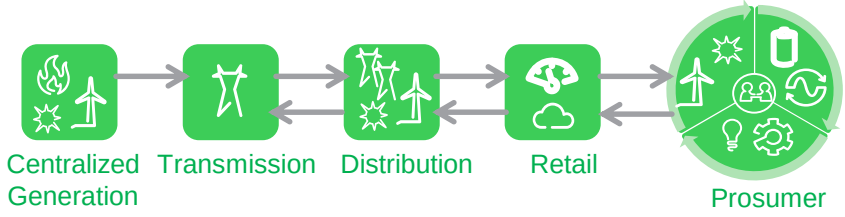
Decarbonization | **Digitization** | **Decentralization** | **+ More Energy**

Historical Energy Value Chain



- Consumers responsible for their own MV/LV Traditional Power Distribution Assets and Operations “behind the meter” implement significant EE Measures
- Consumers have traditional backup power generation of many varied capabilities, but all have limitations, both operational and environmental
- Beyond EE, Increasing Local, Sustainable and Efficient Self-Generation + Grid-Interactive Microgrids is the road ahead.

The New Energy Landscape



- Utilities interconnect energy “Prosumers” (Producers and Consumers) at all levels of the grid
- Larger Prosumers and Municipalities leverage new business and partnership models to manage their own energy future. Energy-as-a-Service, Enhanced PPAs, Energy Services Agreements, Consumer Choice Aggregators
- Reduction in costs for Distributed Energy Resource technology, combined with evolved business models, enable cities to support their goals for economic development, emergency preparedness, and service continuity

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What is a Microgrid?

On-site renewables, energy storage and power generation facilities utilized in parallel with grid

Grid-Tied
Grid-Parallel
Grid-Connected

Microgrid will generate energy from local sources in the case of a grid outage OR power quality episode

Islanded
Grid-Islanded

Microgrid will generate energy from local source with no connection to grid

Off-grid

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Microgrids can operate at any scale

Buildings, Industrial, Campus and City Scale

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City Facilities has varying degrees of supply and demand flexibility and needs

The more flexibility the better their site optimization potential

Prosumer 1

Lights and Motors

Grid and Solar

Prosumer 2

Lights and EV Charging

Grid, Solar and Storage

Prosumer 3

Lights and EV Charging, HVAC and Cold Chain

Grid, CHP, Solar and Storage

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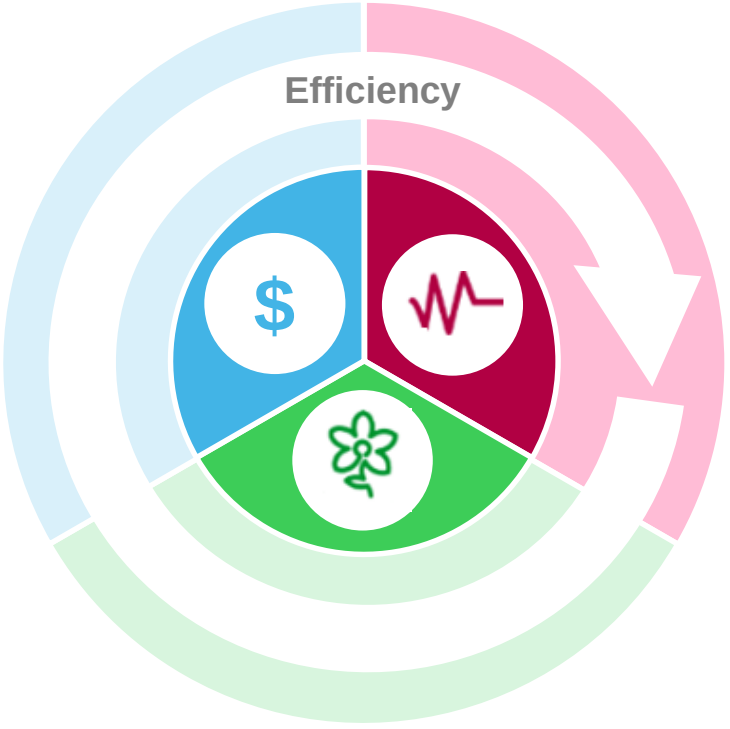
Create the desired integrated Energy Outcome

Historically Passive Consumers are Thinking About Energy in a New Way



Cost

- Lower / More Predictable Energy Costs
- Energy / Fuel Source Arbitrage
- Flexibility drives savings / incremental revenue

Resilience

- Serve loads during times of grid instability
- Oasis for employees / customers – shelter in place
- Protect power sensitive / critical assets from poor power quality

Sustainability

- Reduce carbon footprint
- Improve brand image
- Attract / Service carbon sensitive customers

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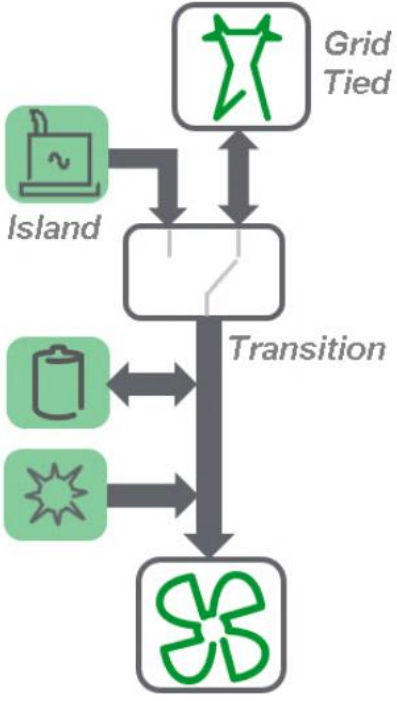
Microgrids: The Intersection of Systems and Energy Outcomes

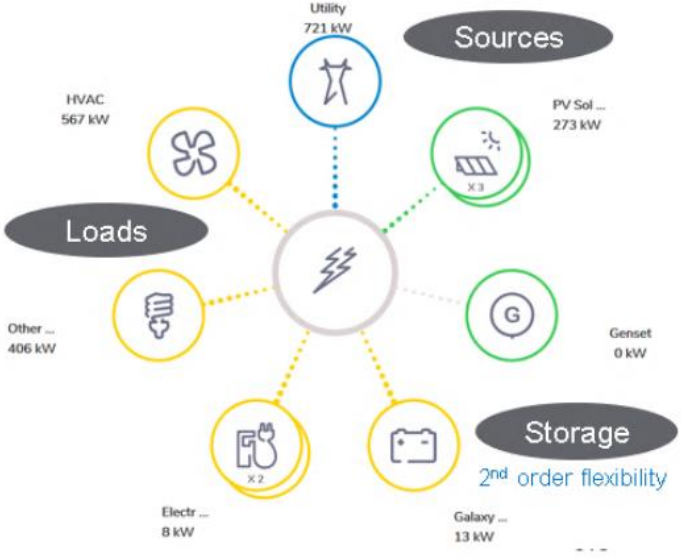
"Its about making wise choices at the intersection between energy smartly acquired, locally produced and efficiently consumed!"

The "Prosumer" Design
Integrated Energy Outcomes

Power System Automation
Operating Modes & Architecture



Energy Management
Flexibilities & Optimization



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Components of a Microgrid

- Energy Management Software: Manages Supply and Demand
- Microgrid Energy Control Centers
- Battery Energy Storage Systems
- Solar PV or Wind Energy
- Fuel Cells
- Generator or Co-Generator (CHP)
- Electric Vehicle Charging Infrastructure
- Utility Grid Connection
- Flexible Demand and Operations

- All distributed energy resources operate in parallel with one another and the grid, both grid-connected and grid-islanded
  - Economic Optimization
  - Resilience during emergency or planned outages
  - Stabilizes cost of energy

Remote Monitoring & Microgrid Controls

EcoStruxure Microgrid Advisor platform automatically optimizes the operation of distributed energy resources (DER).

Manufacturer(s):
Schneider Electric, Scale Microgrid Solutions, C-Power

1 Common Platform

Communication Protocol
Native Open ADR 2.0
Cyber Security Testing
NIKTO, DIRBUSTER, SQLMAP

Energy Control Center

Integrates DER into an intelligent, pre-engineered, and configurable power control center to easily optimize resources and maximize facility performance.

Manufacturer:
Schneider Electric

3 Configurable Modules

800/1200: Typically used with 25–250 kW DER's

1600/2500: Typically used with 100–750 kW DER's

Engineered to Order: Used with any size and type of DER's

Battery Energy Storage System

Modular, scalable architecture with best-in-class power conversion and battery technologies.

Manufacturer:
Schneider Electric

Chemistry:
Li Ion - NMC

4 Standard Modules

125 kW/250 kWh
250 kW/500 kWh
500 kW/1000 kWh
1000 kW/2000 kWh

Solar PV

We work with the best local solar installation professionals to design, engineer, and construct custom rooftop, carport, and ground-mount solar arrays to meet the needs of your facility.

Dispatchable Generator

Provides on-site power that can be adjusted to the output needed.

Manufacturer:
Mitsubishi

Fuel Options:
NG, RNG, Propane

7 Standard Modules

285 kW	1000 kW
380 kW	1200 kW
610 kW	
815 kW	

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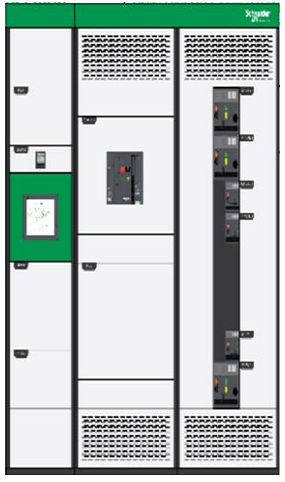
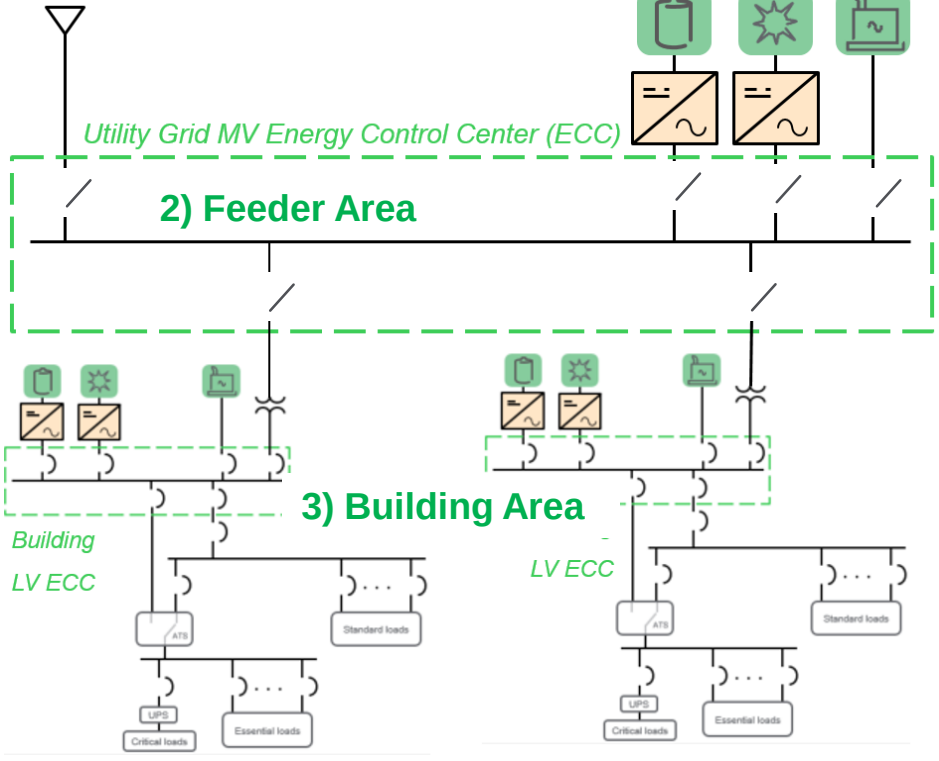
Three Levels of Microgrids

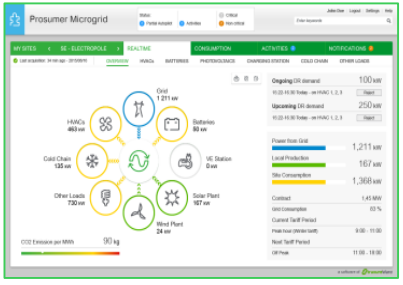
Complementary approaches enables flexibility and not a “one size fits all” concept

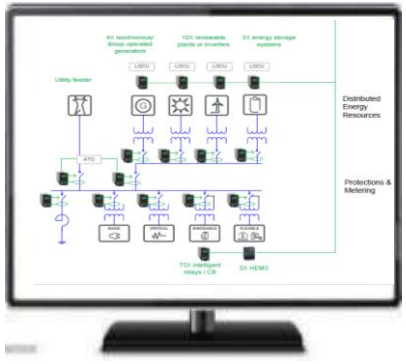
Microgrid Center





Energy Management





Power Management

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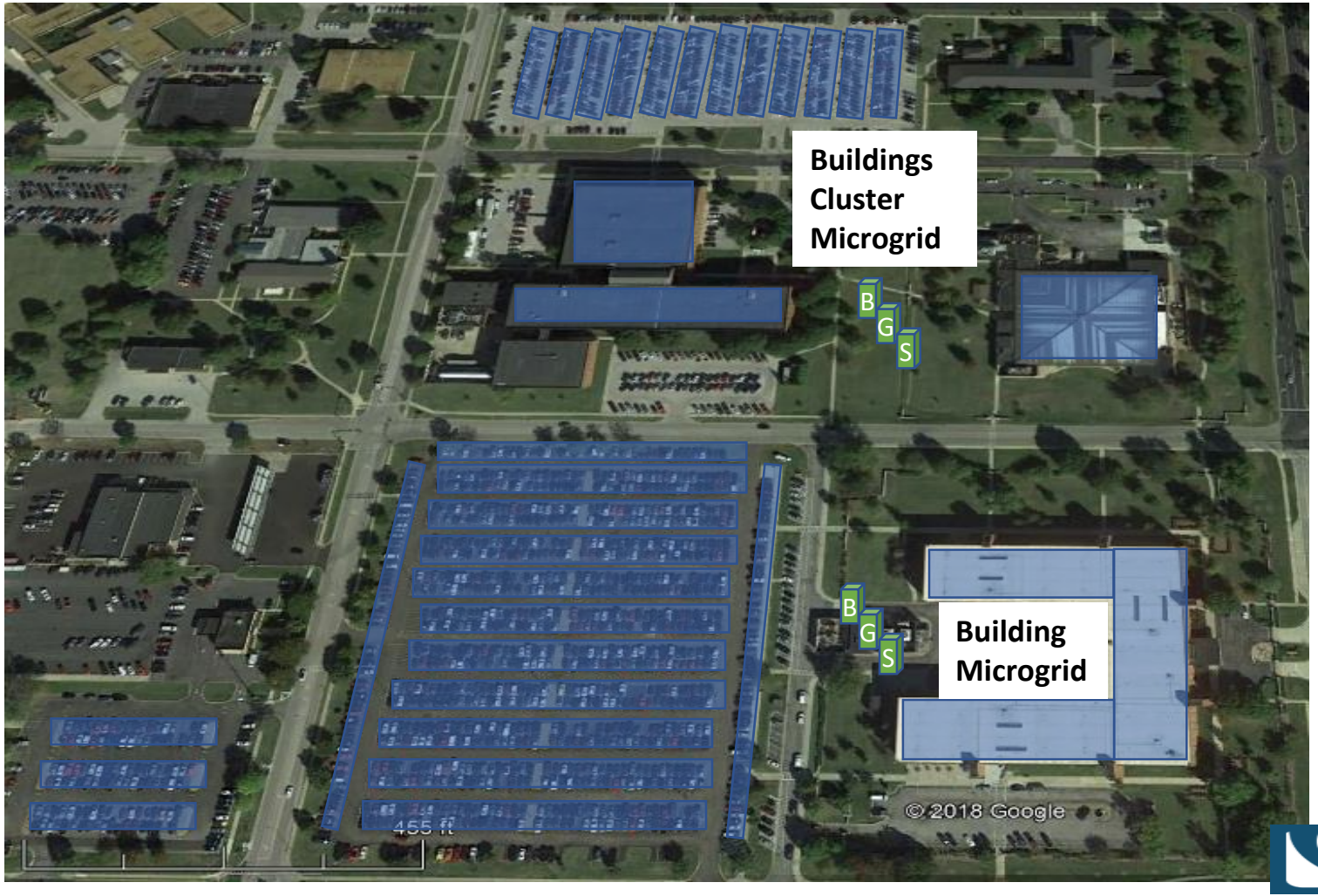

What are we talking about?

- B Battery Storage
- G Generator
- S Utility Switch
- Parking Structure and Rooftop Solar PV

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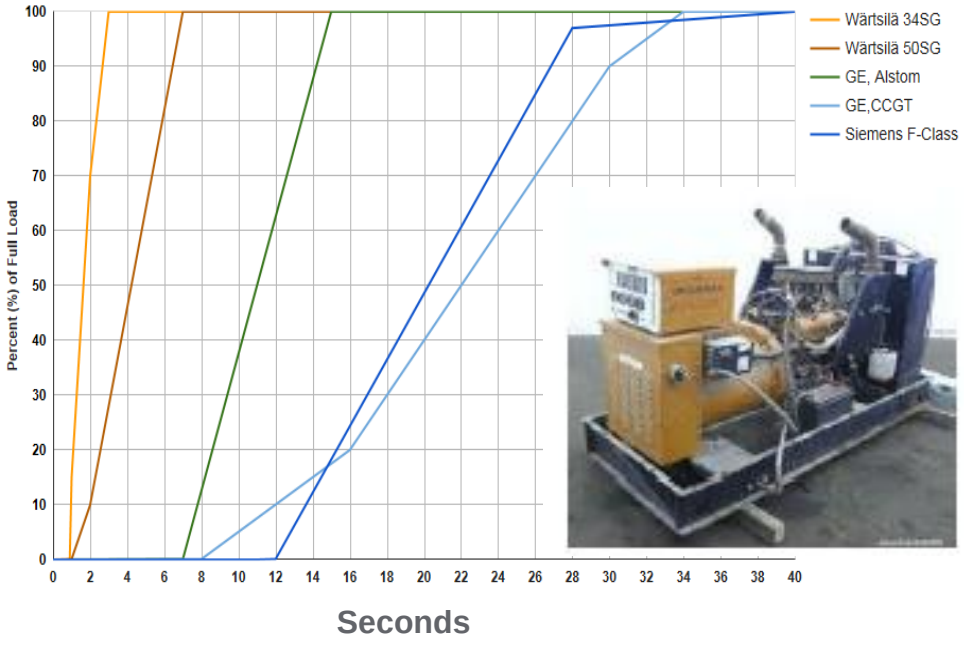
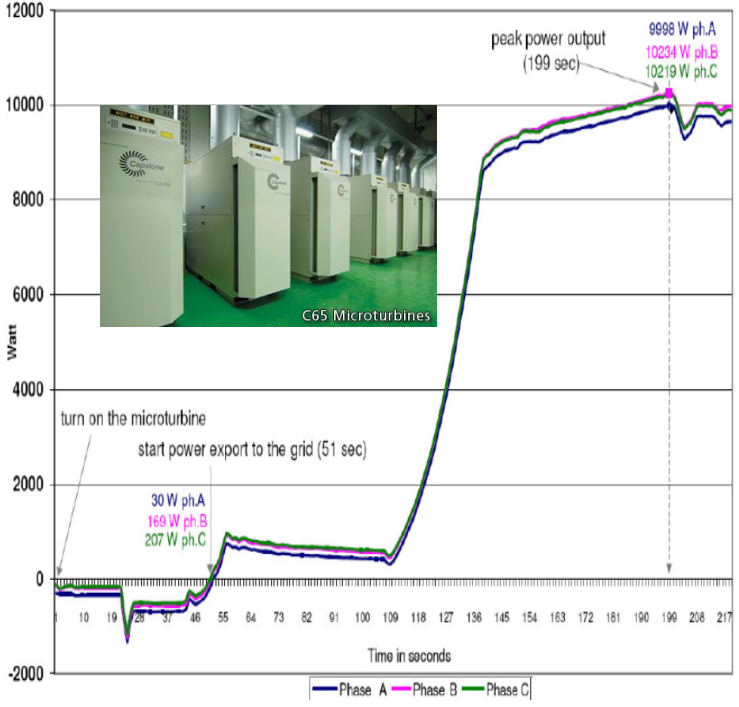
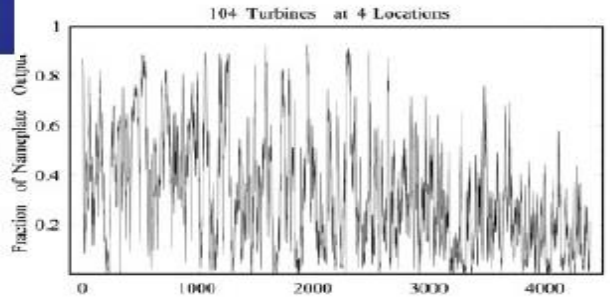
“Tame” Distributed Energy Resources = Predictable dispatchable generation (Generators, Reciprocating & Turbine) and “Base Load”



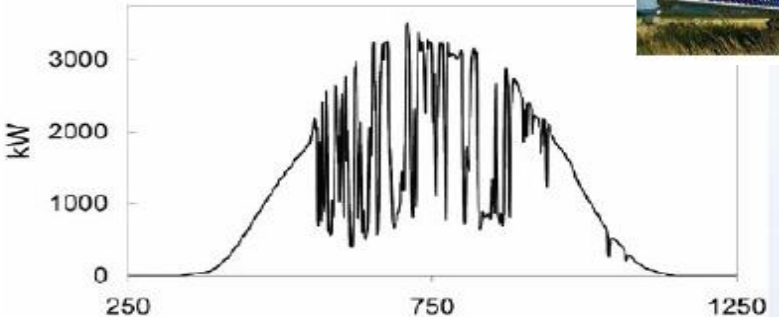


“Wild” Distributed Energy Resources = Intermittent but complementary energy production

Wind/Solar Intermittency

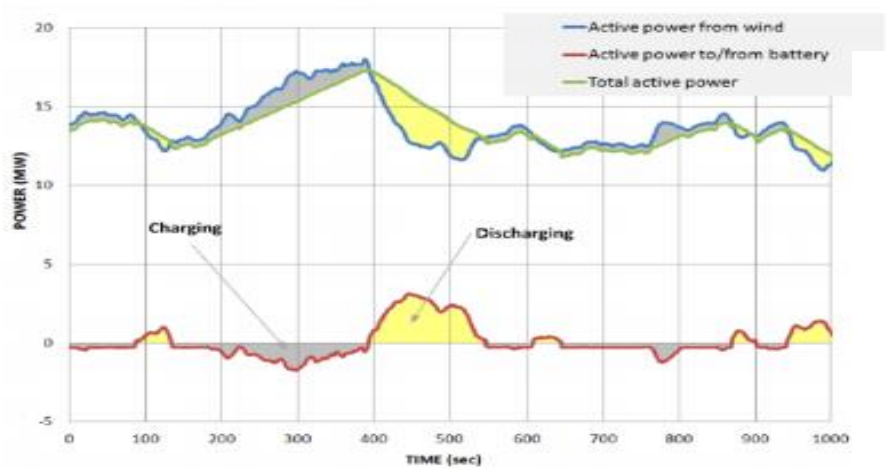


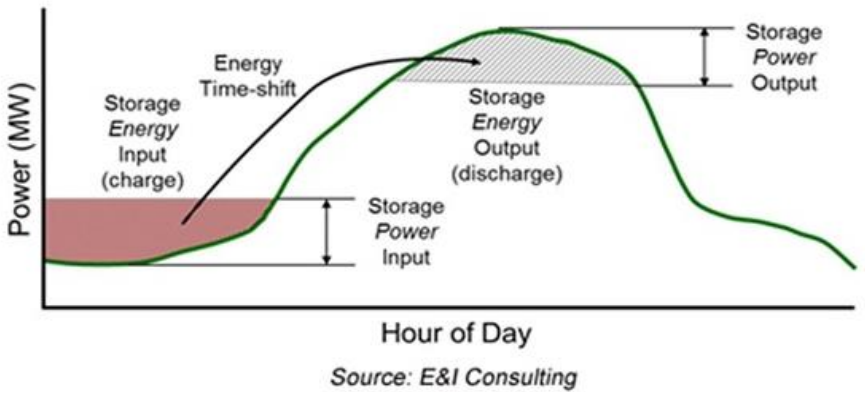
Wind Intermittency



Solar Intermittency

“Wild” Resources + Energy Storage = “Tame” Resources





Source: E&I Consulting

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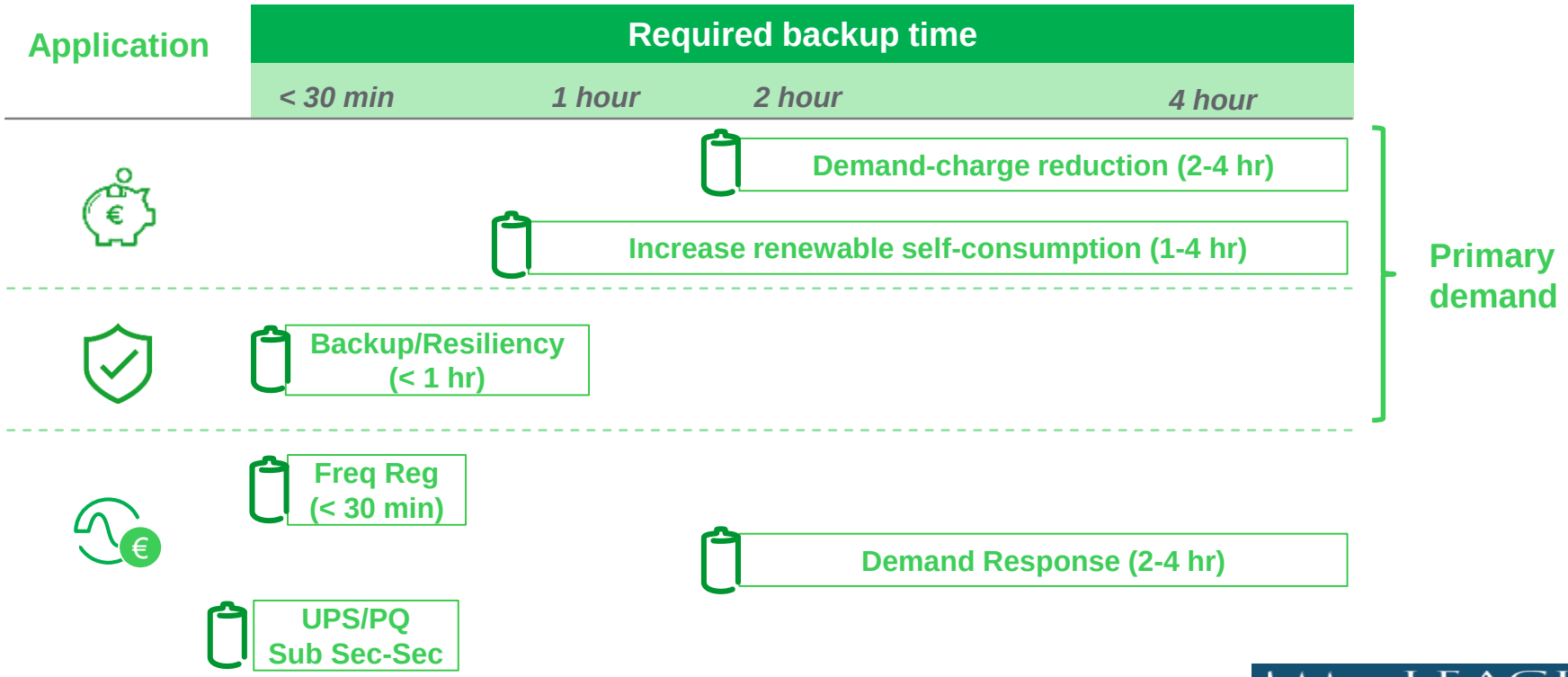
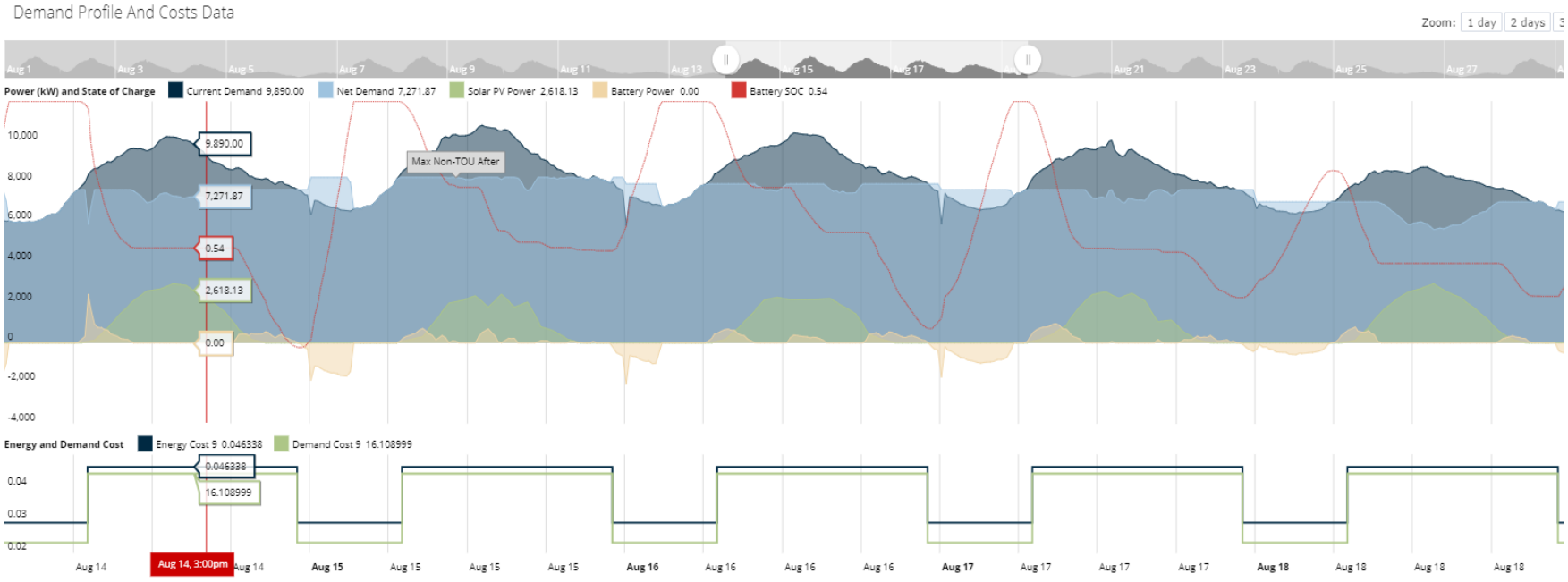
Energy Storage Use Cases

Key C&I applications mostly in 2-4 hours capacity range – Key PQ applications response in the Milli-Second/Cycles timeframe



Power and Energy Modeling determines optimal sizing

City Facilities have unique load profiles and resilience requirements



Model Financials, ROI, Payback for City or Energy Services Investor

Adjust BESS, PV and other DER System Sizes

Adjust Equipment & O&M Cost Assumptions

Factor Rebates and Incentives

Optimize payback period

Factor in needed upgrades to enable microgrid

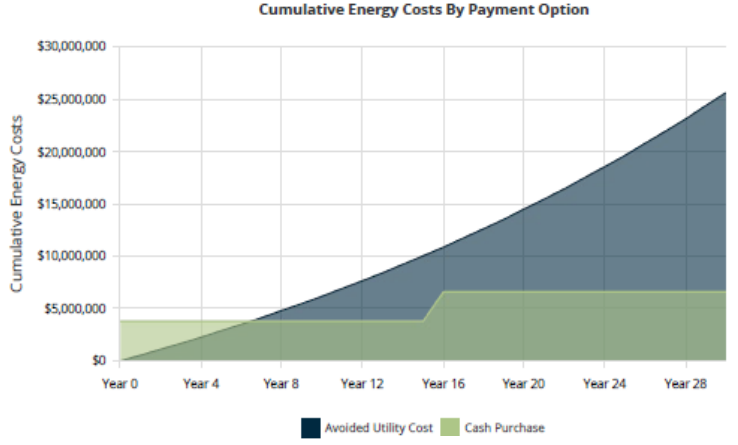
Analyze total lifecycle

- 15, 20, 25 year PPA or ESPC/ESA
- Equipment Upgrades and O&M
- Buyout or Resale

Payment Options	Cash Purchase
Upfront Payment	$3,780,513
Total Payments	$3,780,513
Rebates and Incentives	-
Net Payments	$3,780,513
30-Year Electric Bill Savings	$25,613,787
30-Year IRR	15.94%
30-Year LCOE PV	$0.021
30-Year NPV	$6,733,356
Payback Period	6.5 Years

Combined Solar PV Rating
Power Rating: 4,000,000 W-DC
Power Rating: 3,484,240 W-AC-CEC

Combined ESS Ratings
Energy Capacity: 6,000.0 kWh
Power Rating: 3,000.0 kW



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Pathways to acquire a Microgrid

Microgrid solutions as Capex Projects

We build and deliver the turnkey energy solution. You own, operate and maintain it –or, we can provide ongoing services.

Develop and build  Customer owns and operate

Microgrid Solutions via Energy as a Service

Schneider Electric and our Partners build, own, operate, and maintain the turnkey energy solution. You buy energy with performance requirements from the Investment Partner through a long-term contract. (PPA, Enhanced PPA, EaaS, ESPC, ESA)

Develop and build  Long-term Energy Service Agreement  Operation and Maintenance

Energy-as-a-Service – Option to implement Microgrids

Combining **Carlyle and Schneider** Capabilities

Integrating **Financial and Technology** Expertise

Best-in-Class **Project Delivery**

Digitally-enabled **Asset Optimization**

Schneider Electric

Energy Solution Delivered By:

- Schneider Electric
- The Carlyle Group
- Technology Partners

Energy Solution

Energy Services Agreement

City/County

Benefits of EaaS:

- Cost Savings & Predictability
- Risk Mitigation
  (Regulatory, Technical, Financial)
- Resilience & Reliability
- Sustainability
- Efficiency
- Infrastructure Upgrades

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Why Energy as a Service?

Preserve your organization's capital for core business objectives

Customer CAPEX	Energy as Service
• Burden on balance sheet for costly energy infrastructure upgrades	• **Customer capital freed up for core business needs and priorities**
• Ownership risk associated with new energy technology performing as anticipated	• **Guaranteed system performance for resilience, efficiency, and sustainability**
• O&M staffing skill needed to support a more sophisticated energy system	• **Industry-leading experts manage building and operating system**
• Squeezed year-over-year O&M budgets and exposure to long term energy cost increases	• **Locked in, long-term, predictable OPEX**
• Regulatory risks related to energy and sustainability	• **Protected from financial, regulatory and technical risks**

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Montgomery County MD
Public Safety HQ

Montgomery County Microgrid Architecture

Customer constraints

API / Web services
Open ADR 2.0b

Weather forecast

Energy market pricing

Demand response requests

Predictive DER management, forecast for production, storage, or sale of energy, interface with energy, markets, accessible from anywhere

Energy Management Platform

Cloud

Sites

Microgrid Controller

Public Safety Headquarters (PSHQ)

Montgomery County Correctional Facility (MCCF)

Microgrid Controller

Coming Soon… Electric Bus Depot and Charging Infrastructure

New 13.8KV Main-Tie-Main incoming utility gear

New 480V Microgrid gear

New 800Kw CHP, Heat Recovery & Absorption Chiller

Montgomery County Sites Today

Innovative Project Qualification and Assessment

USGBC PEER Standard

- Independent assessment of performance
- Certified Sustainability Rating from USGBC
- Independent assessment of project value
- Basis for case studies and marketing materials
- Recognition by GBCI and USGBC and candidate for **Annual Galvin Award**

PEER | PERFORMANCE EXCELLENCE IN ELECTRICITY RENEWAL

U.S. GREEN BUILDING COUNCIL LEED USGBC

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Overall PEER Score — 97%

Performance Categories	Max Points	Estimated Points
PEER Estimated Total Score	300	292.2
Energy Efficiency and Environment	100*	100
Reliability and Resiliency	100*	98.7
Operational Effectiveness	100*	93.5

* Able to achieve 100 leveraging bonus points

Additional Value Streams

- Water savings of $5 million
- Reliability and resiliency
- Reduction in power quality events – low voltage, voltage imbalance – that damage equipment
- Insurance cost reduction

Finding Additional Savings or Profits

- Leverage external service for economic dispatch
- 2MW plus solar of excess generation
- Capacity avoidance and sales- ~$140K
- Export power - ~$150K

Reliability and Resiliency

PEER Score 98.7 out of 100

Metric	Benchmark	Project Design
SAIDI, min	181	2
SAIFI	1.2	0.06
Protected Equipment	Exposed overhead lines	Electrical system is underground and enclosed, sump pumps protect equipment in basement
Redundant Supply	Two overhead feeds from same substation	Local generation 2x peak demand, redundant site substations with a cross tie
Redundant Site Distribution	Four of the six site distribution panels have redundant distribution feeds and auto-transfer from the redundant on-site generation bus	No change to site distribution
Islanding Capability	None	Black start, auto restoration

Energy Efficiency & Environment

PEER Score 100 out of 100

Metric	Benchmark	Project	Benefits
Power Efficiency (MMBtu/MWh)	10.5	4.2	Saved 64,000 MMBtu, equivalent to 560 Net Zero Homes
CO_2 (lbs./MWh)	1,330	460	Saved 4,500 tons, equivalent to removing 850 passenger vehicles
NO_x (lbs./MWh)	1.4	1.7	None
SO_2 (lbs./MWh)	2.5	0.07	Saved 13 tons
Water (gal/MWh)	540	73	Saved 5 million gallons
Waste (% recycled)	38%	99%	58% reduction in solid waste to landfills, specifically coal ash

Operational Effectiveness

PEER Score 93.5 out of 100

Metric	Benchmark	Project	Benefits
Energy Savings	NA	$66/MWh	$680,000 in annual savings
System Energy Efficiency (SEE)*	47%	117%	Saved 100,000 MMBtu or 875 net-zero homes
Demand Response Capability	15%	160%	Reduce demand on electricity systems
Load Duration Curve	40%	67%	Increased asset utilization
Waste Identification & Failure Analysis	NA	Process for Both	Process for minimizing waste and addressing failures

$$* SEE = \frac{Total\ energy\ delivered\ (electric, cooling\ \&\ heating)}{Total\ fossil\ fuel\ consumed}$$

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Town of Fairfield, Public Safety Microgrid

Powers critical facilities during electrical grid outage

Project at a Glance

- Modern and harden public safety infrastructure to withstand severe weather supporting 59,000 residents
- Using distributed generation sources, a Microgrid control system was installed to control power distribution both in grid parallel and islanded modes
- Harness Solar and gas powered generation

Efficiency & Optimization

- Distributed generation to provide 120% of critical power demand during all peak periods
- Reduce demand and consumption at Police and Fire HQ over 2 years by about 60 kW and 250,000 kWh annually

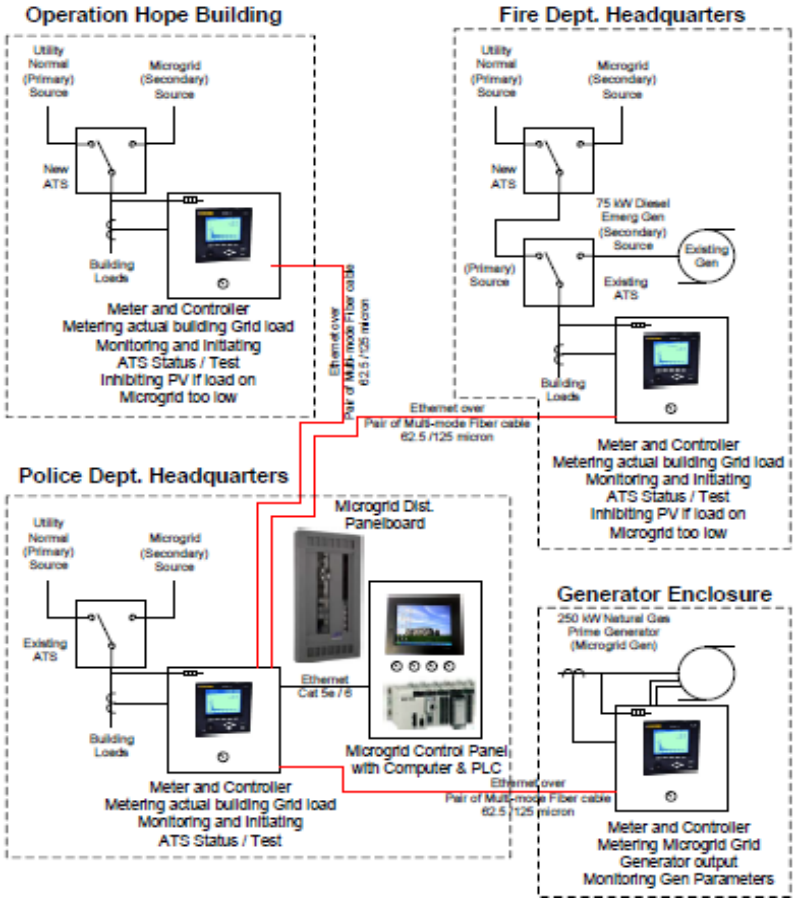
Reliable Energy

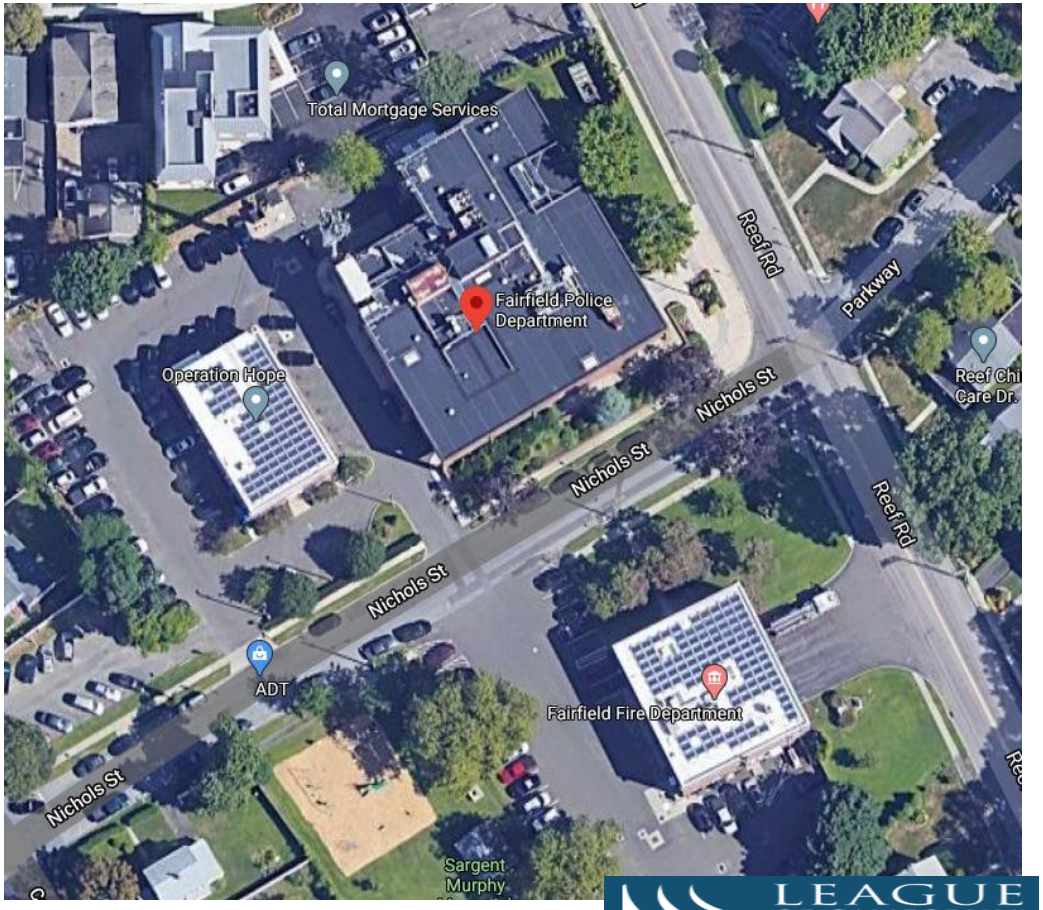
- Ensure 365/24/7 operations of critical infrastructure, including police and fire HQ, emergency comm center, cell phone tower service, and homeless shelter.

Green Energy

- Installed PV system at Fire HQ
- Use natural gas fired CHP generators

Town of Fairfield CT Microgrid #1





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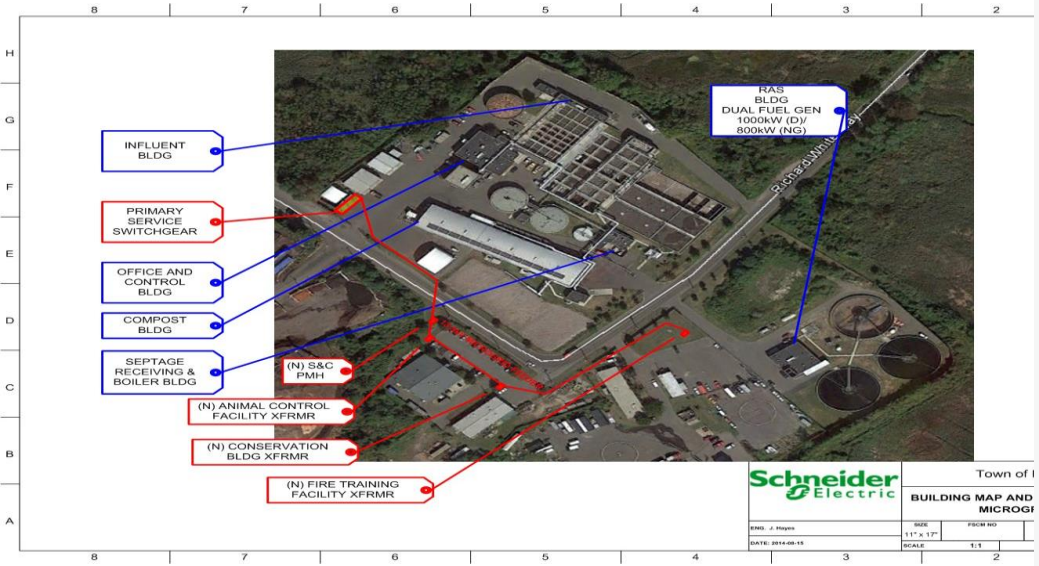
Town of Fairfield Microgrid #2

1St Success leads to 2nd Success



Town of Fairfield, Water Treatment Plant:

- Treatment plant + 6 additional buildings
- Natural gas gens, solar, fuel cell & diesel generation
- HUD grant

Goal

Reach 50 percent renewable energy over the next five years.

Story

After Superstorm Sandy pummeled Fairfield, the town installed its first microgrid. A good experience with the first has led to a second project.

Solution

Complete a second microgrid for Fairfield's waste water treatment facility.

Results

With two microgrids, the town

- Keeps its residents safer
- Protects vital services
- Increases its renewable energy supply

Remarkable for its natural beauty, this seaside town deserves recognition for its foresight as well.

Fairfield's microgrids

Public safety microgrid

Properties:

- Police and fire stations
- Emergency communications center
- Cell phone town
- Public shelter

Project details:

- 350 kW natural gas generator

Wastewater treatment plant microgrid

Properties:

- Waste water treatment plant
- Animal shelter
- Fire safety training building
- Fleet garage
- Landfill
- Compost facility

Project details:

- 6 photovoltaic systems
  - 54 kW and 27 kW installations at the animal shelter
  - 13 kW installation at the fleet garage
  - 21 kW installation at the fire safety training building
  - 1.4 MW installation at the landfill
  - 42 kW installation at the compost facility
- 400 kW fuel cell
- 1.3 MW natural gas generator

City of Milford CT Microgrid Cost Savings for 20 Years

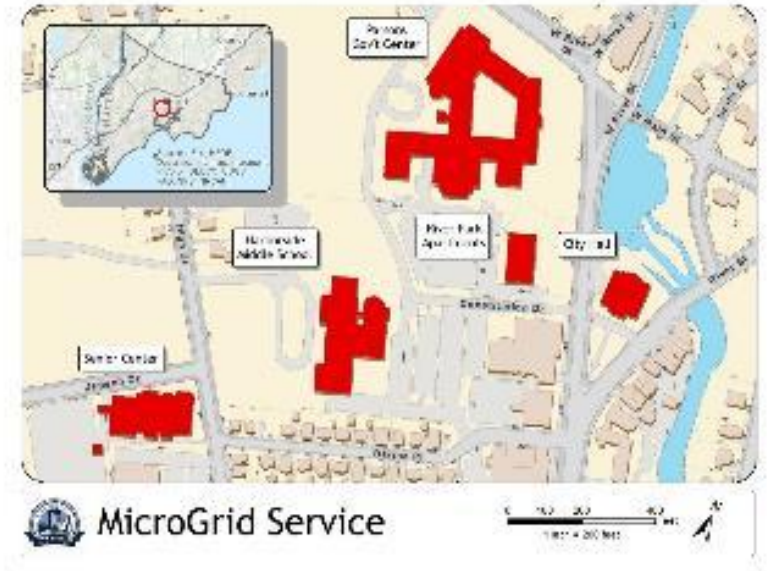
What are the Benefits of Milford's Microgrid?

Cost Savings

- The Microgrid will reduce electricity consumption at 4 City buildings and heating fuel consumption at Parsons Center. Cumulative savings over the life of the project is estimated at **$1-2M over 20 years**
- Currently, 4 City buildings pay approx. $0.16/kWh and total $250k/year electricity
- Currently, Parsons Center heating fuel costs approx. $60k/year natural gas
- Annual net savings are estimated to average $100-200k per year, **approximately 15-30% savings on energy costs for the 4 City buildings**
    - **Effective cost of electricity generation reduced from $0.16/kWh to $0.11-0.13/kWh, including:**
        - **Includes Microgrid fuel costs: $0.05-0.06/kWh**
        - **System operation and maintenance costs: $0.03-0.04/kWh**
        - **Payments for TELP financing: $0.03/kWh**
- Annual savings are estimated to be positive every year for the 20 year life of the equipment

City of Milford:

- Five municipal facilities
- CHP + energy storage
- Operates in parallel to grid
- Creates a revenue stream for the City
- DEEP microgrid grant



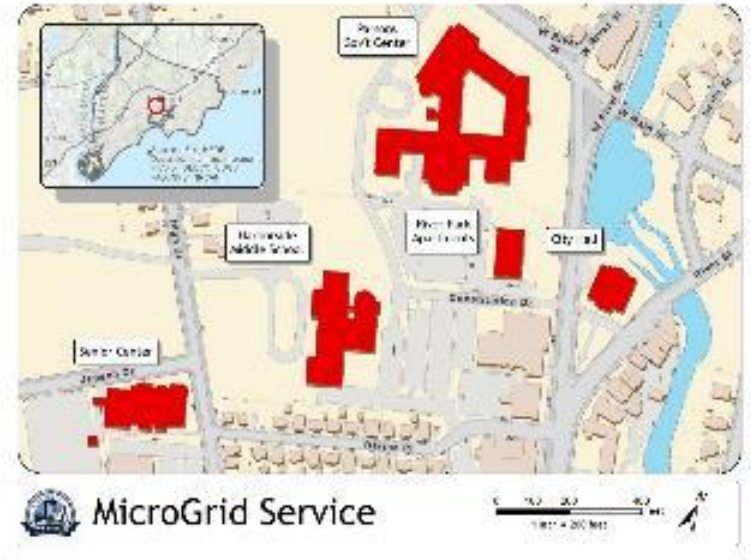
City of Milford CT Microgrid Resiliency

Resiliency

- When the electric grid is off, the microgrid will supply electricity to 5 facilities: Parsons Government Center, Milford City Hall, Harborside Middle School, Milford Senior Center, and River Park Apartments
- The Microgrid is fueled by natural gas and can operate indefinitely during grid outage
    - Recent weather emergencies (Superstorm Sandy, October 2011 snowstorm) resulted in extended electric outages across the state, with little to no impact on natural gas infrastructure
- The Microgrid will provide the City of Milford with a resilient power supply to structures within the City that are crucial for emergency response, public safety and health, and safe refuge during emergency events
- Elderly residents of River Park Apartments will be able to shelter in place during grid outage/emergency events
- City facilities may be used for sheltering, warming, etc. during grid outage/emergency events

City of Milford:

- **Five municipal facilities**
- **CHP + energy storage**
- **Operates in parallel to grid**
- **Creates a revenue stream for the City**
- **DEEP microgrid grant**



General Services Administration Buildings - Texas

Project at a Glance

- **14 buildings in 8 Region 7 Texas cities**
- Building Automation System integration
- Central Plant updates
- Data center controls update
- Lighting and controls retrofit
- Water conservation measures
- Irrigation system controls
- ~ 1 MW solar PV installed across five (5) different sites

Investment: **$17,934,397**
Annual savings: **$1,031,290 / year**

Accomplished through energy and water savings + renewable generation (PV)

LEAGUE OF CALIFORNIA CITIES

Oncor Microgrid

A truly *Autonomous & Dynamic* Microgrid completed in *under 6 months*

Project at a Glance

Management of 9 different DER types

- 200 kW BES
- 120 kW Solar PV
- 06 kW Solar PV
- 65 kW Microturbine
- 45 kW Gas recip
- 560 kW Diesels
- Wind - planned

Square D Switchboards
S&C Intellirupter
Schneider Electric Controllers and software

Efficiency & Optimization

- Predictive and real-time control of DER
- StruxureWare Demand Side Operation software platform for economic optimization and dispatch
- Load preservation features for ensuring the most critical loads are served Integration of MG Controller with BMS
- 4 separate Microgrids, ***autonomous and dynamic***
  - ***Coordinated Automatic Islanding and Reconnect***
  - ***Dynamic management of critical loads and generation and storage assets***

The most advanced microgrid in the US, located near Dallas, Texas

Green Energy

- Solar and cleaner gas (vs. just diesel)
- Low emission CHP (not utilizing thermal)
- Serves as a best practice to deploying an environmentally sustainable Microgrid, using solar in island mode

Site microgrid controller + DSO hardware

Thank you!!!

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