Leveraging Microgrids & Distributed Energy Resources

Microgrid Competency Center

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Our goals for today

How does Schneider Electric work together with you to bring Microgrid Solutions to our customers

- What is a Microgrid?
- Microgrid Products and Services
- Energy as a Service (EaaS)
- Project Examples
The Energy Transition is Underway
We have a unique opportunity to co-create our future

<table>
<thead>
<tr>
<th>Electrification</th>
<th>Decentralization</th>
<th>Decarbonization</th>
<th>Digitization</th>
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<tbody>
<tr>
<td><strong>X2</strong></td>
<td><strong>50/50</strong></td>
<td><strong>6→40%</strong></td>
<td><strong>30%</strong></td>
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- **Electrification**: Electricity consumption between 2020 – 2035 for increased adoption of Information & Communication Technology
- **Decentralization**: Wind, solar and storage will generate 50% of global electricity by 2050
- **Decarbonization**: Electricity from wind and solar by 2040
- **Digitization**: Of energy cost savings on average – up to 85% cost savings potential from customer digital transformation projects

Schneider Electric estimate  
BNEF, New Energy Outlook, 2018  
IEA, World Energy Outlook 2018  
Schneider Electric Digital Transformation Benefits Report, 2019
What is a Microgrid

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

Microgrid will generate energy from local sources in the case of a grid outage OR other external event which makes local energy more desirable.

Microgrid will generate energy from local source.
Solving for Integrated Outcomes
Historically passive consumers are thinking about energy in new ways

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

Resilience
- Serve loads during times of grid stability
- 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
The solution here is to add an anchor resource. Now when the ATS turns on the generator, the microgrid controller can open the main breaker, then tell the solar PV to use the generator as the anchor resource. AND/OR a battery energy storage system can also be an anchor resource, but it is more expensive. This maybe offset or justified by savings in grid tied operation. Use of the generators allows a smaller, more cost effective battery storage system.
Schneider Electric Microgrid Architecture

- Reactive DER management
- Ensures microgrid real time stability & reliability
- Manage of connect/disconnect from the grid
- Optimize energy production & use

EcoStruxure Microgrid Advisor

- Predictive DER management
- Forecast when to produce, store or sell energy
- Interface with energy markets
- Accessible from anywhere

EcoStruxure Microgrid Operation

- Site Operational Constraints
- Weather forecast
- Energy market pricing
- Demand response requests

Local SCADA or HMI & Workstation

Energy Control Center

Cloud or on Premise

Critical Building

Accessible from anywhere

Interface with energy markets

Forecast when to produce, store or sell energy

Predictive DER management
Microgrid Solutions
Schneider Electric Microgrid Technology Suite

Microgrid Feasibility & Engineering
Deep analysis and insights from experts leveraging proprietary algorithms to recommend ideal microgrid structure and layout, size, costs and potential challenges which de-risk project during detailed design and implementation.

EcoStruxure Microgrid Advisor
demand-side energy mgmt. platform automatically optimizes DER operation

EcoStruxure Microgrid Operations
microgrid controller solution providing network, generation, and protection management for microgrid stability, optimization and efficiency

Energy Control Center integrates DER into an intelligent, pre-engineered, and configurable power control center to optimize resources and maximize facility performance.

Battery Energy Storage Systems
hardware solution offers best-in-class energy density, footprint and efficiency to meet applications from industrial to commercial.

Villaya Emergency Microgrid Solution
hybrid mobile microgrid that supports clean and cost effective solar and storage for emergency response; designed for access to energy market.
Schneider Electric Microgrid Solutions

Generic functional layers

Cloud services
- Ancillary services
- Optimization Services
- Information Services

Supervision, HMI & Data Management
- Data Management
- Communication
- Remote and local Interfaces

Microgrid control
- Power Management Solution
- Energy Management Solution

Distributed Energy Resources
- Electrical & control interoperability between DER
- Multi-fluid energies, heat & gas

Protections & Metering
- Decentralized protection schemes
- Loads flexibility management
- Power Quality & Metering

Digital Services Platform

Microgrid
- EMS
- PMS

Ecostruxure™ Microgrid Advisor

Ecostruxure™ Microgrid Operation
Energy Control Center
The Distributed Energy Resource Command Center

Edge Control...
- Edge control enables resilience during outages
- Intelligent metering provides insight into power quality, usage, and DER production

...with Modularity for speed...
- “Configured to Order” approach simplifies the ordering process, reducing design and order time
- Factory wired, programmed, and tested to streamline commissioning, which minimizes risk and disruption to the site

...and Scalability for fit.
- Scales from small and simple to large and complex
- Allows for future facility expansion and integration of additional DERs
Energy Control Center

The Distributed Energy Resource Command Center

- Critical Loads
  - Industrial Plant or Process Loads
  - Healthcare
- Essential Loads
  - Pumps, VFDs, and Motors
  - HVAC System Coolers Freezers
  - BAS, Lighting, Public Safety
- Standard Loads
  - EV Charging
  - Non-Essential Lighting

Supply, Demand & Process Management

Microgrid Controller

Fully Integrated Controls:
- Microgrid Controller
- Microgrid Advisor Optimization Platform
- Load Shedding
Microgrid Controller: EcoStruxure Microgrid Operation

Real-time control of Distributed Energy Resources & islanding management

- A two-part solution:
  - Microgrid Controller
  - Graphical User Interface (Local HMI/SCADA)

- EcoStruxure Microgrid Operation is primarily responsible for:
  - Managing the grid-connect vs. island mode decision and transitions
  - The real-time optimization of DER in island mode

- Flexible & Future-Proof for additional DER, re-configuration
Energy Optimization – EcoStruxure Microgrid Advisor

Predict when it's best to buy, sell, store & consume energy for the best economic outcomes

DER Monitoring & Autonomous Optimization
- Web accessible multi-stakeholder dashboards

Tariff Management
- Consume or produce energy at the most advantageous time based on variable utility rates

Demand Response & Control
- Reduce peak demand charges
- Partner with curtailment service providers for grid ancillary services

Self Consumption & Island Mode
- Toggle from economic optimization to resiliency storm mode
Battery Energy Storage System

**Modular and scalable architecture with best in class energy density, footprint and efficiency.**

**Modular design.** Schneider’s modular design helps provide easier and faster commissioning and servicing.

**Best-in-class density & efficiency.** A fully integrated outdoor-rated NEMA system of 250 kW/570 kWh, including inverters, batteries, controls, switchgear, HVAC, fire detection and suppression fits in a small 68 ft² footprint. Schneider’s BESS transformerless system is highly efficient with round trip efficiency 90% or greater.

**Standardized configurations.** Fully self-contained and integrated NEMA3R/4 systems of 250 kW/500 kWh building blocks can easily be installed by forklift. No cranes required.

**Four-quadrant and multi-mode operation.** The system uses a four-quadrant inverter, capable of providing KW and KVAR, while also able to transfer from grid-tie to grid-forming operation.

**Remote and local monitoring and control.** When combined with Schneider’s EcoStruxure Micogrid Advisor™ cloud-connected software platform using Model Predictive Control you will optimize your energy consumption, while right-sizing your storage solution.

*Together with EcoStruxure Microgrid Advisor (EMA), it meets all your*
Energy supply beyond the grid

Cost effective
Up to 20%
Less expensive than the grid, secured for several years
ZERO Upfront Cost
No O&M Risk

Resilient
24/7d – 365 days
Resilient supply for your critical processes
Hassle-free

Sustainable
Up to 25%
Less carbon emissions
Brand signature

We provide you with the outcome!
Who is GreenStruxure?
Combining Schneider Electric’s top ranked Microgrids w/ Huck Capital’s Clean Investments

To provide bla bla EaaS

- 27% reduction of energy self-consumed
- 40 million metric tons of CO2 managed

Commercial/Industrial Clients
500 kW-5 MW microgrids
Standardized and modular energy-as-a-service solution

1 gigaton CO₂ avoidance target
Bringing together talent, technology, capital at scale to power a new energy landscape

Schneider Electric
Strong association with Sustainability and Efficiency

Technology
Superior, proven technology in microgrid space with +300 microgrids deployed

Business Focus
Backed by Schneider technology and ecosystem of Strategic Origination and Channel Partners

Impact Investor
Building the next generation of sustainable, tech-enabled utility providers
### Why Energy as a Service?

Transfer risk and preserve capital for core business objectives

<table>
<thead>
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<th>Customer CAPEX</th>
<th>Energy as a Service</th>
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<td>Ownership risk associated with long term performance of distributed generation assets</td>
<td>Energy management company providing system performance for resilience, efficiency and sustainability</td>
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<tr>
<td>Use of internal capital competing with funding for process equipment or upgrades</td>
<td>Customer capital freed up for core business needs and priorities</td>
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<tr>
<td>O&amp;M staffing skill needed to support and optimize energy system</td>
<td>Industry-leading experts manage building and operating system</td>
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<tr>
<td>Annual O&amp;M budgets and exposure to long term energy cost increase</td>
<td>Long term contract (10, 15 or 20 years) allows site to budget for specific amount of electricity</td>
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<tr>
<td>Regulatory risks related to energy and sustainability</td>
<td>Protected from financial, regulatory and technical risks</td>
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Simplified Deal Structure

Best-in-Class Alliances

- EPC
- Design Engineers
- Solar PV, Gen Sets

+ Utility
+ Other Suppliers and Partners

Financial Partner

Long-term Operations and Maintenance

GreenStruxure is the Developer and Operator

Capital availability
Structuring capabilities
Performance standards
Industry expertise
One contract

Customer Site

GreenStruxure

+ Schneider Electric Technology and Services

+ Schneider Electric

ESAs

+ Schneider Electric

+ GreenStruxure

+ GreenStruxure

+ GreenStruxure

+ Schroders

+ Schroders
Through Flexible Contract Structures and Pricing

Enabled by a robust and predesigned underwriting process

**ESA Deal Structures**
- Take or Pay
- 10, 15, 20 years agreement terms with 5-year renewal options and buyout terms.
- Evaluate other hybrid structures as we grow including partial/total customer ownership.

**Pricing**
- All-in cost of energy with escalator
- All-in cost of energy flat fee
- Cost of energy with escalator + capacity fee + Bill Optimization contracts
Process of Engagement

- **Preliminary Analytics/ Term Sheet**: <1 month
- **Validate technical and economic assumptions**: <3 months from now
- **Final proposal, ESA, signature**: ~9 more months
- **Construction**: ~15 months from now
- **Commissioning & operation**: ~15 months from now
Customer Challenge
Aging infrastructure, aggressive resiliency and sustainability goals.

The Solution
Microgrid-as-a-Service project at Duke Energy Renewables to improve reliable power supply for Montgomery County Public Safety HQ & Correction Facility.

Customer Benefits
- Secure resiliency of public services
- Infrastructure upgrade – reduced capex
- Protect critical operations during power outage
- Mitigate risk of escalating energy prices
- Reduce greenhouse gas and other emissions

The Results: Life is On with...
No-money down microgrid providing greater operational reliability and ensure resiliency during severe weather and other incidents.

“It’s making significant strides in our key priorities— sustainability, safety and security. Upgrades to critical facilities improve the County’s resiliency, so we can keep residents safe and provide needed services even in the event of prolonged power outages.”

Isiah Leggett, MD County Executive, Montgomery County

Download Link
Video Link
Stakeholder Video Link
www.schneider-electric.us/microgrid

One of the first “No-Money Down” microgrids helping protecting Washington D.C. area citizens

First US GCI PEER Certified Campus microgrid

Apps, analytics, and services
EcoStruxure Microgrid Advisor
Edge control
EcoStruxure Microgrid Controller
Connected products
Smart LV/MV Switchgear
Inverters

Montgomery County, Maryland
Innovative Resiliency solution for Public Facilities

Montgomery County, Maryland
Innovative Resiliency solution for Public Facilities
Customer Challenge
Schneider Electric’s new headquarters experienced utility-related outages.

The Solution
Pre-configured microgrid solutions with site optimization platform owned and operated by third-party capital partners.

Customer Benefits
Greater electrical reliability, resiliency, demand-side efficiency, and sustainability at no upfront cost.

The Results: Life is On with...
When we collaborate with partners to develop real-world solutions that enhance the electric reliability, boost use of clean energy, and manage energy economically—all while sparing customers from paying any upfront capital costs.

“In the sustainability aspects of the microgrid create savings, and equipment upgrades can be funded by those savings.,”
Mark Feasel, Vice President Smart Grid, Schneider Electric

www.schneider-electric.us/microgrid
Ameren Microgrid

Type: Campus, office building, Islandable
Location: Illinois, USA
Size: 1,2 MW
Completed: 2017

Customer pain point
Building an islandable microgrid in order to face severe weather + optimizing DER in grid connected mode

Solution
Providing EcoStruxure™ Microgrid Advisor and developing tailor made use cases for Ameren (off grid mode preparation)

Scope
- EcoStruxure Microgrid Advisor being connected to a 3rd party Microgrid Controller
- Multiple advanced use cases including islanding mode preparation
- DERs ranging from Natural Gas Genset, PV, energy storage to EV charging station
Oncor Microgrid

Type: Campus, industrial facility, Islandable
Location: Texas, USA
Size: 1 MW
Completed: 2016

Customer pain point
Willingness to demonstrate Microgrid technology at their campus for raising awareness about microgrids

Solution
Advanced microgrid in term of control, with full islanding capabilities + customer showroom. The grid-tied system consists of four interconnected microgrids and nine different distributed generation resources

Scope
• 4 separate Microgrids, autonomous and dynamic
• EcoStruxure Microgrid Advisor and Operation
• Design and delivery of the customer showroom
• DER: PV, BMS (HVAC), EV, Energy storage, micro turbine
Shedd Aquarium

Type: Campus, Grid-Tied
Location: Illinois, USA
Size: 3 MW
Completed: 2016

Customer pain point
Willingness to reduce energy bill and use cleaner energy

Solution
Delivery of a 1MW lithium ion battery system for participating into Frequency Regulation system, in order to participate in reducing by 2 the facility’s energy bill by 2020

Scope
• EPC + energy storage inverter
• EcoStruxure Microgrid Advisor installed to enable economic optimization, energy visibility and control
Gordon Bubolz Nature Preserve

Type: Office building
Location: Appleton, Wisconsin, USA
Size: 450 kW
Completed: 2018

Customer pain point
Looking to improve resiliency and meet sustainability goals in their environmental center

Solution
• Deploying an Energy Control Center for facilitating the integration of all DER and control solution for optimizing energy usage
• Working with Faith Technology as a partner

Scope
• Energy Control Center
• EcoStruxure Microgrid Advisor and Microgrid Controller
• Management of DER including: energy storage, PV, HVAC, EV charging stations, micro turbine, CHP
Port of Long Beach, CA

**Type:** Port, Islandable  
**Location:** CA, USA  
**Size:** 1 MW  
**Completed:** under execution

**Customer pain point**
Ensuring a stable supply of energy is crucial to the zero-emissions future of Harbor Commissions envisions for the Port of Long Beach.

**Solution**
Design and build a Microgrid enabling critical energy resilience at the Port of Long Beach
Providing peak shaving and demand response algorithms

**Scope**
- EcoStruxure Microgrid Advisor, EcoStruxure Microgrid Operation, EcoStruxure Power Monitoring Expert, EcoStruxure PSO
- DER: PV, BESS, Diesel Genset
Costa Mesa Facility Battery Energy Storage System

Type: Industrial facility, Grid-tied
Location: Costa Mesa, Ca, USA
Size: 2 MW
Completed: 2016

Customer pain point
High peak demand charge ($13.57/kW)

Solution
Engineered, procured and constructed install of 2 batteries that provide 1MW/2MWh of capacity – offsetting peaks incurred from facility product testing, in coordination of EcoStruxure Microgrid Advisor

Scope
• Participating into California Public Utility Commission’s (CPUC) Self-Generation Incentive Program (SGIP) funding
• System design, installing electrical equipment, supplied battery, commissioning equipment
• EcoStruxure Microgrid Advisor platform
Refinery Load Preservation Microgrid

**Type:** Industrial facility, Grid-tied  
**Location:** USA  
**Size:** Several buildings, including in CA  
**Completed:** Completed in from 1999 to 2012

**Customer pain point**  
Multiple and costly outages in industrial facilities

**Solution**  
Designed, engineered, and constructed a load preservation system microgrid for 165 MW co-generation systems serving 185 MV of load in the initial phase.

**Scope**
- 90% net-zero (gas-fired CHP)
- 7 cycle islanding to preserve steam system from tripping offline
- 100 breakers shed at high, medium, and low voltage, closed transition
- Export of power to utility (SCE)
- Integration of sequence of events recording
- Typical of 15 similar projects in chemicals, refining, and paper