Localized Energy Supply

Microgrids made possible by Schneider Electric

Current State

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Desired State moving towards Clean Distributed Energy Resources (DER)

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Our purpose is to empower all to make the most of our energy and resources bridging progress and sustainability for all

At Schneider, we call this

Life Is On

Overview

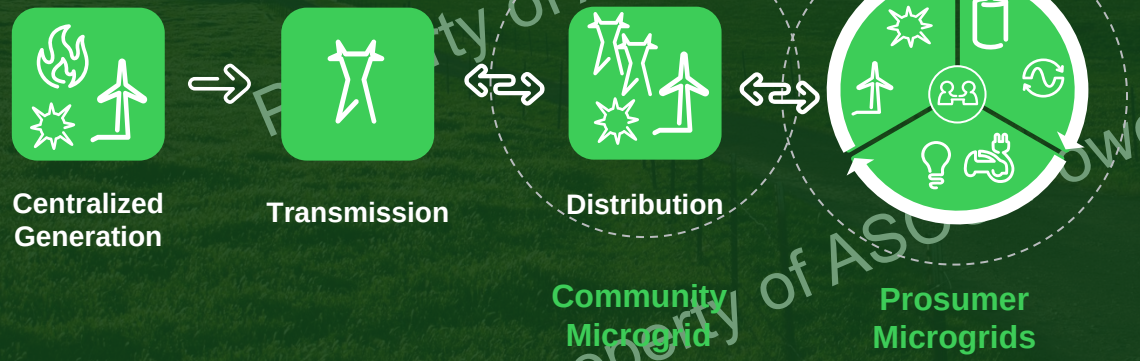
- The New Energy Landscape
- Connecting It All Together
- *Designing for Function*
- *Energy as a Service*
- *Microgrid Project Process*
- *Case Studies*
- *Moving Forward Together*

The New Energy Landscape is powered by Microgrids

Historical Energy Value Chain

or

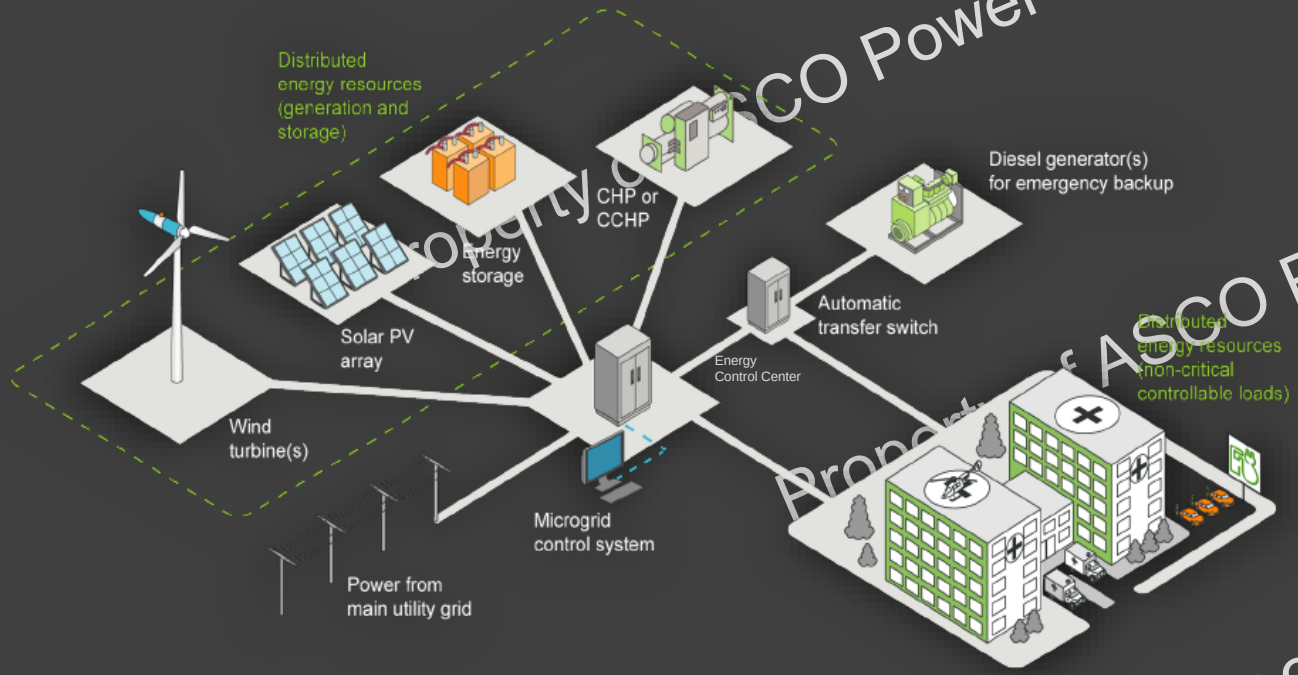
The New Value Chain

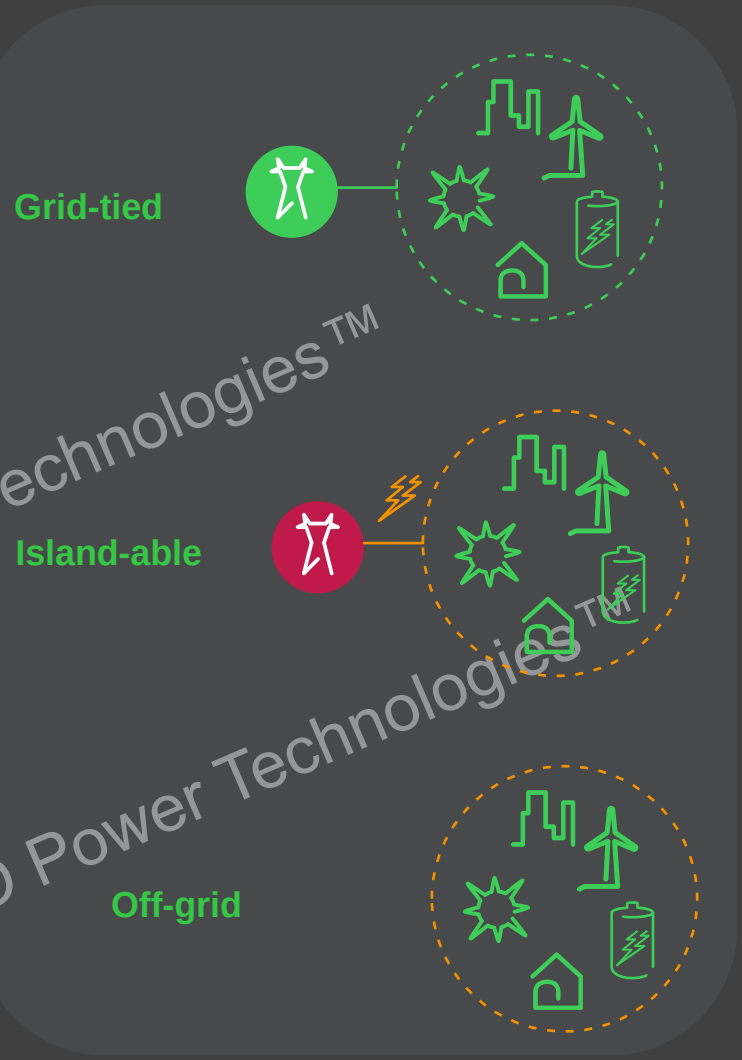


or

Localized Energy Supply (aka Microgrids)

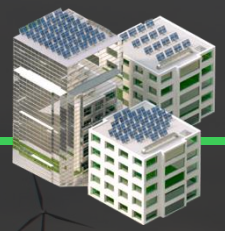
A **local electrical distribution network** with Distributed Energy Resources(DER): generation, storage, and flexible loads interconnected and **coordinated by intelligent management systems**…

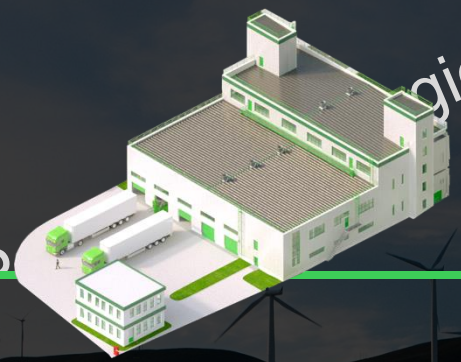




Resilient | Clean | Cost Responsible

Microgrids are everywhere





BUILDINGS

- Hotels
- Retail
- Real estate

LARGE SITES

- Hospitals
- Consumer Goods
- MMM
- Oil & gas
- Data Centers

INFRASTRUCTURE

- Eco-District
- Electrical companies
- Green Ports
- Airports
- National Security

Microgrid use cases

ECONOMIC PERFORMANCE

Savings $

Monitoring & Forecasting

Demand Charge Reduction

Tariff Management

Self Consumption & “no wire”

Earnings $

Frequency containment Reserve / Fast Frequency regulation

Demand Response

SUSTAINABILITY

Renewable Integration

Export Management

Sharing strategy and fuel saving

RESILIENCE

Back-up power & safety

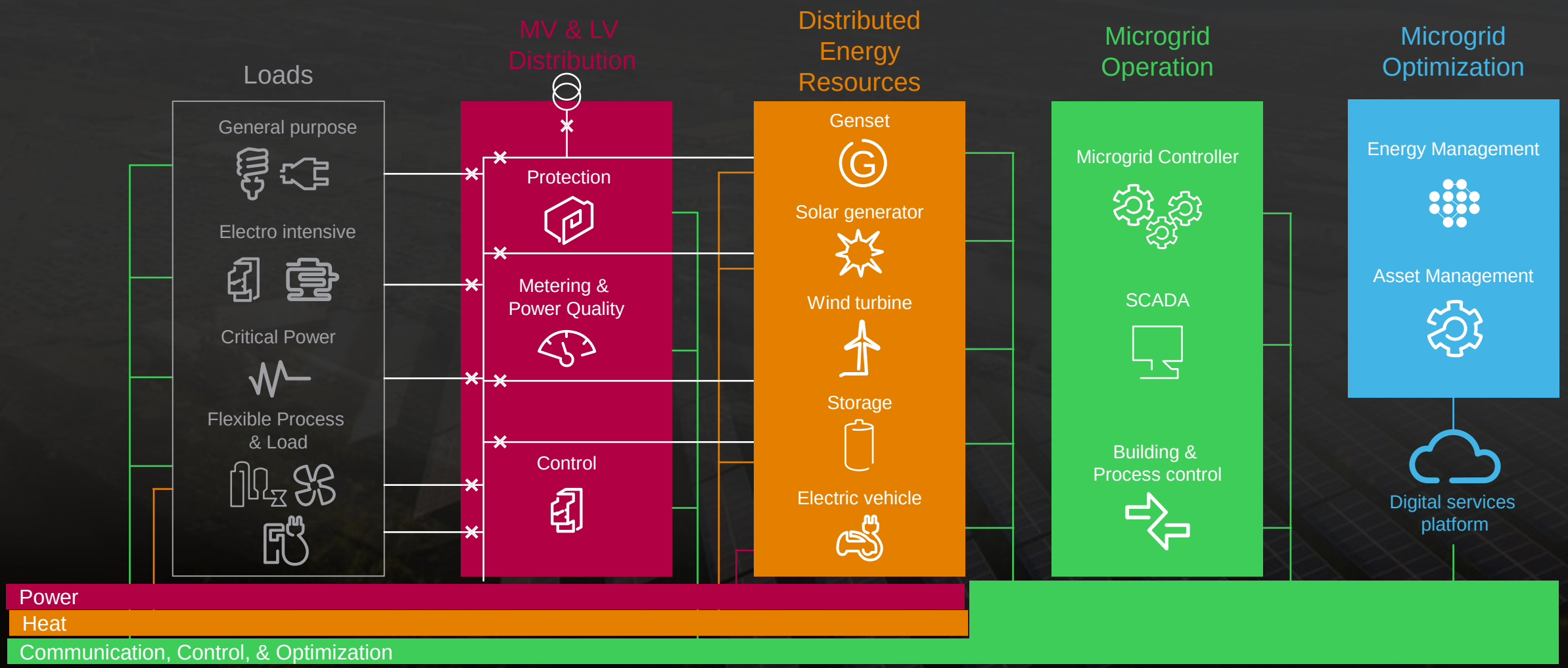
Off-grid preparedness

Grid connection management

Load shedding

Protection setting management

Microgrid Components

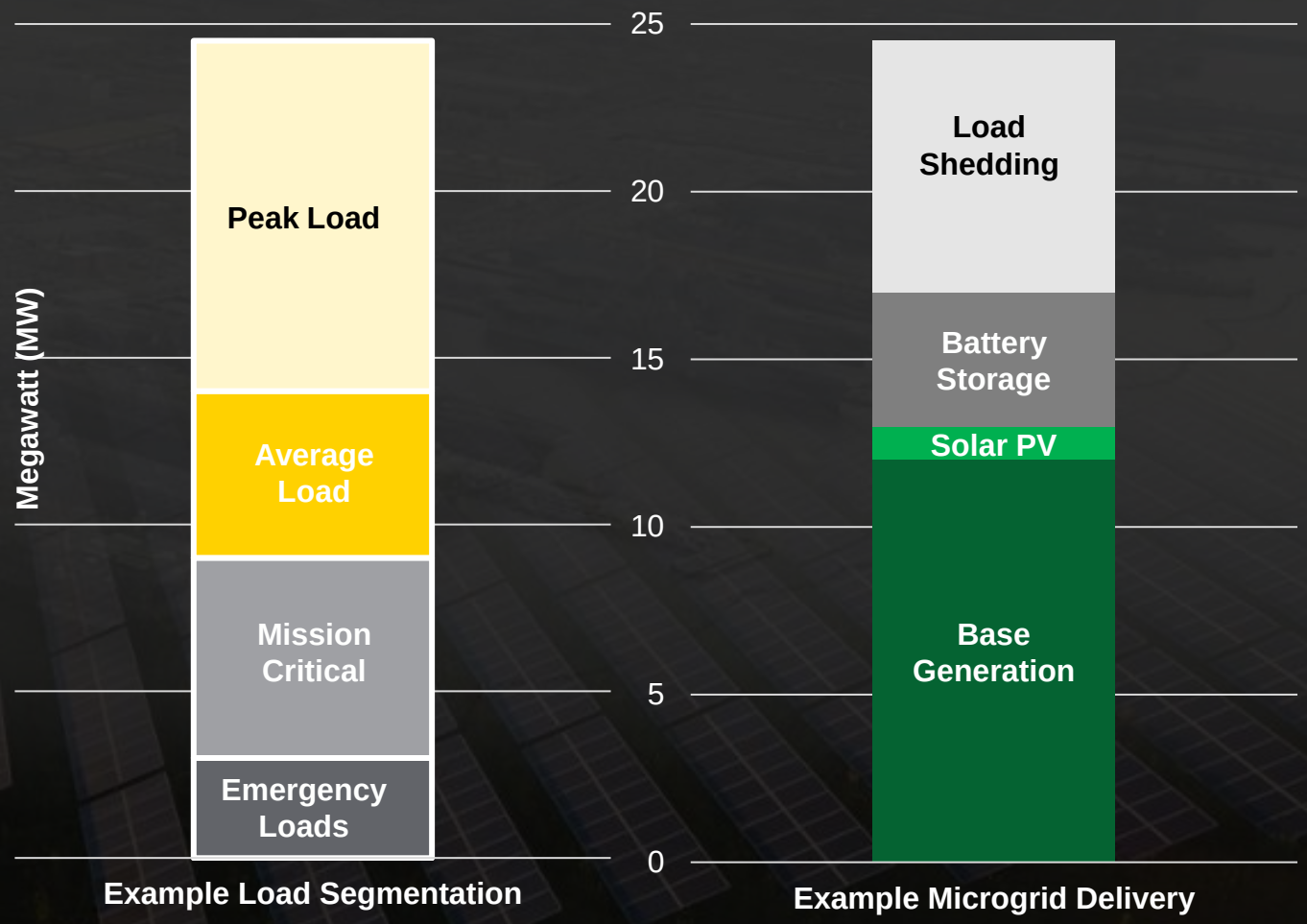


Understanding Site Loads

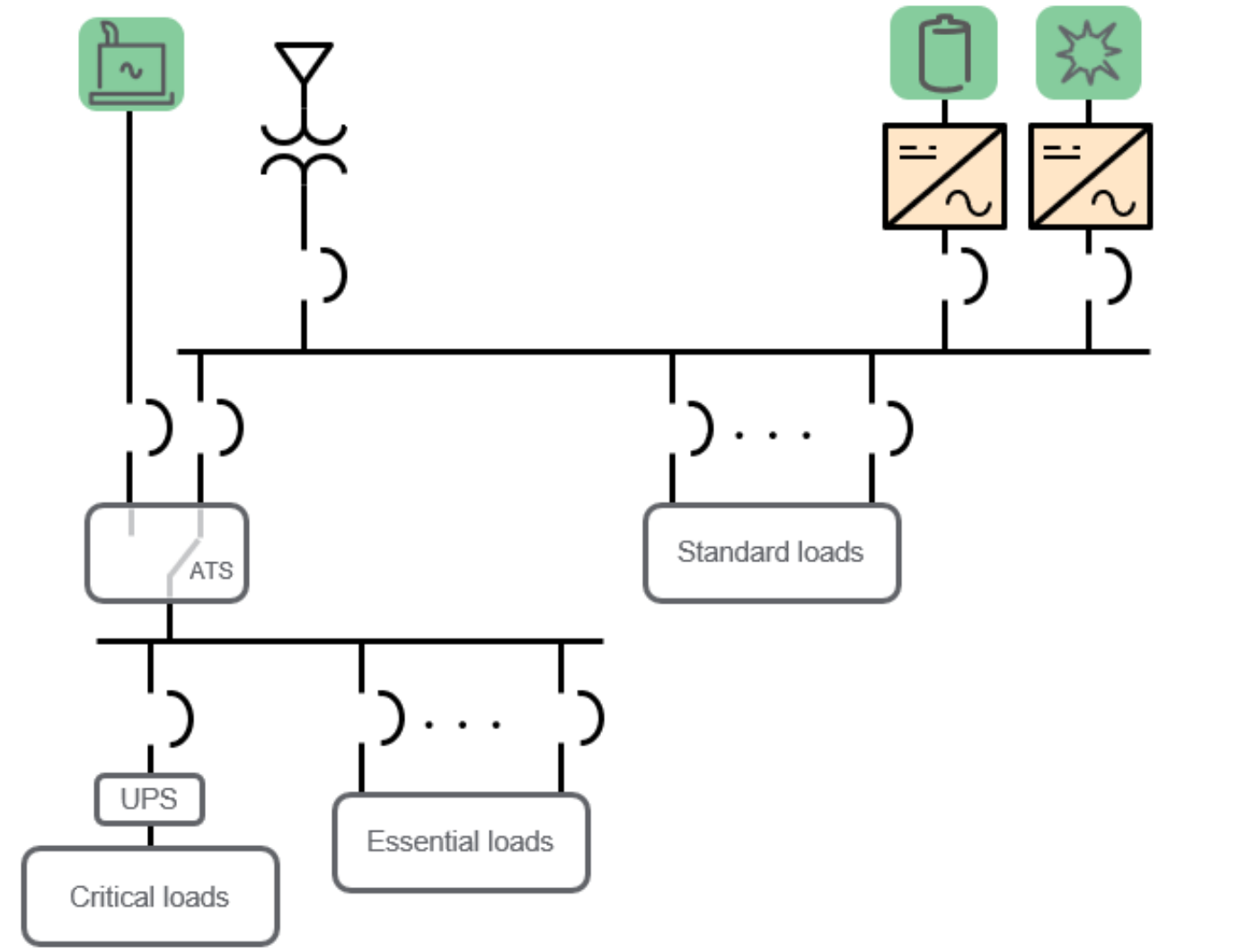
Collaboration and Discovery Process:

- Understanding mission objectives
- Assess existing assets
- Load segmentation & prioritization
- Load forecasting / energy efficiency
- Impact/cost of power outages to installation
- Energy resilience metrics
- Energy resilience plans
- System sizing & operational reliability
- Resource diversification
- Fuel diversification, storage, sourcing/production
- Transition time needs
- Network communications & operating center

DER's are sized based on emergency critical, average, and peak demands



The “stranded assets & loads” problem



DER’s connected this way do **not** work during an outage! Standard loads go completely “dark” during an outage.

Consider the implications during extended shutdowns like California’s “**public safety power shutoff (PSPS)** events.

Local, valuable energy assets are simply wasted.

The Story of Andover

Customer: Schneider Electric
Microgrid type: Facility, islandable
Location: Andover, MA
Capacity: 1.2 MW

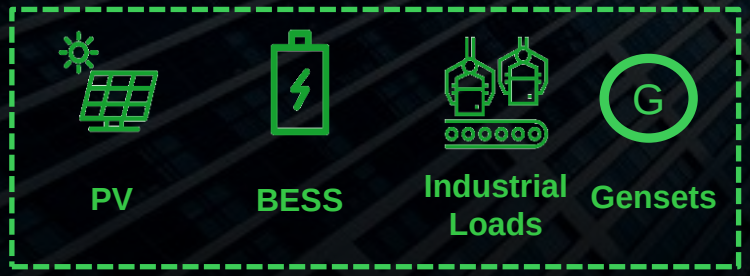
Challenges

Energy reliability issues, aggressive sustainability goals, preserve capital for R&D

Solution

Pre-configured microgrid solutions with site optimization platform owned and operated by third-party

Video Link



EcoStruxure™ Microgrid **Advisor**

EcoStruxure™ Microgrid **Operation**

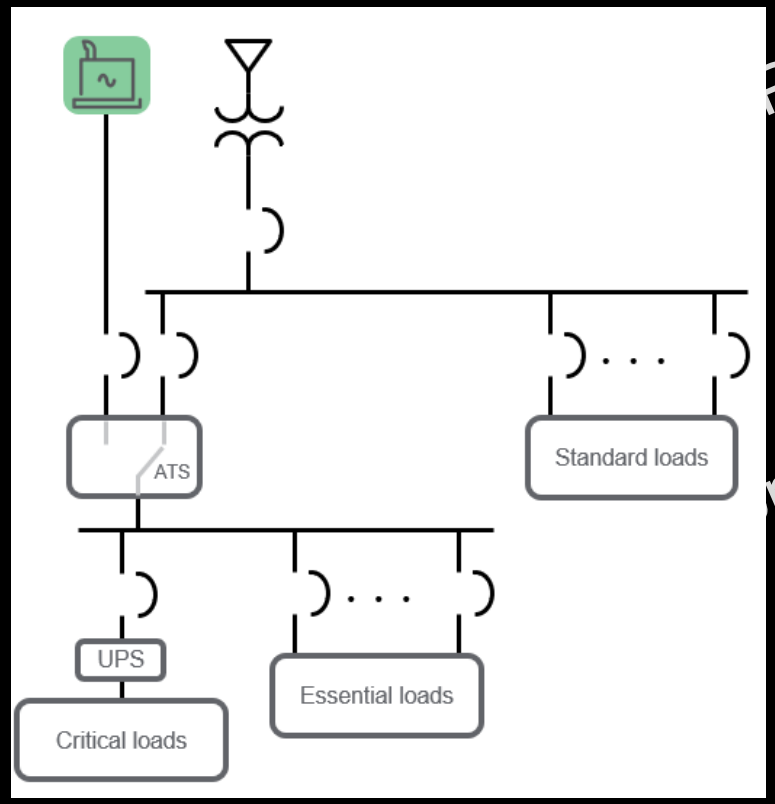
BESS + Solar inverters + LV/MV + BMS

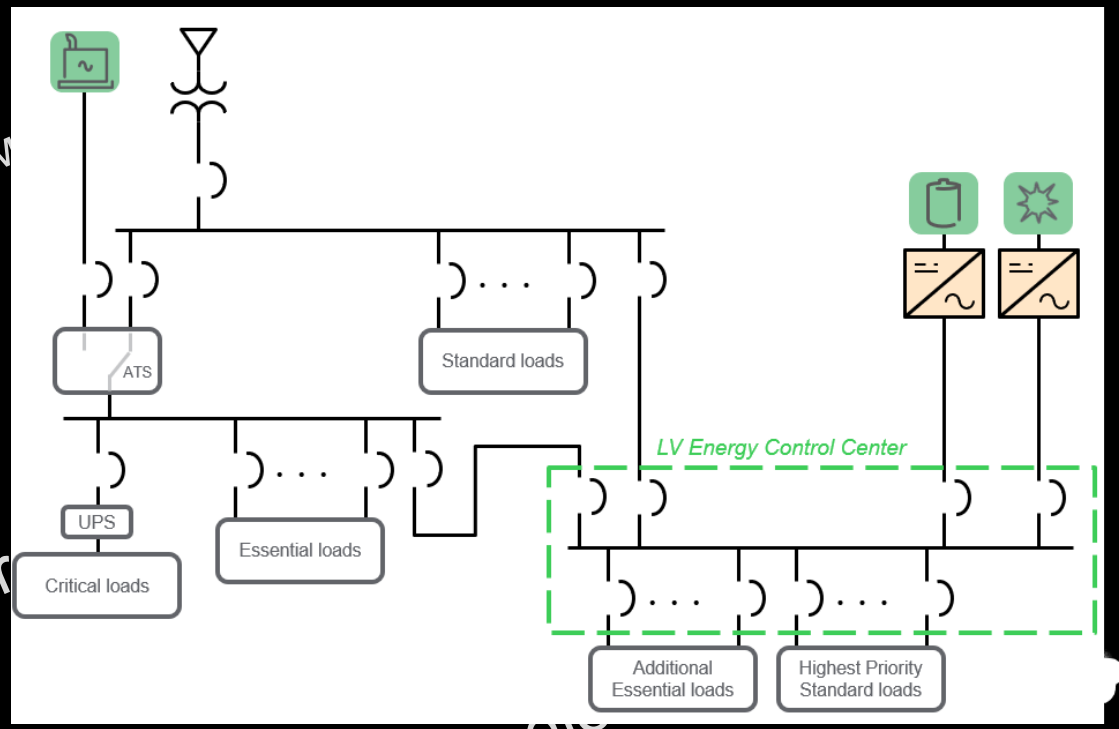
Life is On…

Collaboration with partners to develop real-world solutions that enhance electric reliability, through use of clean energy.

Demonstrate how customers can optimize energy usage while leveraging alternative energy procurement (reducing upfront capital expenditures) for mission functionality.

Andover Approach (Add Subpanel)





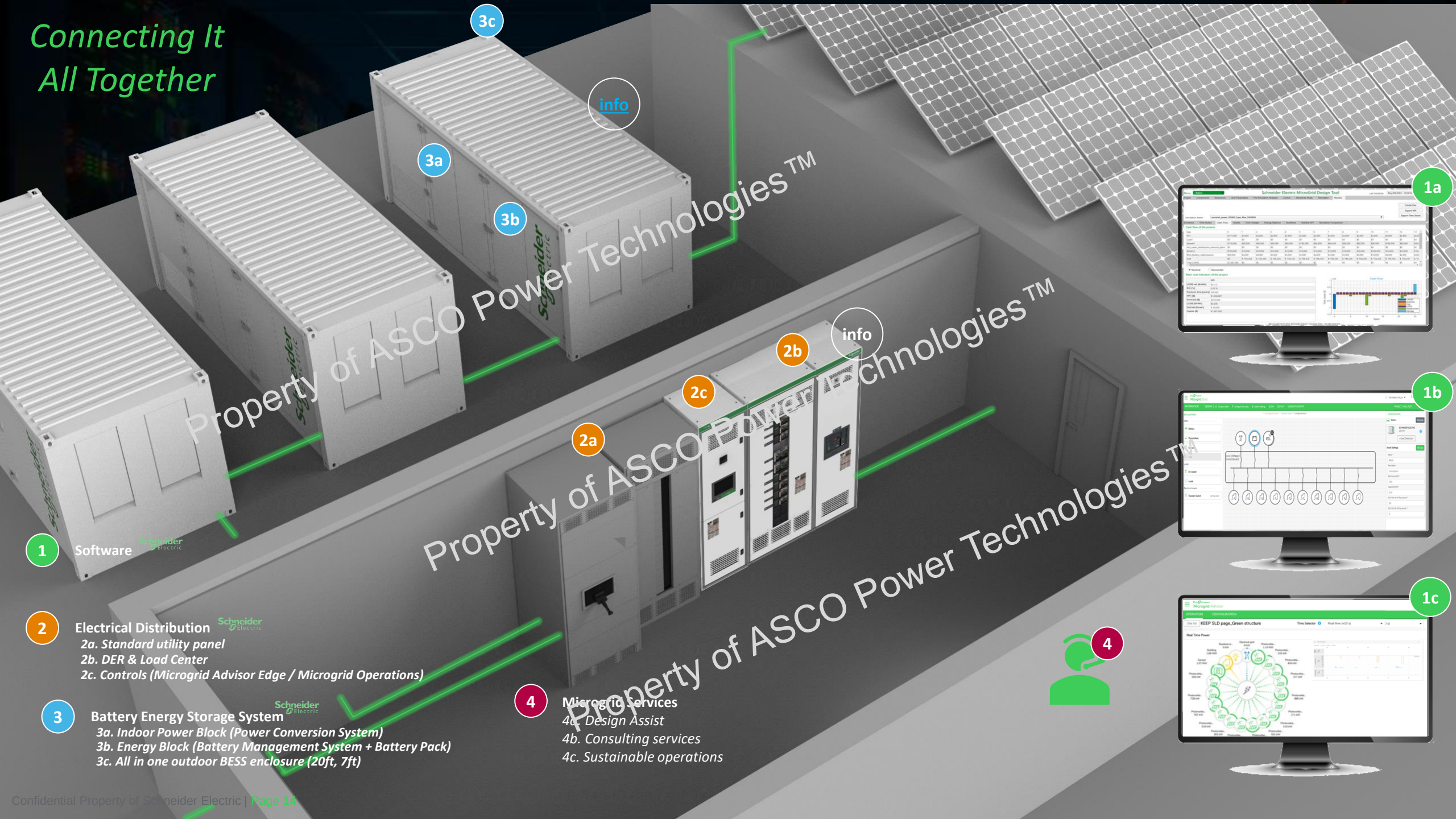
Approach Pros:

- Leaves infrastructure for Critical loads and Essential loads as-is (“if not broke, don’t replace it”)
- Harnesses spare genset capacity as anchor resource for ECC
- Spare genset capacity allows additional Essential loads
- Loads relocated from Standard loads in main gear to ECC may receive power during an outage

Approach Amber lights:

- Requires contractor to move loads from original connection points into ECC
- Review life safety rating of ATS output to make sure rating is not compromised

Connecting It All Together



1 Software

2 Electrical Distribution
- *2a. Standard utility panel*
- *2b. DER & Load Center*
- *2c. Controls (Microgrid Advisor Edge / Microgrid Operations)*

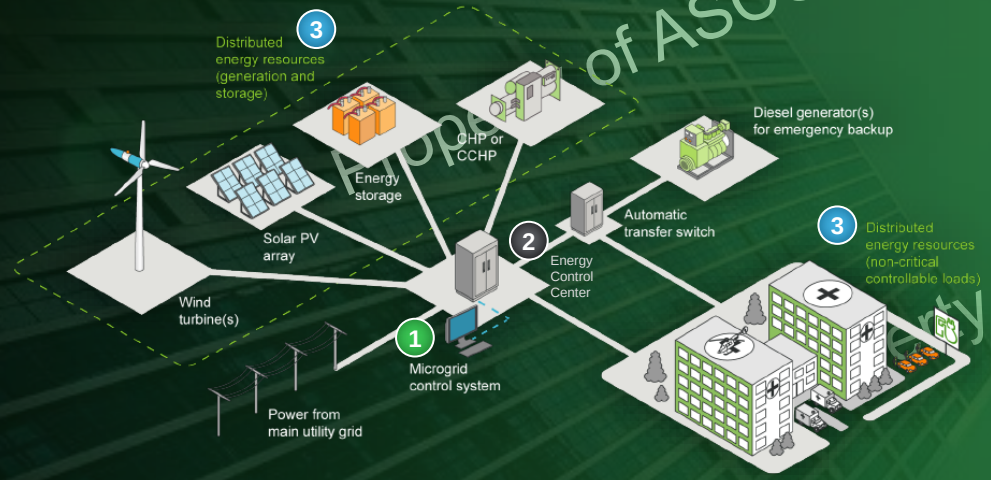
3 Battery Energy Storage System
- *3a. Indoor Power Block (Power Conversion System)*
- *3b. Energy Block (Battery Management System + Battery Pack)*
- *3c. All in one outdoor BESS enclosure (20ft, 7ft)*

4 Microgrid Services
- *4a. Design Assist*
- *4b. Consulting services*
- *4c. Sustainable operations*

Schneider Electric Microgrid Technologies

Life Is On Schneider Electric

A fully integrated digital experience



1	**EMS** Energy Management System	EcoStruxure Microgrid Advisor Forecast and Optimize when to consume, produce, Store, or Sell Energy
1	**PMS** Power Management System	EcoStruxure Microgrid Operation Ensure stability and reliability of energy supply in all grid conditions
2	**ED** Electrical Distribution	Power Meter, Circuit Breaker, LV panel, MV etc. Core offers of SE, ensure easy integration and management of DER
3	**DER** Distributed Energy Resources	BESS, PV inverter, BMS, EV chargers… Use or provide energy or flexibility to the microgrid

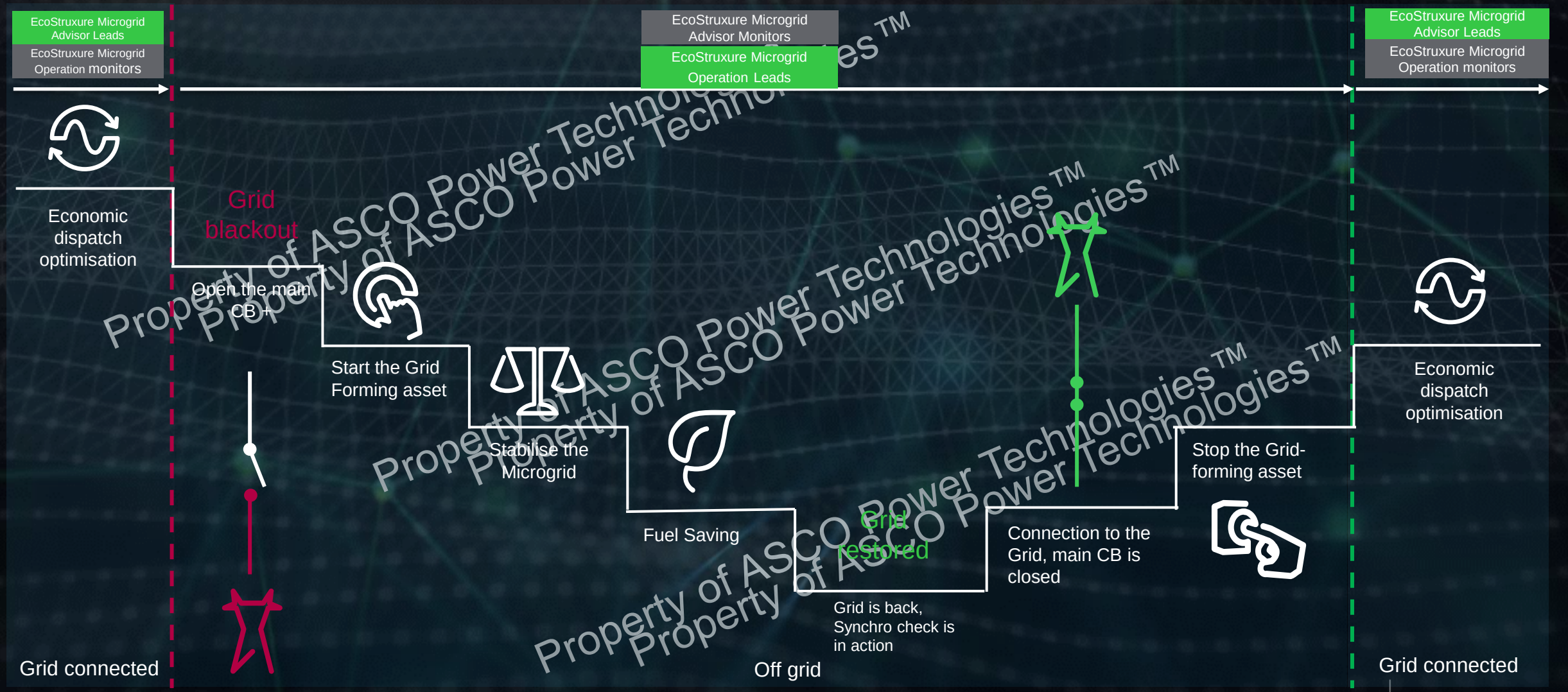
Services

- DER sizing
- Power System Engineering
- Financing (EaaS)
- Maintenance plans

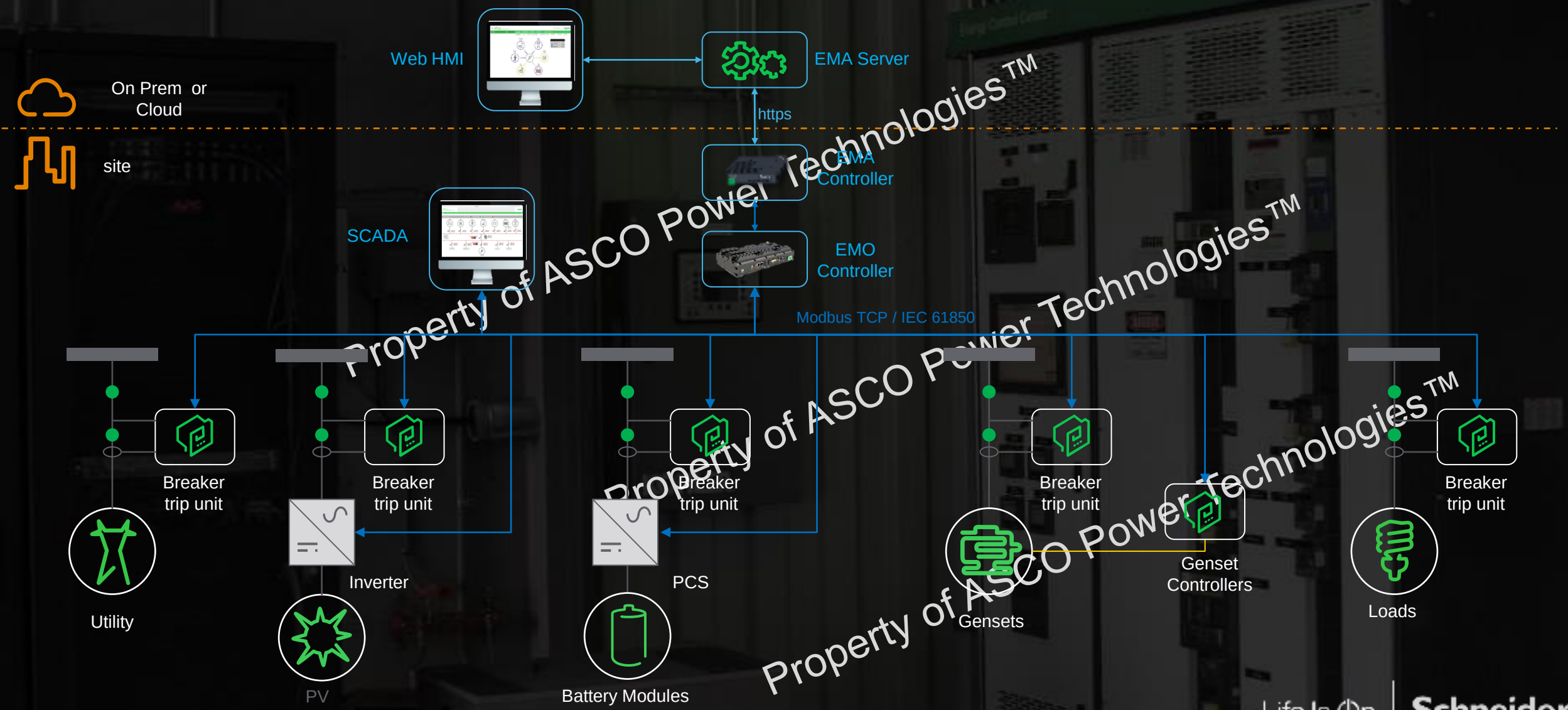
Software & Tools

- Design
- Quote
- Build
- Install
- Commission
- Operate & Maintain

Sequence of Operation



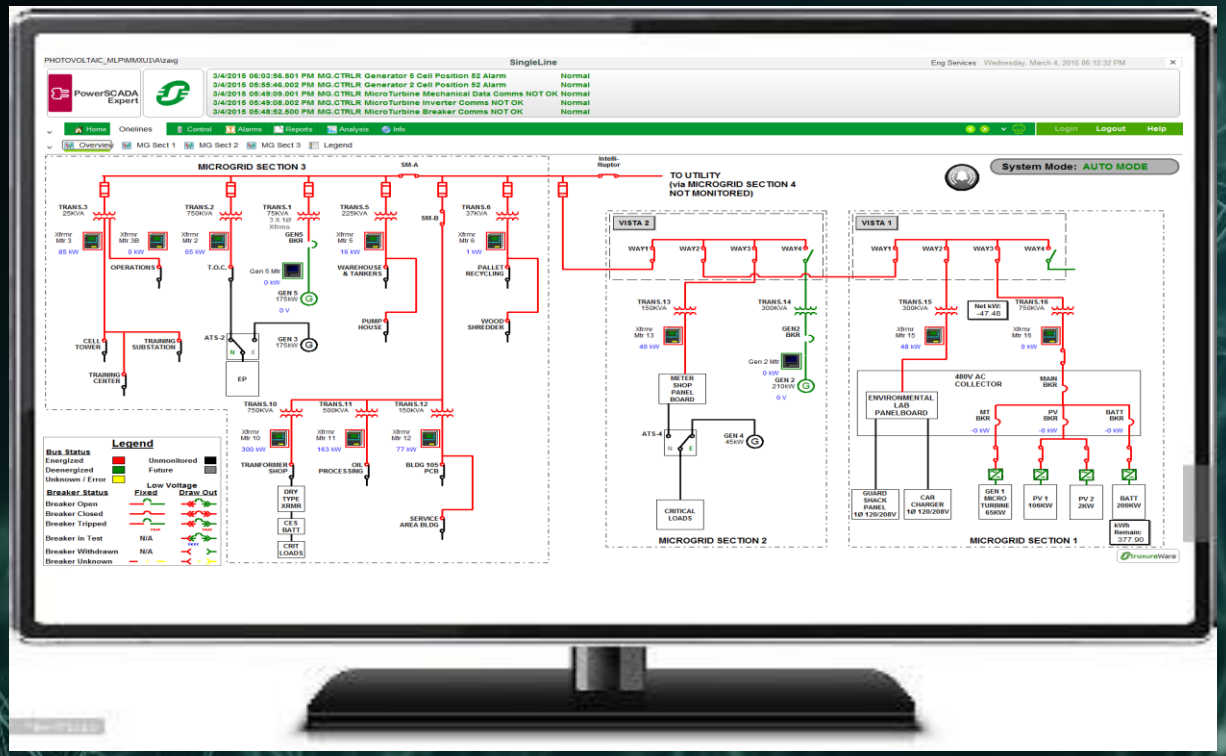
Command and Control Architecture



Microgrid Control System built into an Energy Control Center

Manage island mode, transitions, and optimize DER when grid tied

EcoStruxure™ Microgrid Operation



EcoStruxure™ Microgrid Advisor

Forecast and optimize when to consume, produce, store, or sell energy

Scheduling systems

Weather forecast

Energy market pricing

Demand response requests

EcoStruxure™ Microgrid Advisor

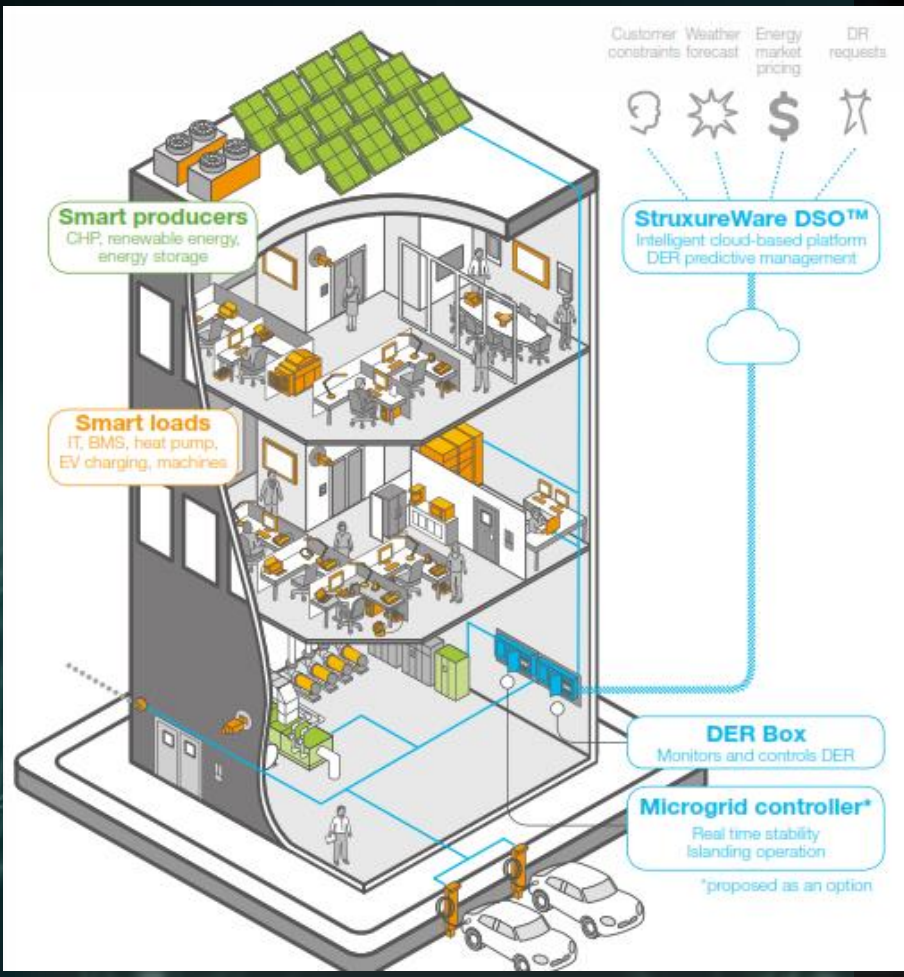
WebHMI

On-site generation (renewable, conventional)

Storage

Flexible loads

Cloud-based demand side energy platform that enables you to dynamically control on-site energy resources and loads to optimize your system's performance.

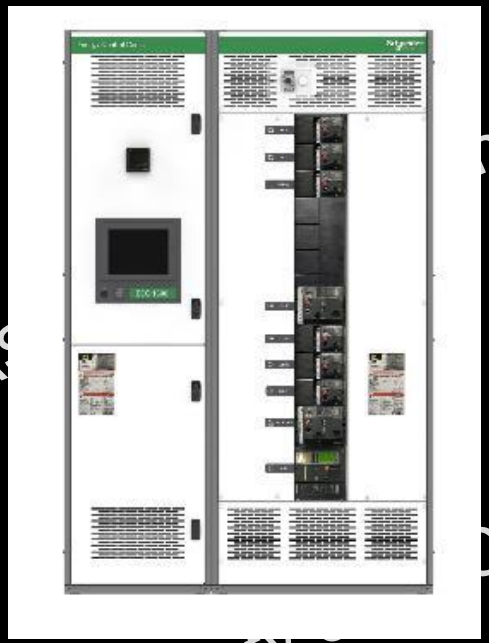


The Energy Control Center Can Support a Building's Specific Needs

ECC 800/1200

Typically used w/ 25–250 kW DER's

- Islanding for resiliency
- Generator or Battery Storage as anchor resource
- PV usable while islanding or grid-tied
- Load management
- Multi-source management
- Economic optimization of DER's from EcoStruxure Microgrid Advisor
- 800-1200 A bus rating



ECC 1600/2500

Typically used w/ 100–750 kW DER's

- Islanding for resiliency
- Generator or Battery Storage as anchor resource
- PV usable while islanding or grid-tied
- Load management
- Multi-source management
- Economic optimization of DER's from EcoStruxure Microgrid Advisor
- 1600-2500 A bus rating

ECC (Engineered to Order)

Used w/ any size and type of DER's

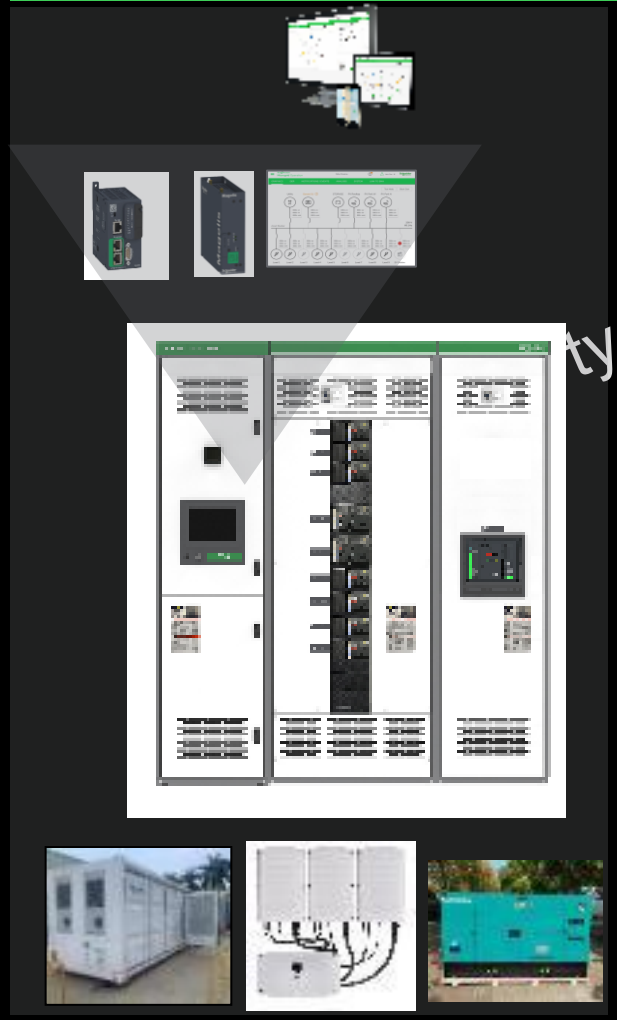
- Islanding for resiliency
- Fast load shedding available with IEC61850
- Customized Sequences of Operations, use cases, load/source management available
- Customized protective relaying available
- Generator(s), CHP, Battery Storage or other DER as anchor resource
- PV usable while islanding or grid-tied
- Economic optimization from EcoStruxure Microgrid Advisor
- Up to 5000 A bus rating

Manufactured in the United States

EcoStruXure Microgrid Flex ANSI

Microgrid solution for medium buildings | Available for Purchase: Q4 2023

A tested and validated offer …



Cloud

- EcoStruxure Microgrid Advisor: Remote monitoring & Optimization
- Remote access

Real time optimization

- EcoStruxure microgrid operation
  - Main anchor resource – Genset, BESS
  - Transition Genset to Grid – Closed/Open

Energy control center

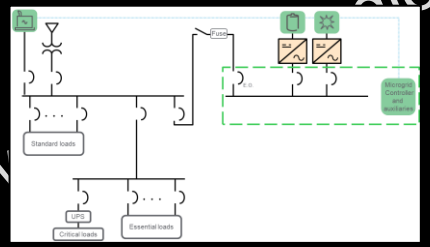
- QED2 based ECC (expedited lead time)
  - 3000A iline, 3000A max sources, 1200A rest (max), 3000A IMCB
  - Protection relay
  - 65kA @480V, NEMA1/3R
  - No utility entrance
- Mains – MasterPact MTZ (IMB) Fixed controllable
- Rest all – PowerPact P/H/J/L motorized
- Metering - Mains – MTZ embedded metering, PV – PM5563, BESS – PM5650 in Schneider BESS, Genset – Cummins controls/Generic hardwired

DERs

- **PV** (2 CB, 15 inverters) – Solar Edge/ SMA, **Genset** (1CB, 1 Genset)– PCC3300 (Cummins), Generic hard wired, BESS (1CB, 1 BESS) – Schneider, Loads (Upto 10 sheddable)

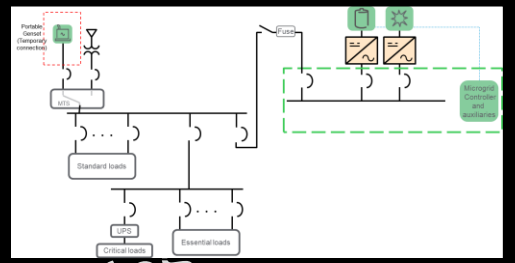
TVDA plan

- ✓ DER lib. Cummins Genset + Brand agnostic hard wired / Schneider BESS / Solar Edge PV
- ✓ Genset as main anchor resource, BESS grid tied
- ✓ Closed transition from Genset to utility (Open Utility to Genset), No transition between DERs



Islandable

- ✓ DER lib. Schneider BESS / Solar Edge PV
- ✓ Portable Genset – Disconnect PV & BESS



Always Grid tied with portable genset

Key value propositions

Energy cost optimization

Resilience

Sustainability

Easy to select, quote, build, install and commission

Tested, Validated, Documented

Shorter lead time

Compliance to latest standards

Target segments (>1.5MW MGs)

Education (Schools)
Grocery stores
Shopping center
Libraries
Government offices
Laboratories
Nursing homes
Mixed use buildings

Target GTM

Energy as a Service
Contractors
Specifying engineers
System integrators
End users

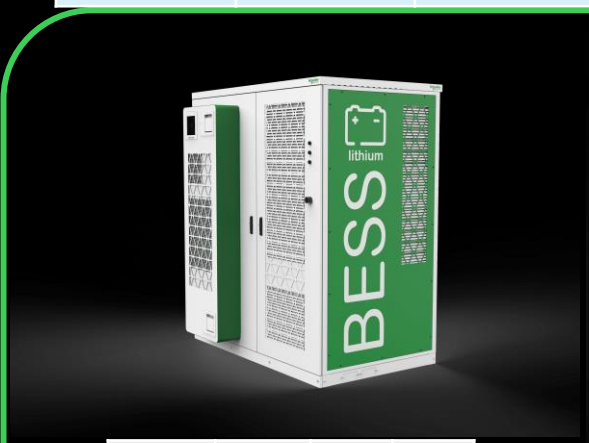
All-in-One Enclosure BESS – *Connection Ready*

Fully integrated with inverters/batteries, cooling, output transformer, safety features & controls

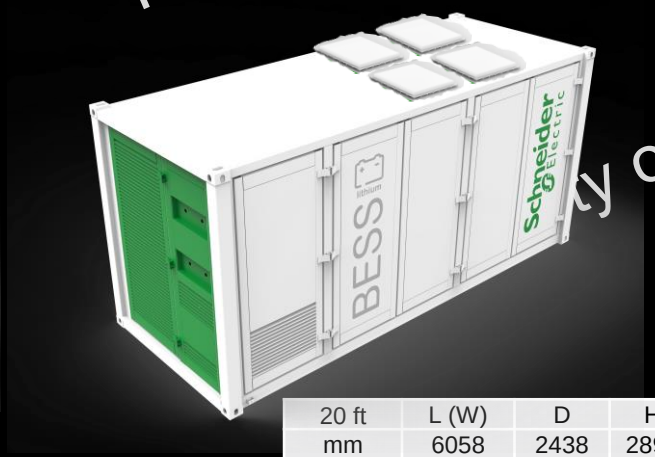
BESS Size	Power kW	Energy kWh	# of Enclosures	Comments
7 feet IP54 Enclosure (L x D x H mm): 2100 x 1300 x 2350				
Small	60	205	1	**Make to order** - 60kW BESS hybrid option available (PV plus battery input <AC and DC coupled Options>). **Lead Time**~ 43 weeks
	90	205	1	
	180	410	2 x 90 kW	
20 feet IP54 Enclosure (L x D x H mm): 6058 x 2438 x 2896				
Medium	375	860, 1147, 1434, 1720	1	**Make to order** - shipping directly to customer site. (AC Coupled only) **Lead Time** ~ 43 weeks
	500	1147, 1434, 1720	1	
	> 500	> 500kW can be realized by connecting additional 20 feet enclosures in parallel up to 2MW. For example: 750kW/1720kWh (2 x 375kW/860kWh), 2MW/4588kWh (4 x 500kW/1147)		

Key offer details:

- Tested and validated with EcoStruXure MG Operations/Advisor (EMO/EMA)
- **UL9540** certified
- Lithium-ion Iron Phosphate chemistry (UL9540A)
- 6000 cycles/15-20-year battery life (application dependent)
- Battery modules shipped installed
- Overload capabilities 105-150% (timescale dependent)
- AC interconnections made up to 500kW
- Dry pipe sprinkler system standard
- **Optional:**
  - Deflagration venting
  - UL listed Novec 1230 fire suppression



7 ft	L (W)	D	H
mm	2100	1300	2350
feet	6.9	4.2	7.7



20 ft	L (W)	D	H
mm	6058	2438	2896
feet	19.9	8.0	9.5

Each enclosure includes:

- AC and DC protections, disconnect, fuses, and pre-charge
- Battery management system, battery racks, modules
- PM 8K Series DIN rail meter
- Auxiliary power,
- Uninterruptible Power Supply (UPS) for controls
- Output isolation transformer, 4-wire output
- HVAC cooling thermal management
- System controller with Modbus TCP interface
- Dry pipe sprinkler system
- Smoke, temperature, and humidity sensors
- Deflagration venting and explosion prevention system
- Cabling bottom entry
- 3 Std. warranty

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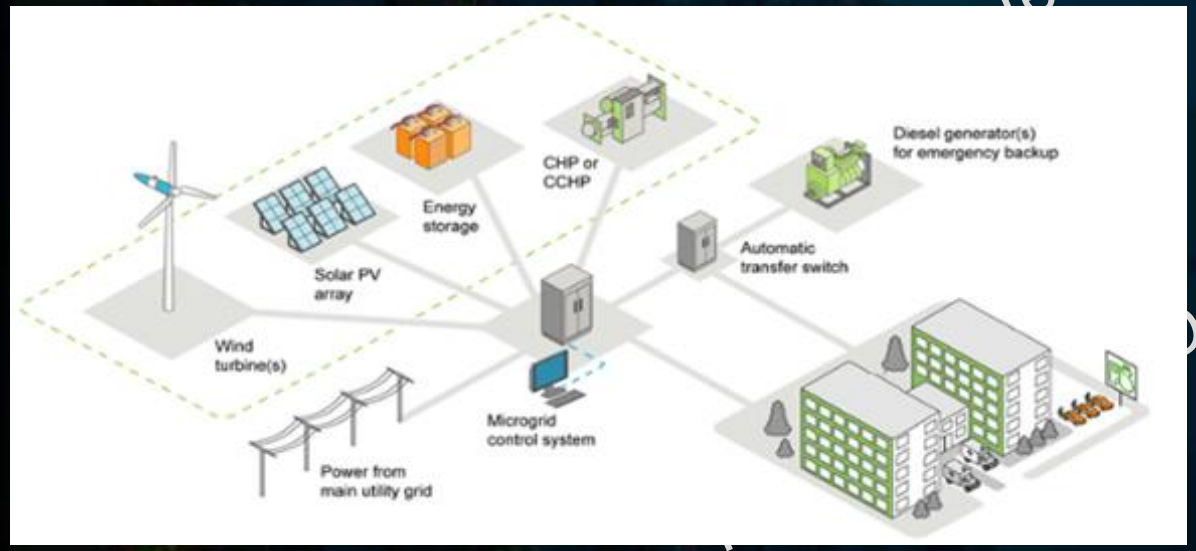
Transitioning to Sustainable Operations



Key Questions to Consider for Operations Maintenance and Optimization

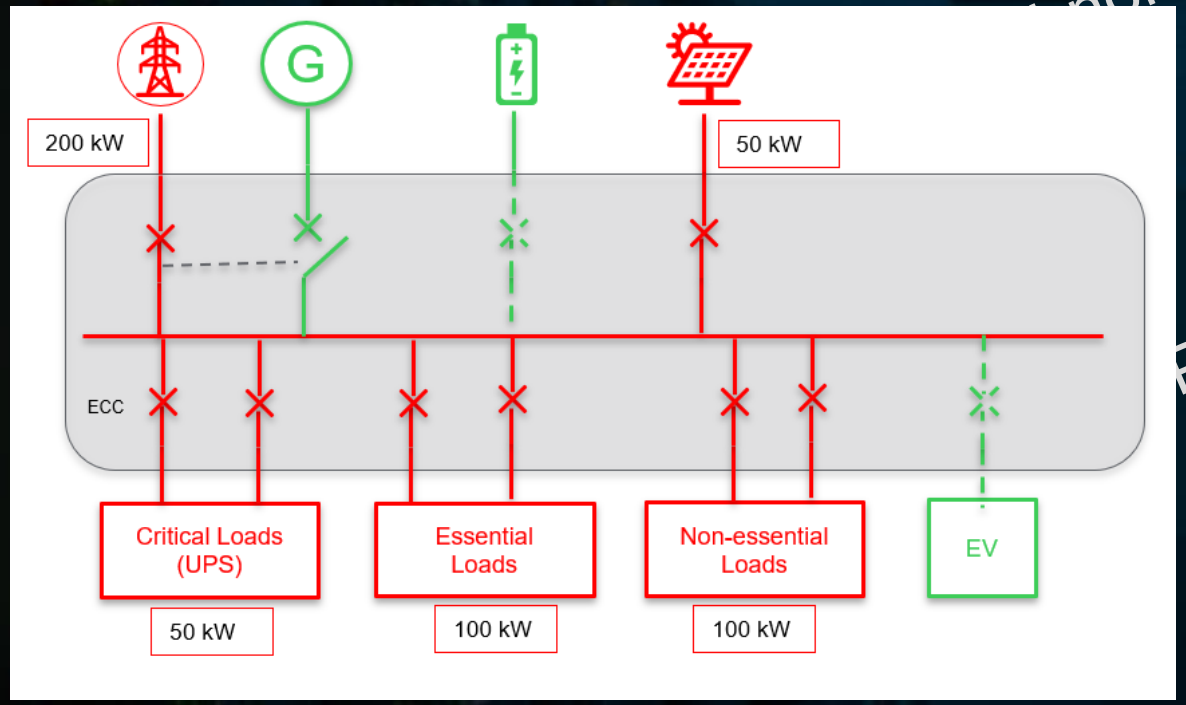
Who and how will the entire system be monitored?	Is remote system access available for remote troubleshooting?	Who will receive system alarms and what types of alarms are needed?
Is grant or other reporting needed?	Who is the main point of contact for the various parts of the microgrid system and how will root-cause and responsibility be determined?	How will the system settings be changed over time to account for changes in load, tariffs, and use cases?
Do you do real time continuous monitoring of electrical equipment health?	Do you plan to run the systems to failure or employ a preventative maintenance strategy?	What is the spare parts strategy?

Designing for Function

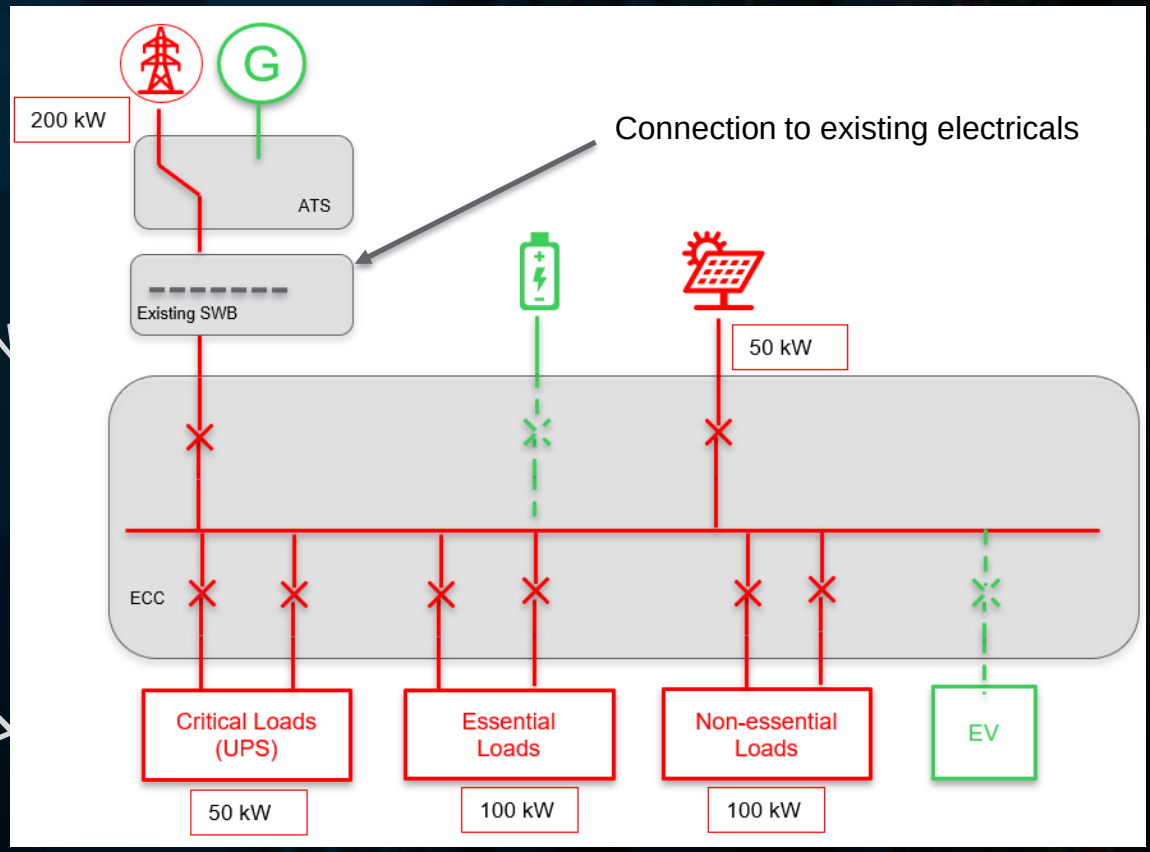
Greenfield vs. Brownfield Approaches

Designing for Function is Key

Greenfield



Existing installation

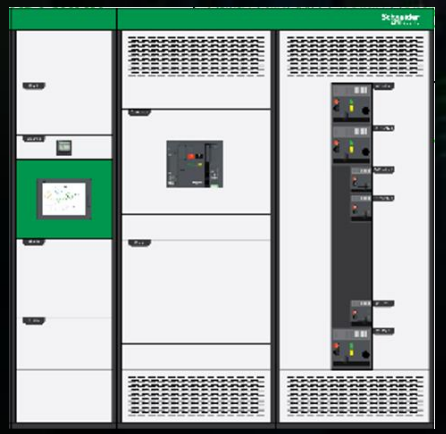


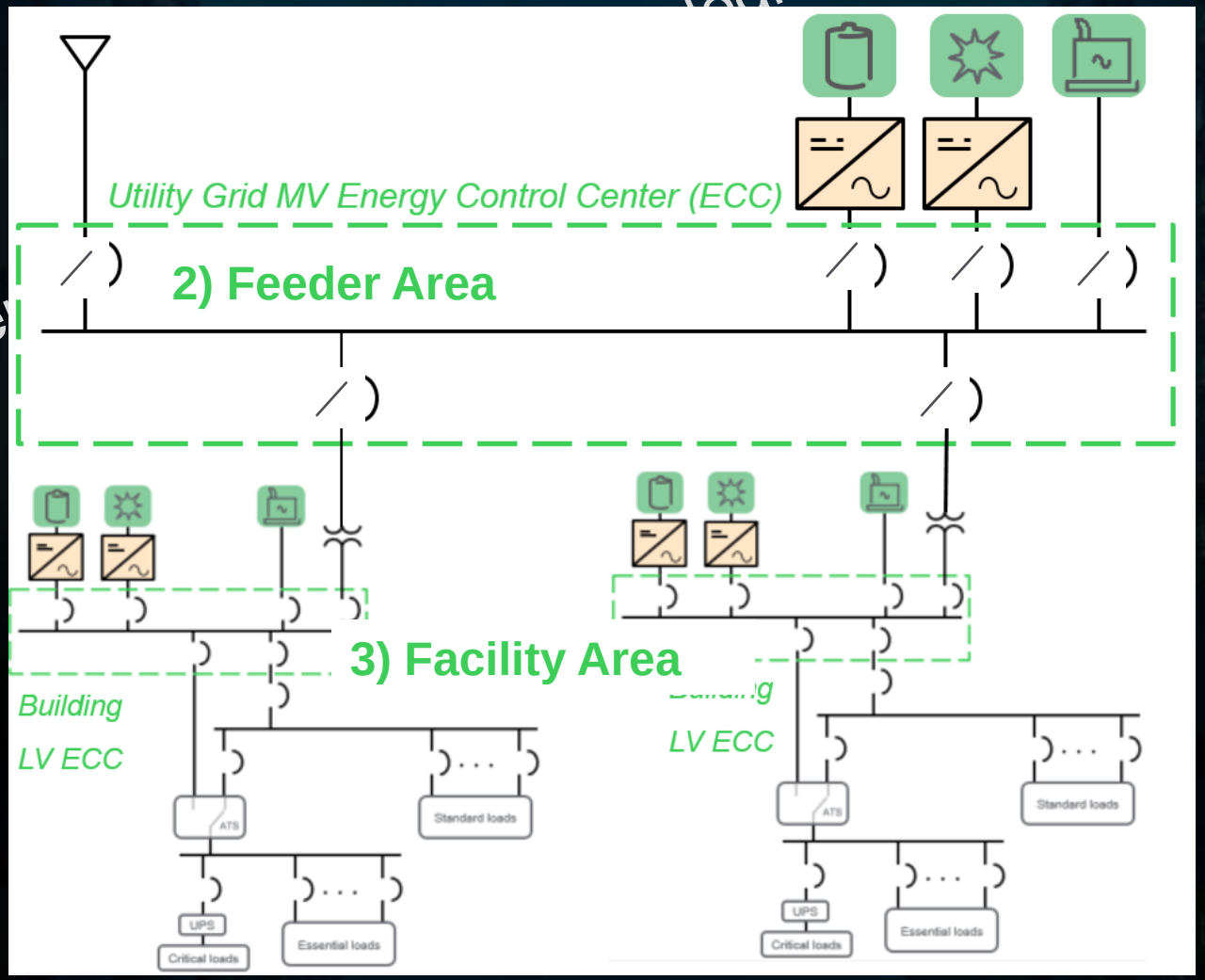
Different configurations of ATS, DER combinations etc. and incorporating existing switchboards are possible needs.

Three Levels of campus Microgrids

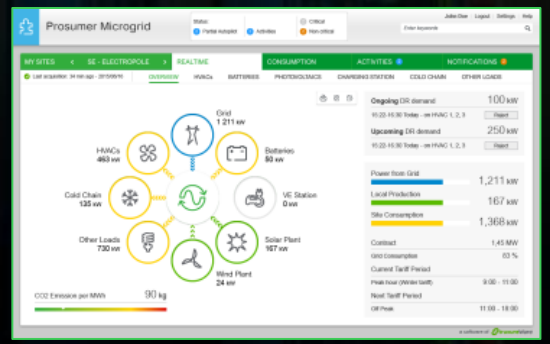
Complementary approaches, not a one size fits all concept

Substation, DER or PCC Microgrid Automation Controller. Load Shed/Add, Protection, Metering, Integration with Utility SCADA





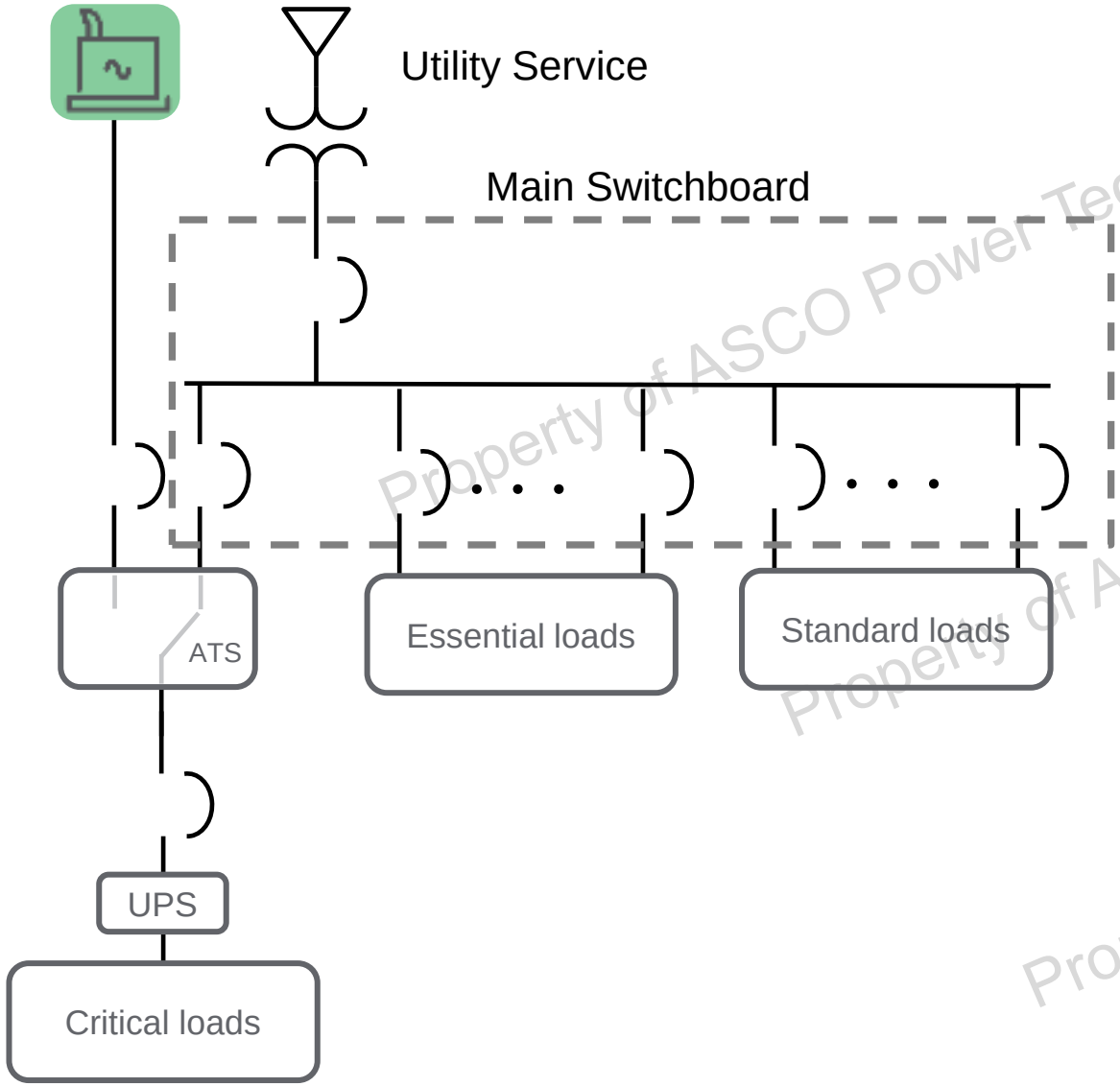
- DER Point of Coupling
  - Solar PV
  - Battery Energy Storage (BESS)
  - Generator
  - Combined Heat and Power
  - Fuel Cells
  - Wind Energy



- Economic Optimization
- Building Automation
- Process Automation
- Energy Automation

Typical Electric Configuration with Backup Generator

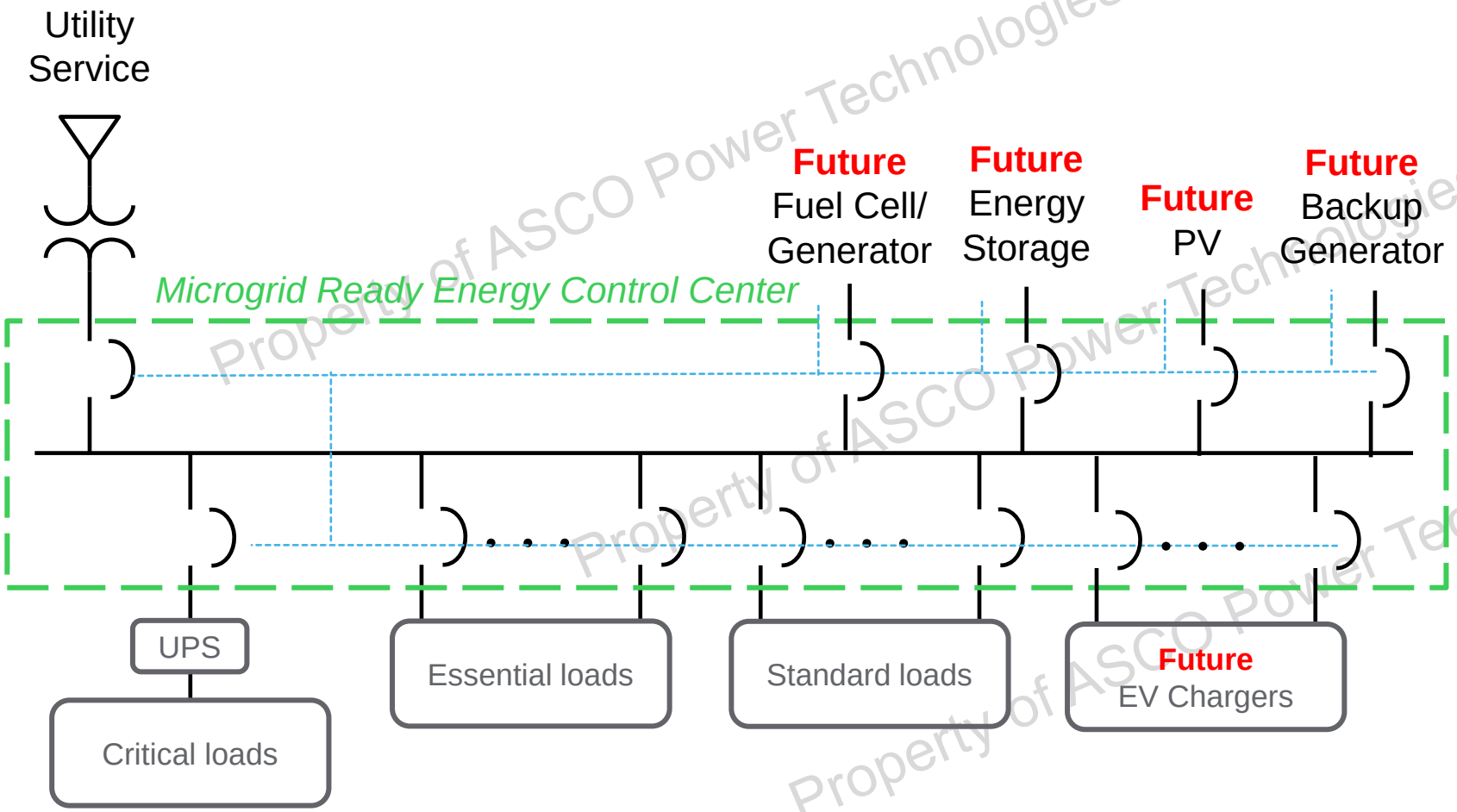
Backup Generator



Features:

- Standard breakers
- No controls
- ATS to critical loads

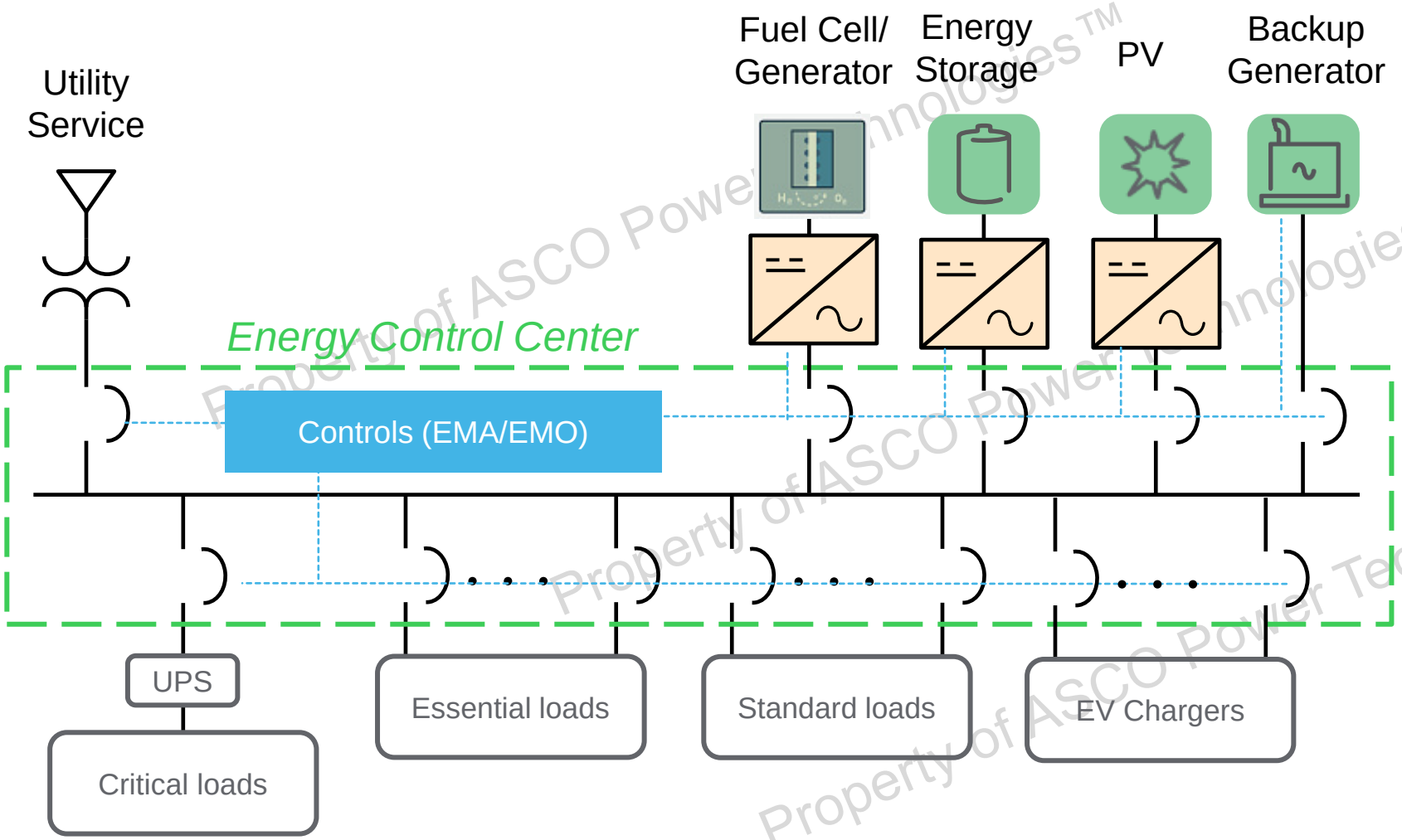
Microgrid Ready Approach



Features:

- Smart and electrically operated breakers
- Pre-wired power and controls connectivity to generation systems
- Main bus sized for future loads and DERs
- Pre-configured for islanding capabilities
- Pre-configured for controls
  - Energy management
  - Island operations

Fully Resilient Microgrid



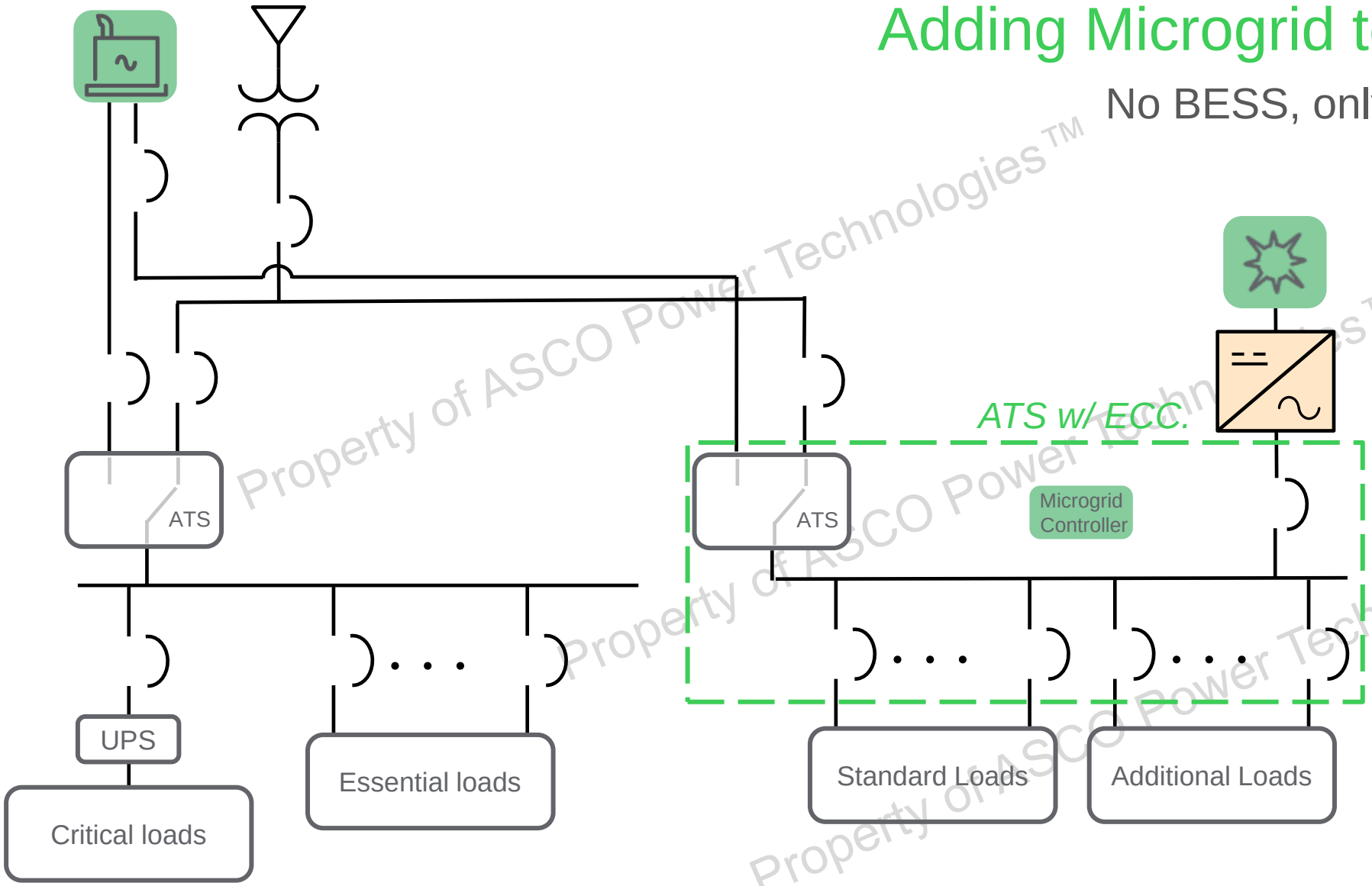
Features:

- Smart and electrically operated breakers
- Power and controls connectivity to generation systems
- Islanding capabilities
- Integrated controls
  - Energy management
  - Island operations

ATS Design Approaches for Microgrids

Adding Microgrid to a Brownfield

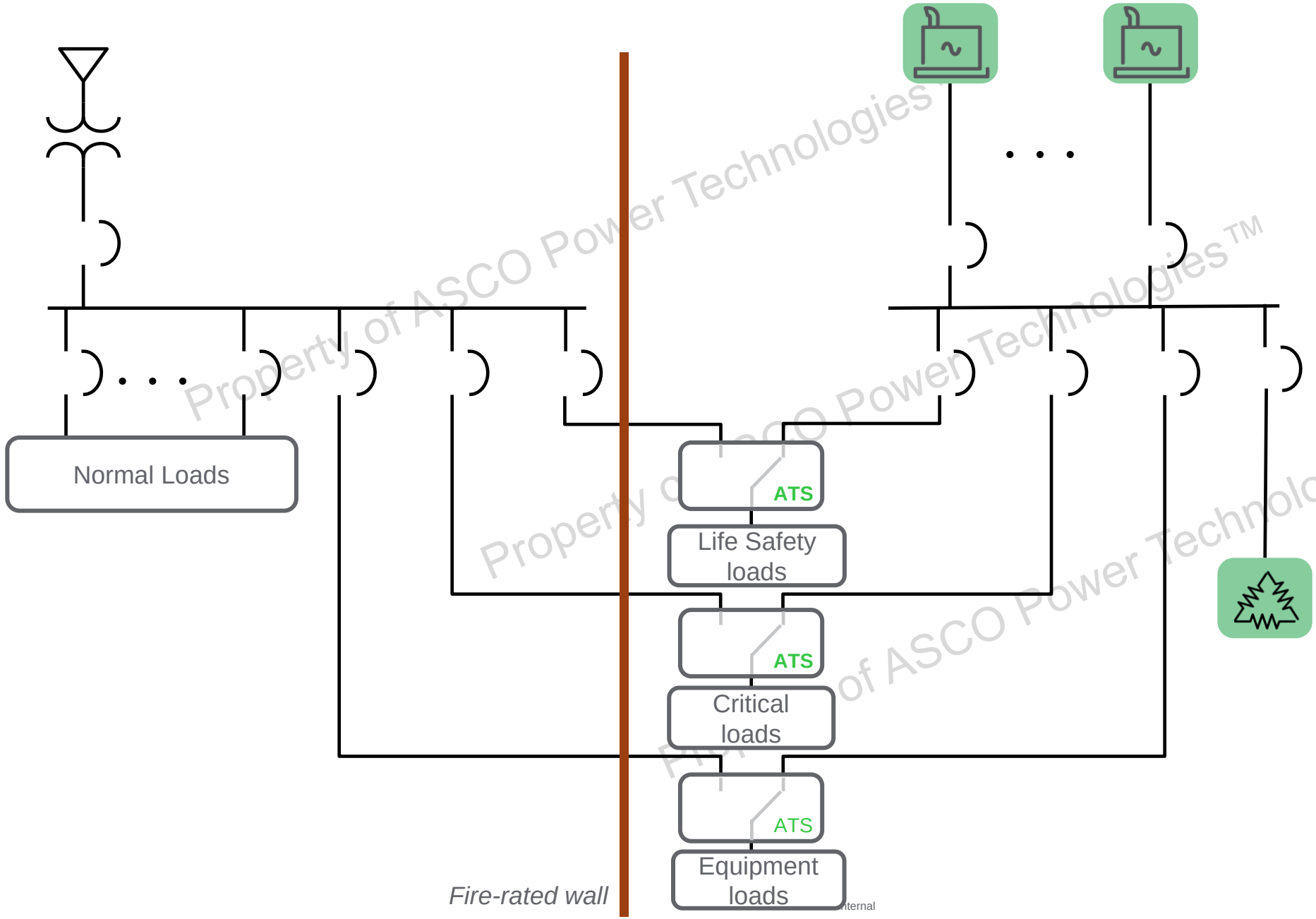
No BESS, only Solar. ATS add-on



Highlights:

- ATS is the anchor resource
- Distribution added on load side
- Microgrid Controller (DP scope).

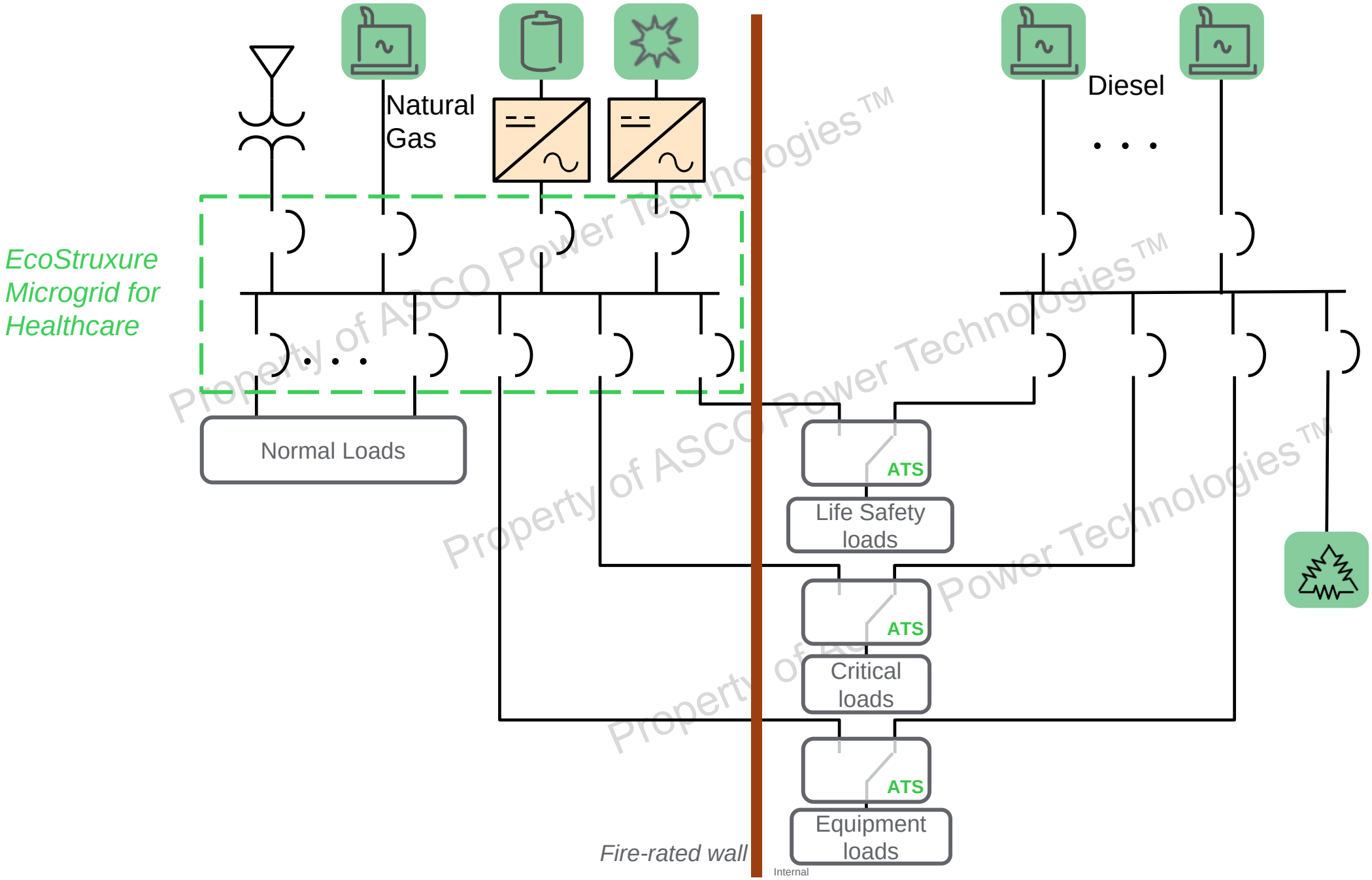
Traditional Architecture (simplified for Hospital)



Example (New Facilities)

- Design per NEC
- Must use calculated loads with minimal demand factors
- Load ends up twice as much as actual “Used” load
- Generator ends up one third or half loaded
- Current NEC calculated normal load of Example is 1400KW or 14 w/sq. ft.
- Current NEC calculated emergency load of Example is 1200KW

Microgrid added to Traditional Architecture



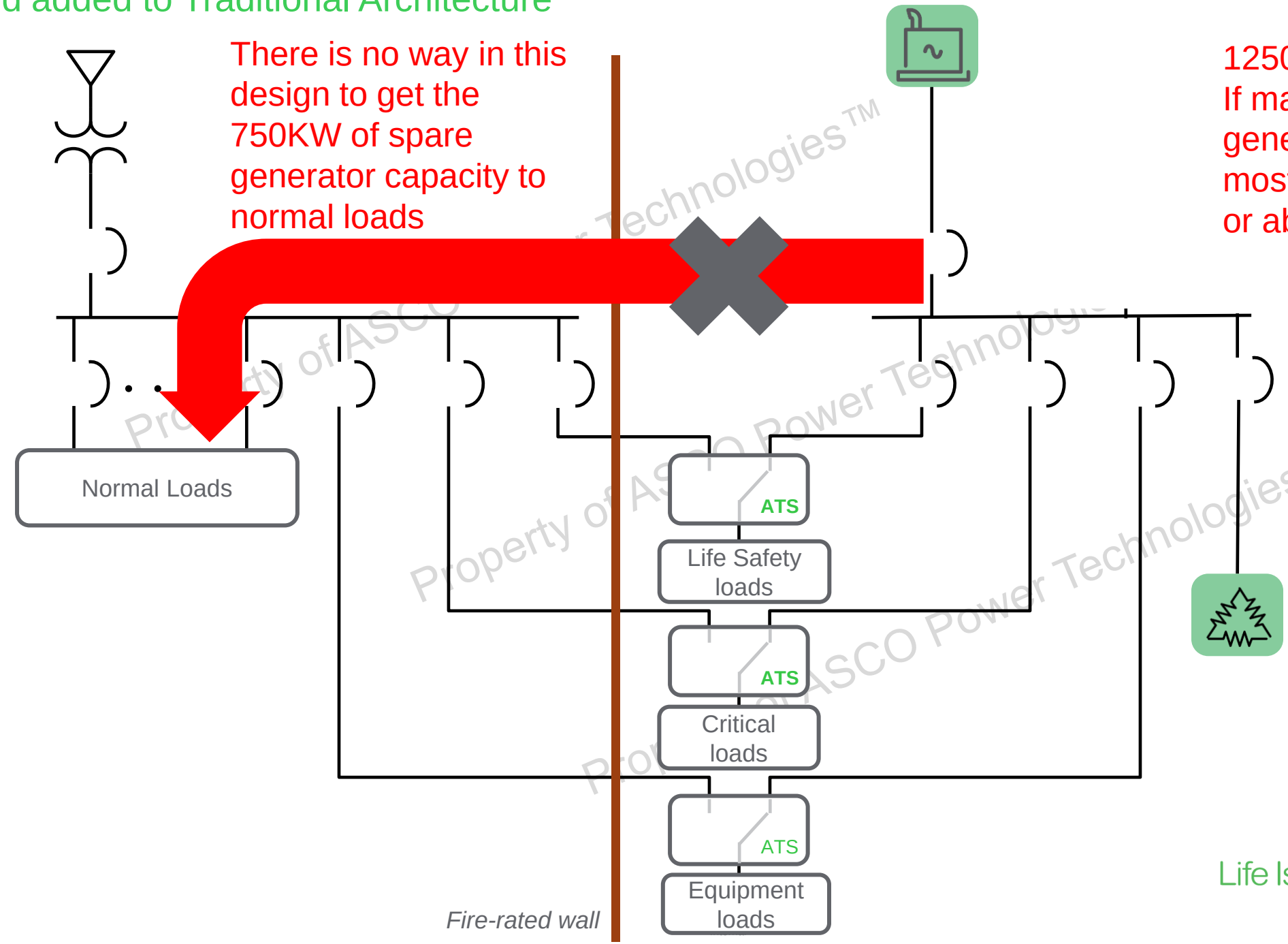
Design Microgrid with Actual Loads not Calculated Loads

- Microgrid Design for Example
- Assume 800KW is maximum load for Example
- Design Microgrid around the 800KW maximum load
- Take 1250KW and make it two 750KW generators to have N+1 redundancy
- Add 50KW to 200KW microturbine to have N-1 generation capacity of at least 800KW
- Have Microgrid Energy Control Centers on both normal and emergency sides of power distribution system
- Develop a sequence of operation that works in island mode and can run the hospital

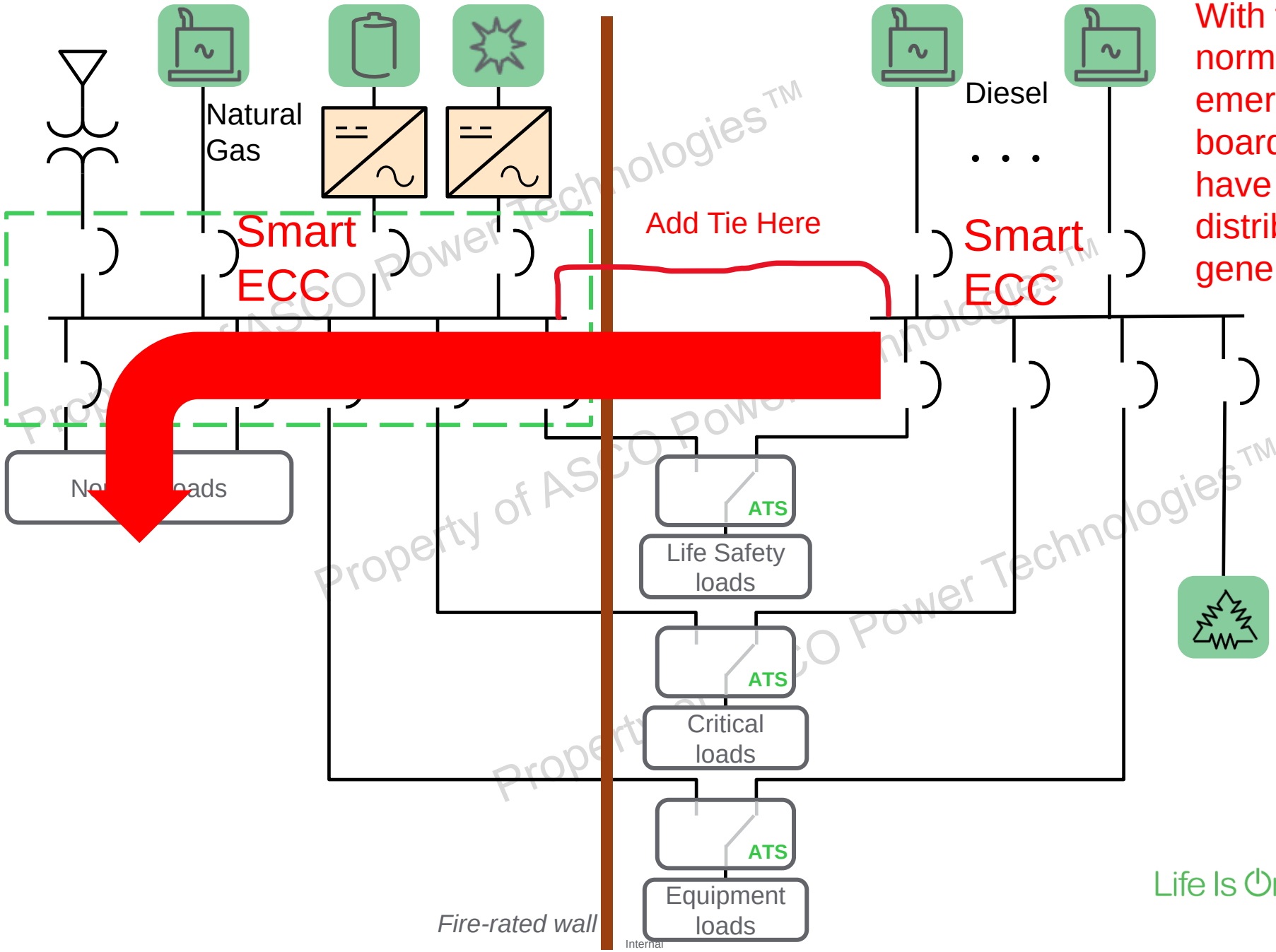
Microgrid added to Traditional Architecture

There is no way in this design to get the 750KW of spare generator capacity to normal loads

1250KW Generator
If max load is 800KW generator load will most likely be 500KW or about 40% capacity



Microgrid for Healthcare



With tie between normal and emergency boards we now have path to distribute generator power

Applicable Standards for Microgrids

Disclaimer: Partial list only. Wide variety of national, state & local regulations apply.

Standard	Title	Description
IEEE1547 & 1547.1	Standard for Interconnection & Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces	Establishes criteria and requirements for interconnection of distributed energy resources (DER) with electric power systems (EPS), and associated interfaces.
UL1741, UL1741-SB	Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources	Describes manufacturing (including software) & product testing requirements to specify inverters more capable of riding through grid excursions and actively managing grid reliability functions.
UL891, UL1558	Standards for Switchboards & Switchgear	Supplements ANSI switchgear standards C37.20.1 and C37.51. Used in conjunction with NFPA70/NEC.
NEC 705	Interconnected Electric Power Production Sources	Standard for busbar sizing
NFPA99	Healthcare Facilities Code	Covers aspects of emergency power systems and associated testing in healthcare facilities.
UL3001* (evolving)	Standard for safety and performance of distributed energy systems	Covers DER system design, integration, and operation.
IEEE2030.5	IEEE Standard for Smart Energy Profile Application Protocol	Defines the application layer with TCP/IP providing functions in the transport and Internet layers to enable utility management of the end user energy environment, including demand response, load control, time of day pricing, management of distributed generation, electric vehicles, etc.
IEEE 2030.7	IEEE Standard for the Specification of Microgrid Controllers	Address functions at the microgrid system level (above the component control level) to enable control functions to manage itself, operate autonomously or grid-connected and seamlessly connect/disconnect from the grid.
IEEE2030.8	IEEE Standard for the Testing of Microgrid Controllers	Testing procedures to enable verification, performance quantification and comparison of different functions of microgrid controllers
IEEE2030.9	IEEE Recommended Practice for the Planning and Design of the Microgrid	Best practices for the planning and design, including system configuration, electrical system design, safety, power quality monitoring and control, electric energy measurement and scheme evaluation.
California Rule 21	Tariff document describing the interconnection, operating, and metering requirements for generation facilities to be connected to a utility's distribution system.	Rules for the performance, function, metering, and communications of generation and energy storage systems

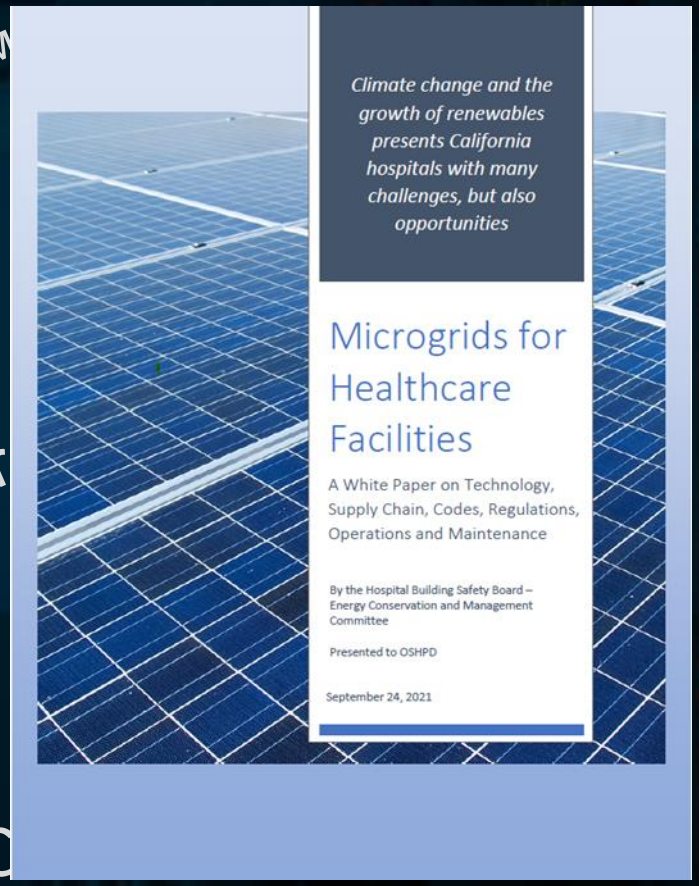
Code Compliance Microgrids in Healthcare Facilities

- **Current Code Compliance for normal power**
  - State and local codes adhered to
  - System does not jeopardize the reliability of healthcare facilitate
  - Emergency Power separate from Microgrid
  - Code issues for Microgrids as an EPS (Emergency Power Supply)
    - NFPA 110, 99 & CEC codes written around generators & ATS (without reducing the reliability of the emergency system)

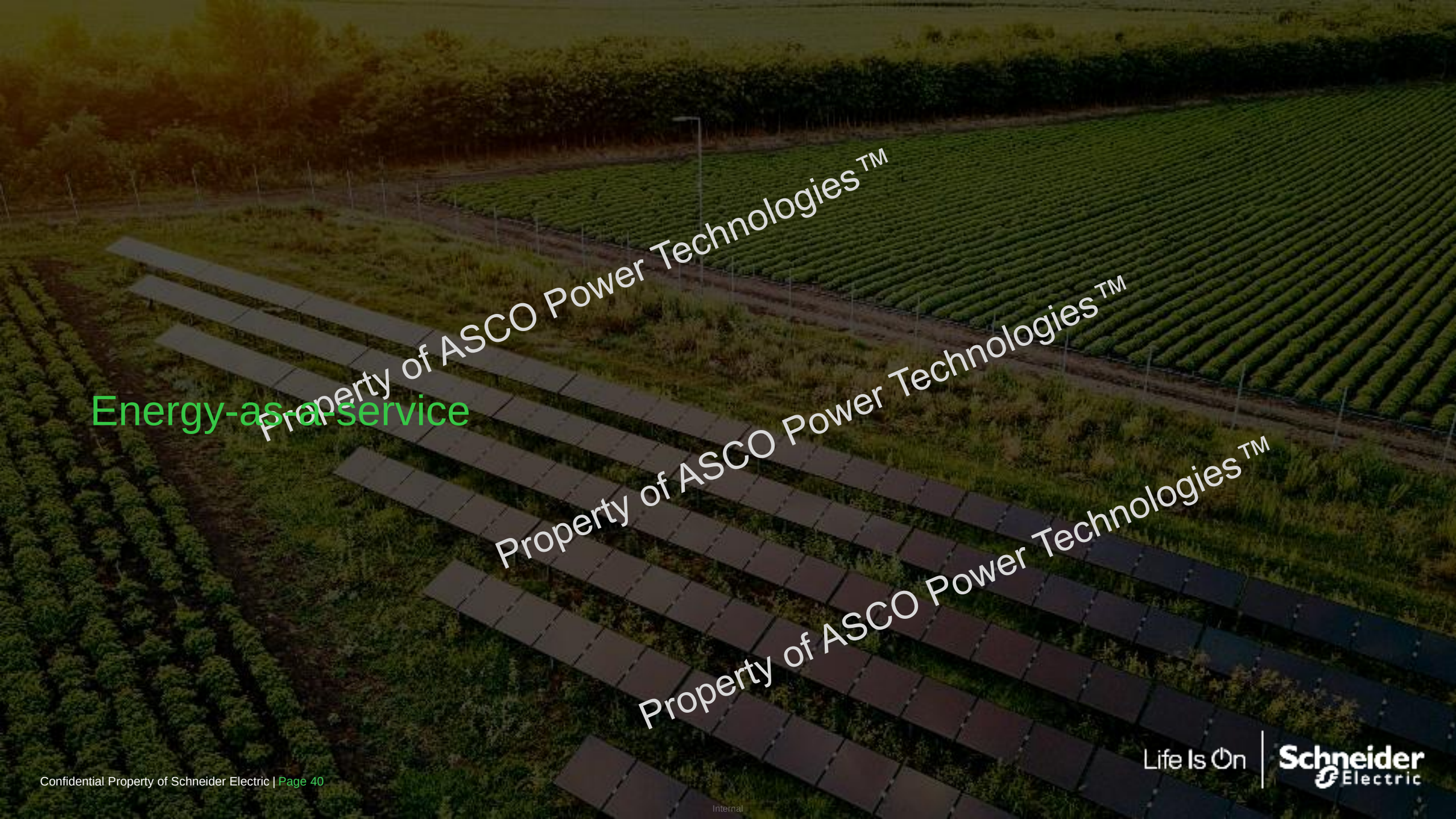
- **2021 NFPA 99 states:**

  "microgrids can be used as an EPS id designed with sufficient reliability to provide effective facility operation consistent with the facility emergency operation plan" – no criteria to measure by to enforce

New Code Revisions Underway



Hospital Building Safety Board (HBSB) & Energy Conservation and Mgmt (ECM) White Paper presented to OSHPD as guide for the adoption of a Microgrid technology to reduce or eliminate the need to rely on generators as the source of emergency power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Transfer risk and preserve capital for core business objectives

Customer CAPEX	Energy as a Service
• Ownership risk associated with long term performance of distributed generation assets	• Energy management company providing system performance for resilience, efficiency and sustainability
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• O&M staffing skill needed to support and optimize energy system	• Industry-leading experts manage building and operating system
• Annual O&M budgets and exposure to long term energy cost increase	• Long term contract (10, 15 or 20 years) allows site to budget for specific amount of electricity
• Regulatory risks related to energy and sustainability	• Protected from financial, regulatory and technical risks

Creating a **different approach to sustainable outcomes**

With Energy As A Service, you get the functional energy outcomes you need to run your business with cost-responsible, resilient, and sustainable energy.






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You get the energy outcomes you need to run your business and a competitive advantage.	Capital is freed up for core business needs and priorities.	You get an energy partner that helps you take control of your energy – we work alongside you for the long-term to meet your goals.	You agree to the security of a long-term contract (15-25 years), allowing you to budget for electricity while adding protection from increasing electricity rates.	Our industry-leading experts design, build, own, operate and maintain the microgrid's power and operating systems.	We provide regular updates on your resilience, efficiency and sustainability metrics.

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GreenStruxure™
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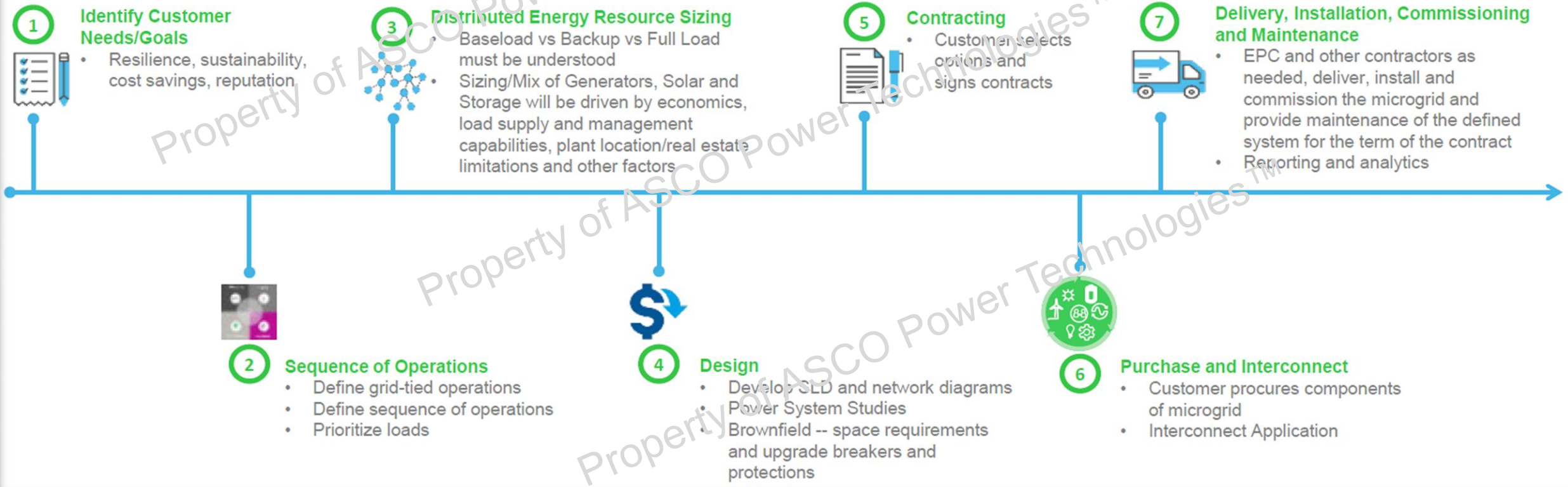
Microgrid Project Process

Building out an advanced microgrid



US Microgrid Experience

Microgrid Control & Load Management supporting 1,131 MW
of distributed generation in the United States

Microgrids powered by Schneider Electric examples delivered in the past 5 years

Project	Location	Microgrid Capacity (MW)			
		Carbon Free Electricity Generation	Energy Storage	Fossil-Based Generation	Total
John F. Kennedy Airport New Terminal One	Queens, New York	7.7	2	3.7	**13.4**
Brookville Bus Depot Microgrid	Montgomery County, MD	2	3	2	**7**
EMTOC Bus Depot Microgrid	Montgomery County, MD	5	2	-	**7**
Marine Corps Station Miramar	San Diego, California	4.5	1.5	7	**13**
Yokota Air Base	Tokyo, Japan	1.5	-	10	**11.5**
Marine Corps Logistics Base	Albany, Georgia	8.5	-	7.5	**16**

Forward Together

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Microgrid Acronyms:

Commons Terminology

- DER – **D**istributed **E**nergy **R**esource
- Blackstart – The ability to prevent the loss of power through use of on-site power generation when the main grid fails.
- Title 24 – Landmark California law that ensures that building construction and system design and installation achieve higher energy efficiency.
- PV – **P**hoto**v**oltaic, energy source that converts sunlight into electricity.
- Islanding – Process of attaching and detaching a system from the power grid.
- Grid-tie – System dependent on the power grid. Inverter is connected to the grid and “follows” another source’s voltage and frequency
- Grid forming: Inverter creates the reference voltage and frequency to become the “anchor” resource and is able to form own grid
- Anchor Resource: the reference source for voltage and frequency
- CHP: Combined Heat & Power, or cogeneration
- PV capabilities – Lacks the ability to black start on its own due to low continuous output.
- Battery Energy Storage System (BESS) – Generating power and storing it in batteries throughout off hours to be used during peak loads or power outages