DoD/DoE Installation Microgrid Concepts

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ROBINS AIR FORCE BASE

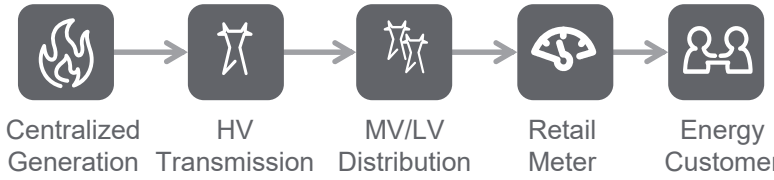
1	Energy Trends
2	Tools for planning microgrids
3	Building scale microgrids
4	Utility scale microgrids

Society of SAME American Military Engineers

Energy Megatrends – 3D+E is setting the stage

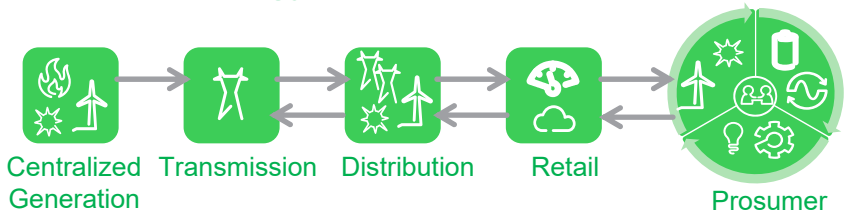
Decarbonization | **Digitization** | **Decentralization** | **+ More Energy**

Historical Energy Value Chain



- Consumers responsible for their own MV/LV Traditional Power Distribution Assets and Operations “behind the meter”, Many implement Energy Efficiency (EE) Measures
- Consumers have some partial base-load and traditional backup power generation of many varied capabilities, but few significant islanding systems.
- Beyond EE, Increasing Local, Efficient Self-Generation + Microgrid Islanding is the road ahead.

The New Energy Landscape



- Utilities house significant Grid-Connected 3rd party owned Solar PV plants with complementing BESSs. In some cases the developer is the utility, but in others it is a 3rd party or a new “Prosumer”.
- Larger Prosumers and Municipalities use PPA and ESCO/IPP PPA/Lease models to leverage existing and build new DERs
- Reduction in costs for DER technologies, increase in reliable delivery + new business models for Energy Services result in the new Energy Landscape

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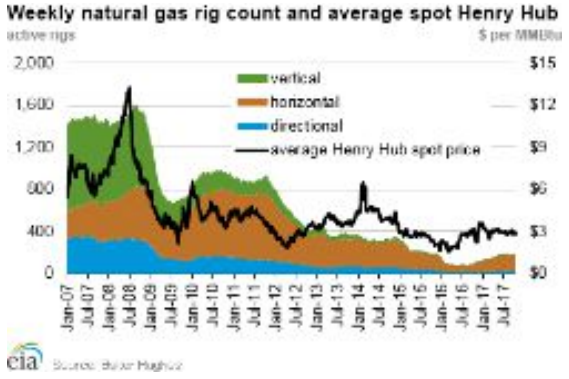
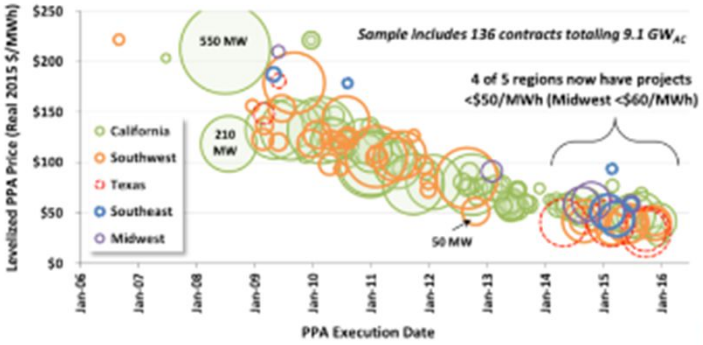
Driving the New Energy Landscape

Inexpensive Natural Gas

North America, wholesale gas prices are still ½ to 1/3 Europe and Asia, about U.S. $ 1.5 - $ 4 MMBtu



Inexpensive Solar



Solar PV is a cost effective tool for lowering an organization's energy bill. Non-Residential costs average U.S. $0.05 to $0.12 per kWh.

Solar generation is often at peak production when electricity demand and prices are the highest

Energy Storage

The cost of lithium ion-based battery energy storage systems are decreasing dramatically, helping solve the intermittency of renewables and heling "behind the meter" enterprises balance supply and demand

FIGURE 19: BATTERY PRICE PROJECTIONS
[Y-AXIS 2012$/kWh]

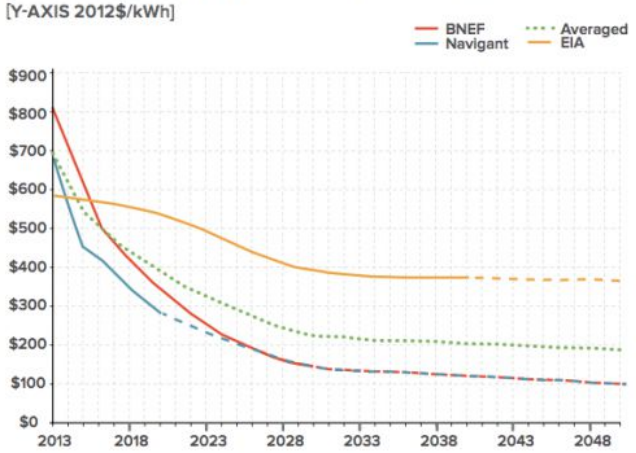


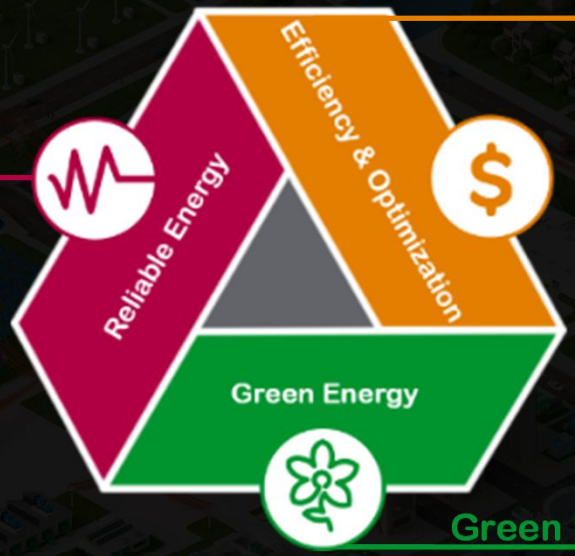
Photo Credit: Rocky Mountain Institute

Integrated Energy Outcomes

Microgrids – System of interconnected Distributed Energy Resources

Reliable Energy

- Distributed Energy Resources for diversification from of grid power
- Making renewable energy work without the grid
- Improved power quality on site assets



Efficiency & Optimization

- Avoided costs through fuel switching
  - Solar PV, gas, biogas
- PPAs = cost predictability
- Higher combined efficiency of CHP, CCHP (cogen) with adsorption chillers
- Capture RECs, tax credits, grants and other incentives

Green Energy

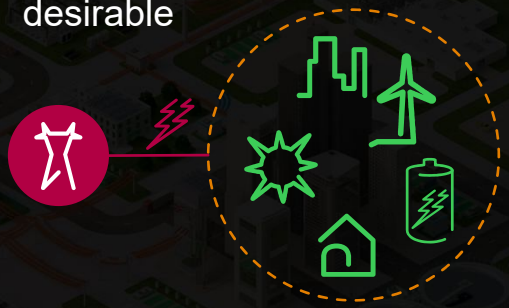
- Renewable energy integration = meet the mandates customer loyalty, employee sat, and perceived leadership

Microgrid Operating Modes

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 other external event which makes local energy more desirable



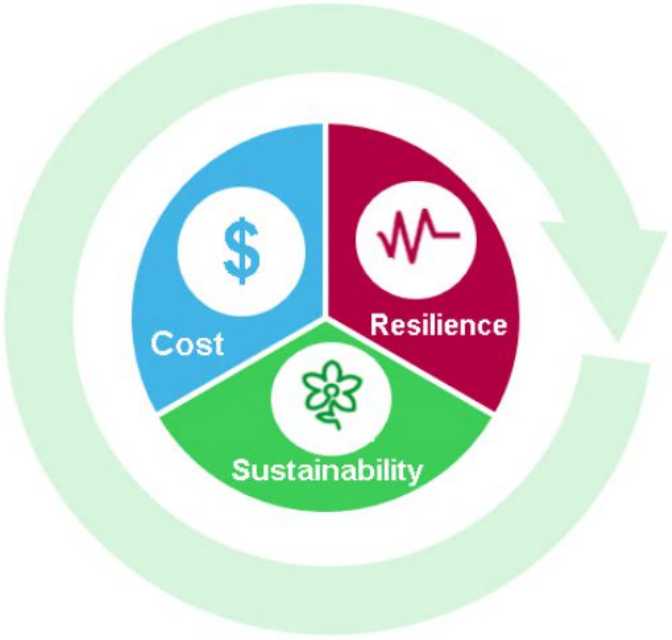
Island-able
Grid Islanded

Microgrid will generate energy from local source

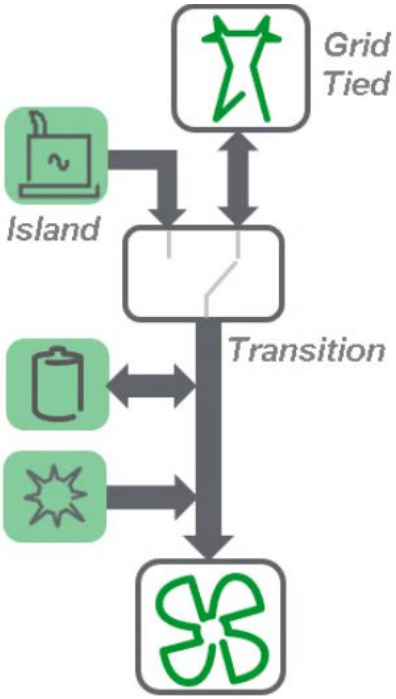
Off-grid

Microgrids: The Intersection of Systems and Energy Outcomes

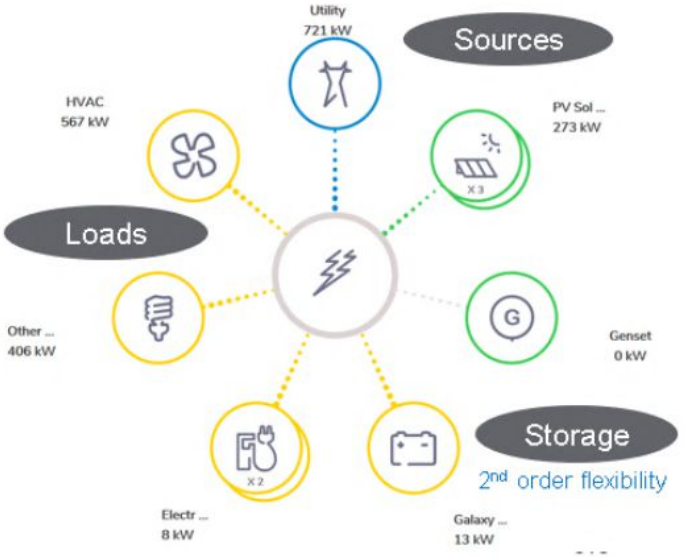
Integrated Energy Outcomes



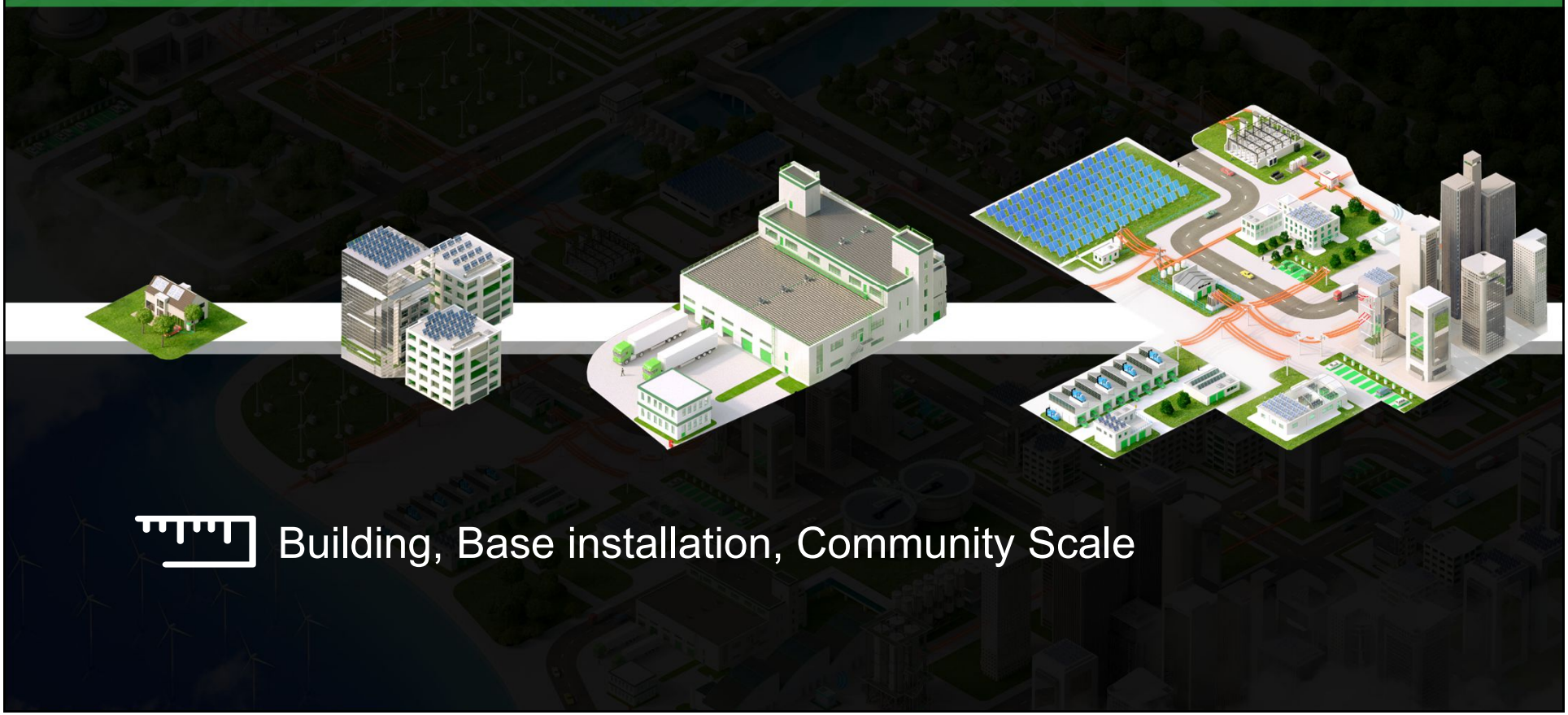
Modes & Architectures



Management & Optimization



Microgrids can operate at any scale



Building, Base installation, Community Scale

Tools for Building Microgrids

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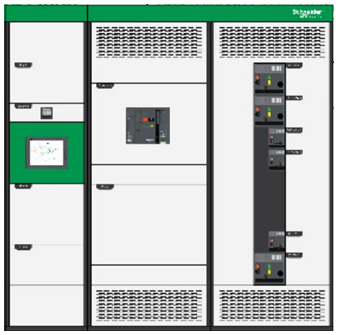
DoD/DoE Installations: Distribution and Building Microgrids

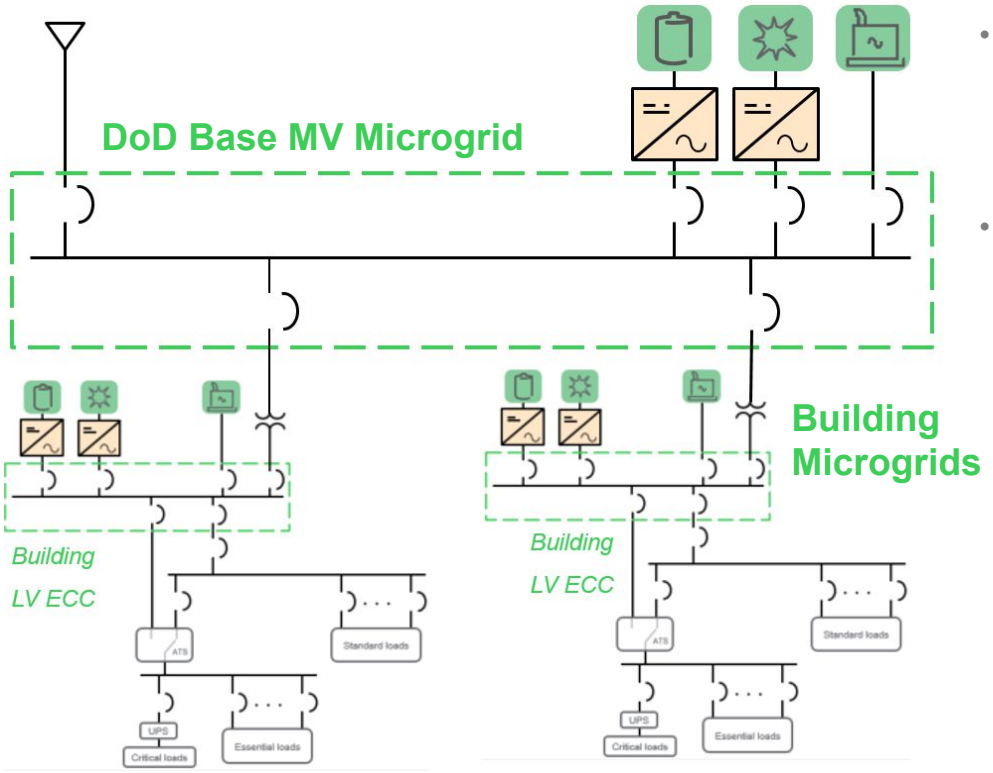
Leverage EcoStruxure Grid level control and monitoring
EcoStruxure Power and Buildings enable the Installation Campus or Building Microgrid

Substation Automation

- Substation, DER PCC
- Microgrid Automation
- Load Shed/Add, Protection, Metering
- Grid-Tied and Grid-Islanded Operation

Energy Control Center





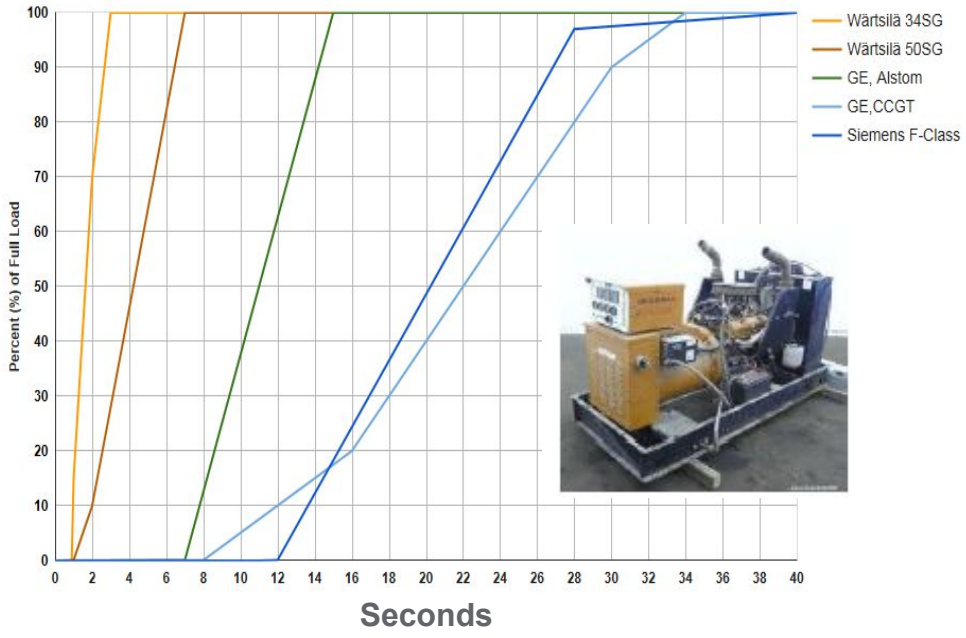
Feeder Automation

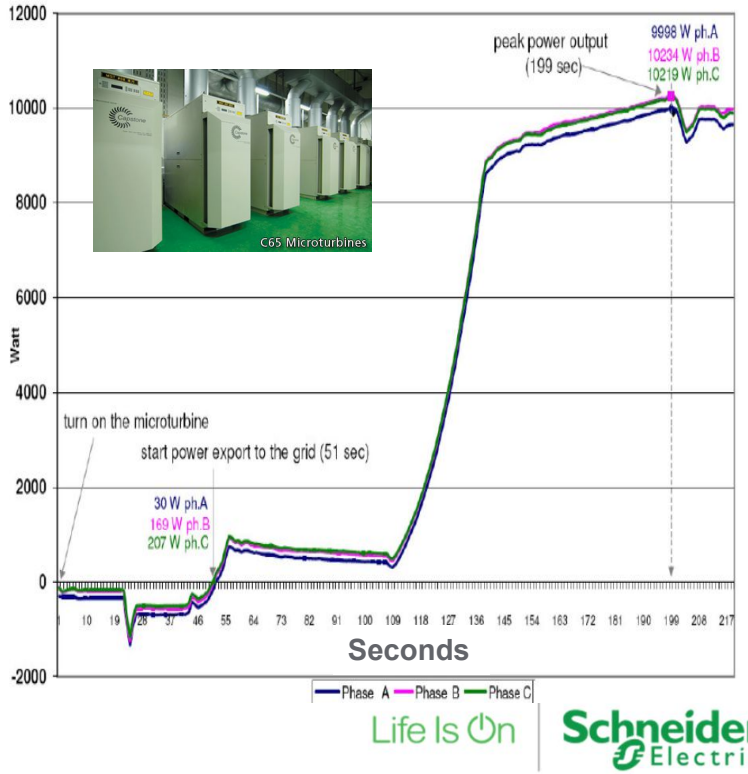
- DER Point of Coupling
  - Solar PV
  - Battery Energy Storage (BESS)
  - Generator/CHP
- DA/Self-Healing Distribution

Microgrid Advisor

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

“Tame” Distributed Energy Resources (DER)
Genset, Turbines, Fuel Cells, Combined Heat & Power





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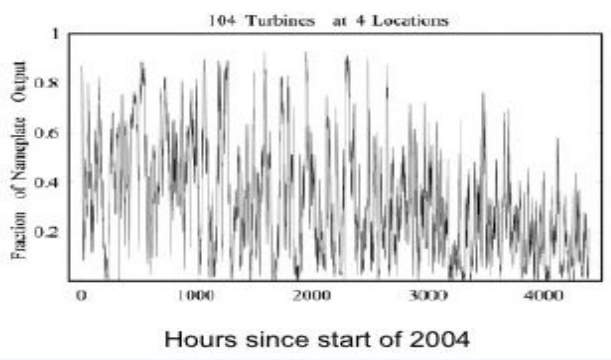
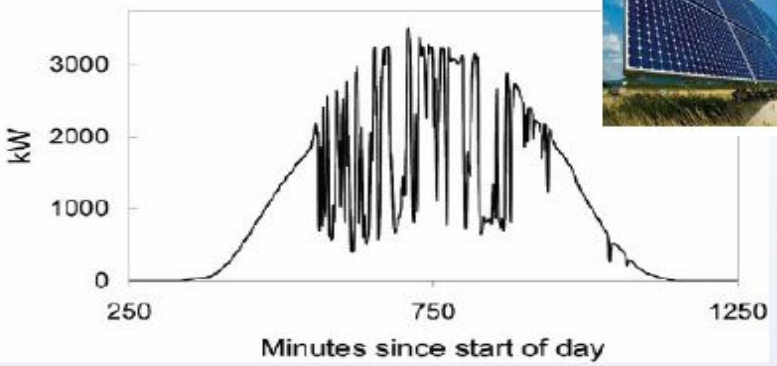
“Wild” Distributed Energy Resources = Intermittent Renewables

Wind/Solar Intermittency



Wind Intermittency



Solar Intermittency

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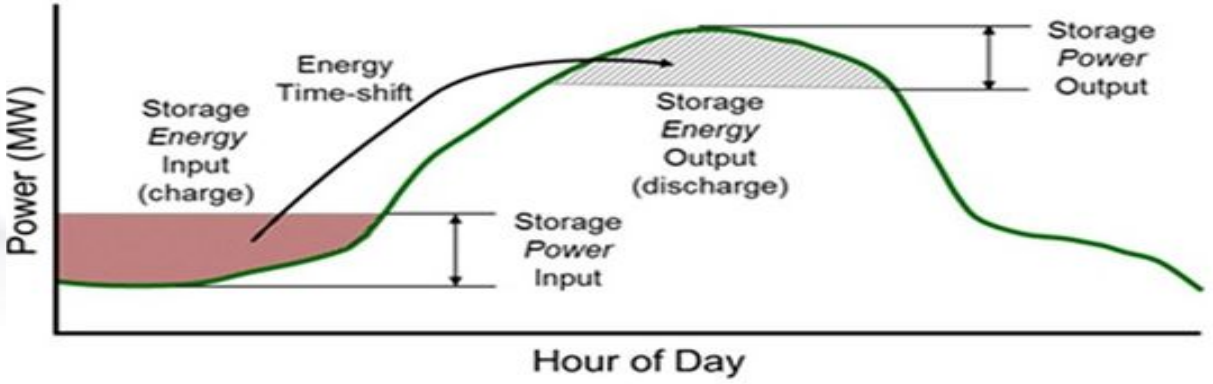
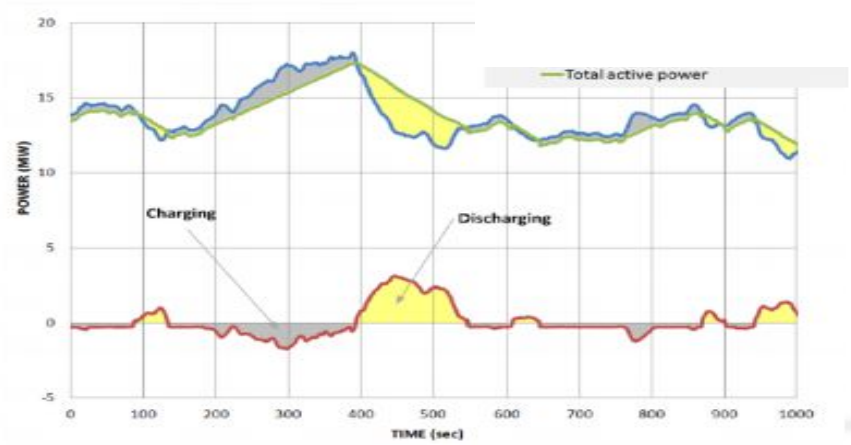
“Wild” DER + Energy Storage = “Tamed” DER
At any Scale



Source: E&I Consulting



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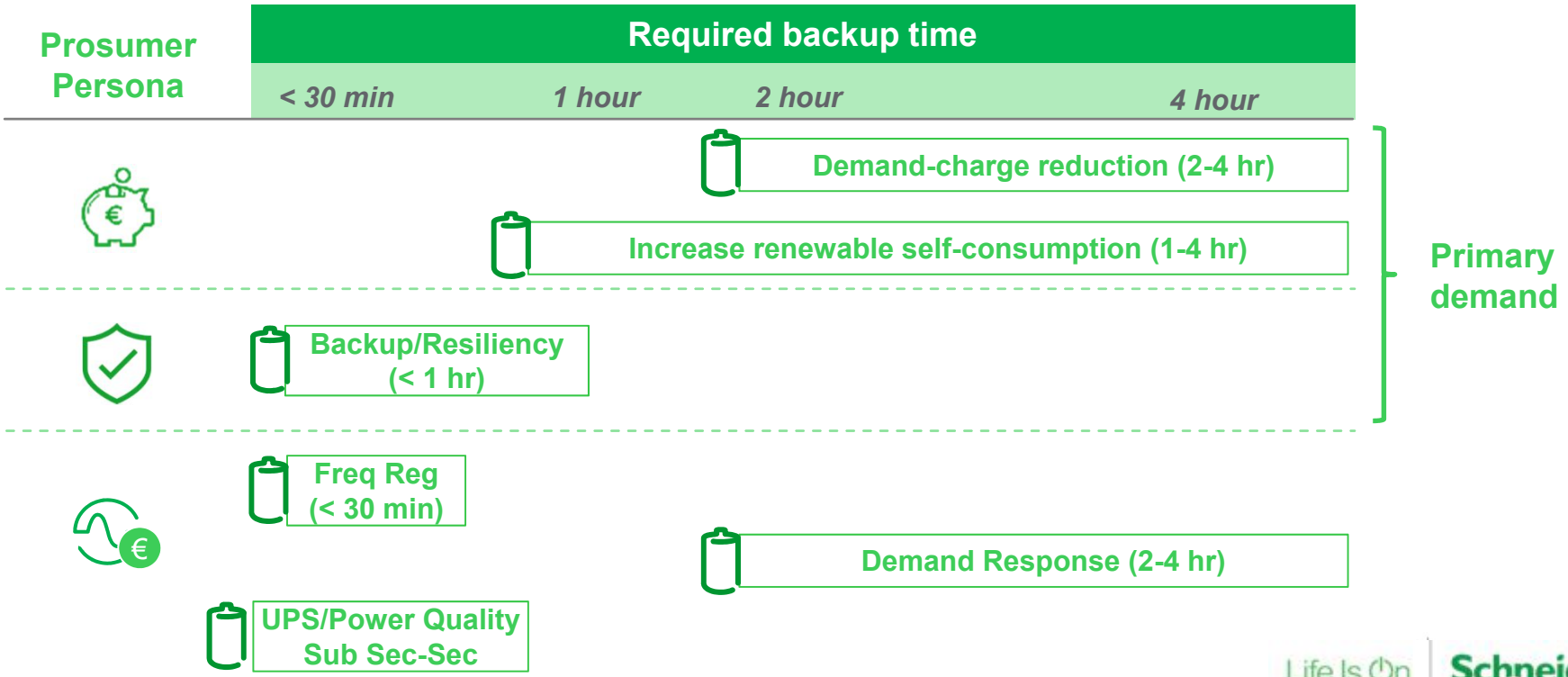
Different prosumer personas have different energy storage requirements

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



Microgrid Project Development

Feasibility, Energy and Financial Modelling

- Customer goals are defined
- Address, site data
- Interval data on electric and gas usage obtained
- Tariffs, incentives evaluated
- Interconnect process mapped
- Fatal flaws identified
- Schedules created

Concept Design Iteration Use Case Refinement

- Fatal flaws mitigated (interconnect challenges, study periods, air quality permits)
- Further design and refinement
- Direct utility involvement
- Sequence of Operation (SOO)
- Schedules finalized

Customer and Partner Workshops and Contracts

- Select vendors and execute contracts for DER, EPC, PPAs, SOWs and guarantees as needed
- An “off ramp” may be agreed to in case fatal flaws cause the project to fail – NEPA, permits, interconnect

Use Cases

Final engineering

- ARO, receive interconnection approval, air quality and other permitting
- Get NTP from investor if applicable
- Test use cases and controls, often with model based design SIL, HIL

Integration testing and Construction

- Deliver and install DER solution at customer site

Final Testing and Configuration

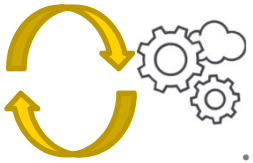
- Final testing of initial configuration by using pre-developed use cases

Commissioning and COD

- Finalize commissioning of the DER solution
- Interconnect the DERs
- Guarantee performance

Analytics and Reporting

- Advanced analytics framework provides detailed reports outlining DER and site performance



Operation, Maintain, Optimize

- Begin metering and verification, maintenance and optimization as needed

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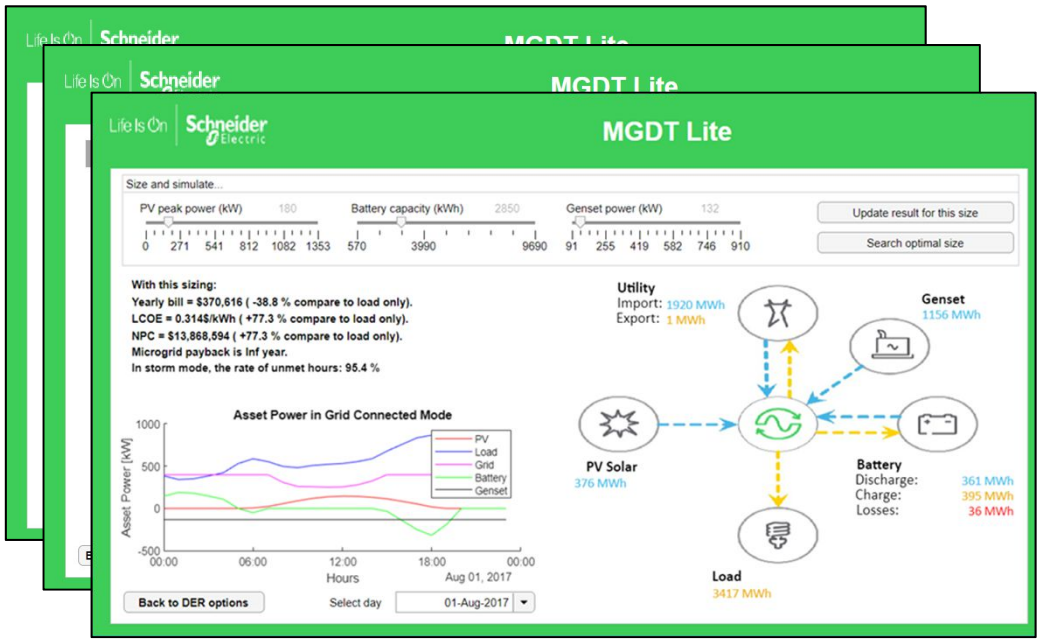
Schneider's Microgrid Design Tool (MGDT) in a nutshell



Typical case settings (weather, load usages, energy rate)

Microgrid configuration (PV, BESS, Genset, offgrid mode)

Results: economic KPI (+off grid autonomy), sizing impact, automatic size optimization

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Building Scale Microgrids
For Buildings and Building-Clusters

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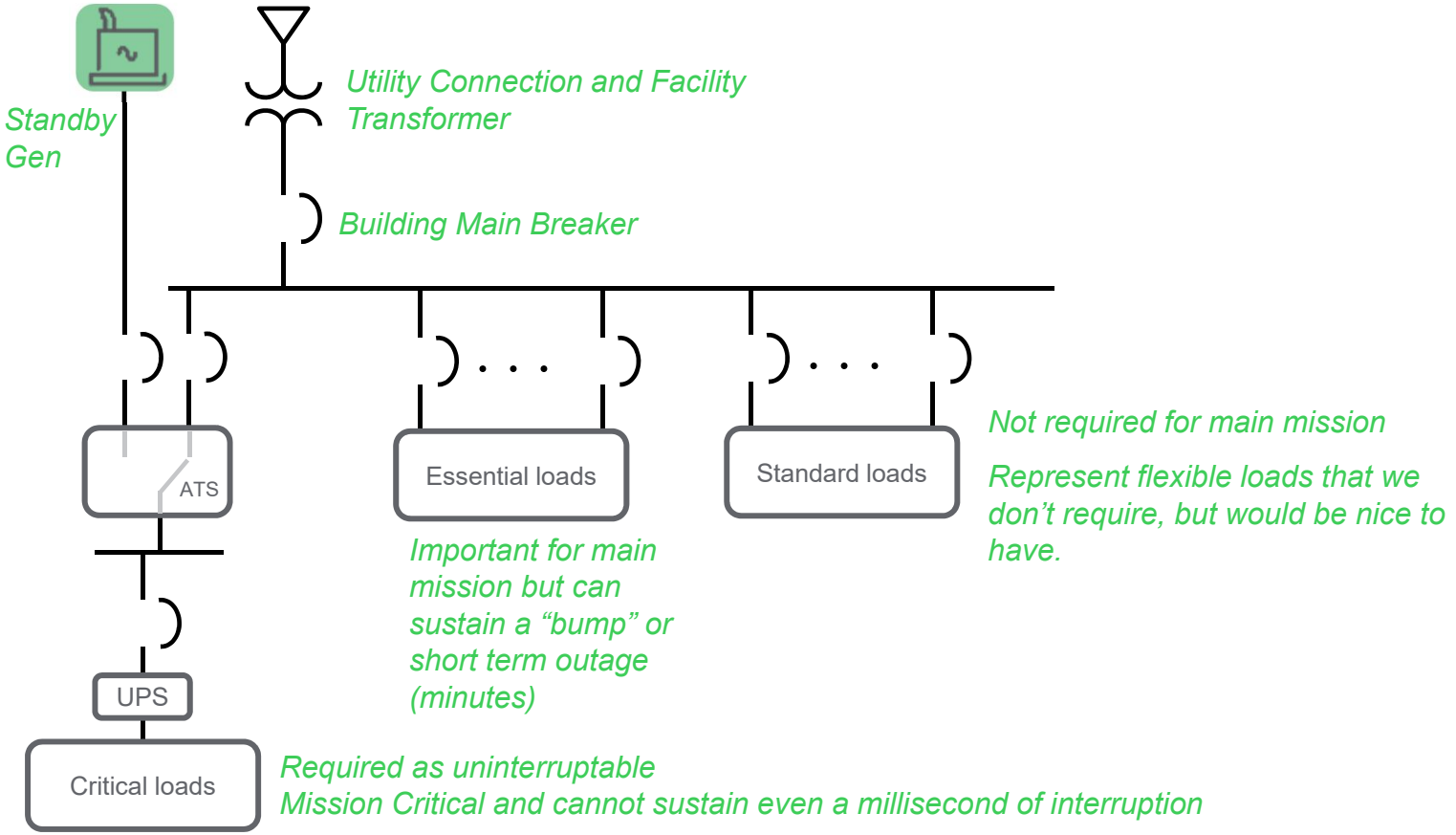
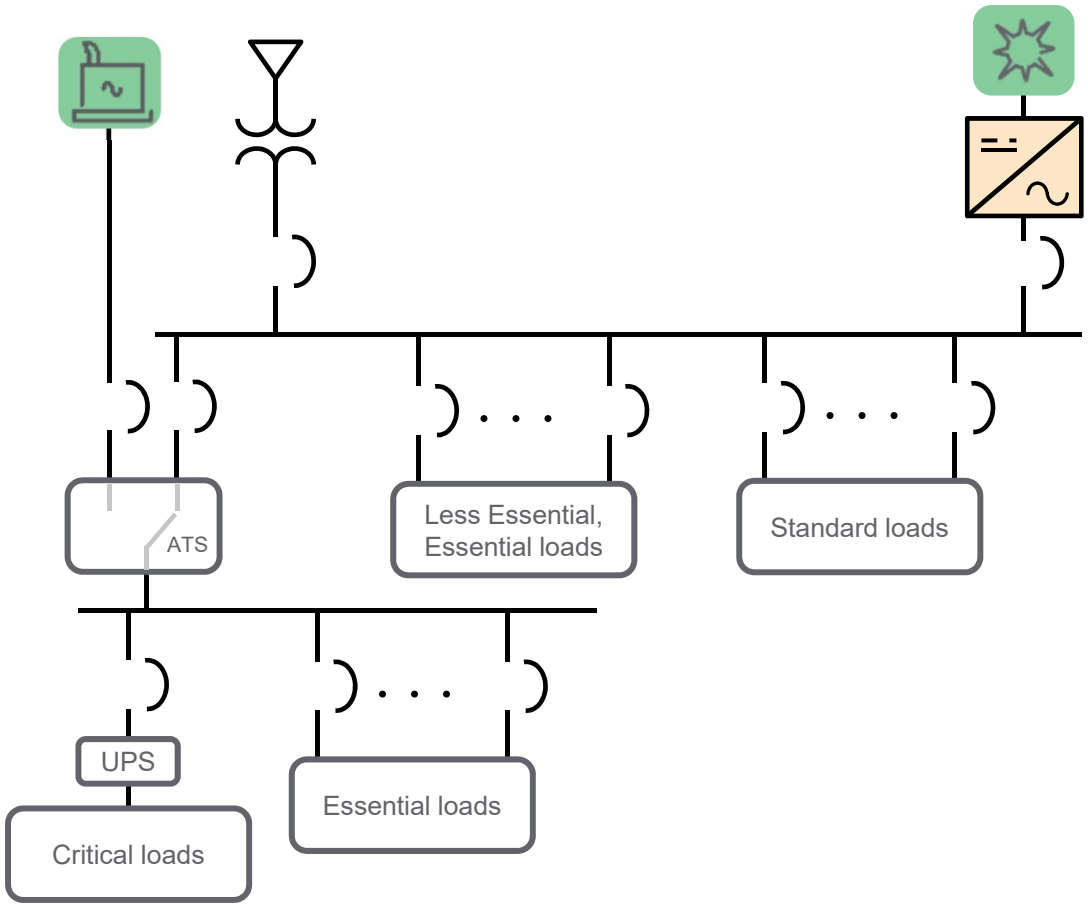
Microgrid Node – Traditional Critical Infrastructure Building



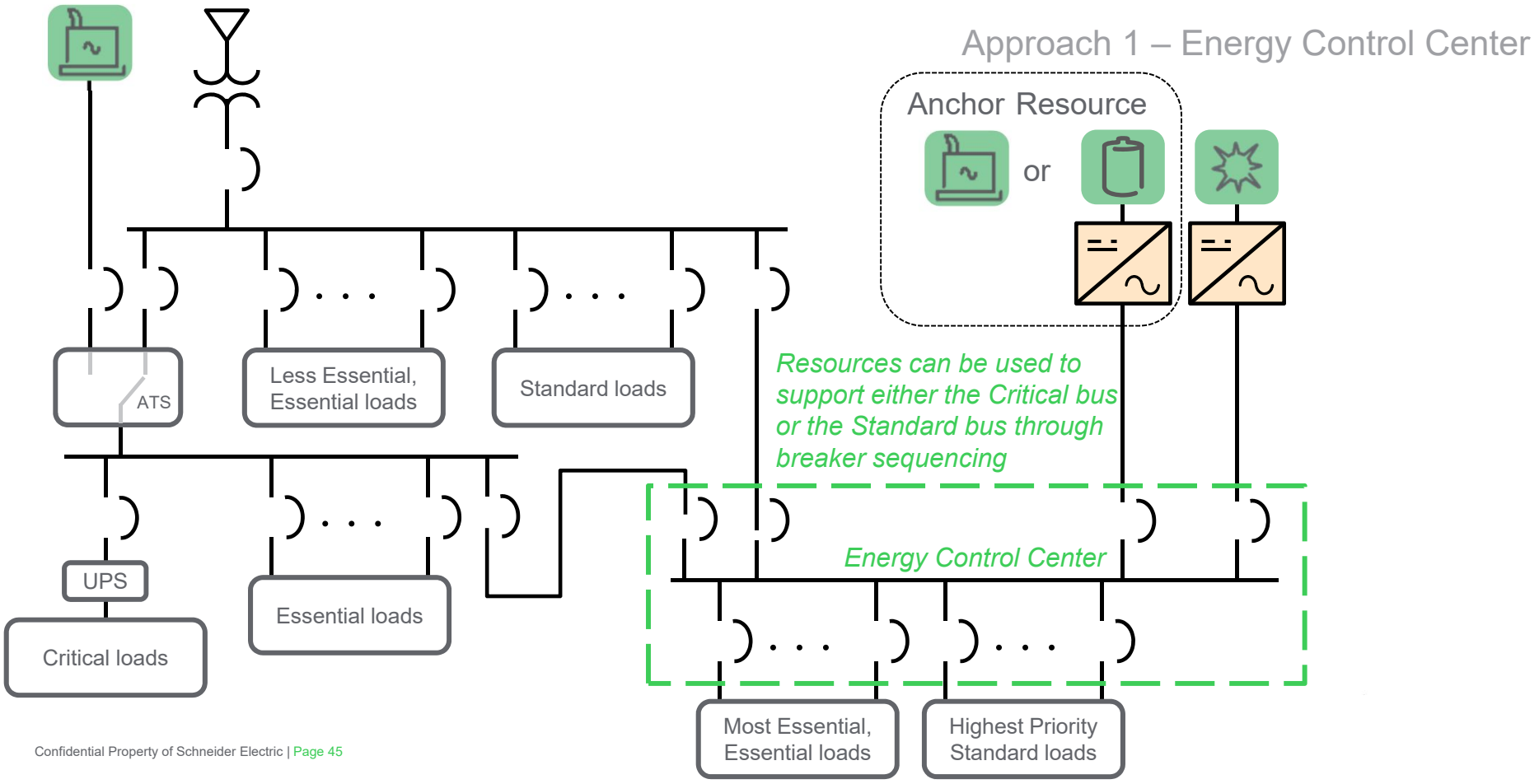
Microgrid Node – Traditional Building + Solar PV



Grid Tied Solar cannot be used when in standby power emergency operating mode

Excess power from the standby generator is stranded and cannot be used for less essential and standard loads

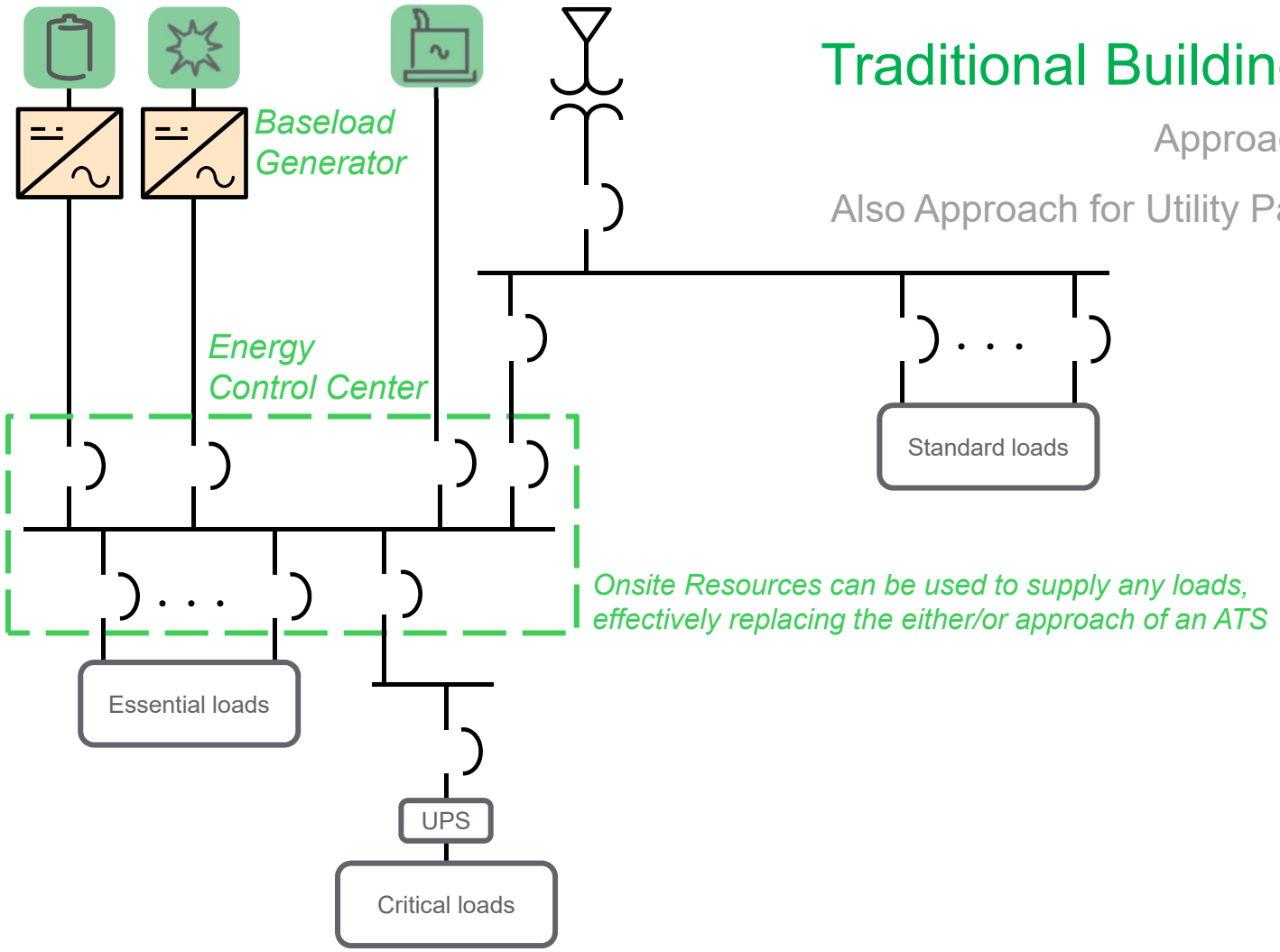
Microgrid Node – Traditional Building + Microgrid



Traditional Building + Microgrid

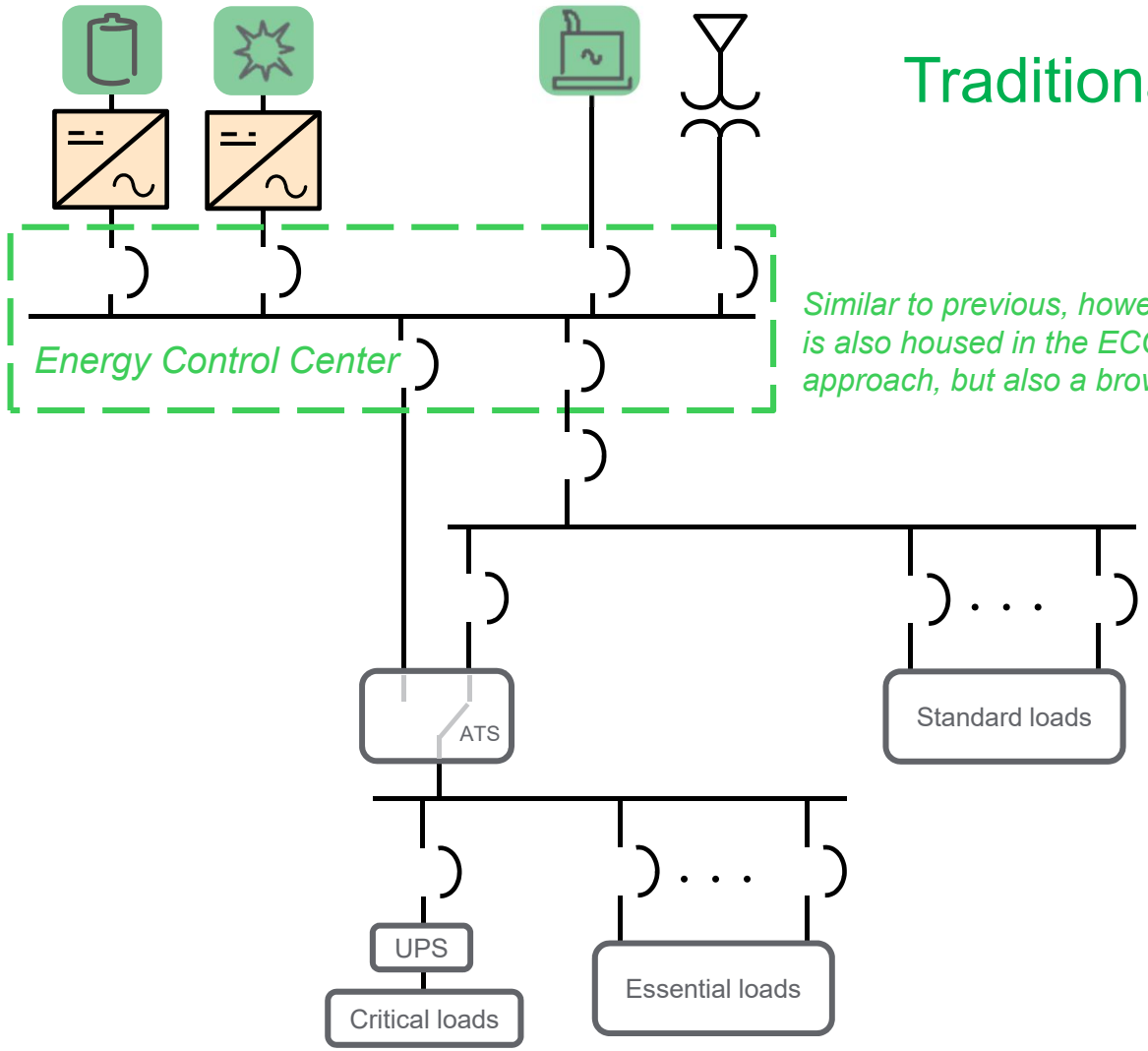
Approach 2 - Upgrade ATS

Also Approach for Utility Paralleling Generator



Traditional Building + Microgrid

Approach 3 (Intercept Utility)



Similar to previous, however the utility main breaker is also housed in the ECC. This is a greenfield approach, but also a brownfield approach

Microgrid Energy Control Center

Supply, Demand and Process Management

Microgrid architecture considerations

Development - Use cases, sequence of operations

Existing stand-by generation – stranded capacity

Existing PV solar or other DER's capacity to operate in island-mode

How to release stranded capacity?

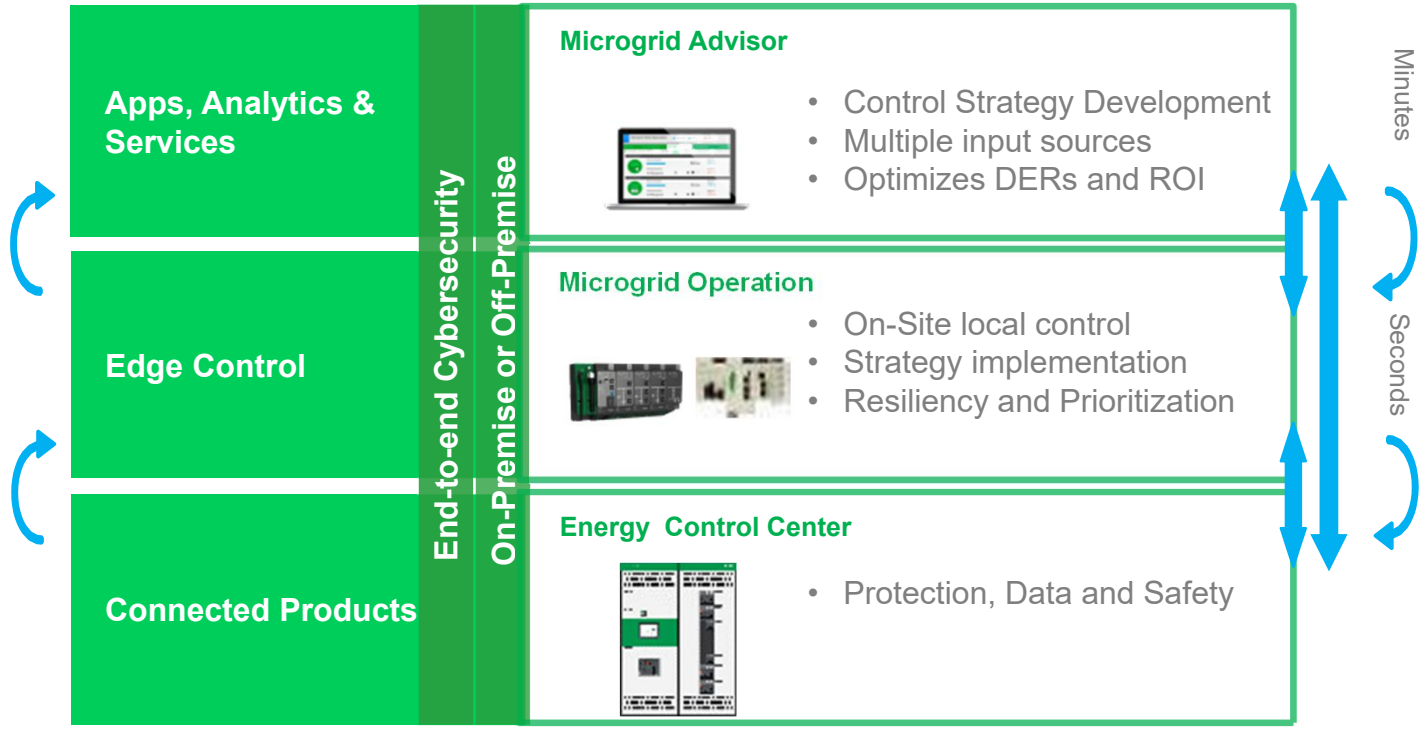
How to access non-island mode DER capacity for critical or essential loads?

What infrastructure modernization is required to control and monitor the sources and loads?

Control system communication to DER assets and controllable elements

Software to manage the system to achieve the mission objectives

Distributed Energy Resource Management Layers



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Microgrid Advisor

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

Remote Monitoring of DER

- For monitoring and visualization

Tariff Management

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

Demand Control

- Reduce utility peak demand charges

Self Consumption

- Leverage your on site production capability

Demand Response

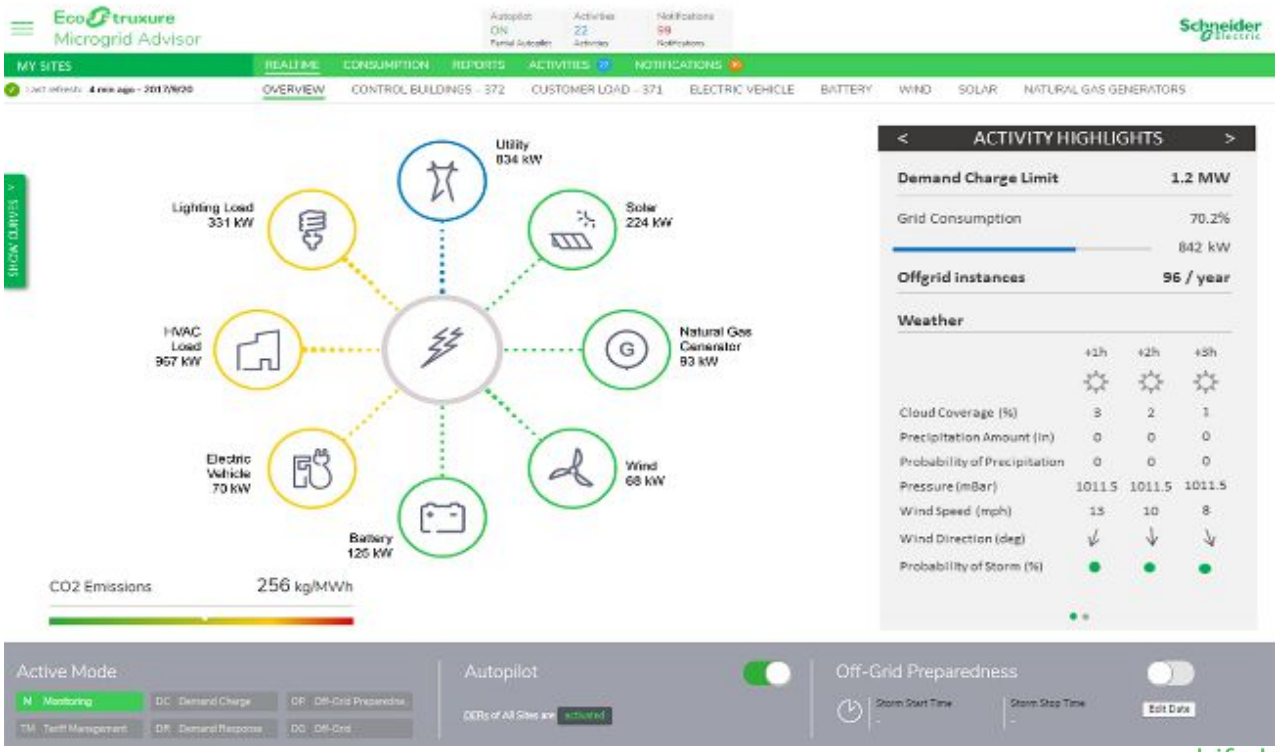
- Participate into the grid balancing mechanisms

Island Mode

- Leverage weather forecasts to anticipate black-outs

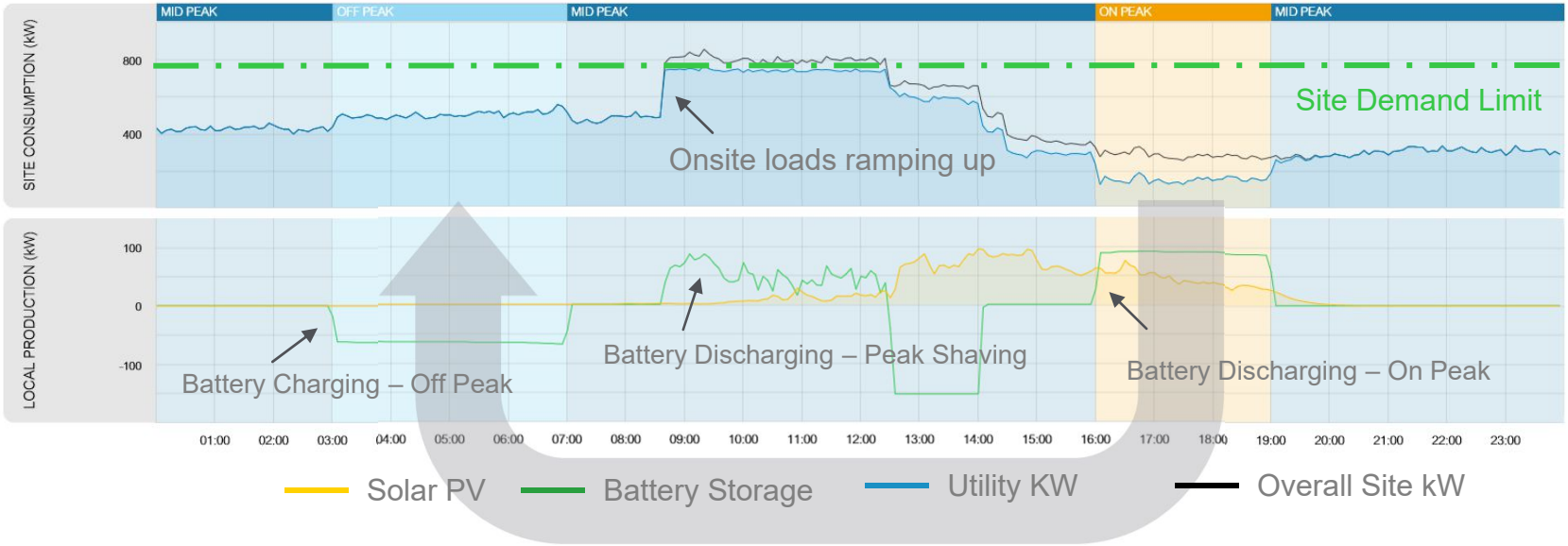
Microgrid Advisor

Visibility and control of all of your DERs in a single platform



Detailed Visualization - Tariff Management and Peak Shaving

Shift consumption and reduce demand charges



- *Example 1:* Charge an energy storage system during “off peak” period and discharge during “on peak” period
- *Example 2:* Discharge energy storage to avoid Peak Demand Charges

Microgrid Planning Concepts

Bringing it all together

Energy Trends – Decarbonization, Digitization, Decentralization

Clarify the Energy Missions - Reliability / Resiliency, Energy Efficiency, Carbon footprint

Tools for Microgrid Project Development

- Tame and Wild DERs
- Existing and new DERs
- Iterative Analysis methodology & tools- technical and financial

Building level and Grid level microgrid architectures

Modernization of the power system with electrically controlled devices and automation

Software Advisor for overall strategy visualization and deployment

Questions and Comments

Contact Information

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