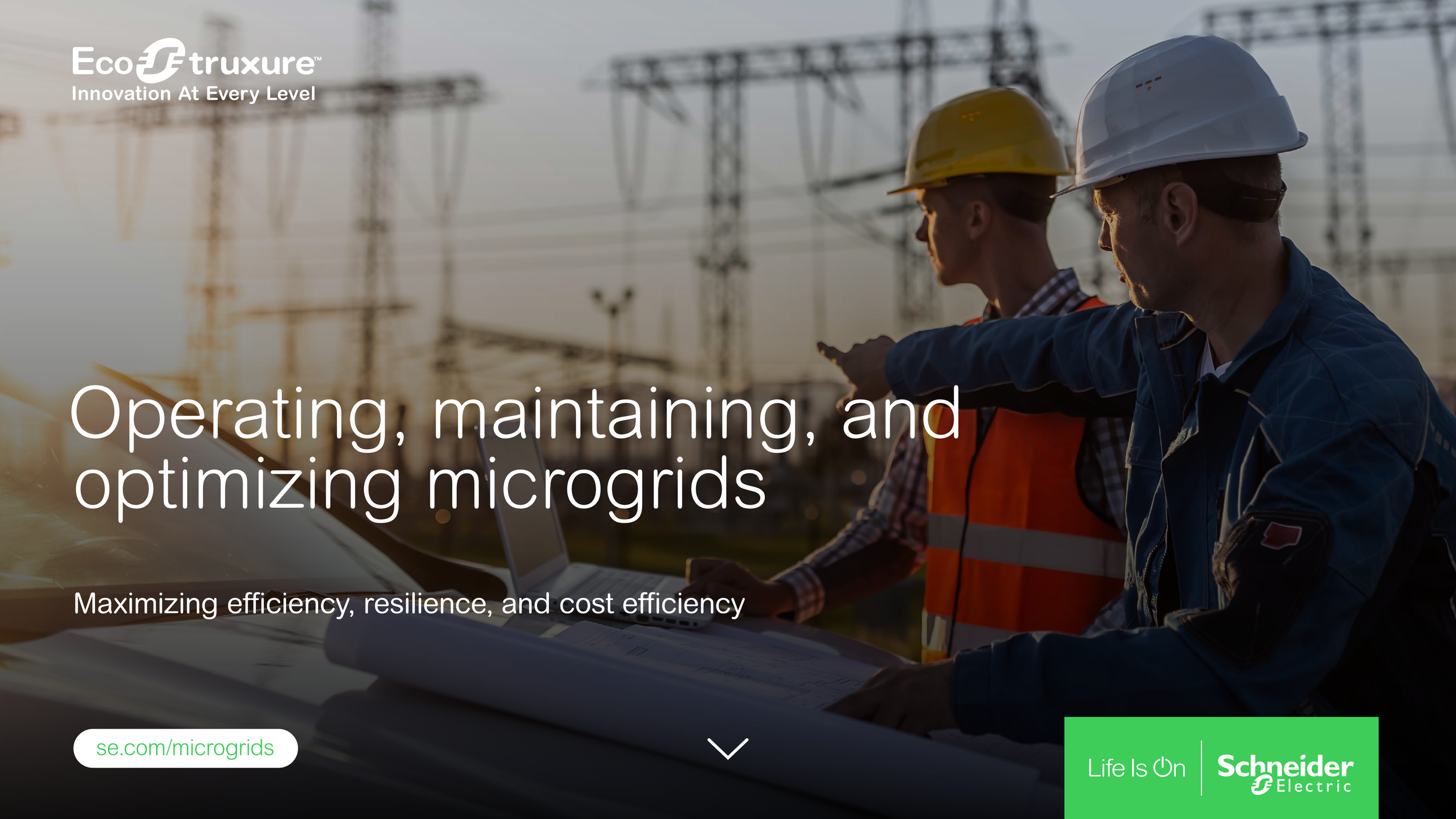

EcoStruxure™
Innovation At Every Level

Operating, maintaining, and optimizing microgrids

Maximizing efficiency, resilience, and cost efficiency

se.com/microgrids

Life Is On | Schneider Electric

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Introduction

Introduction

Driven by the expansion of renewable solar energy storage systems, the increasing adoption of electric vehicles (EVs), and electrification demand, the global microgrid market is projected to expand from $24.6 billion in 2021 to $42.3 billion by 2026.

Microgrid benefits include resilience, energy savings, and sustainability; achieving them should be part of long-term business continuity planning.

This guide provides insights, strategies, pragmatic considerations, and best practices to help ensure that your microgrid maintains high availability, efficiency, and safety over the next 20-30 years.

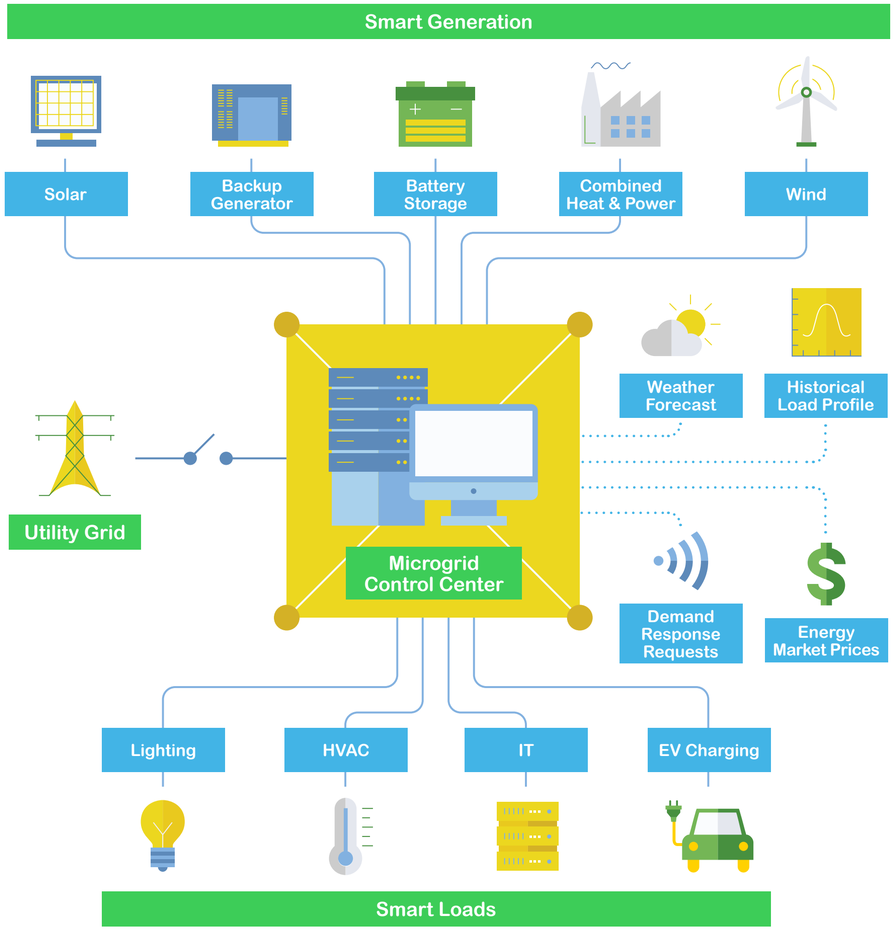
The global microgrid market is projected to expand from $24.6 billion in 2021 to $42.3 billion by 2026.

What is a microgrid?

A microgrid is a collection of local on-site distributed energy resources (DERs) working together as a single system, enabling facilities and communities to operate independently off the primary grid.

Unique capabilities

- **Automatic energy load** and resource adjustments to optimize cost
- **“Island-mode” operation** for continued site functionality during grid outages
- **Intelligent control technology** for optimizing on-site generation and storage resources



Microgrid system example

Three microgrid business benefits

1 Economic

Configurations can **optimize energy consumption**, production, storage, or sales based on factors like weather and utility rates, allowing operators to:

- Support electrical loads
- Avoid peak utility rates
- Sell excess power

2 Sustainability

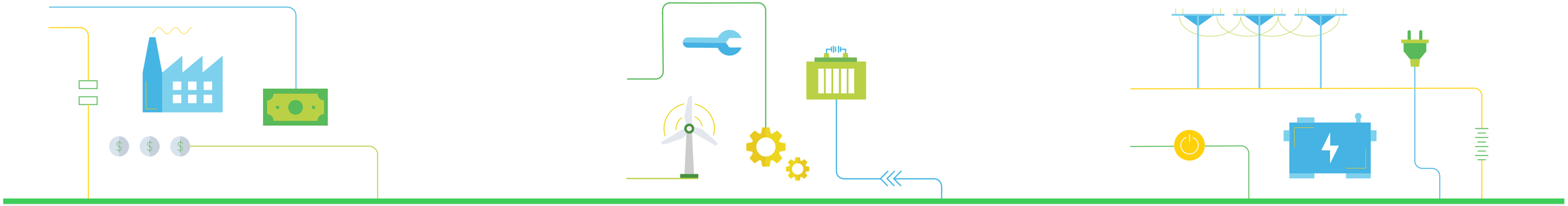
A microgrid's technical infrastructure can **simplify sustainability compliance** by piloting, integrating, and scaling renewable energy systems.

Its software, controllers, and interconnected equipment enable renewable sources, e.g., battery storage, to supply energy. Excess decarbonized power can be sold back to utilities, benefiting homes and businesses.

3 Resilience

With increasing utility outages (often caused by weather disasters and aging infrastructure), a microgrid **provides uninterrupted power** by seamlessly switching to on-site generation or storage.

In cases of grid failure, the microgrid controller disconnects from the utility, activating "island mode," and reconnects when service is restored.



A microgrid can be a long-term hedge against rising fossil fuel costs by integrating renewable sources.

Planning for ongoing microgrid system needs

You can maximize long-term microgrid energy cost optimization, sustainability, and resilience benefits with service investments and a robust maintenance plan.

What should a microgrid service plan include?

Regular asset monitoring

System readjustments and updates

Time-based maintenance planning

What are the benefits of a sound service strategy?

Identify and address potential problems before they cause outages

Improve facility uptime and business continuity

Reduce emissions by ensuring optimum utilization of renewable energy assets

Meet regulatory compliance

Without a robust service plan, your microgrid ROI decreases and downtime risks increase.

Developing a performance continuity blueprint

Developing a performance continuity blueprint

Effective microgrid operations require prioritizing a long-term service plan during the design stage to help avoid:

- **Missed opportunities** for government grants or funding applications
- **Higher post-installation expenses** for retrofitting modems, routers, and cell plans
- **A lack of methods of procedure** (MOPs), standard operating procedures (SOPs), and emergency operating procedures (EOPs)

Six recommended best practices for a maintenance plan strategy framework

1. **Budget for long-term operating expenses (OpEx)**
2. **Support cross-functional collaboration**
3. **Understand the role of remote monitoring**
4. **Determine your maintenance strategy**
5. **Enhance performance with monitoring and alarms**
6. **Plan/prepare for microgrid modernization**

Achieving maximum benefits

Achieving maximum benefits

During early microgrid planning, consulting services can assist with:

Microgrid feasibility studies

Determine the viability of a microgrid at a given site, verifying electrical designs comply with local codes and standards through:

- Energy analysis
- Evaluating existing infrastructure
- Identifying upgrade requirements
- Assessing available energy resources

Front End Engineering Design (FEED)

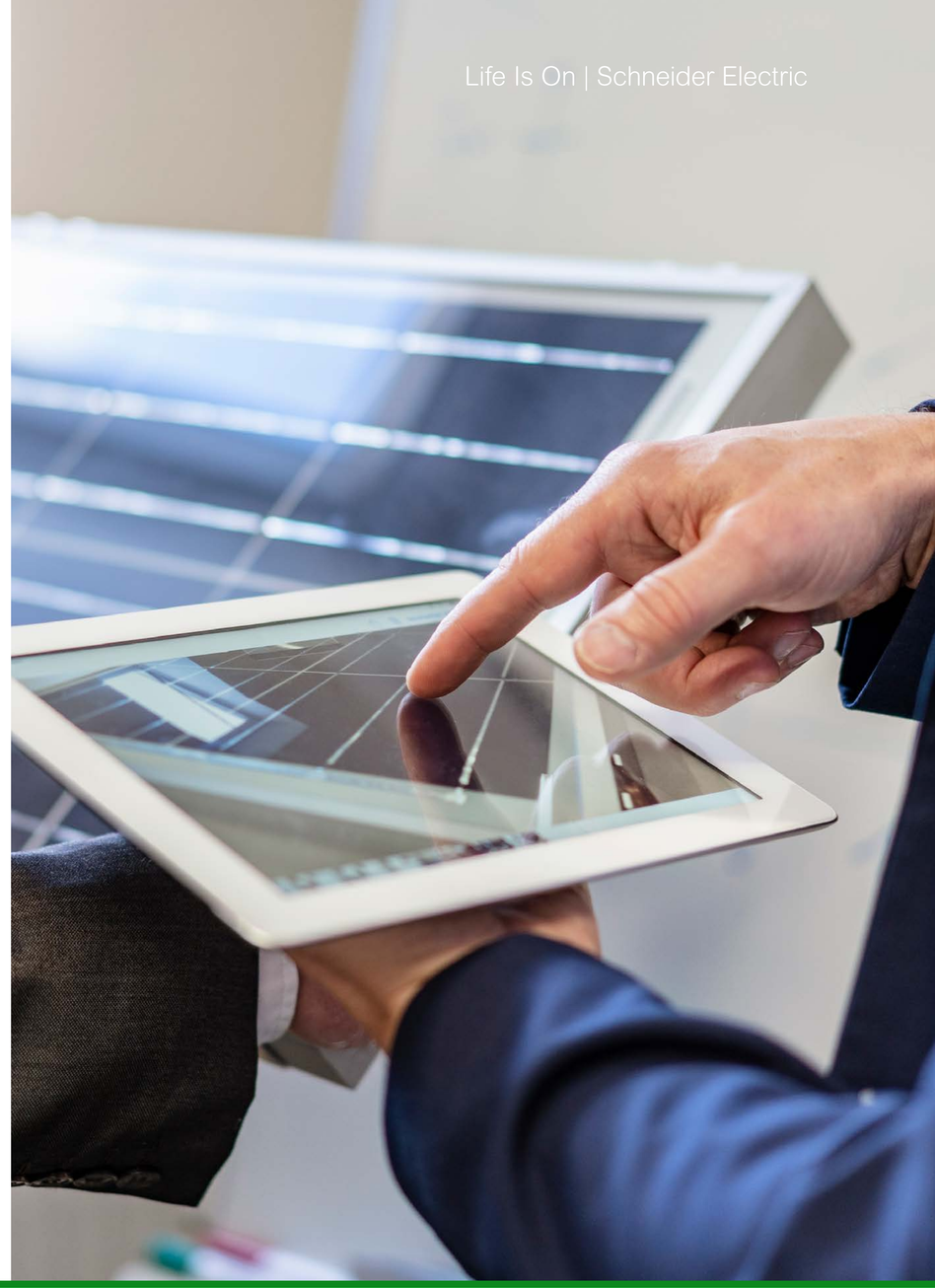
This service establishes a:

- Detailed initial design
- Financial analysis
- Accurate project pricing model

Optimizing your microgrid solution

Once operational, to maximize the microgrid's software tools' effectiveness, create a plan for ongoing software patches, updates, and testing by:

- **Implementing provisions** to help ensure patch updates do not compromise existing communication system mapping
- **Adjusting settings**, such as energy storage minimum state of charge, to optimize energy efficiency
- **Assessing historical data** to confirm ongoing operational performance and resilience value
- **Incorporating new data**, such as updated utility tariff structures, into the service and support strategy



Impacts of optimizing your microgrid

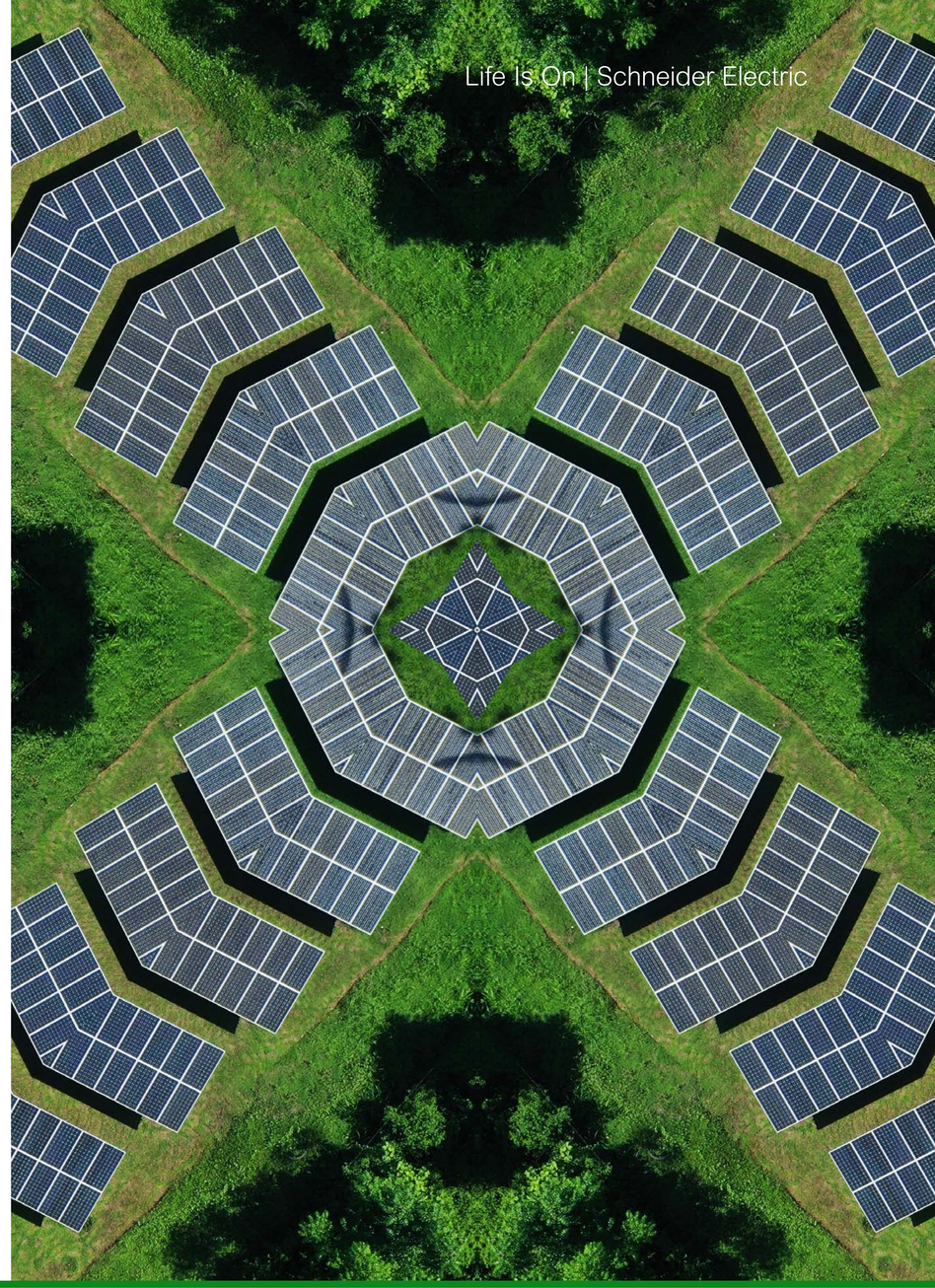
When operational, microgrid software requires optimization to effectively generate and store energy.

Cloud-based microgrid software, like EcoStruxure™ Microgrid Advisor, can adjust real-time energy use and deliver optimization benefits such as:

Helping enable cost savings through a digitized demand response, improving load flexibility

Operating as a demand-side energy management software platform – gathering, forecasting, and optimizing DER operations via predictive algorithms

Facilitating sharing cost savings information with stakeholders, identifying opportunities for microgrid scaling as energy requirements grow



Testing for system resilience

During grid outages, rapid access to backup power is crucial. Test all operational modes regularly to ensure system resilience.

Grid-tied mode = Rely on utility for power

Island/microgrid mode = Independent of utility power

A **sequence of operations test** aids in ensuring proper sequencing is achieved in island mode and:

- Helps confirm whether capability is functional and meets operational intent
- Can be completed during a real or simulated outage
- Includes a report outlining results and recommendations

Assess whether your microgrid can power some or all power loads in island mode.

When should you test?

- At least annually
- During already scheduled site shutdowns
- Before regional “outage season”

The more critical the facility, the higher the recommended sequence of operation testing frequency should be.

Testing for system resilience

Proactive testing helps ensure that software properly guides the system through the necessary transition steps when shifting from one power source to another.

EcoStruxure Microgrid Operation provides a control solution based on programmable logic controllers (PLCs) and supervisory control and data acquisition (SCADA) architectures that:

Promote renewable energy use and automatically manage "island mode" standalone operation in case of abnormal electrical grid conditions.

Combine advanced power control and management with a simple system structure and automatically, dynamically, and remotely manage DERs to control energy spending.

Preventative maintenance for your system

Having a strategy for preventative maintenance mitigates unplanned downtime.

Preventative maintenance plan considerations should include:

1 Annual energized diagnostic

Provides early warning signs of equipment failure without interrupting operations

- Infrared scanning
- Transformer oil sampling
- Visual inspections

2 De-energized maintenance

Completed once every 3-5 years, these services provide comprehensive maintenance to support your facility's schedule

- Overcurrent protective device testing
- Cleaning and lubrication to meet specification
- Electrical testing, including insulation and current path

Sustainability

To enable CO_2 emissions reductions, microgrids often include solar generation equipment. Perform regular solar output reporting as part of the ongoing service and maintenance plan strategy.

Cloud-based microgrid management solutions provide an intuitive Human Machine Interface (HMI) to help operators:

- **Process demand**/response requests
- **Optimize output** decisions based on energy time of use (TOU) tariff rates and weather forecast predictions
- **Factor in** user consumption constraints
- **Tightly control** energy consumption, minimize CO_2 footprint, and provide operational flexibility

Optimizing for scale

Optimizing for scale

Electrification projects that lead to the addition of loads, changes in facility usage, updates to electrical equipment, and changes in utility structures all contribute to a microgrid system evolution.

Customize plans with system updates and expansions when:

- **Adding new loads** like EV charging stations or switching from gas to electric-based heating systems and processes
- **Utility rate structures change**
- **Updating software controls** for resilience, CO_2 avoidance, and cost optimization
- **Adding a combined heat and power** (CHP) energy system
- **Adding solar panels** and inverters or battery energy storage systems (BESS)
- **Responding to new ancillary market opportunities** (e.g., income generation from frequency- and demand-response scenarios when excess energy is sold to the grid)

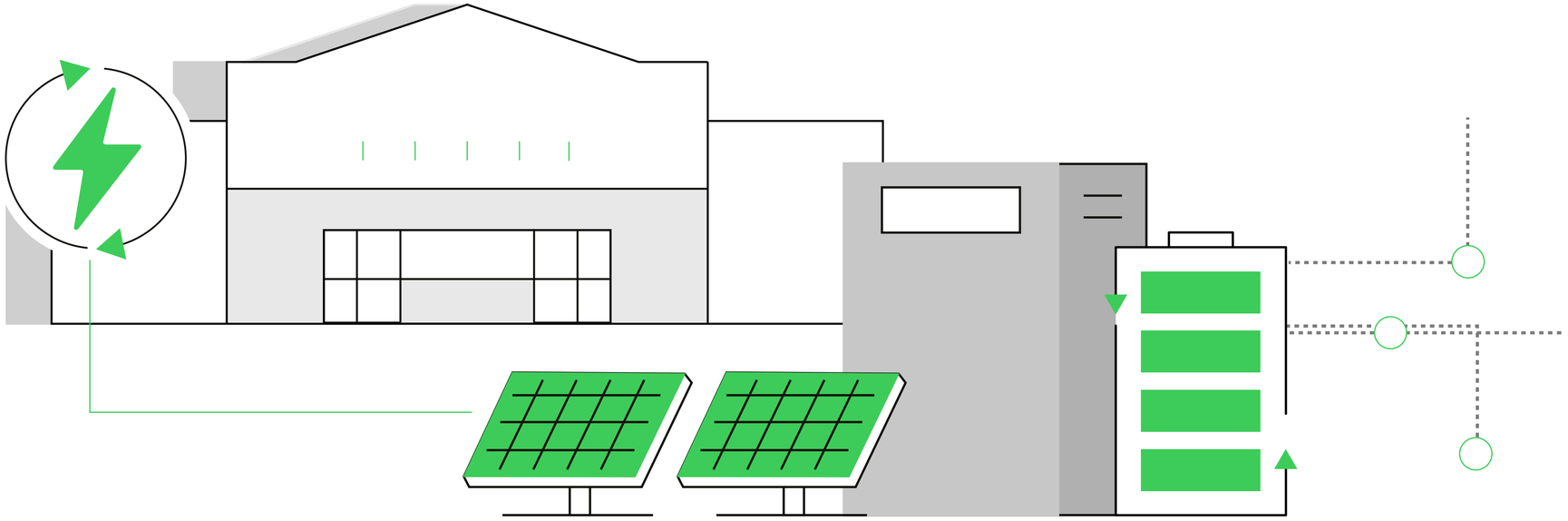
Optimizing for scale

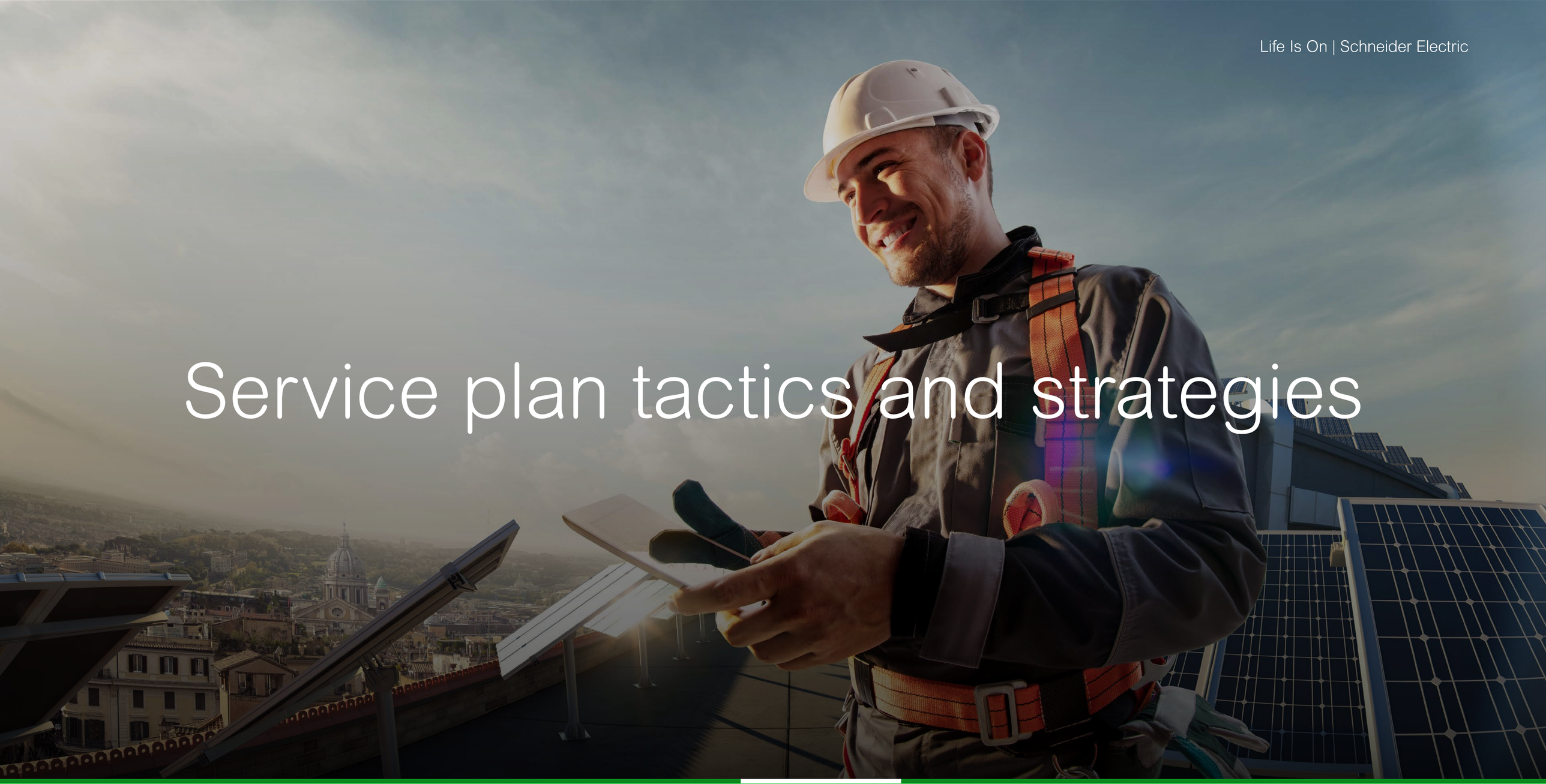
Schneider Electric's design and engineering services support retrofits to existing microgrid systems by offering:

System controls and metering assessment – Experts determine digital devices to be updated or added for microgrid control integration.

Load management assessment – Specialists identify existing load types and establish priorities for load control.

Efficiency and energy performance services – Technicians measure energy intensity across the system and identify opportunities for energy savings.





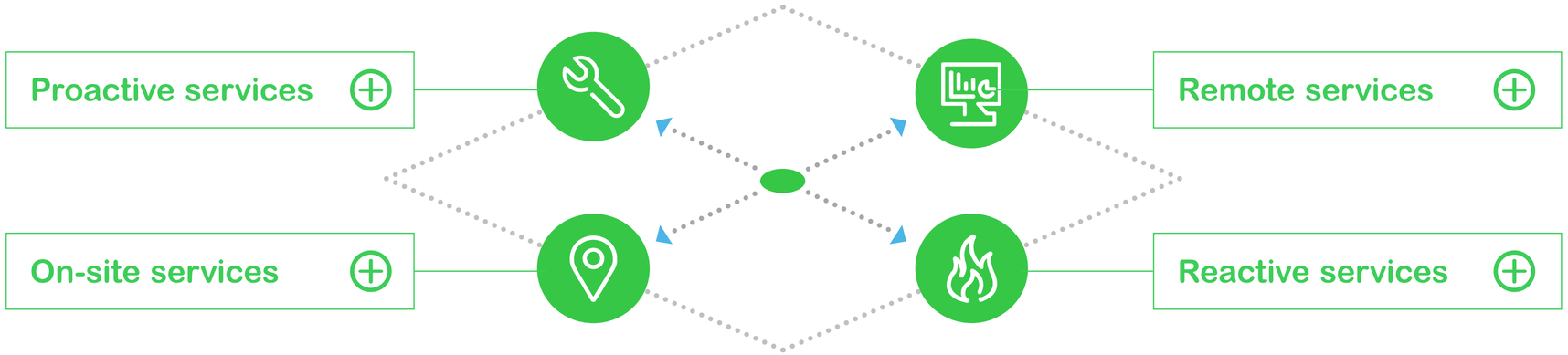
Service plan tactics and strategies

Service plan tactics and strategies

Microgrid service plans differ based on facility energy needs (critical or non-critical), and facility traits determine backup system testing frequency (weekly, monthly, quarterly, or annually).

These services are often required throughout a microgrid's lifecycle. Microgrid owners must choose a service package based on their unique maintenance philosophies.

Regardless of facility type, develop a service framework to include:



Embracing a comprehensive plan early helps avoid unforeseen costs or the risk of paying higher prices for reactive support and spare parts when emergencies occur.

Service plan tactics and strategies

Additional best practices to help optimize microgrid performance and enhance safety include:

1. **Documenting essential procedures**
2. **Establishing a central documentation repository**
3. **Building a reporting strategy**
4. **Modernizing testing, maintenance, and cleaning procedures**
5. **Cybersecurity planning**
6. **Recognizing single- vs. multi-site management differences**

Assessing microgrid service options

Service maintenance strategies are often based on individual site conditions and preferences, such as risk tolerance, energy costs, and business criticality.

Common approaches include:

Preventive or recurring – Schedule maintenance per pre-established calendar dates, regardless of equipment servicing needs. While proven effective, preventive maintenance is costly. Industry 4.0 advancements make it possible for stakeholders to afford more data-driven maintenance strategies.

Condition-based – Condition-based maintenance (CBM) monitors actual asset conditions and identifies the nature of required maintenance. CBM dictates service only when indicators show decreasing performance or upcoming failure. This approach provides both cost savings and improved uptime.

Predictive – Advanced analytics help mitigate accelerated aging due to usage and environmental conditions and optimize productivity and Overall Equipment Effectiveness (OEE). Analytical models predict abnormal asset behavior and enable corrective action long before a problem materializes.

Troubleshooting, diagnostics, and maintenance can be performed on-site or remotely, depending on the nature of the maintenance. Spare parts planning will also be an important consideration in the overall strategy.

Assessing microgrid service options

Schneider Electric's service plan choices that have proven effective for boosting microgrid systems' uptime and site energy resilience include:

Essential and advanced options

Schneider Electric Services Team is a piece of the overall O&M puzzle, providing support for our equipment and controls that make up part of the microgrid system.

Plus advanced option

Schneider Electric provides a comprehensive maintenance package for Schneider Electric equipment along with 3rd party equipment such as the DERs.

Assessing microgrid service options

Facilities and finance executives also have the option to transfer financing, ownership, installation, and management of their microgrid via long-term agreements with third-party organizations.

AlphaStruxure

Learn more

A joint venture between The Carlyle Group and Schneider Electric offers energy-as-a-service (EaaS), allowing stakeholders to:

- Improve productivity
- Meet energy-related reliability, resilience, sustainability, and cost objectives with no up-front capital outlay
- Outsource energy management tasks to specialists, enabling them to focus on their core business

GreenStruxure™

Learn more

A joint venture between Huck Capital's sustainability-focused investments and Schneider Electric's microgrid experts help to:

- Deliver modular, standardized EaaS solutions to medium-sized commercial, industrial, and governmental buildings in the U.S.
- Simplify and accelerate microgrid market adoption
- Offer an innovative outcome-based alternative for sustainable, cost-effective, resilient, on-site energy delivered hassle-free as a service with no upfront CapEx and low operational risks

Conclusion

Conclusion

Incorporating a microgrid into your site is a first step towards lower emissions and higher resilience. However, to realize its powerful benefits, a comprehensive ongoing service and support strategy must be in place.

Control and maintenance act as the resilience of the central nervous system. Without local and remote asset monitoring, the risks of downtime and recovery costs increase.

Have tested, documented, and validated architectures with technology components proven to work over a long period.

Evaluate an integrated microgrid system from a maintenance, cybersecurity, and networking point of view.

Design with operation and maintenance in mind – plan for ongoing services early in the project design stage.

A condition-based maintenance approach provides remote access to offer equipment users performance dashboards and real-time insights into current microgrid conditions and all its interconnected sub-systems.

To learn more about how Schneider Electric microgrid services can lower costs and increase uptime at your site, access our microgrid or maintenance services web page.

Solely investing in DERs and controls cannot guarantee that your microgrid system will deliver the desired outcomes.

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To learn more about **maximizing microgrid efficiency and resilience**, visit:

se.com/microgrids

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