EcoStruxure™ Power for EV Battery Manufacturing Plants

Utilizing a Digital Twin for Electrical Distribution to Drive Efficient Facilities

01/2023
Purpose of the Document

Target Audience
This document is intended to address End User Engineering, Operations and Maintenance, Consultants, EPCs (Engineering, Procurement, and Construction) and Service teams and other qualified personnel.

Objective
To understand the challenges of designing and operating an EV battery manufacturing plant with an efficient and sustainable electrical distribution strategy.
### Table of Contents

#### SECTION 1: Introduction to the Electrical Vehicle Battery Manufacturing Plants
Introduces the context and the challenges of EV battery manufacturing plants.

#### SECTION 2: How Schneider Electric Can Support Electrical Vehicle Battery Manufacturing Plants
Describes the solutions that Schneider Electric and, more specifically EcoStruxure Power provides for EV battery manufacturing plants, with typical electrical and digital architecture.

#### SECTION 3: Digital Solutions and Services
Gives information about EcoStruxure Power capabilities for EV battery Manufacturing plants, sorted by value proposition:
- Transverse Lifecycle Capabilities
- Capabilities to Improve Time To Market
- Capabilities to Improve Your Process
- Capabilities to Improve Quality
- Capabilities to Grow Sustainability

#### BIBLIOGRAPHY
Contains useful documents to find out more about capabilities. Provides details about Green Premium.
SECTION 1

Introduction to the Electrical Vehicle Battery Manufacturing Industry

The objective of this section is to:

• Introduce the growth, trends and challenges of the EV battery market
• Present the 4 pillars to meet the EV battery manufacturing plant challenges.
EV Battery Market

An industry driven by the electrical vehicle market

27 B$ investment
By General Motors in EV infrastructure through 2025 with the aim of releasing 30 EV vehicles onto the market within the same timeframe.

1 M hybrid & electrical vehicles
On the road pledged by Volvo by end of 2025. Expectation of 50% of global sales from EVs.

8 EV models
Launched by Nissan by the end of 2023. Goal is to be on pace to sell 1M hybrid or electric vehicles per year globally.

15-25% sales of hybrid & EV
For BMW by 2025.

10 EV models
Introduced by Mercedes by the end of 2023.

20 EV models
Launched by Audi by the end of 2025.

Ban of diesel- and gas-powered cars
In the UK expected to go into effect by 2030.

Sources: https://www.caranddriver.com/news/g35562831/ev-plans-automakers-timeline/
The market trends: a changing landscape

- Significant investment in Greenfield and expansions
- A growing focus on efficiency and sustainability
- High demand for energy and power to meet battery production capacity
- Cybersecurity
EV Battery Manufacturing Plant Challenges

Four pillars to drive efficiency, reliability and sustainability KPIs

The strong growth of the EV market leads to an increasing need for battery manufacturing plants. Creating or expanding EV battery manufacturing plants is not without its challenges. Four pillars must be addressed:

**Improve Time to Market**
- How can we accelerate the design & build of new EV battery plants?

**Improve Your Process**
- How can we reduce the cost of finished battery cells?

**Improve Quality**
- How can we minimize downtime to increase yield rates and improve production quality?

**Grow Sustainability**
- How can we be best-in-class for CO2 emissions per kWh?
- How to improve the overall energy efficiency of the plant and process?
SECTION 2

How Schneider Electric Can Support Electrical Vehicle Battery Manufacturing Plants

WHY READ THIS SECTION?

The objective of this section is to:

• Present the solutions to address the four pillars to meet the EV battery manufacturing plant challenges
• Explain how Schneider Electric EcoStruxure™ Power can support this industry
• Give an example of electrical and digital architectures.
The four pillars can be addressed by the following solutions:

**Improve Time to Market**
- **Use Standardized Architectures**
  Use standardized electrical distribution and IT infrastructures in order to speed up the “design, build and commission” phase of new plants.

**Improve Your Process**
- **Increase Production Efficiency**
  Digitize and modernize your operations and turn data into useful business intelligence to empower your workforce, understand the profitability of your production assets and make smart business decisions for your entire ecosystem.

**Improve Quality**
- **Reduce Production Hazards**
  Reduce downtimes and manage end-to-end quality to reduce production scrap.
  Utilize control tower and IoT platforms to collect analytics on processes, settings and maintenance.

**Grow Sustainability**
- **Track Sustainability KPIs**
  Monitor sustainability criteria to accelerate environmental transition and be compliant with sustainability standards and customer expectations.
Schneider Electric Value Propositions

At company level

Through its entire organization, Schneider Electric has developed value propositions to address the four pillars for the different parts of EV battery manufacturing plants:

- **Infrastructure / Facility**
  - Design and Modeling
  - Digital Automation & IOT Framework
  - EcoStruxure Machine Architecture

- **Manufacturing Process**
  - Energy Efficiency
  - Process Efficiency
  - Machine Performance & Flexibility

- **Manufacturing Machine**
  - Power Availability
  - Predictive Quality
  - Machine Tracking & Monitoring

- **Grow Sustainability**
  - Green House Gas and Energy Compliance
  - Energy Optimization
  - Sustainable Sourcing

**Transverse Lifecycle Capabilities**
(Cybersecurity, Green Premium, Digital Twin)
Schneider Electric Value Propositions

At EcoStruxure Power level

This guide focuses more specifically on value propositions provided by EcoStruxure Power:

- **Infrastructure / Facility**
  - Manufacturing Process
  - Manufacturing Machine

- **Design and Modeling**
  - Digital Automation & IOT Framework
  - EcoStruxure Machine Architecture

- **Energy Efficiency**
  - Process Efficiency
  - Machine Performance & Flexibility

- **Power Availability**
  - Predictive Quality
  - Machine Tracking & Monitoring

- **Green House Gas and Energy Compliance**
  - Energy Optimization
  - Sustainable Sourcing

**Transverse Lifecycle Capabilities**
(Cybersecurity, Green Premium, Electrical Digital Twin)
Schneider Electric Value Propositions

At EcoStruxure Power level

From electrode production to cell finishing,

From electrical design to operations and maintenance,

EcoStruxure Power helps deliver an end-to-end digital solution for efficient, reliable and sustainable EV Battery Plants.

Our collaborative environments, enhanced by the Electrical Distribution Digital Twin of your Plant, enable high productivity operations.
Energy is key, whether for processes or for utilities: specific attention must be given to the design of the electrical architecture and associated digital architecture which will enable digital solutions and services.

**Example of Electrical and Digital Architecture**

**Typical EV battery manufacturing plant**
Example of Electrical and Digital Architecture

Typical electrical architecture for an EV battery manufacturing plant
Example of Electrical Architecture

**ELECTRODE PRODUCTION**
- Mixing
- Coating & Drying
- Calendering
- Slitting
- Vacuum Drying

**CELL ASSEMBLY**
- Electrode shaping
- Stacking
- Electric contacting
- Case insertion
- Case closure

**CELL FINISHING**
- Electrolyte filling
  - Pre-charging
- Filling hole closure
- Ageing & formation

**PROCESS**
- 60%

**UTILITY**
- 40%

**INFRASTRUCTURE**
- Emergency Loads
- IT and Control Room
- Lightings and other

**UTILITIES**
- Dry Room MV Chillers and Dryers
- Clean Room MV Chillers
- Cooling Water
- Waste Treatment
- Inert gas (N2)
Suggested digital architecture (high-level view) for an EV battery manufacturing plant
Example of Electrical and Digital Architectures

Corresponding detailed digital architecture for an EV battery manufacturing plant.
SECTION 3 – Digital Solutions and Services

Digital Solutions & Services

Why Read This Section?

This section gives information about EcoStruxure™ Power capabilities for EV battery manufacturing plants aligned to industry challenges.
Introduction

EcoStruxure Power provides capabilities to support the challenges of EV battery manufacturing plant throughout the plant lifecycle:

- **Design, Build, Commission (Consultants & EPC)**
- **Operate & Maintain (Operators, maintenance team, service teams)**

### Improve Time to Market
These capabilities provide standardized designs and digital architectures, and enable easy simulation, to reduce cost of design and ownership.

### Improve Your Process
These capabilities use digitization to provide intelligent information to the workforce, allowing them to make smart decisions that reduce operating costs and increase efficiency.

### Improve Quality
These capabilities use digitization to reduce unplanned downtime, increase reliability, and thus reduce production waste.

### Grow Sustainability
These capabilities help track energy consumption and carbon emissions to meet sustainability requirements.

**Transverse Lifecycle Capabilities**

Digital Solutions that support your project from the Design, Build, Commission to Operate & Maintain phases.
### Overview of Digital Solutions and Services

#### Design, Build, Commission
(Consultants & EPC)
- AC&DC electrical network design and simulation
- Electrical network short circuit simulation
- Network load flow and voltage drop simulation
- Device coordination and selectivity
- Arc fault protection and coordination
- Power quality simulation and modeling
- Renewable & microgrid energy storage sizing simulation

#### Operate & Maintain
(Operators, maintenance team, service teams)
- Operator training simulation
- Energy monitoring and usage analysis
- Energy performance, modeling and verification
- Capacity management

#### Improve Time to Market

#### Improve Your Process
- Predictive simulation
- Simulate before Operate
- Electrical distribution monitoring and alarming
- Power event analysis
- Asset performance
- Power quality monitoring and compliance
- Power quality and power factor correction
- Continuous thermal monitoring
- Arc flash protection

#### Improve Quality
- Carbon neutrality consulting services
- Energy efficiency compliance
- Greenhouse gas reporting

### Transverse Lifecycle Capabilities

#### Electrical Digital Twin
- Asset performance
- Power quality monitoring and compliance
- Power quality and power factor correction
- Continuous thermal monitoring
- Arc flash protection

#### Green Premium
- Carbon neutrality consulting services
- Energy efficiency compliance
- Greenhouse gas reporting

#### Cybersecurity
Overview of Digital Solutions and Services

Transverse Lifecycle Capabilities

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(Consultants & EPC)

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Improve Time to Market

Improve Your Process

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Improve Quality

- Asset performance
- Power quality monitoring and compliance
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Grow Sustainability

- Carbon neutrality consulting services
- Energy efficiency compliance
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BIBLIOGRAPHY
Maintain a Digital Twin of your electrical distribution

**Benefits**

- Intelligent user-interface for all levels of AC and DC networks
- Enables users, from the design to operate phases, to model, simulate, analyze and validate electrical power systems to predict their electrical network behavior
- Takes the day-to-day system modeling and design tasks to a new level of speed, accuracy and ease
Green Premium

Manage sustainability from design to end of life

Benefits

• Provides products delivering sustainable value

ZOOM ON SF6-FREE MV SWITCHGEAR

For decades, SF6 (sulfur hexafluoride) has been trusted for use in MV switchgear, but it is the most potent greenhouse gas.

At Schneider, we have decided to move away from SF6 and to switch to the best sustainable gas: pure air.

The new SM AirSeT MV switchgear is powered by air and digital: while using established air and vacuum technology to preserve the planet, it keeps the original functionalities and connectivity of our renowned switchgear for optimum efficiency.

SF6-free SM AirSeT Medium Voltage Switchgear
Cybersecurity

Help secure the digital power distribution system

**Benefits**
- Provides a selection of cybersecurity certified products
- Provides certified system architectures and solutions
- Delivers lifecycle services

**Certified products**
Certified products developed according to IEC 62443 functional requirements with Secure Development Lifecycle processes.

**Certified systems & solutions**
Certified secure system architecture according to IEC 62443-3-3 with documented processes and solutions for a secure system. Cybersecurity system configuration software for consistent security policy deployment.

**Lifecycle services**
Consulting services from design, implementation, operations and maintenance to tailor your security solutions to your strategy and budget.
Overview of Digital Solutions and Services

**Design, Build, Commission**
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**Operate & Maintain**
- Operator training simulation
- Energy monitoring and usage analysis
- Energy performance, modeling and verification
- Capacity management

**Improve Time to Market**
- ▪

**Improve Your Process**
- ▪

**Improve Quality**
- ▪

**Grow Sustainability**
- ▪

**Transverse Lifecycle Capabilities**

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Introduction
- Overview of Digital Solutions and Services
- Transverse Lifecycle Capabilities
- Capabilities to Improve Time to Market
- Capabilities to Improve Your Process
- Capabilities to Improve Quality
- Capabilities to Grow Sustainability

**Cybersecurity**
- Carbon neutrality consulting services
- Energy efficiency compliance
- Greenhouse gas reporting

Reference Guide
EcoStruxure™ Power for EV Battery Manufacturing Plants

SECTION 1 – Introduction to the EV Battery Manufacturing Industry

SECTION 2 – How SE Can Support EV Battery Manufacturing Plants

SECTION 3 – Digital Solutions and Services

BIBLIOGRAPHY
Optimize bus design allocation and simulation

**Primary Department**
- Design
- Construction

**Benefits**
- **Single solution/environment**
  - Unified AC & DC solution from HV to LV
  - One unique platform and one database
- **Efficient profile management**
  - User-defined loading and generation profiles
  - External data profile based on field measurements
- **Scalability**
  - Load growth study for future planning
- **Event simulations within the calculation period**
### Electrical Network Short Circuit Simulation

**Design and simulate unbalanced short circuits**

### Primary Department
- Design
- Construction

### Benefits
- Expedite design studies with a wide range of calculation scenarios, including advanced fault analysis
  - IEC & ANSI duty calculation for balanced and unbalanced faults
  - Simultaneous fault at selected nodes
  - Inclusive 3-Phase and 1-Phase fault analysis
  - Pre-Fault system loading consideration

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*Electrical Network Short Circuit Simulation in ETAP*
Perform power flow analysis and voltage drop calculations

**Primary Department**
- Design
- Construction

**Benefits**
- Simulation of bus voltages, branch power factors, currents, system losses, power generation versus loading
- Use of ETAP Electrical Digital Twin model with powerful calculation engines and user-friendly interface
- Simulation using multiple loading and generation conditions
Device Coordination and Selectivity

Automatically detect and evaluate the system protection and coordination/selectivity

**Primary Department**
- Design
- Construction

**Benefits**
- Verified and validated libraries
- Graphically adjustable device settings
- Detailed device settings reporting
- Continuous synchronization with one-line and integrated equipment database
Perform sequence of operation for arc fault and bolted fault

Primary Department

- Design
- Construction

Benefits

- Evaluate, verify, and confirm the operation and selectivity of the protective devices for various types of faults for any location directly from the single-line diagram
- Animation displayed on the single-line diagram
- 3-phase / 1-phase sequence of operation
Power Quality Simulation and Modeling

Evaluate and validate distortion due to harmonics

Primary Department
- Design
- Construction

Benefits
- Simulate harmonic current and voltage sources:
  - To identify potential harmonic problems (report of harmonic voltage and current distortion limit violations)
  - To identify the need for a harmonics filter
- Simulate and analyze the size of the harmonics filter your system will need to optimize performance and reduce nuisance trips

Power Quality Simulation and Modeling in ETAP
Design and optimize the microgrid system

Primary Department
- Design
- Construction

Benefits
- Build renewable energy models combined with full spectrum power system analysis calculations for:
  - Accurate simulation
  - Predictive analysis
  - Equipment sizing
  - Field verification of wind, solar farms and other DERs
- Enable designers and engineers to conceptualize the collector systems, determine wind penetration and perform grid interconnection studies

[Image: Renewable and Microgrid Energy Storage Sizing Simulation in ETAP]
# Overview of Digital Solutions and Services

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## Improve Your Process
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## Improve Quality
- Carbon neutrality consulting services
- Energy efficiency compliance
- Greenhouse gas reporting

## Grow Sustainability

### Transverse Lifecycle Capabilities
- Electrical Digital Twin
- Green Premium
- Cybersecurity
Train new employees and build confidence on new systems

Primary Department

- Facility Operations & Maintenance

Benefits

- Practice operation within a simulated but highly realistic environment to enhance safety and operational efficiency
- Track and review trainee actions to analyze and challenge them
Energy Monitoring and Usage Analysis

Determine where to focus energy conservation initiatives

Primary Department

- Facility Operations & Maintenance

Benefits

- Bring awareness to utility consumption
  - Turn data into easy-to-interpret graphical dashboards and reports to raise awareness amongst key stakeholders

- Identify “quick-win” opportunities for energy savings
  - By comparing and visualizing energy usage and cost for different utilities over different time periods
  - By identifying and prioritizing which areas lend themselves to a high energy-saving return on investment
Energy Monitoring and Usage Analysis Reference Architecture

Apps, Analytics & Services

Edge Control

Connected Products

MV Switchgears and Transformers

LV Switchgears

Hardwired devices

Serial devices

Wireless devices

Public LAN/WAN

Technical LAN

Hardwired

Serial

OPC

Wireless – 2.4 GHz

PowerLogic

PFC

Capacitor bank

PowerLogic

AcE

Active harmonic filter

SureVolt™

Automatic Voltage regulator

SagFighter™

Active Voltage Conditioner

ASCO

SPO with ASM

Burge protection device

Power Quality

Backup Power

Microgrid

Loads

Galaxy, Smart-UPS

Uninterruptible Power supply

Generator set

PV Inverter

Battery Energy Storage system

Energy Control Center (US only)

Active Variable Speed drive

Motor
Energy Performance, Modeling and Verification

Analyze the energy performance of a plant against a model baseline

**Primary Department**
- Facility Operations & Maintenance

**Benefits**
- Provide energy usage information based on equipment and processes
- Compare model versus actual consumption
- Compare pre-retrofit versus post-retrofit energy consumption to track improved performance and savings as a result of energy conservation initiatives
Energy Performance Modeling and Verification Reference Architecture
**Capacity Management**

Monitor the capacity of electrical distribution

**Primary Department**

- Facility Operations & Maintenance

**Benefits**

- Monitor electrical network capacity
- Track and review capacity efficiency
- Minimize downtime by tracking the capacity of transformers, circuit breakers, UPSs, generators, etc.

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**Breaker Capacity Single-line Diagram in EcoStruxure Power Operation**

**Capacity Management Reference Architecture**
### Overview of Digital Solutions and Services

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Design, Build, Commission (Consultants & EPC)

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**BIBLIOGRAPHY**

- Reference Guide
Help employees make better decisions

**Primary Department**
- Facility Engineering
- Design Engineering

**Benefits**
- Reduce safety risks by practicing emergencies and high-risk situations
- Enhance operational efficiency by running “what-if” scenarios
- Provide faster analysis response to incidents
Simulate Before Operate

Empower operators with predictive outcomes

Primary Department

• Facility Operations & Maintenance

Benefits

• Provide operators with a list of potential side effects, prior to executing a command
• Empower employees to feel more confident when operating their facilities by providing real time guidance
• Reduce human error that could lead to outages or safety concerns

Reference Architecture

Principle of Simulate before Operate Application
Electrical Distribution Monitoring and Alarming

Monitor and control electrical network

**Primary Department**
- Facility Operations & Maintenance

**Benefits**
- Show real-time status of the power distribution
- Customized single-line diagram
- 24/7 power monitoring and alarm notification
Power Event Analysis

Analyze the root causes of electrical events

Primary Department
- Facility Operations & Maintenance

Benefits
- Automatically classifies and describes any electrical events
- Uses system intelligence to determine root cause and location of events
- Shows context and sequence of events using the timeline analysis interface
Benefit from a strategic maintenance approach

Primary Department

- Facility Operations & Maintenance

Benefits

- Move from reactive or preventive to condition-based (predictive) maintenance strategies for critical assets like circuit breakers, gensets, transformers, etc.
- Provide event details and notification to the operator if a protection setting has been changed
- Receive notifications and diagnostics reports from expert service engineers with recommendations to optimize maintenance by asset or site
Power Quality Monitoring and Compliance

Gain insights to improve power quality and comply with standards

Primary Department

- Facility Operations & Maintenance

Benefits

- Bring awareness of power quality
- Enhance operational efficiency by making sure clean power is fed to sensitive process equipment
- Help protect sensitive equipment by tracking power quality problems before they arise
Power Quality and Power Factor Correction

Help protect sensitive equipment from power quality issues

Primary Department

• Facility Operations & Maintenance

Benefits

• Monitor sensitive process lines and busbars
• Provide clean power to sensitive process equipment
• Track Power Quality problems to help avoid downtime
• Reduce financial impact of power factor on energy bill
Continuous Thermal Monitoring

Help prevent electrical fires and help protect equipment

Primary Department
- Facility Operations & Maintenance

Benefits
- Bring early detection of temperature abnormalities
- Help reduce the risk of equipment and electrical room damage and improve service continuity
- Enable cost effective maintenance
**Arc Flash Protection**

**Help protect employees and equipment**

**Primary Department**
- Facility Operations & Maintenance

**Benefits**
- Help prevent loss of life and reduce the risk of equipment and electrical room damage
- Improve maintenance team awareness to help troubleshoot and identify the root cause of arc flash events
# Overview of Digital Solutions and Services

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*(Consultants & EPC)*

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Carbon Neutrality Consulting Services

Track and reduce carbon emissions to demonstrate the carbon neutrality of the company

Primary Department

- Facility Operations & Maintenance
- Sustainability Office

Benefits

- Get support from our consulting services to define your strategy for achieving carbon neutrality

Carbon neutrality

1. Reduce Carbon Emissions
   - Energy Efficiency
     - Sustainable building design & operations
     - HVAC Efficiency
     - Lighting Efficiency
     - Operational Efficiency

2. Produce Renewable Energy
   - Behind-the-Meter Renewables
     - Solar Panels / Heating
     - Wind
     - Geothermal

3. Purchase Renewables/Offsets
   - Supporting Technologies
     - Microgrid with Smart Management
     - Battery Storage
     - Fuel Cells
   - Purchase Renewables
     - Renewable Power Purchasing Agreements (PPA)
     - Renewable Energy Certificates (REC)
     - Biofuels
   - Purchase Offsets
     - Carbon Credits
     - Carbon Capture
     - Tree Planting

BIBLIOGRAPHY
Capabilities to Grow Sustainability

Energy Efficiency Compliance

Comply with standards related to energy management systems

**Primary Department**
- Facility Operations & Maintenance
- Sustainability Office

**Benefits**
- Report and show facility compliance to local sustainability requirements
  - To benefit from tax credits
  - To gain credibility to participate in new projects

**Introduction**
Overview of Digital Solutions and Services
Transverse Lifecycle Capabilities
Capabilities to Improve Time to Market
Capabilities to Improve Your Process
Capabilities to Improve Quality

**Sustainable Organizations and Standards**

**BIBLIOGRAPHY**

**Reference Architecture**
Greenhouse Gas Reporting

Track and report carbon emissions

Primary Department
- Facility Operations & Maintenance
- Sustainability Office

Benefits
- Track and report carbon emissions and waste (e.g., water) in one single place
- Provide period-over-period usage comparison to detect a drift

Greenhouse Gas Reporting and Dashboard Examples in EcoStruxure Power Operation
BIBLIOGRAPHY
Digital Applications for Large Buildings and Critical Facilities

The Digital Applications Design Guide provides comprehensive details on the building blocks of EcoStruxure™ Power: the IoT applications are driven by a software layer to control the traditional electrical distribution infrastructure. Developed to help engineering consultants and designers, this guide is an invaluable resource for specifying, designing and prescribing EcoStruxure Power architectures capable of performing one or more of the business-driven applications described within.

IEC EcoStruxure Power Design Guide
Ref: ESXP2G001EN
09/2022

NEMA EcoStruxure Power Design Guide
Ref: 0100DB1802
09/2022
Digital Applications by Market Segment for Large Buildings and Critical Facilities

The objective of EcoStruxure™ Power is to offer a range of digital applications to fulfill customers’ needs in large buildings and critical facilities such as data centers, large hotels, healthcare, and industrial facilities. Those applications are presented in the EcoStruxure Power Design Guide, sorted by value proposition. The current document is a supplementary guide to the EcoStruxure Power Design Guide. It proposes a selection of the most appropriate applications, depending on the targeted segment.

IEC EcoStruxure Power Selection Guide
Ref: ESXP2G001EN
09/2021
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