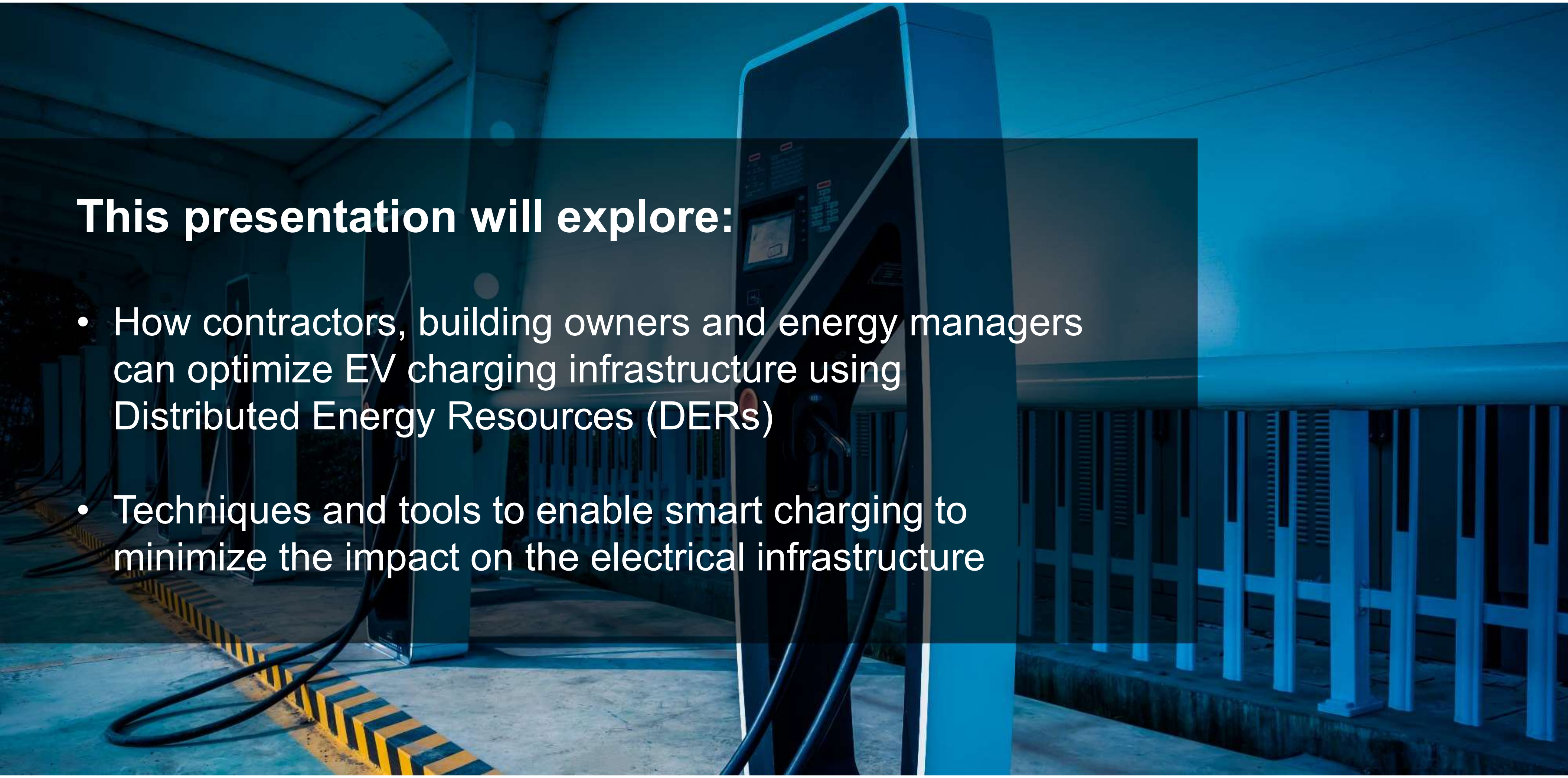
Impacts of the electrification of transportation on homes, buildings and the grid

Powering Business Worldwide

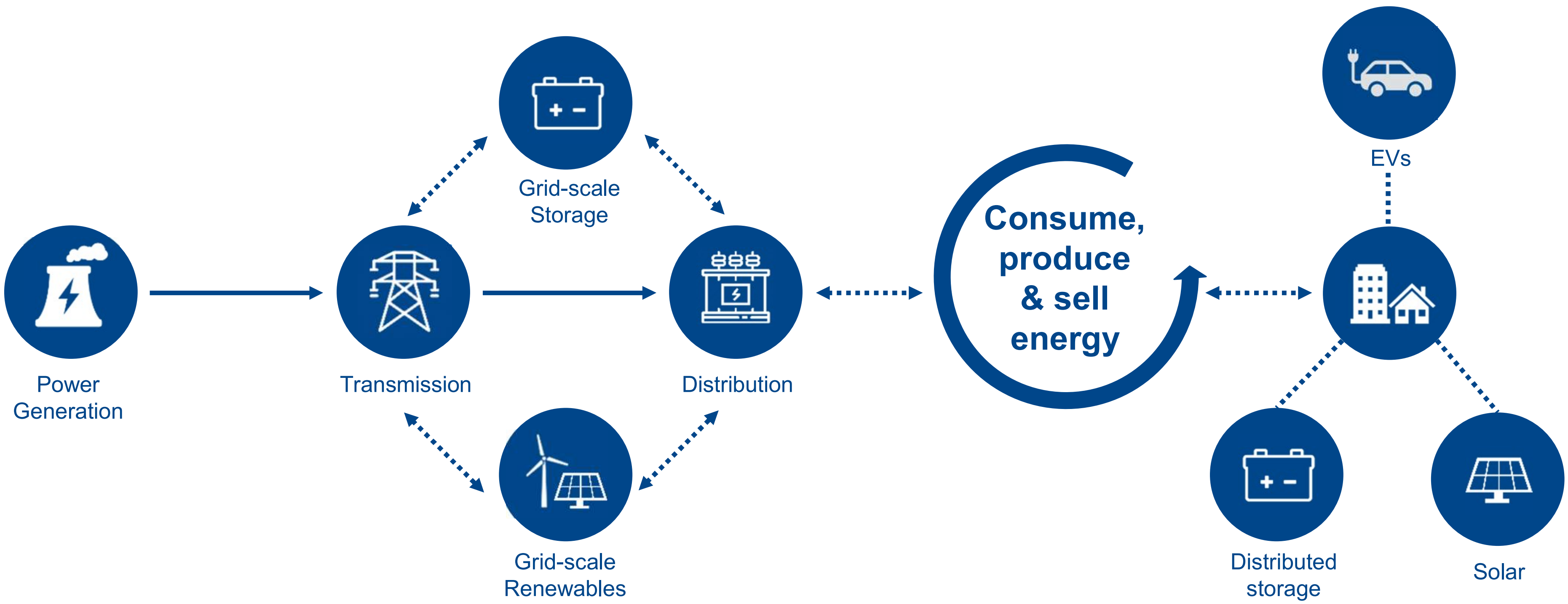


This presentation will explore:

- How contractors, building owners and energy managers can optimize EV charging infrastructure using Distributed Energy Resources (DERs)
- Techniques and tools to enable smart charging to minimize the impact on the electrical infrastructure

EATON
Powering Business Worldwide

Energy transition is changing the electrical power value chain



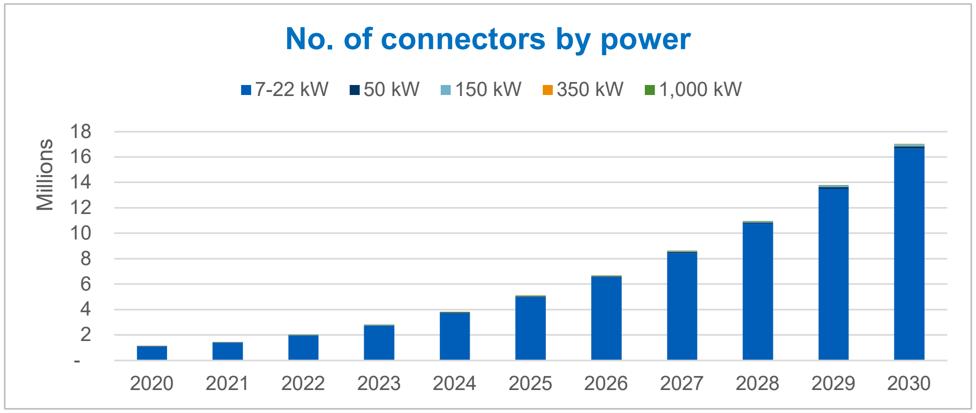
The energy transition will require flexible energy systems

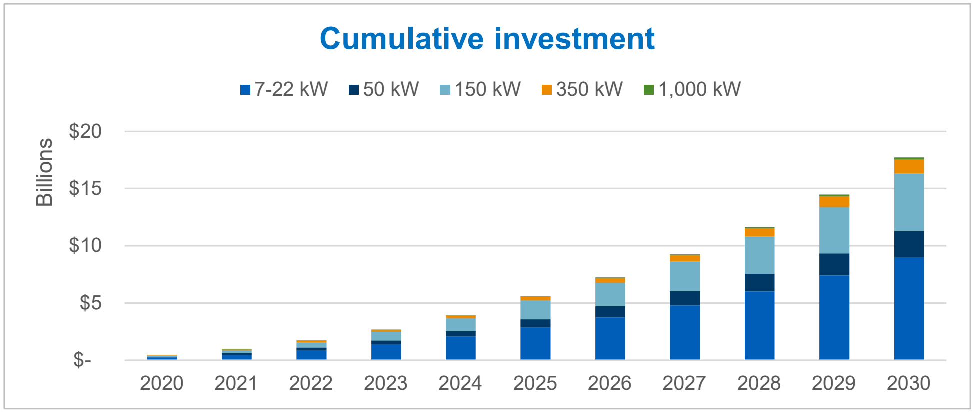
Through our
EVERYTHING AS A GRID
approach, advanced technologies and digital intelligence, we are optimizing the energy the world relies on and helping customers safely add renewables and storage to their energy systems

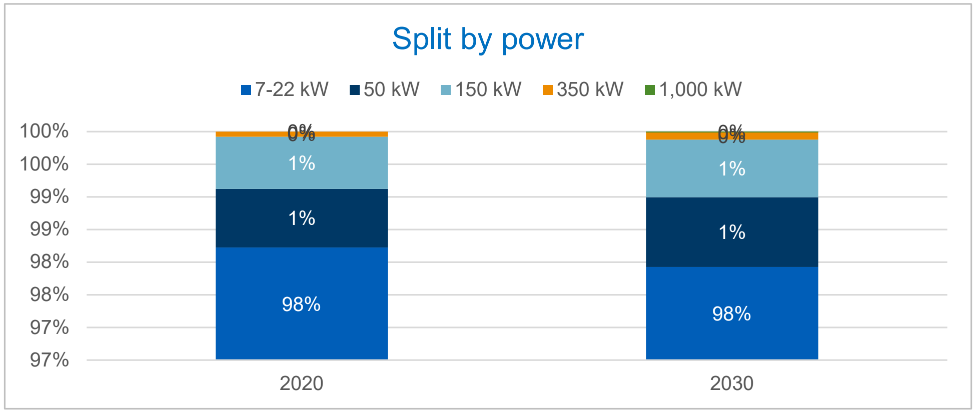
EATON
Powering Business Worldwide

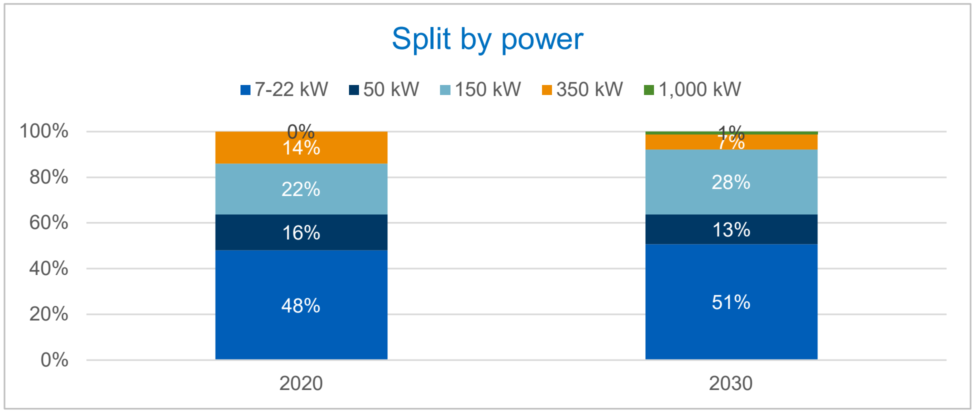
EV charging infrastructure details

98% of chargers expected to be 7-22 kW; however, represent only 48% of revenue opportunity





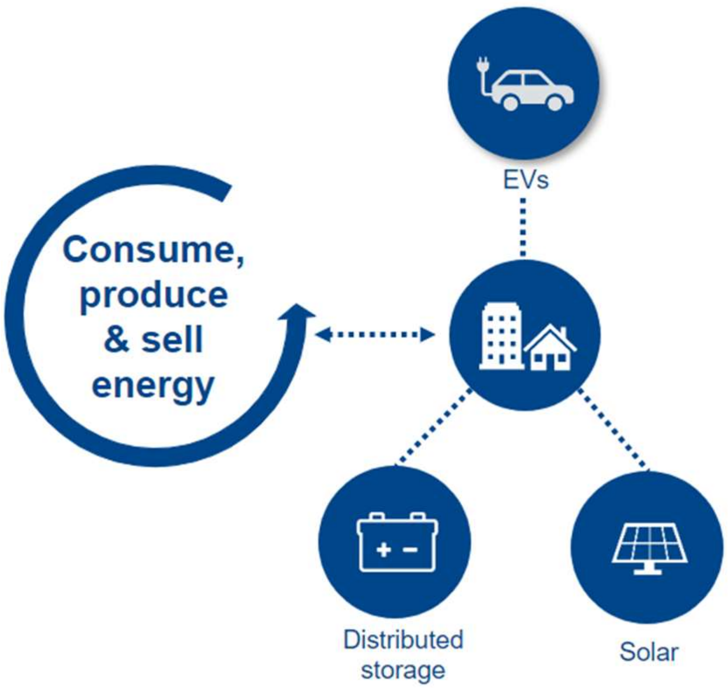




Powering Business Worldwide

Source: BNEF

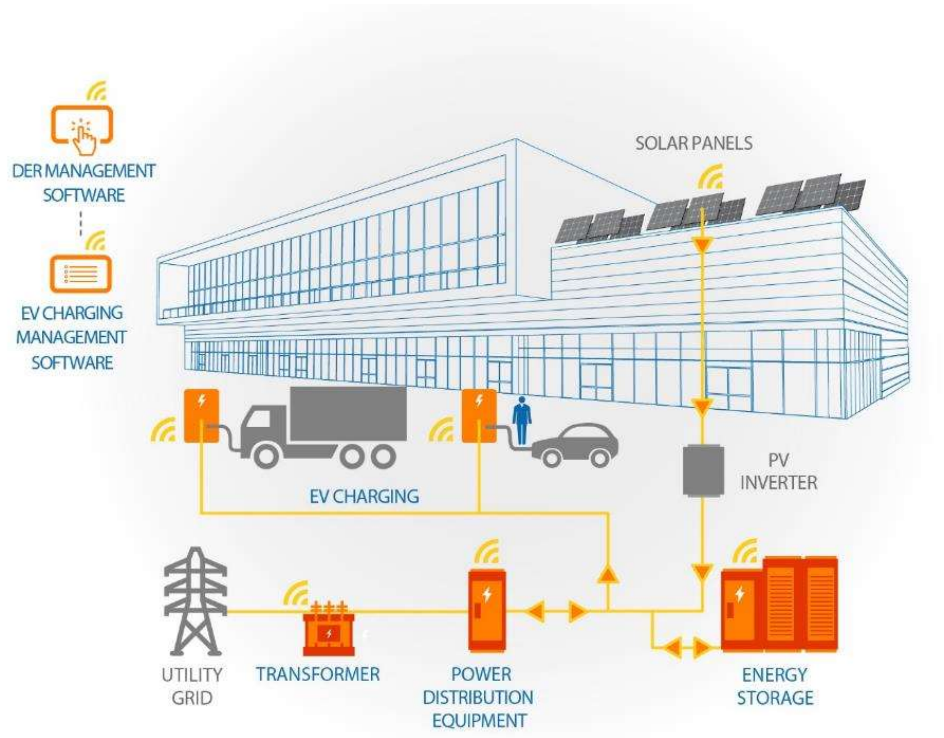
Building electrical systems are becoming more complex



EVs and renewables introduce complexity into both residential and commercial building electrical systems

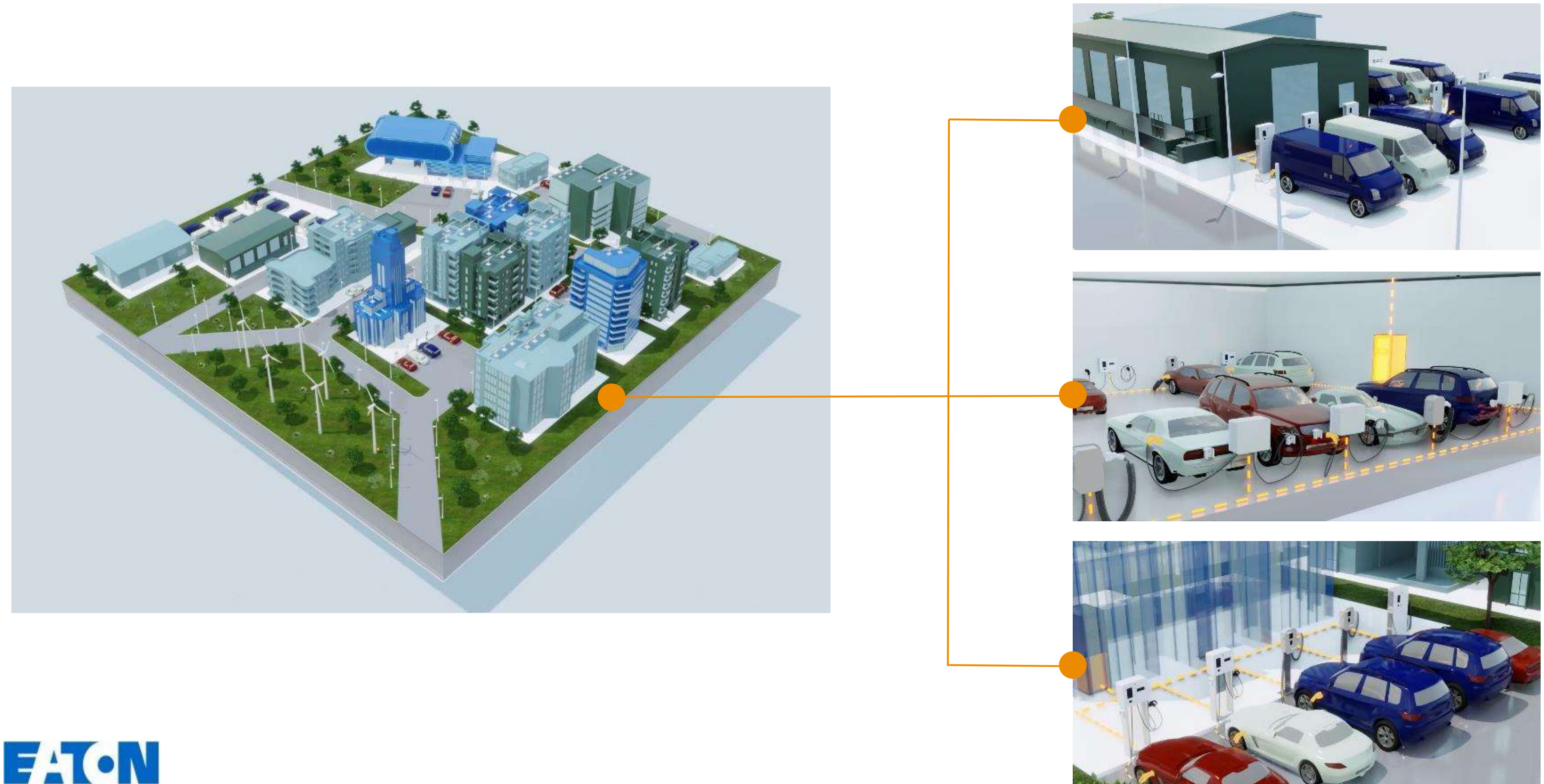
Commercial buildings will need to integrate EV chargers, produce renewable energy onsite and control energy flows

- Integrate AC and DC EV chargers
- Manage fleet charging needs
- Provide charging for employees
- Electrical system upgrades
- Microgrid control solutions to provide resiliency, meet sustainability goals, manage energy costs
  - Energy storage
  - Integration of renewable energy
  - Existing backup generators
  - Complement incoming utility service

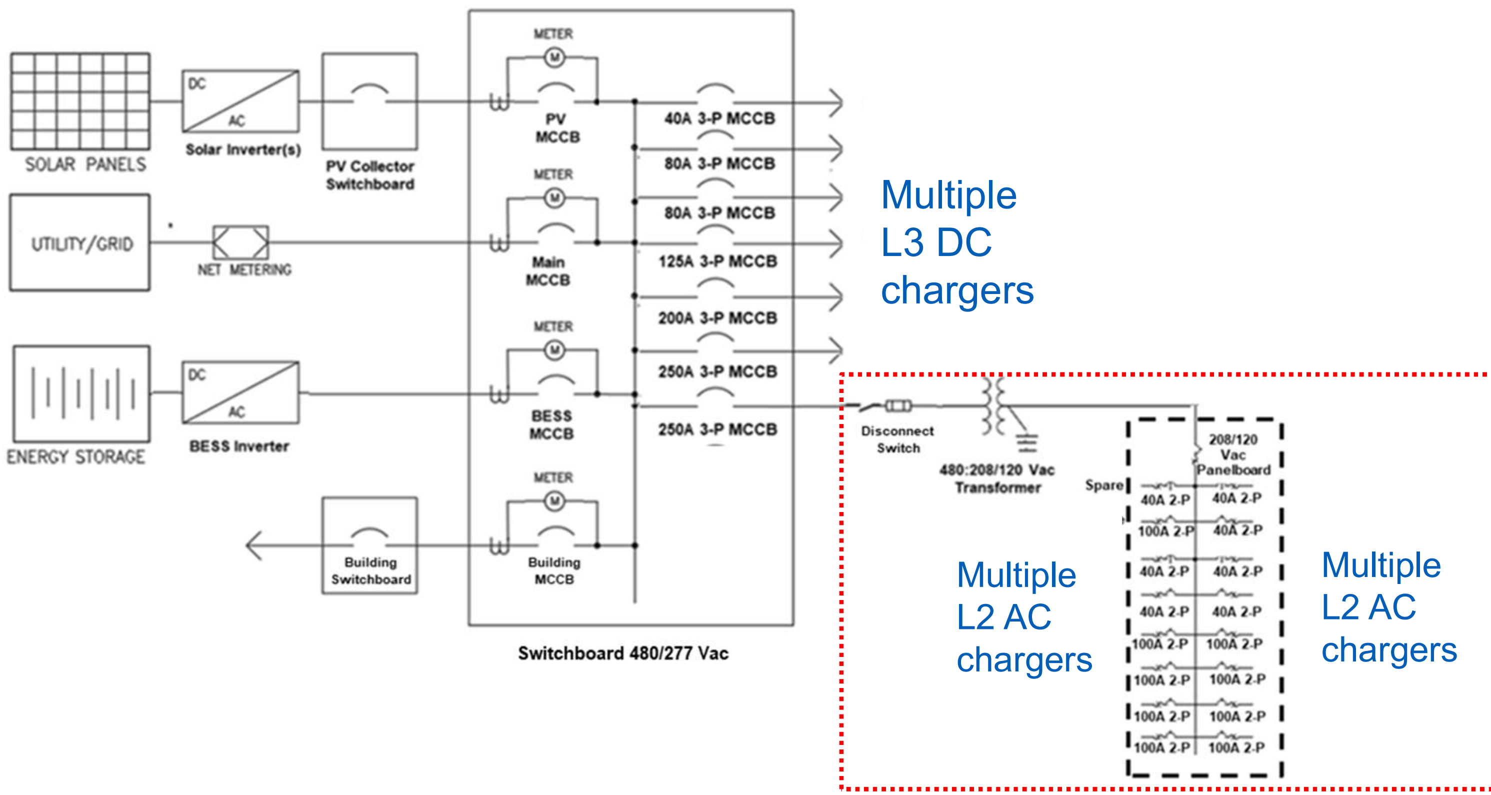


Powering Business Worldwide

EV charging deployments across multiple buildings



Well-designed power distribution equipment is essential to integrate multiple L2 and L3 chargers with renewable energy and battery storage

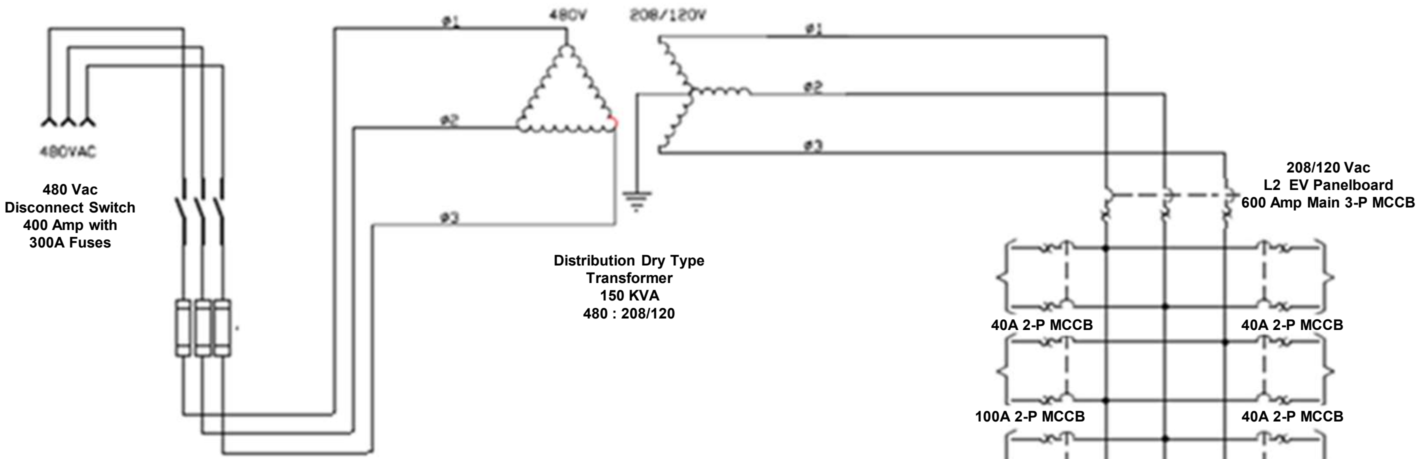


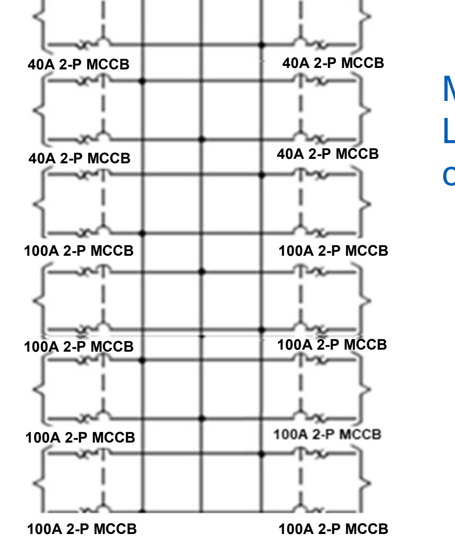
EATON
Powering Business Worldwide

Today's electrical systems must be flexible to optimize bi-directional power flow, energy usage and efficiency

A closer look at AC L2 charging electrical infrastructure

A robust electrical infrastructure is required to support AC L2 charging





Multiple L2 AC chargers

Multiple L2 AC chargers

Disconnect switch

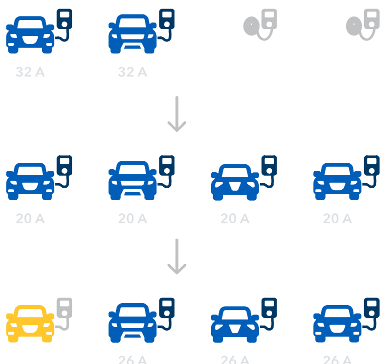
Dry type transformer

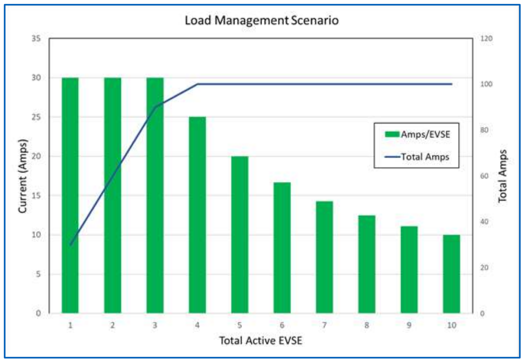
Panelboard

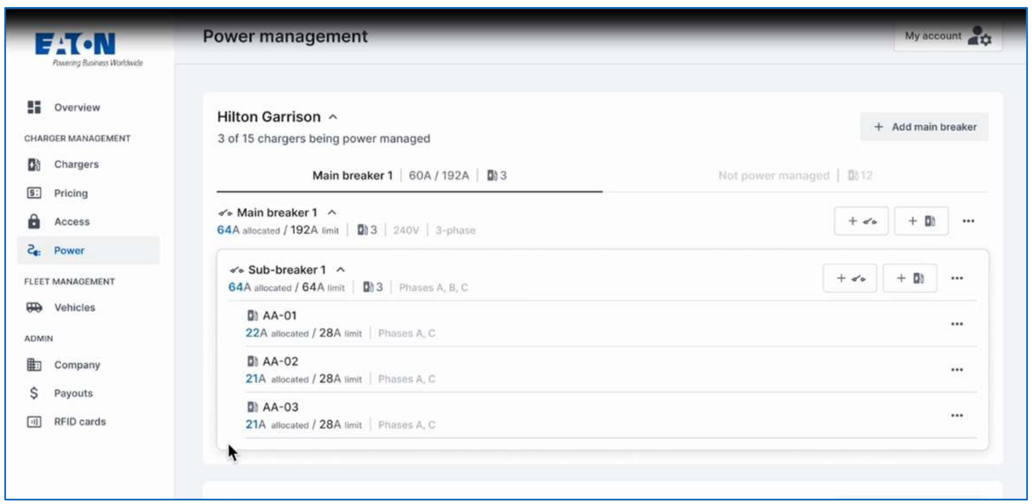
7.7 to 19.2 kW L2 AC EV chargers

EATON Powering Business Worldwide

Power Management via Software



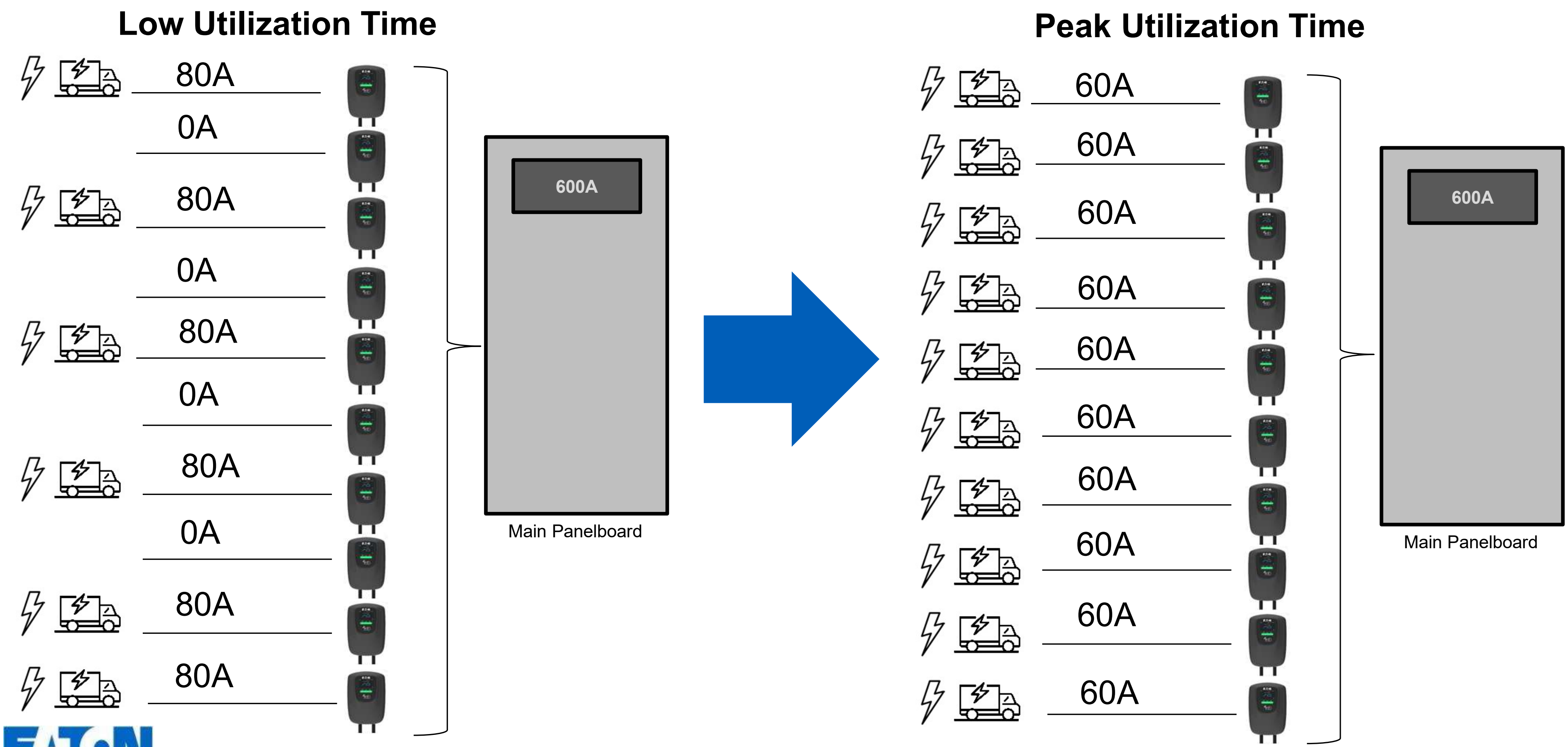




- Creates a virtual twin electrical panel with both EVSE and uncontrolled loads
- Allows site hosts to install more chargers on a limited electrical service
- Output amperage is automatically adjusted based on the number of vehicles plugged in to a group of chargers

Powering Business Worldwide

Power Management via Software: Avoid infrastructure upgrades through managed charging & load management



Powering Business Worldwide

Optimize EV charging infrastructure with load-balancing software, storage and solar

22 kW AC chargers

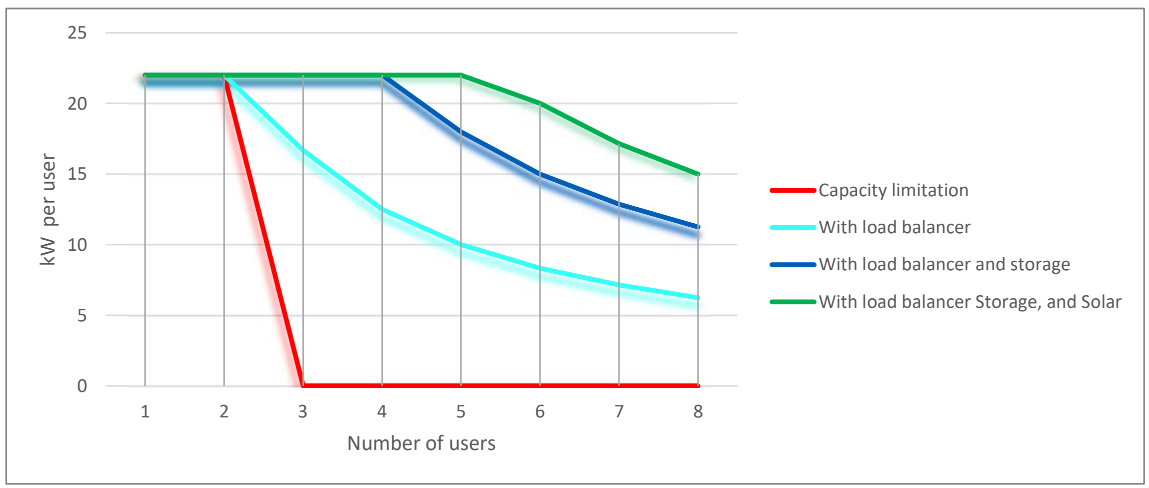
Load balancing and EMS

Battery storage 40 kW / 50 kWh

Solar PV 30 kW

50 kW incoming capacity

- The combination of DER management, energy storage and solar allows increased
  - **number of chargers installed**
  - **available power per charger**
- Leading to
  - **better user experience** at peak time
  - improved business performance
  - potential for **grid support**

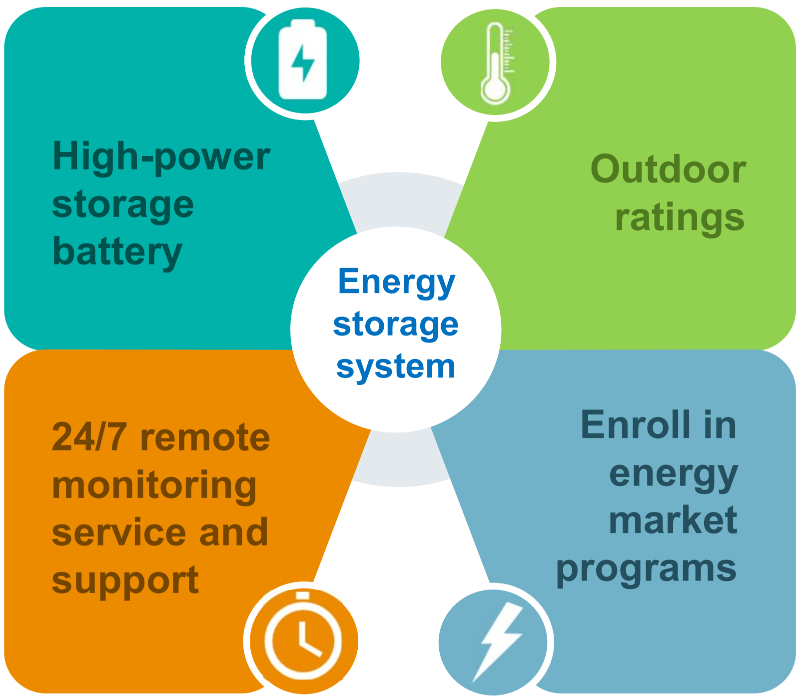


Powering Business Worldwide

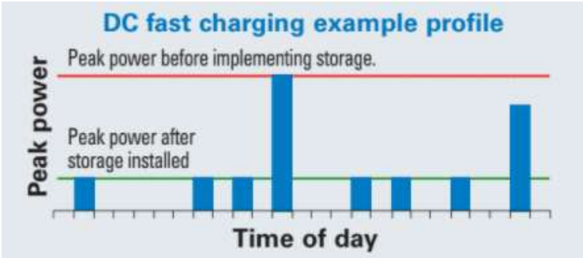
Energy storage

Critical enabler for fast charging at depots, in parking garages and on the highway

Stationary energy storage to optimize EV fast charging without overloading power networks

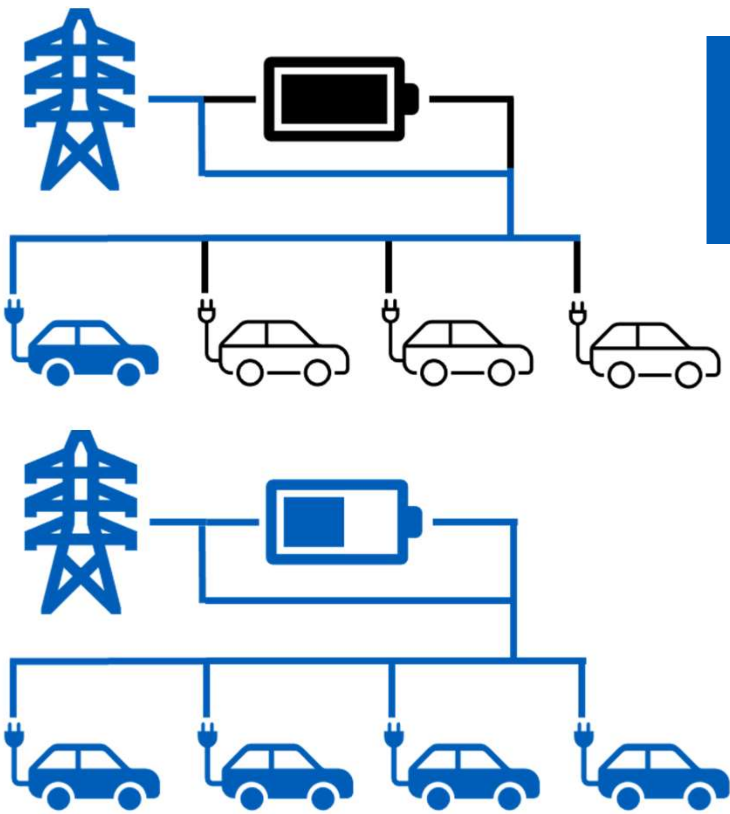


Application spotlight: EV charging

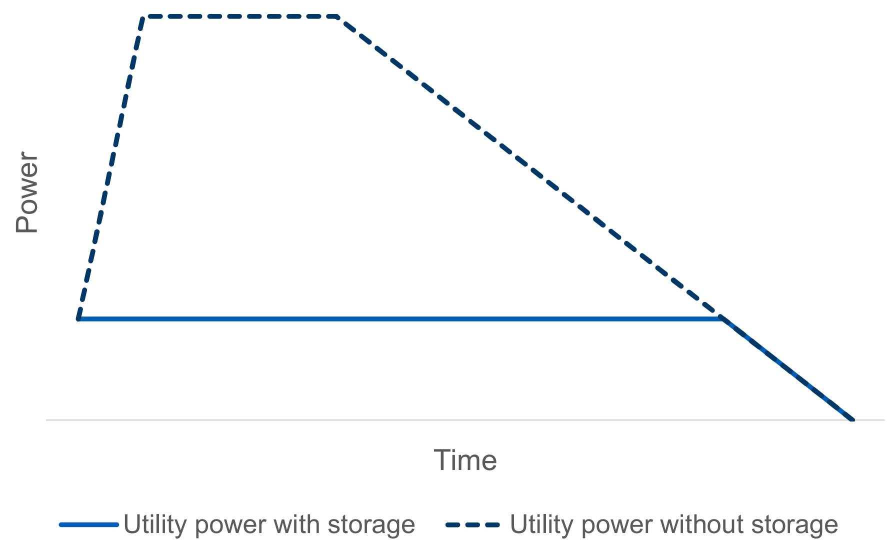


Battery energy storage system

Example charging site with battery storage



xStorage 400 boosts charging power without infrastructure upgrades or demand charges



EATON
Powering Business Worldwide

xStorage400 Video

Electrical system upgrades and microgrid solutions

Meet resiliency, sustainability and energy cost goals

Slide 18

OR2 Future of EV charging
Orie, Rob, 1/21/2022

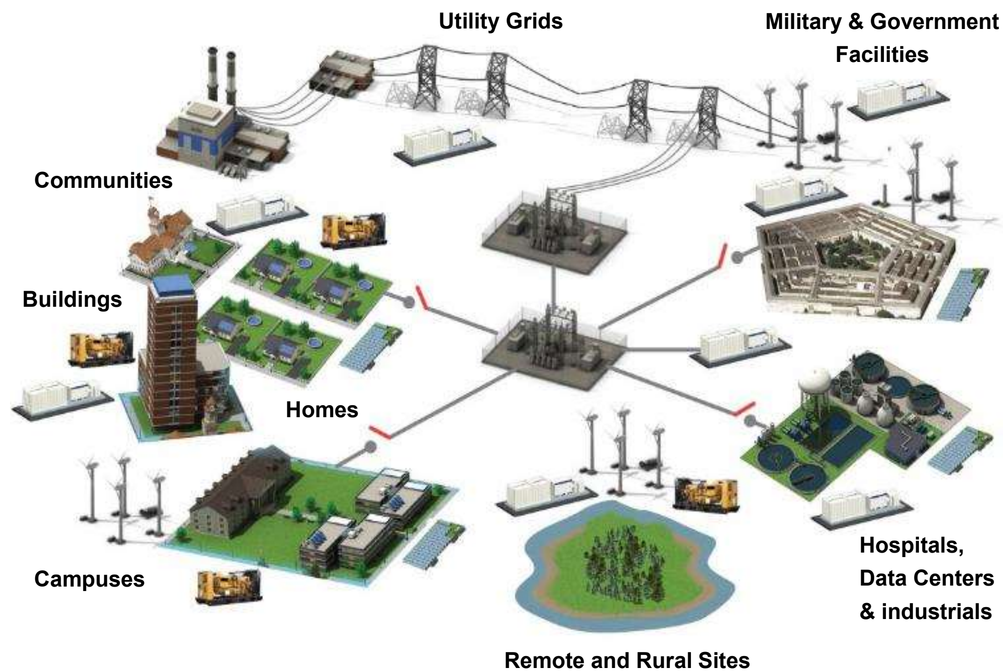
Microgrids are a grid within the grid and the Microgrid Controller is really the conductor of the DER orchestra – making the system work in harmony

Distributed Energy Resources (DER) System

A defined boundary of interconnected electrical loads and decentralized generating assets controlled as an integrated system and operating in parallel with the grid

A **Microgrid** is a DER system than can operate autonomously or "islanded" from the grid for maximum system resiliency

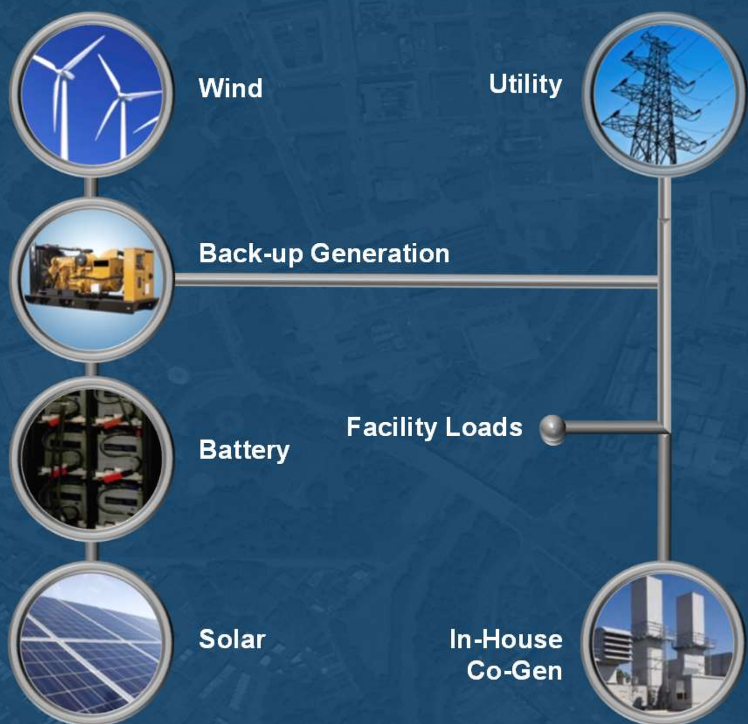
DER systems can be | **Community • Campus • Building • Home**



Common system elements

- **Controllable loads**
  Machinery, equipment, EVs, computing, lighting, HVAC, etc.
- **Distributed Energy Resources**
  Solar, energy storage, generators, combined heat & power (CHP)
- **Intelligent Controls**
  Hardware (DER controllers) and software (control algorithms)

How a microgrid works



A group of generating assets and defined loads that can operate within the utility grid or islanded from the grid, as a self-sufficient stand-alone application

Local "grid within the grid"

- Delivers power reliability and resilience

Distributed energy resources (DERs)

- On-site renewables and fuel cells
- Battery energy storage
- Backup generation
- In-house co-generation
- CHP (Combined Heat and Power)

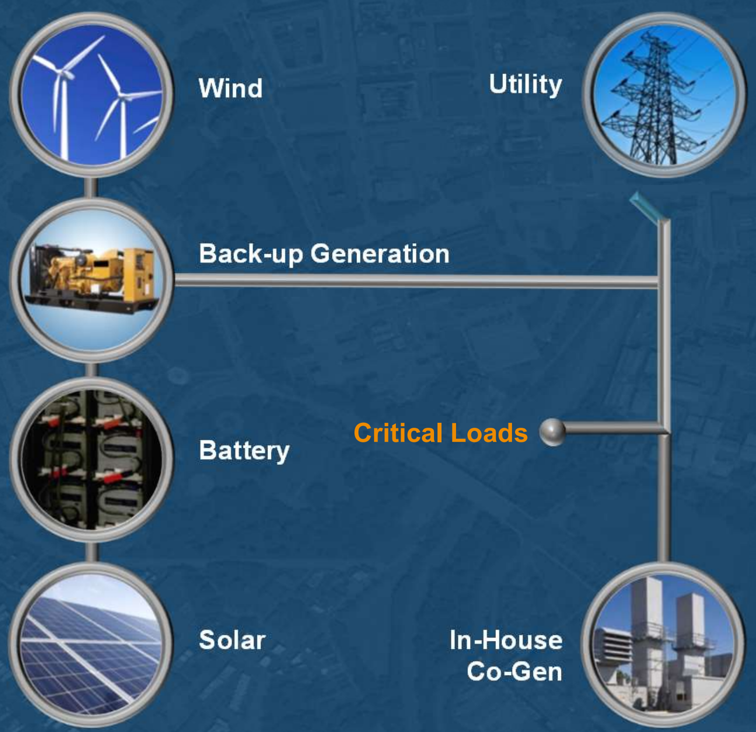
Microgrid applications

- Islanding & Synchronization
- Black Start
- Generation/load balance control
- Ancillary services like frequency regulation

Requires intelligent control system as the "glue" to achieve system performance

EATON
Powering Business Worldwide

How a microgrid works



A group of generating assets and defined loads that can operate within the utility grid or islanded from the grid, as a self-sufficient stand-alone application

Local "grid within the grid"
- Delivers power reliability and resilience

Distributed energy resources (DERs)
- On-site renewables and fuel cells
- Battery energy storage
- Backup generation
- In-house co-generation
- CHP (Combined Heat and Power)

Microgrid applications
- Islanding & Synchronization
- Black Start
- Generation/load balance control
- Ancillary services like frequency regulation

Requires intelligent control system as the "glue" to achieve system performance

Looking to decarbonize, improve power reliability or reduce costs

Microgrids can help!

Challenges

Opportunities: Microgrids

How to reduce your carbon footprint?

Many large energy users are committing to accelerate the transition to a **zero carbon energy infrastructure** with carbon reduction commitments (e.g. RE100)

SUSTAINABLE

Microgrids integrate electrical loads and **decentralized generating assets** like solar and energy storage into an interconnected system that operates as one

How to keep the power on?

The aging grid infrastructure is **increasingly unreliable** - the number of large, sustained power outages in the U.S. has more than doubled since 2000

RESILIENCE

Microgrids can operate autonomously or **"islanded" from the grid for maximum resiliency** in the case of a utility outage

How to lower your energy costs?

Electricity prices are rising with time of use (TOU) rates and demand charges making up a significant portion of your energy utility bills, fluctuating month-to-month

ECONOMIC

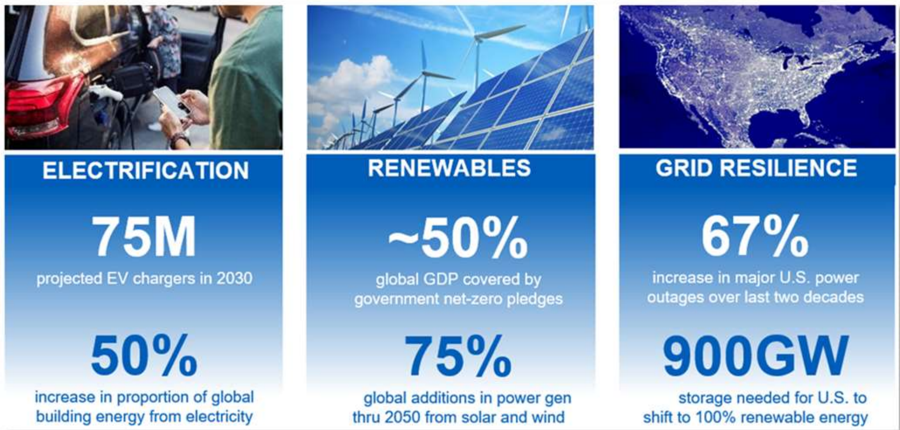
Various **attractive governmental incentives & grid flexibility programs** are available for distributed energy resources (DERs) like solar and battery storage*

* Proposed federal stimulus and infrastructure bills have the potential to significantly reduce capital costs of new battery storage and microgrid projects

EATON Powering Business Worldwide

Multiple drivers are accelerating growth in microgrids

Energy Transition mega-trends are fueling microgrid growth



Sources: EIA, Wood Mackenzie, Climate Central, BloombergNEF

Energy transition mega-trends are fueling microgrid growth
- Decentralized, decarbonized and digitized
- Double digit growth in EV charging & energy storage

Access to available financing and incentives
- Federal Stimulus & Investment Tax Credit (ITC)
- Energy as a Service business models

Evolving regulatory environment
- FERC Order 841 – energy storage
- FERC Order 2222 – wholesale energy markets

Improving microgrid/DER economics
- Rising electricity prices & tariffs
- DER monetization with grid services

Expanding global commitments to ESG goals
- Government climate change actions/proposals
- Ambitious net zero pledges by corporations

EATON
Powering Business Worldwide

Achieving a more resilient energy infrastructure with microgrids is a balance across three key value propositions depending on the customer's priorities

Value Propositions of a Microgrid / DER system

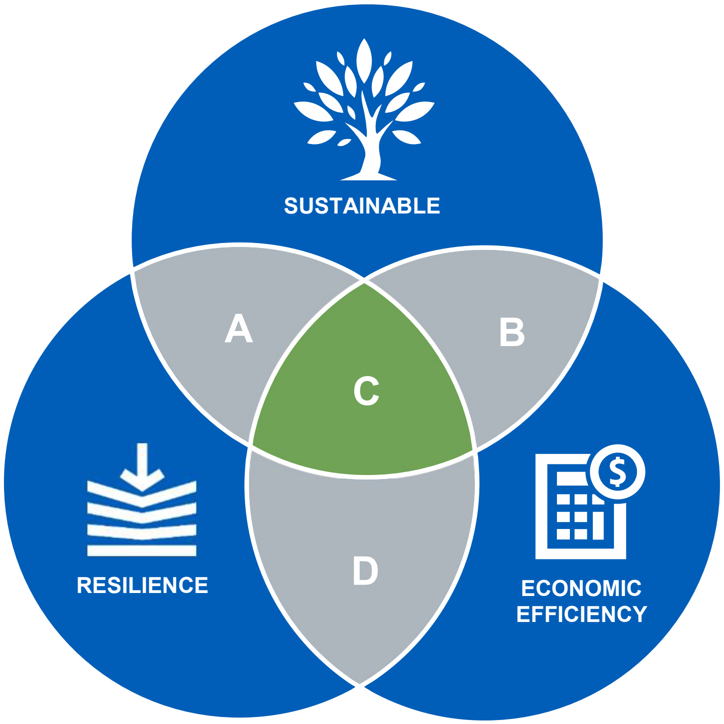
Sustainability: minimize carbon emissions
- Generate more power from renewable sources
- Build renewable EV infrastructure
- Sell clean power back to the grid

Resilience: support for critical operations
- Bolster operations to ensure business continuity
- Operate off-grid in "island" mode
- Protect people, assets and data

Efficiency: reduce energy costs
- Optimize energy consumption
- Avoid peak demand charges
- Energy as a Service financing (OpEx vs. CapEx investment)

EATON Powering Business Worldwide

Three primary value propositions of a microgrid often with fundamental trade-offs underlying them



It is often easy to get 2 of 3 but getting 3 of 3 is a challenge:

- **A** **Resilient + Sustainable** but more expensive
  microgrid in an area with low cost of power
- **B** **Sustainable + Economic Efficiency** but lacks resilience
  simple storage or PV+storage project - no back up power
- **C** Achieve trifecta of **Sustainable + Resilient + Efficiency**
  microgrid with attractive incentives & DER monetization programs
- **D** **Economic Efficiency + Resilient** without sustainability
  benefits *traditional back up diesel generator or co-generation*

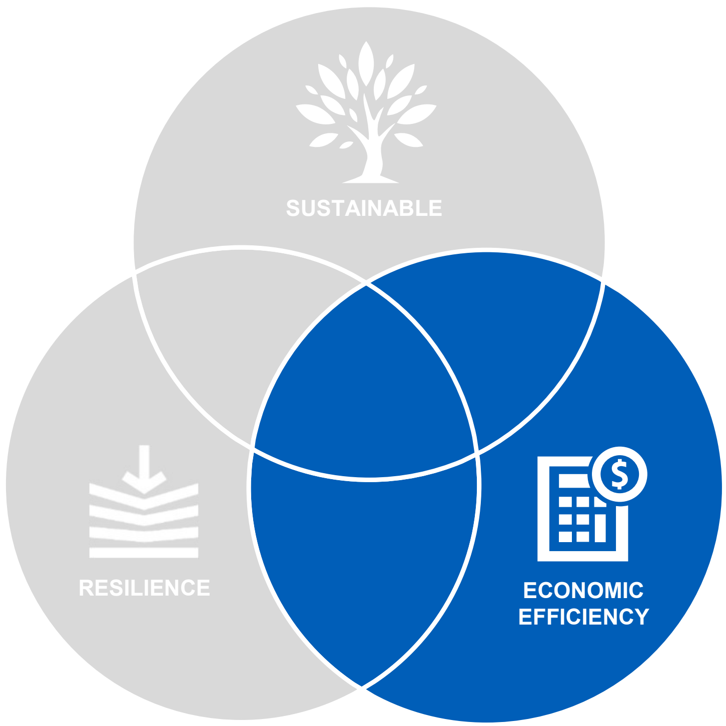
Clean energy microgrids aim to address all three benefits of **sustainability, resilience and economic efficiency**

EATON Powering Business Worldwide

Economic efficiency generally comes in certain geographies

These are often driven by available incentives, high costs of power, or strong solar resources

Where to hunt for microgrid opportunities:



Solar

- California
- Massachusetts
- Connecticut
- New Jersey
- Puerto Rico
- Illinois

Storage

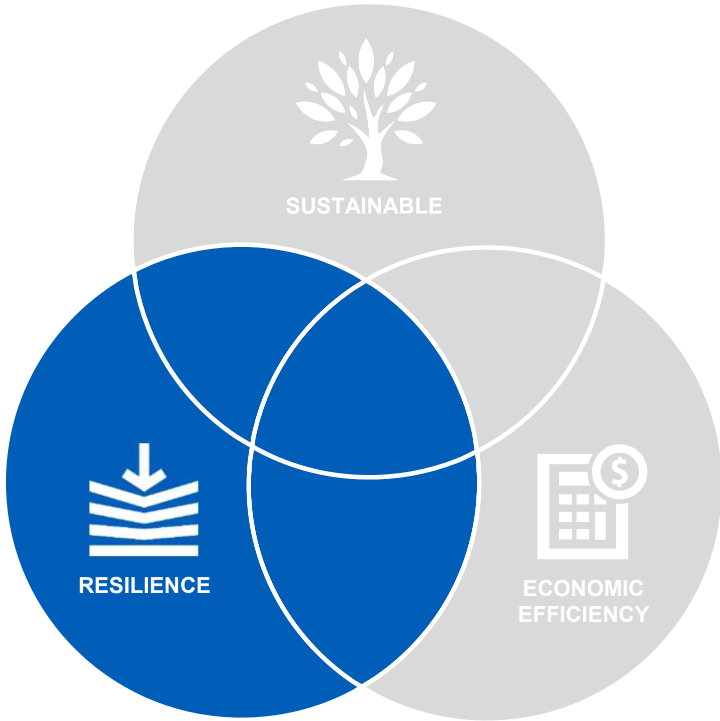
- Ontario
- California
- Massachusetts
- New York (downstate)
- Connecticut
- Parts of PJM & Texas

These geographies offer the most compelling economics today for solar & storage projects - but projects can still make sense in other areas as well, particularly with the new ITC tax incentives

EATON Powering Business Worldwide

Resilience is a key driver for certain customers

Even beyond the intangible (and safety) benefits, there is economic value to resiliency



Example "High Pain" Response

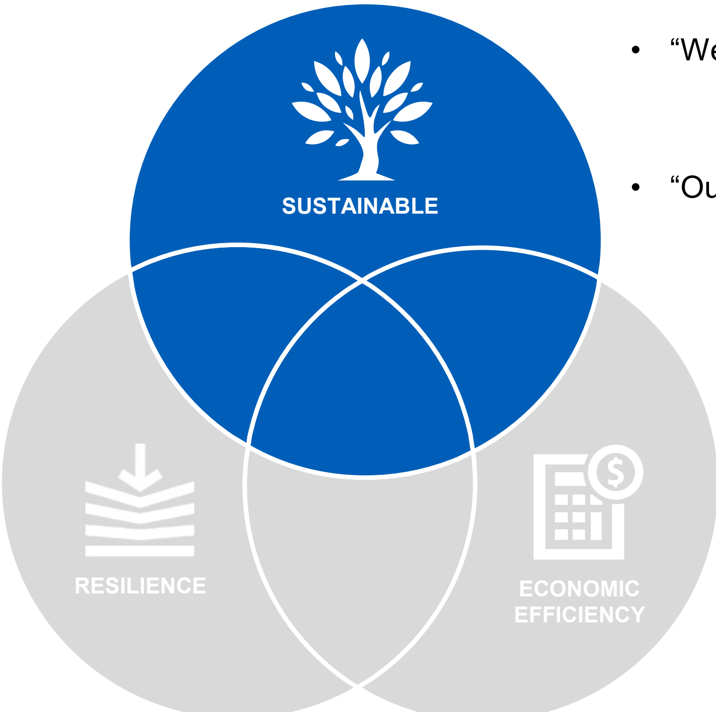
- "We have an outage every month or two, each one only costs us about 3 hours with scrap lost too, but we bake that into our production forecasts so it is already accounted for"

  >> Follow ups – over the year, how much would 50 extra production hours be worth in profit? Is it disruptive to your team to restart the factory each time one of these outages occurs?

By helping the customer quantify their outage pain/cost, we can bolster the need/financials for a microgrid…

Sustainability is a growing driver for many customer segments

From ESG commitments to 24x7 renewables matching, customers need sustainable energy solutions



<u>High Need Responses</u>

- "We're committed to 100% carbon free energy and don't think off-site solutions meet our need"
  >> Follow ups – are you thinking about net-zero emissions over the course of the year or meeting your actual usage 24x7x365 with renewable energy?
- "Our employees and customers are pushing us to be more sustainable… net-zero by 2030"
  >> Follow ups – what plan to you have in place to meet those objectives? Do you see value in having a tangible / visible symbol of your commitment on-site for your customers and employees to see?

By helping the customer quantify their sustainability needs, we can bolster the need/financials for a microgrid … or if there is no sustainability need, a BESS or microgrid with gen based on cost savings + resiliency could be a fit

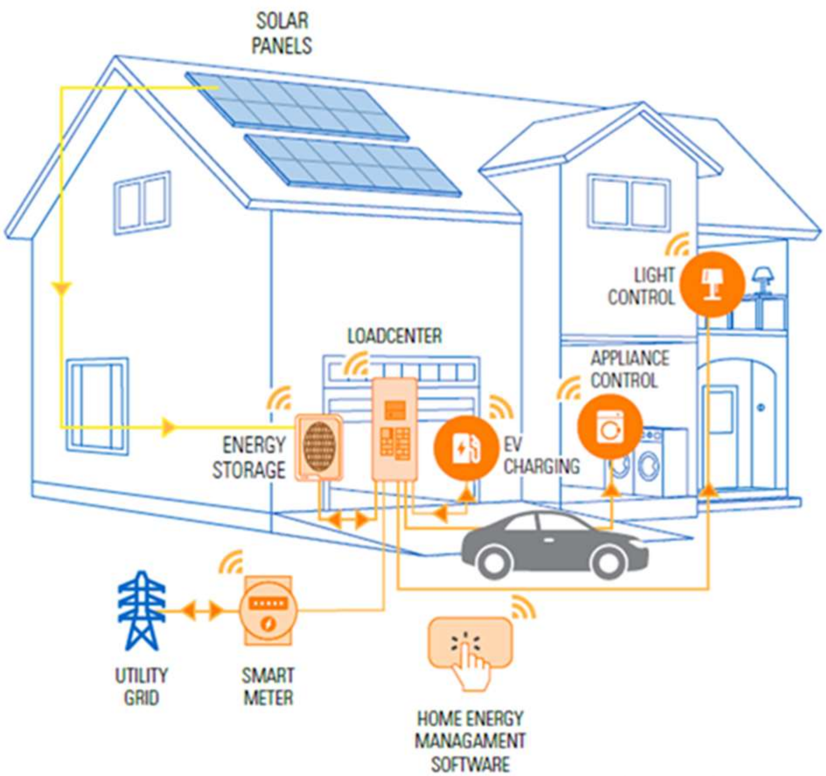
Residential / commercial applications and V2X

Vehicle to home, to building, to grid

Slide 29

OR2 Future of EV charging
Orie, Rob, 1/21/2022

Residential customers are adding local renewable generation, storage and EV charging



EVERYTHING AS A GRID

Homeowner benefits

- **Integrate** solar and DERs
- Growing **EV adoption**
- Optimize **energy consumption** and costs
- Take advantage of **time-of-use** rates

Utility benefits

- Access more **granular view and control**
- Increase participation in **demand response** and grid support programs
- **Manage demand** with generation

EATON Powering Business Worldwide

Smart breakers for energy management

Smart Breakers

Available in two variants: BR, BAB, for loadcenter or panelboard installations

Circuit Protection

- UL 489 Thermal-Magnetic
- Short Circuit, Overload Protection

Remote Control

- On/Off Control Relay
- Independent from trip mechanism

Branch Circuit Metering

- Revenue Net Metering (ANSI C12.20 ±0.2%)
- Time Stamped Values

Communications

- Cloud Connected and local Wi-Fi
- Open APIs
- Mobile app

Appliance monitoring

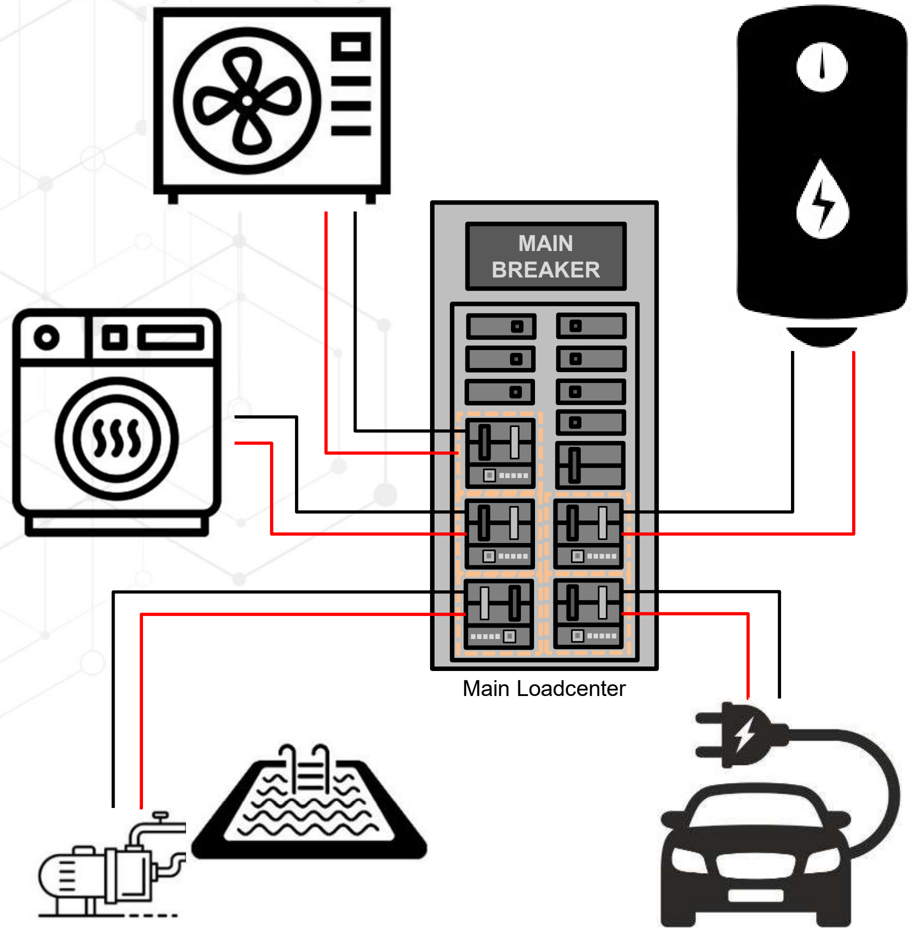
EV Charging

Demand/load management

Powering Business Worldwide

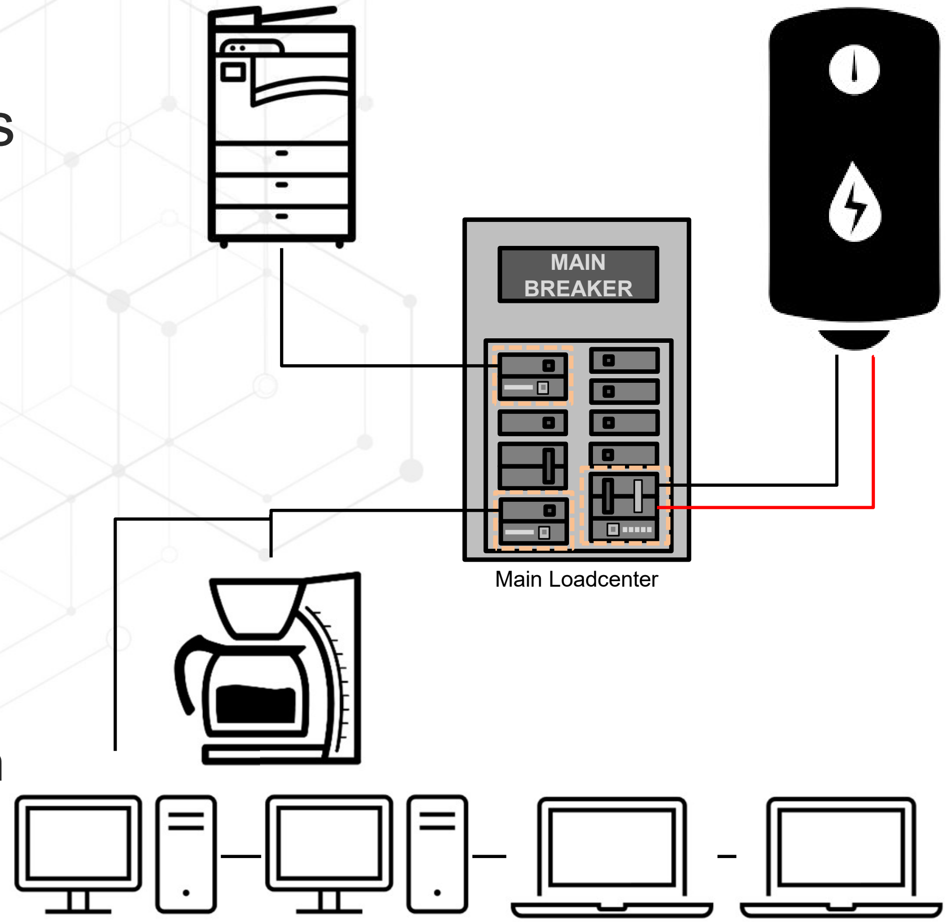
Example use case - Residential

- Utilize Smart Breakers in panels to monitor and control loads
  - Smart Breaker features:
    - Metering
    - Remote On/Off
    - Wifi enabled
  - API's allow for HEMS integration
  - Can remotely turn off items when not in use



Example use case - Commercial

- Utilize Smart Breakers in panels to monitor and control loads
  - Smart Breaker features:
    - Metering
    - Remote On/Off
    - Wifi enabled
  - API's allow for HEMS integration
  - Can remotely turn off items when not in use



Smart Loadcenter: Energy insights & control

Monitoring and energy usage

- Whole home monitoring and energy usage with smart breakers and metering solution

Control

- Control of select loads with smart breakers & mobile app

Energy insights and costs

- Summarize daily, weekly, and monthly energy usage
- Daily, weekly, monthly, and yearly usage and costs, appliance notifications

Compatibility & flexibility

- Integration with Samsung SmartThings Energy, Amazon Alexa, Google Smart Home Energy, and Alarm.com
- Retrofit and new construction options

Smart Loadcenter 1.0

Monitor | Control | Save

EATON
Powering Business Worldwide

AC Vehicle-to-home/building offers resiliency benefits

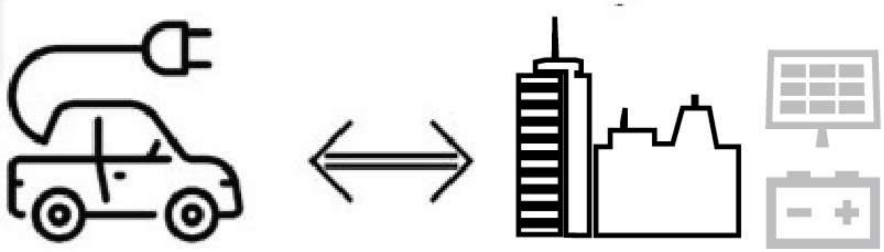

Texas Tesla Owners Are Drawing Power From Their Cars During Blackouts

Widespread outages demonstrate both the promises and current shortcomings of the energy transition.

Average outage (100 min) would drain a 40 kWh EV by 5%


Will Your EV Keep the Lights On When the Grid Goes Down?

Home battery systems can help during power outages. So can the battery packs rolling around in electric vehicles.




How California Can Use Electric Vehicles to Keep the Lights On

Commentary


CANADA'S NATIONAL OBSERVER

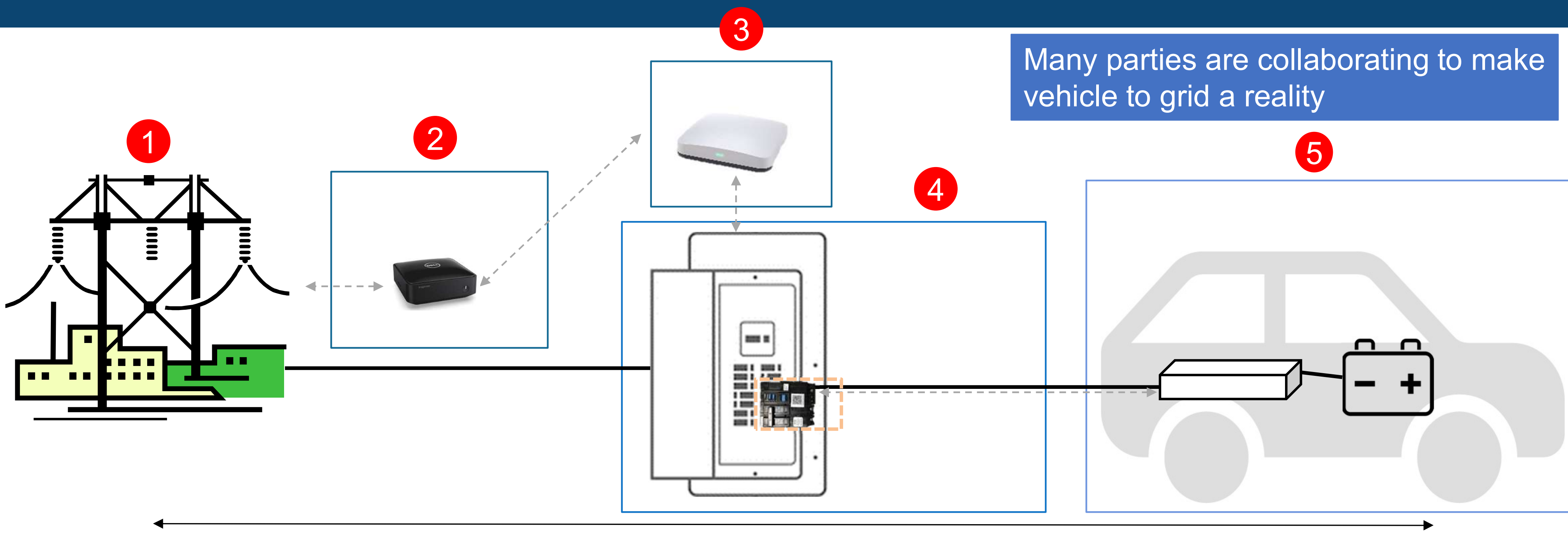
ABOUT NEWS OPINION SPECIAL REPORTS ANALYSIS CONVERSATIONS ZERO CARBON CANADA NOW SUBSCRIBER BENEFITS ADVERTISE

Your electric vehicle could help power your home

By Maria Galucci | News | June 22nd 2021

System communications and power flow architecture for Vehicle to Grid (V2G) demonstration project using EV smart breakers

Many parties are collaborating to make vehicle to grid a reality



IEEE 2030.5 (J3072)

1 Utility service

2 System aggregator service platform

3 Home energy management system

4 V2G controls + EV smart circuit breakers

5 AC bidirectionally-capable EV

EATON Powering Business Worldwide

36

Questions?

AaronAPowellJr@Eaton.com - **Energy Transition Application Engineer**

EATON

Powering Business Worldwide