

Mission-Critical Microgrids

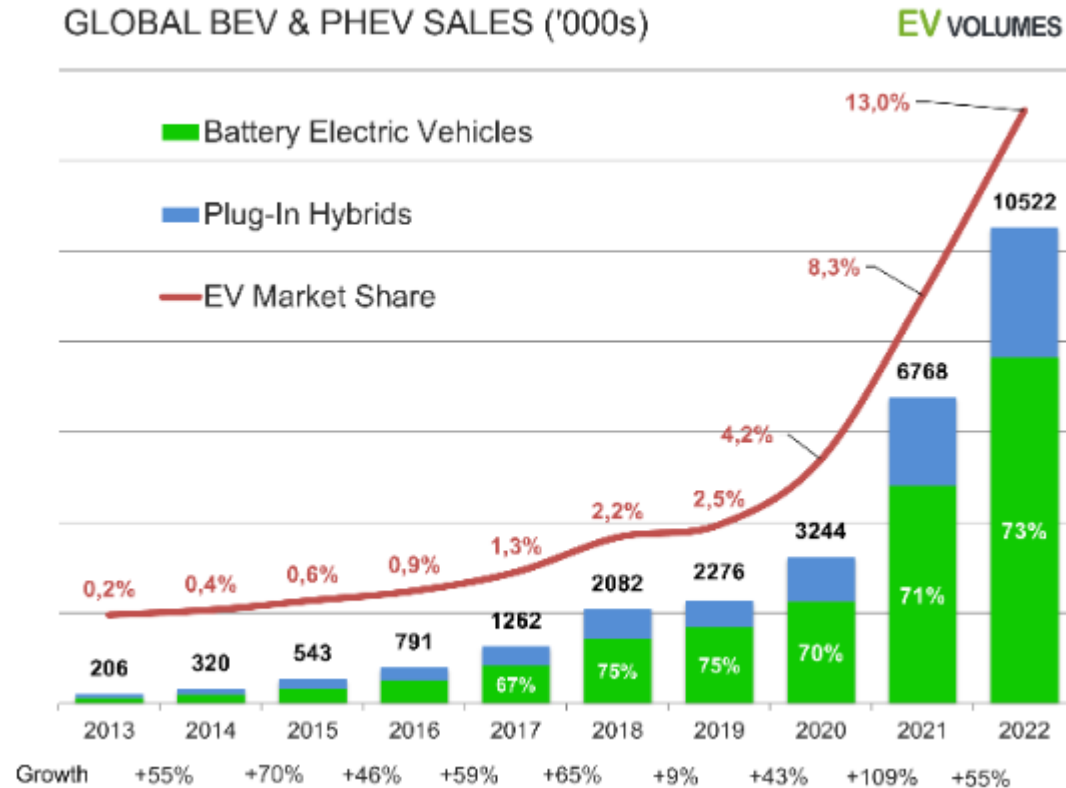
(patent pending)

Michael Benson, MPA EFO

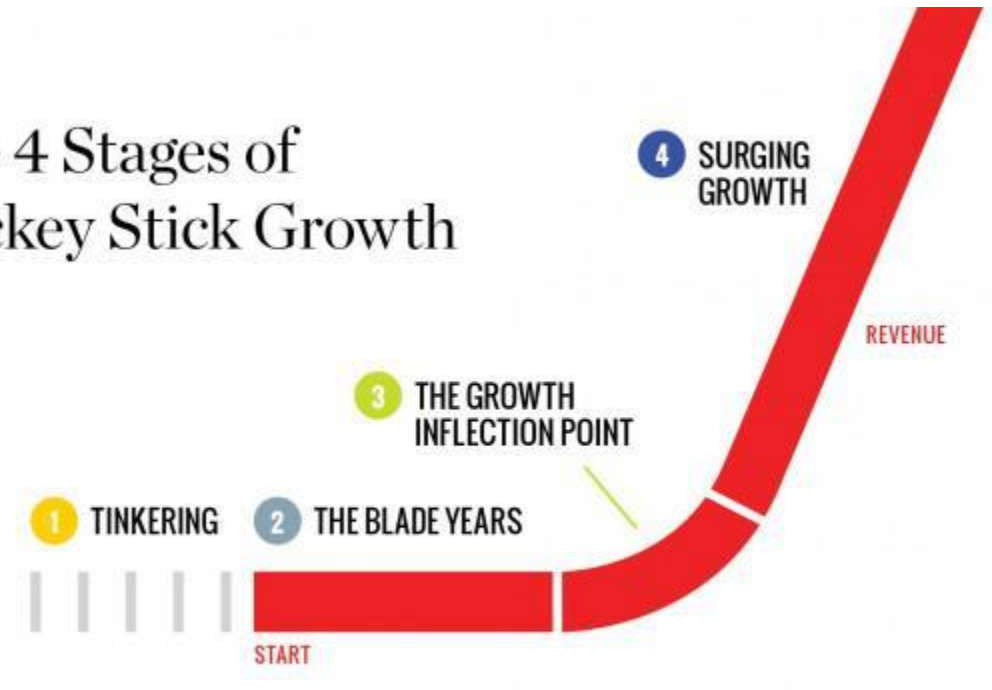
FRI EVMS - August, 2023



Electric Vehicles (EV) are here



The 4 Stages of Hockey Stick Growth



Forbes 2016

EV Charging 101

Public Charging

Level 1 is at home

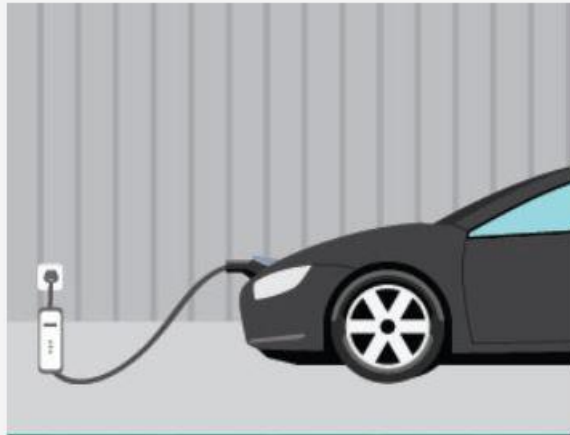
Level 2 is at home, work
or destination

DC fast charging is for
vacation

Public DC fast is not Mission-Critical

The DC fast you need is
special (up to 3MW)

Level 1



VOLTAGE:
120V 1-Phase AC

AMPS:
12-16 Amps

CHARGING LOAD:
1.4-1.9 kW

CHARGING TIME:
3-5 Miles per Hour

Level 2



VOLTAGE:
208V or 240 V 1-Phase AC

AMPS:
12-80 Amps (Typ. 32 Amps)

CHARGING LOAD:
2.5-19.2 kW (Typ. 6.6 kW)

CHARGING TIME:
12-60 Miles per Hour

DC Fast Charge



VOLTAGE:
208V or 480V 3-Phase AC

AMPS:
>100 Amps

CHARGING LOAD:
50-350 kW

CHARGING TIME:
60-80 Miles in 20 Minutes

How do we get Fast Charging?

First, some terms,

- **Watt** = unit of power (W)
- **Watt-hour** (Wh) = unit of energy
- **Volt** (V) = electrical potential
- **Amp** (A) = electrical current
- **Watts** = Volts x Amps
- **Kilowatt** (kW) = 1,000 W

and what we get today ...

- 50kW
 - 240V x 210A
 - 480V x 105A
- 150kW
 - 480V x 313A
- 350kW
 - 480V x 729A

How high does this go?

- 1,250V x 3,000A = 3.75Megawatts

Fast charging for public safety

80% State of Charge (SOC), turnaround time: 15 minutes

- EV Fire Engine
 - $327\text{kWh} \times 80\% = 261.6\text{kWh} \times 4 = 1,046\text{kWh}$ (megawatt)
- EV Police Car
 - $100\text{kWh} \times 80\% = 80\text{kWh} \times 4 = 320\text{kWh} \times 4 \text{ cars} = 1,280\text{kWh}$ (megawatt)



Emergency Services Station Power/Energy Examples

- One pumper, one ladder
 - **1.4 MW** power and **1.2 MWh** energy
- One staff vehicle, two ambulances, one pumper, one ladder
 - **1.4 MW** power and **2 MWh** energy



What we need for emergency service electrification:

- Charging system for every day
- Quick charging for busy days
- To charge anytime
- To charge even when the power is out
- A mission-critical charging infrastructure
- Is this available from your utility?
- Can you afford it?



<https://apnews.com/article/wildfires-storms-science-business-health-7a0fb8c998c1d56759989dda62292379>



<https://www.npr.org/sections/health-shots/2021/05/15/996872685/growing-power-outages-pose-grave-threat-to-people-who-need-medical-equipment-to->



Electrical grid “reliability”

North American Energy Reliability Corp.

- Manage the pace of generator retirements until solutions are in place that can continue to meet energy needs and provide essential reliability services
- Include **extreme weather scenarios** in resource and system planning
- **Address IBR performance and grid integration** issues
- **Expand resource adequacy** evaluations beyond reserve margins at peak times to include energy risks for all hours and seasons
- **Increase focus on DERs** as they are deployed at increasingly impactful levels
- **Mitigate the risks** that arise from growing reliance on just-in-time fuel for electric generation and the interdependent natural gas and electric infrastructure
- **Consider the impact that the electrification** of transportation, space heating, and other sectors may have on future electricity demand and infrastructure

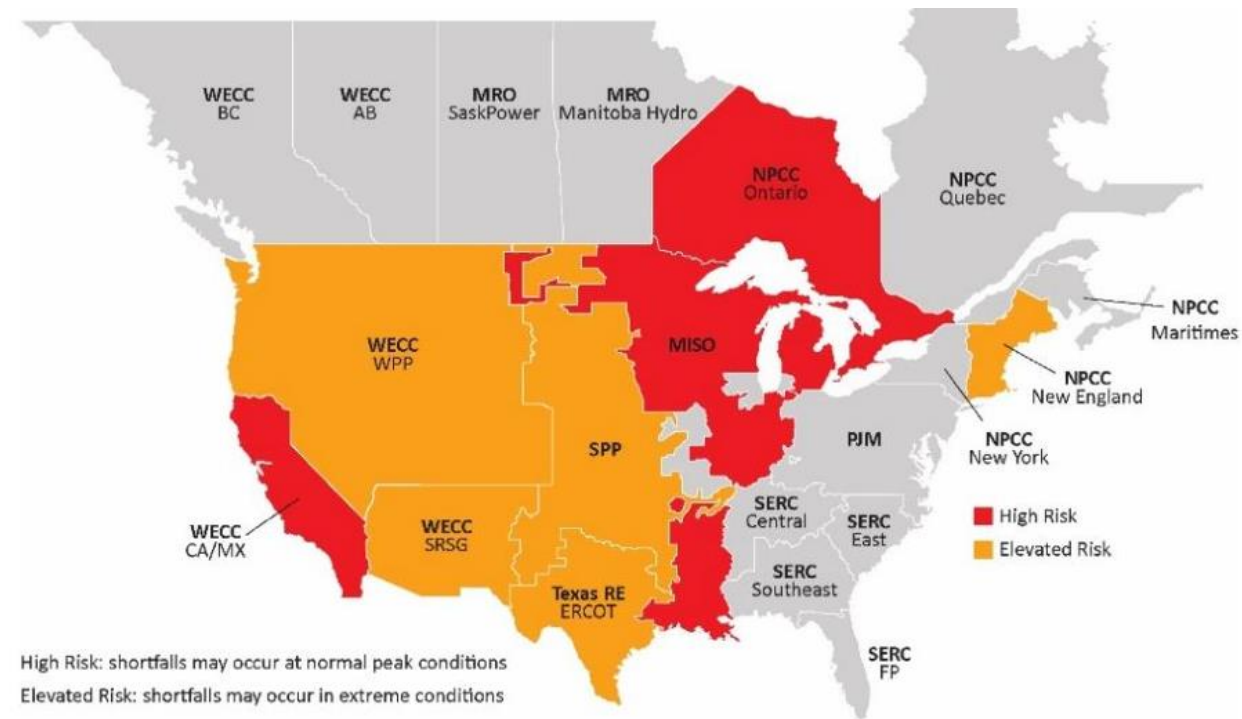


Figure 1: Risk Area Summary 2023–2027

Big batteries to fill up smaller batteries

Add a battery to your facility

- Now you have a microgrid ... almost
- A microgrid is local power source, able to operate independent of the electric grid
- Requires smart controls and system integration

Include DC fast charging

- DC to DC charging – most efficient
- We also need to charge this thing
- What is the best way to do that?

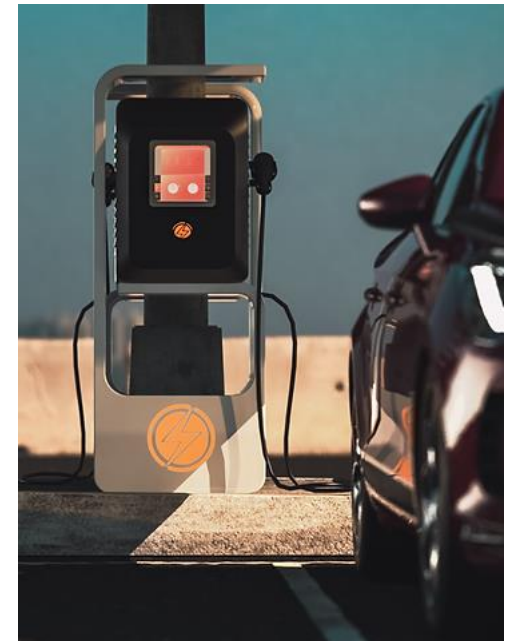
Use renewable energy



ESS Iron Flow Battery

- Safe
- Long duration
- Long life
- Sustainable

Czar-Power DC-DC EVSE



Renewable energy



Solar, wind, water*

- Solar is everywhere, every day
- Wind and water are local
- Rooftop solar is typical
- Combined with storage is real microgrid
- What you use depends on what fits your needs

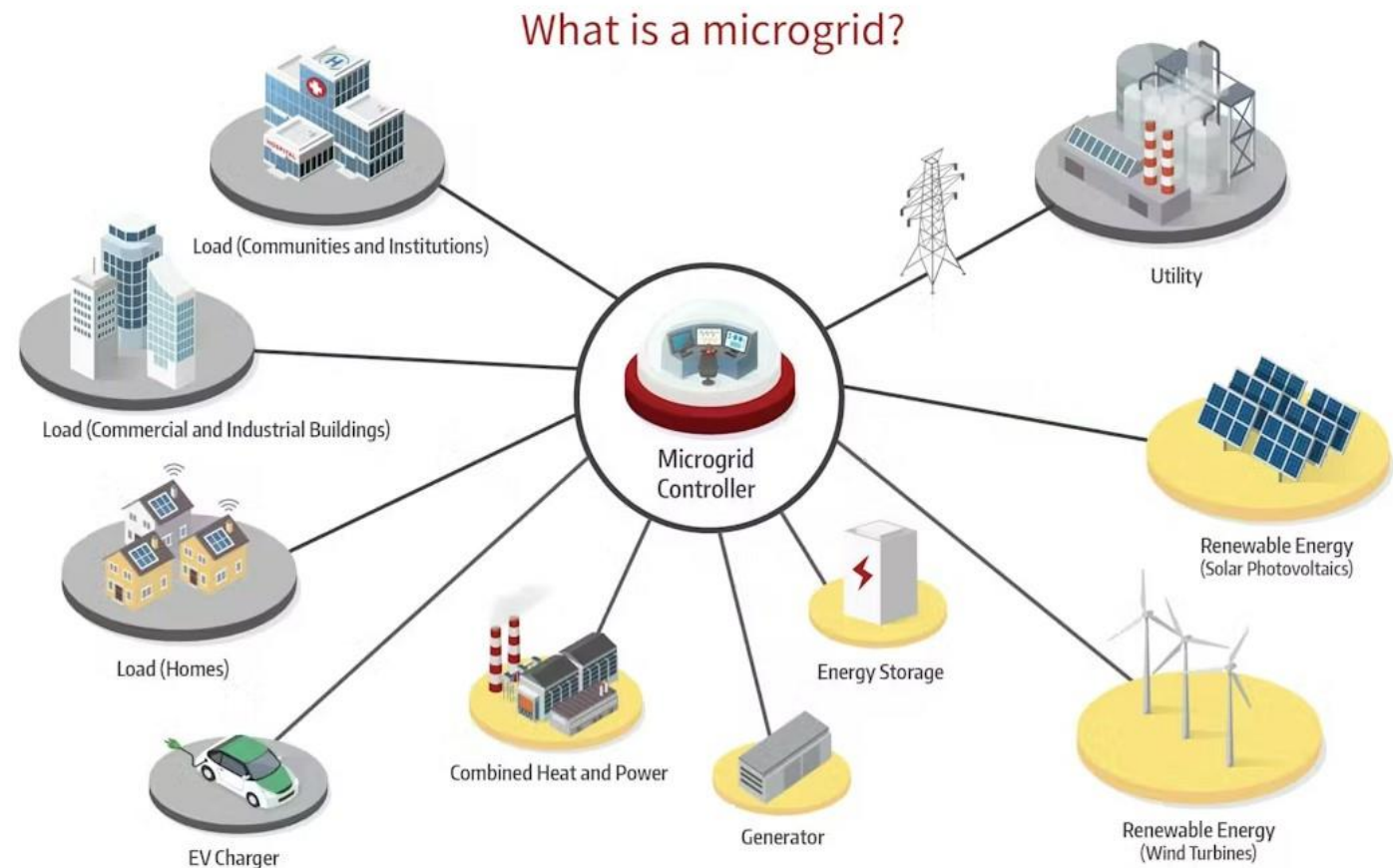
***Also includes biomass, geothermal, waste gas**

Microgrids

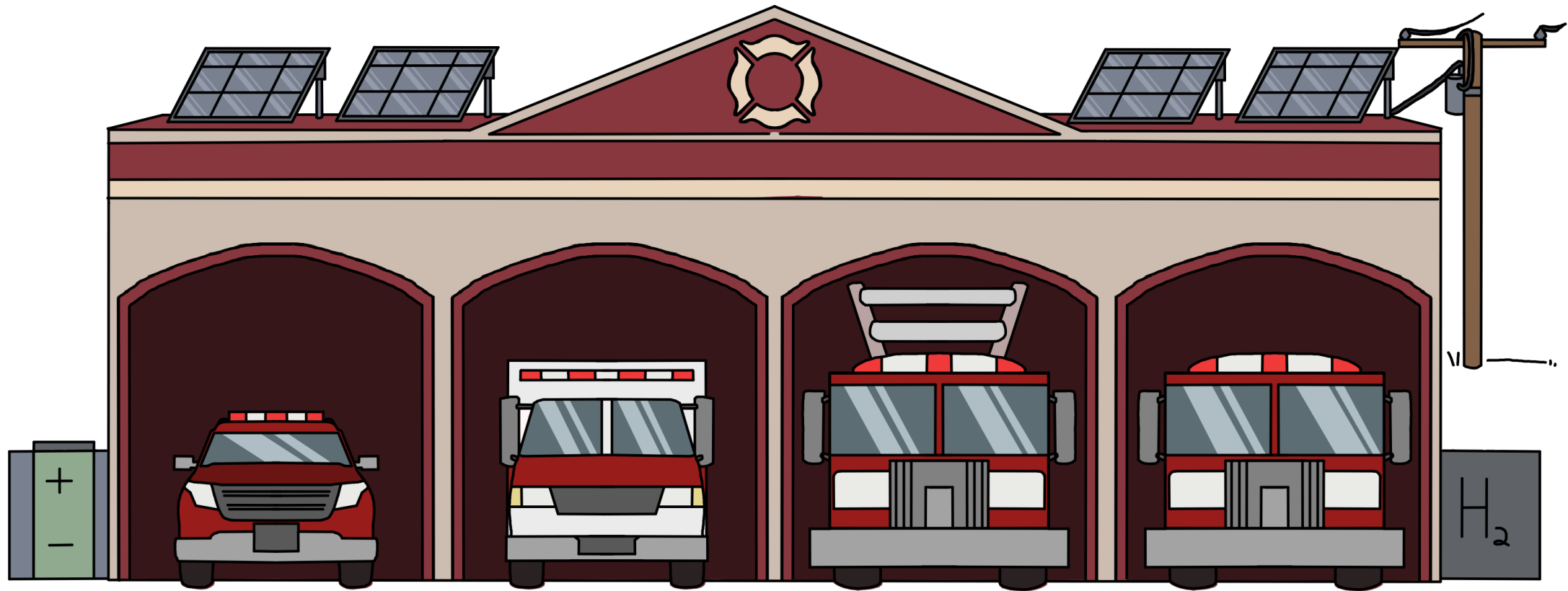
- “a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid.” U.S.D.O.E. 2012

In other words:

- Renewable energy generation (WWS)
- Energy storage (battery)
- Controller (computer)
- Distribution (wires, switches, relays)
- Electrical Vehicle Supply Equipment (EVSE)
- Electric Vehicles (EV)



What does this look like?



Microgrids for Public Safety

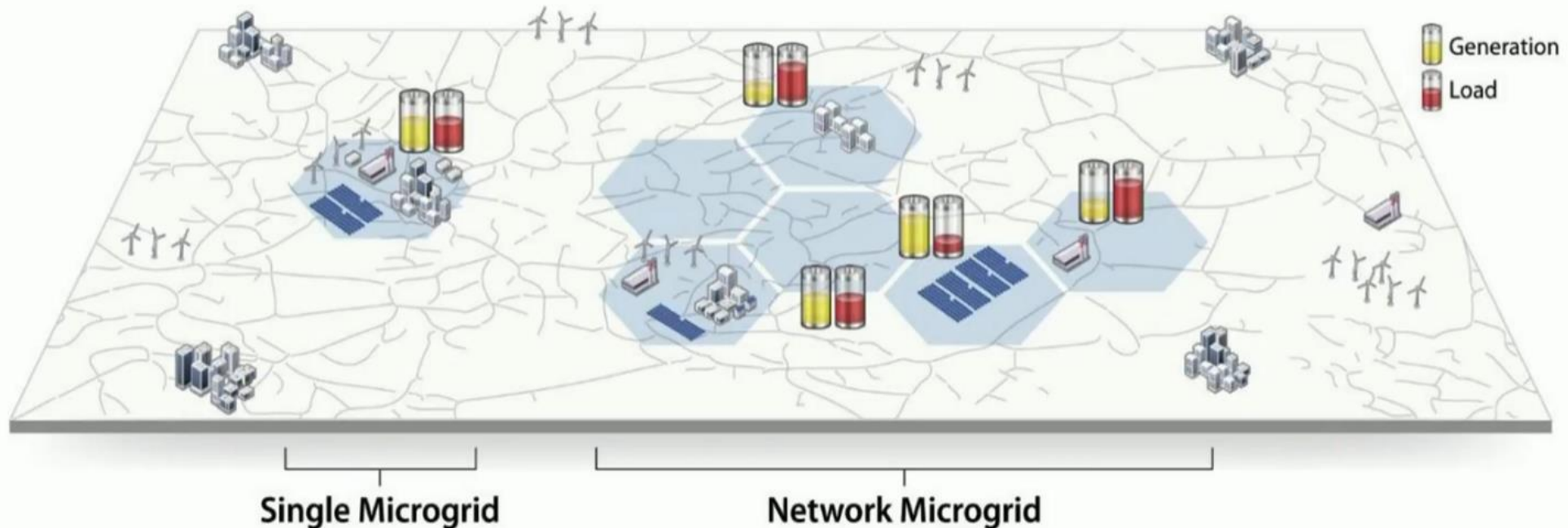




Fire station-based microgrids are a first step

DOE Microgrid Strategy

By 2035, microgrids are envisioned to be essential building blocks of the future electricity delivery system to support resilience, decarbonization, and affordability.



Remember that reliability slide?

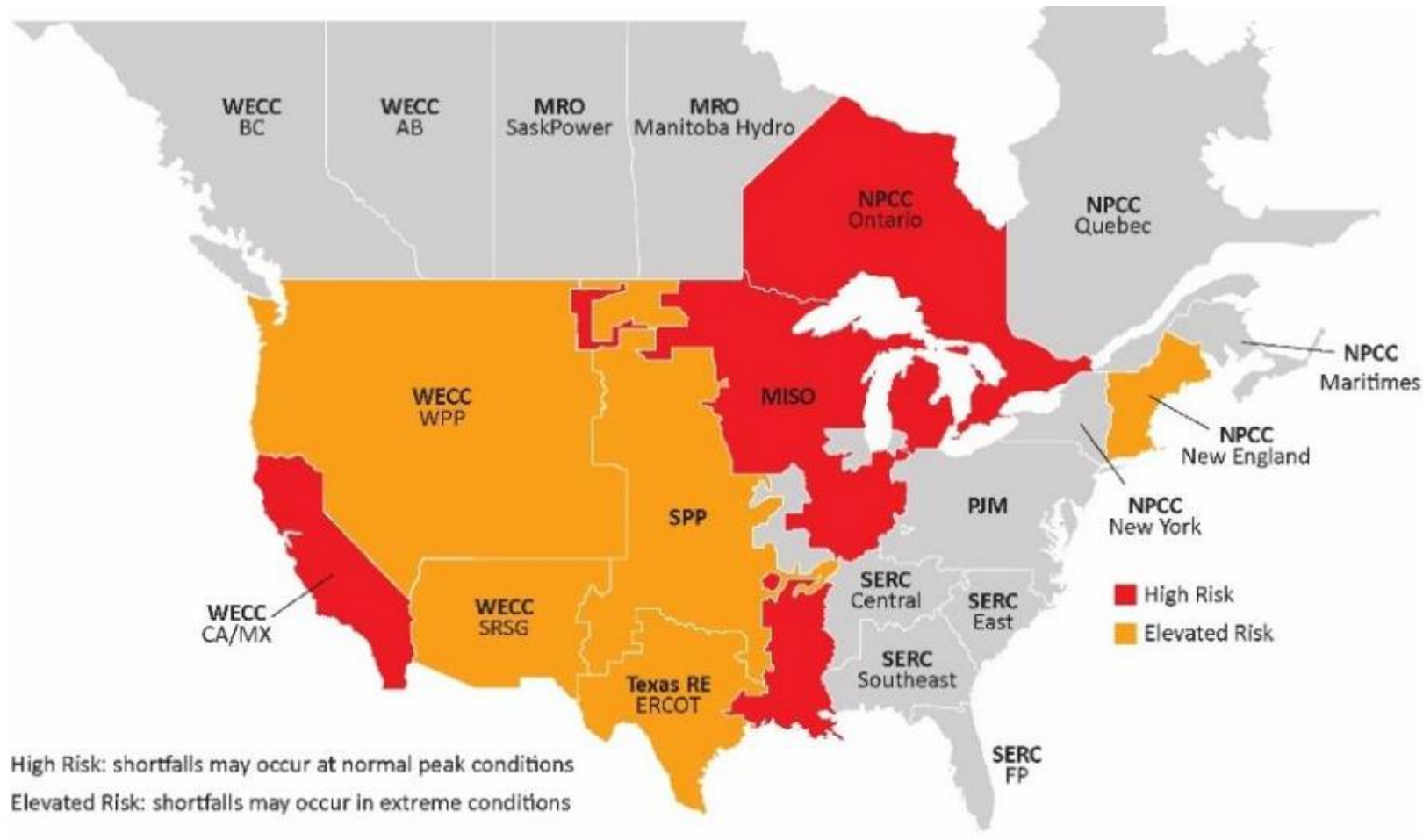
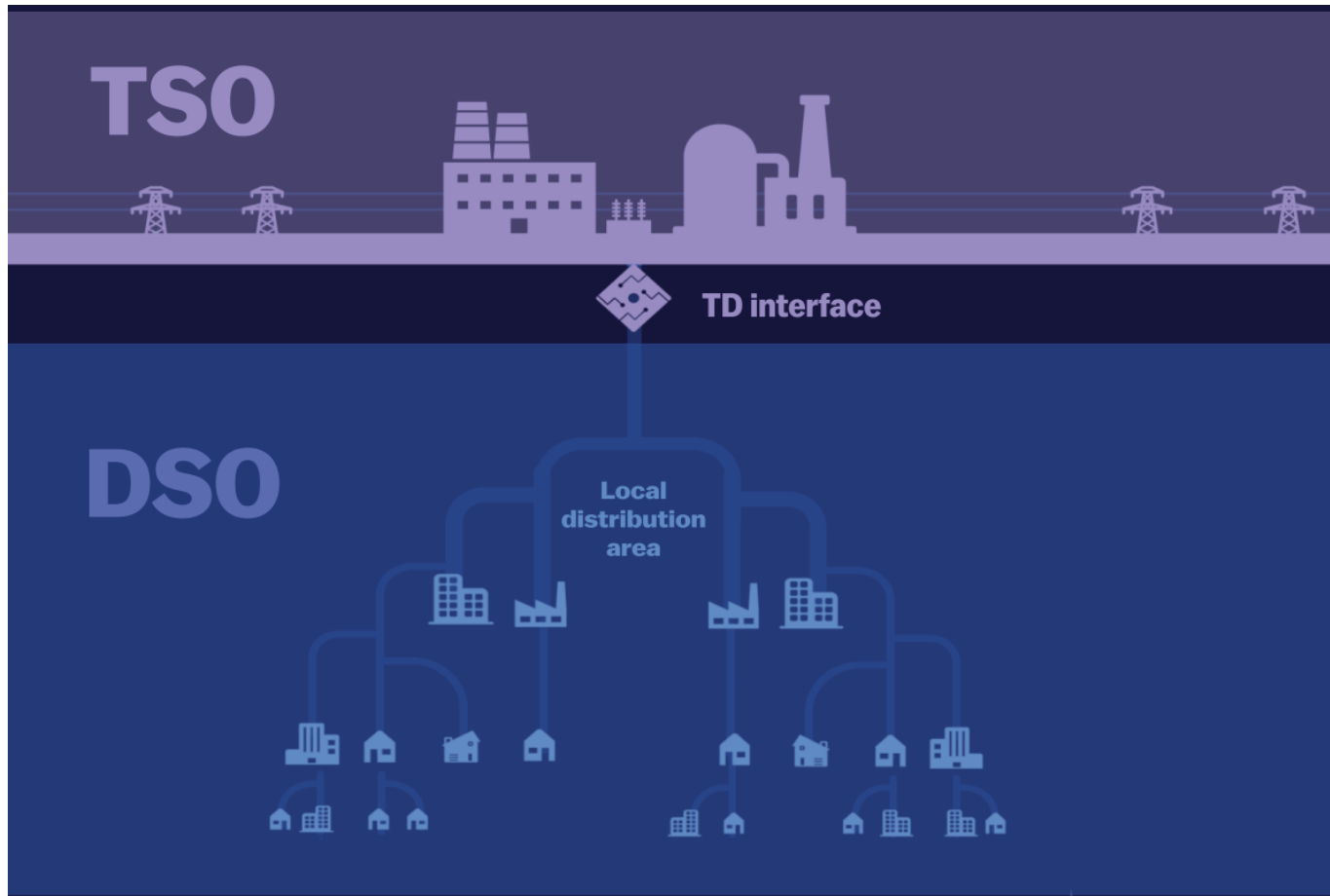


Figure 1: Risk Area Summary 2023–2027

How our electric grid works



David Roberts
Volts Podcast



Animations from his 2018 Vox Article

<https://www.vox.com/energy-and-environment/2018/11/30/17868620/renewable-energy-power-grid-architecture>

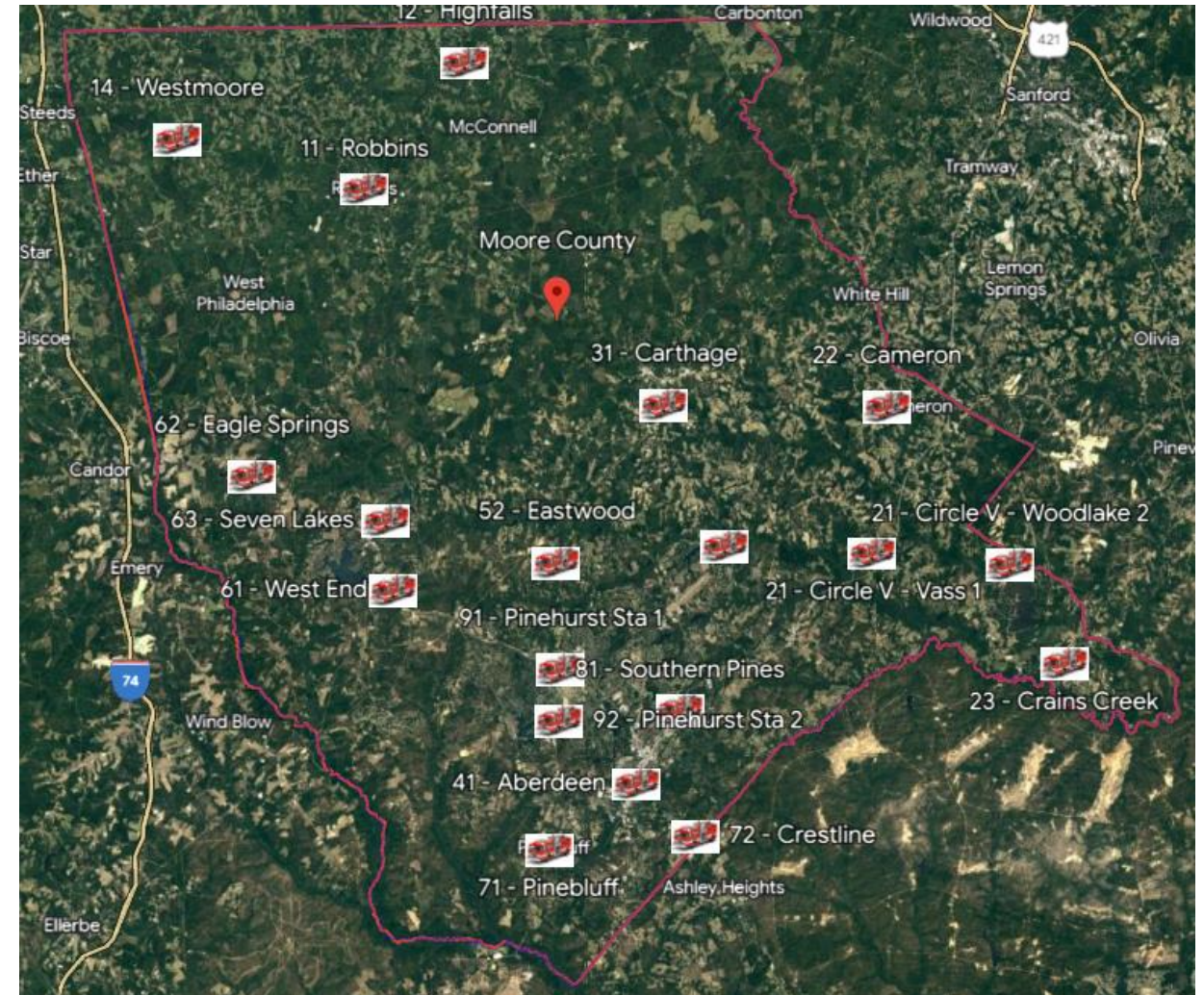
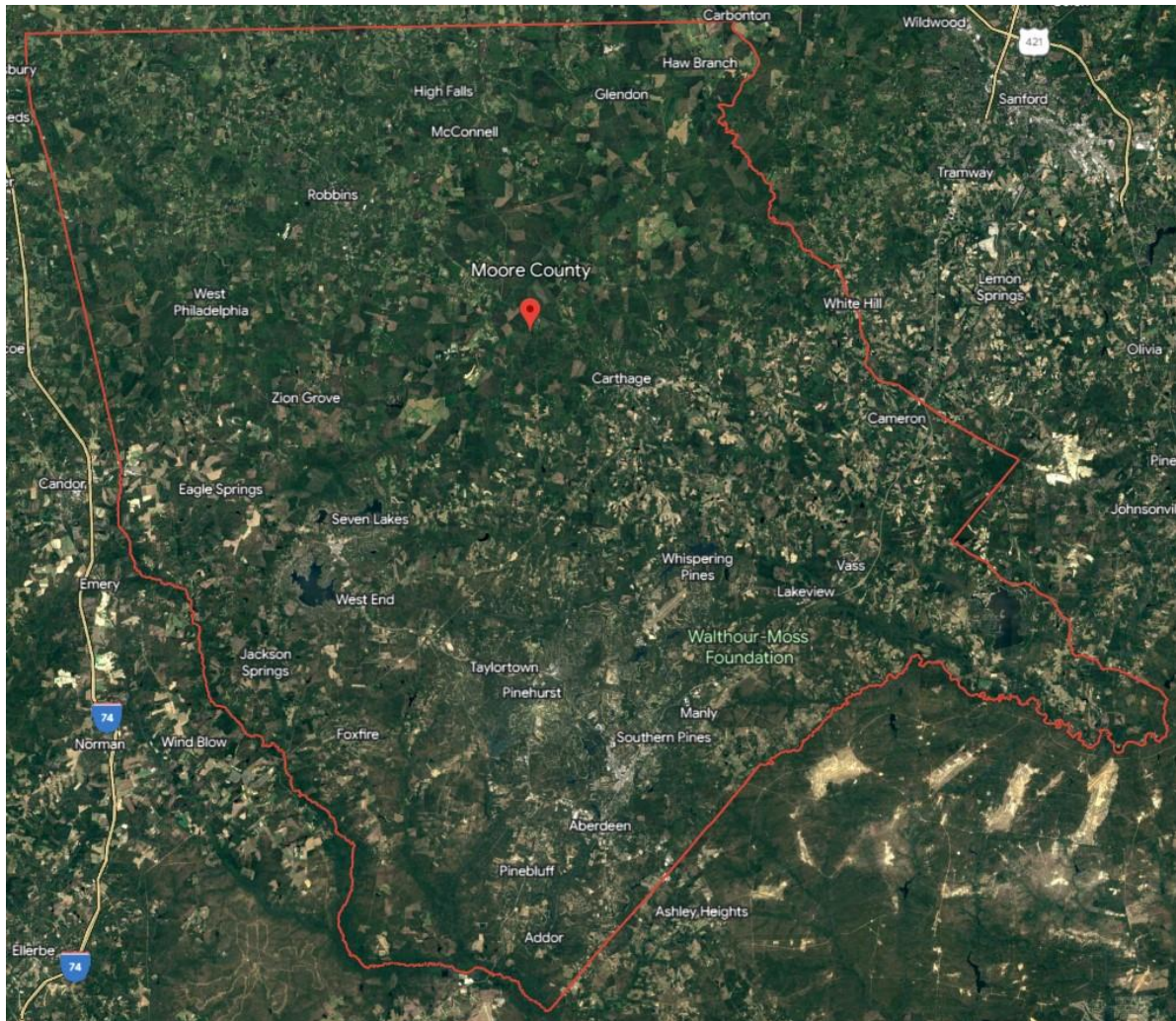
What we are doing to our electric grid



What we need our electric grid to be



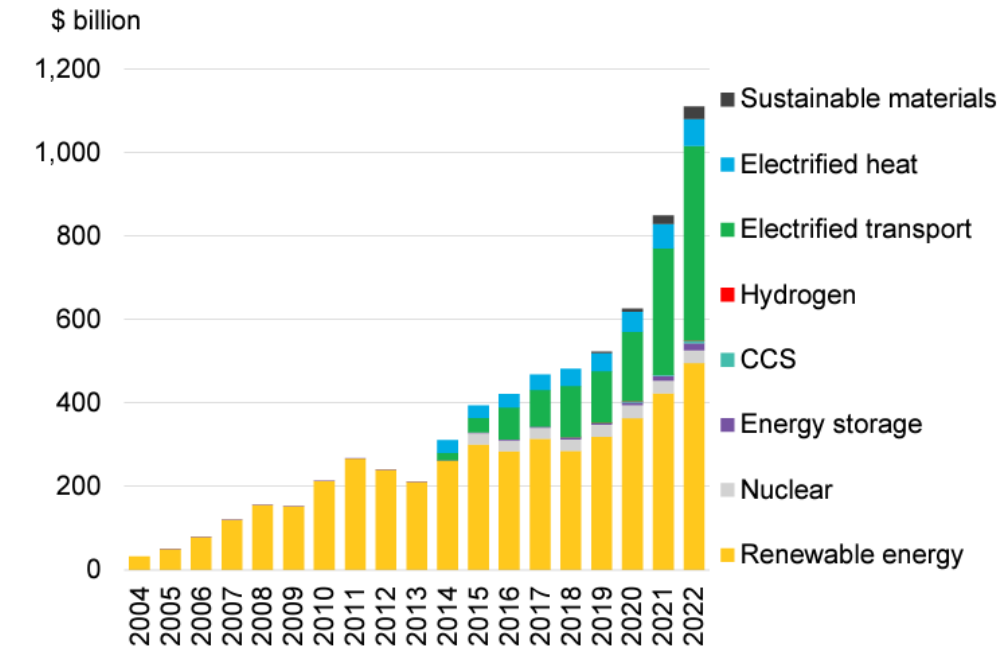
Imagine If ...



Microgrids are an Investment – Not a Cost

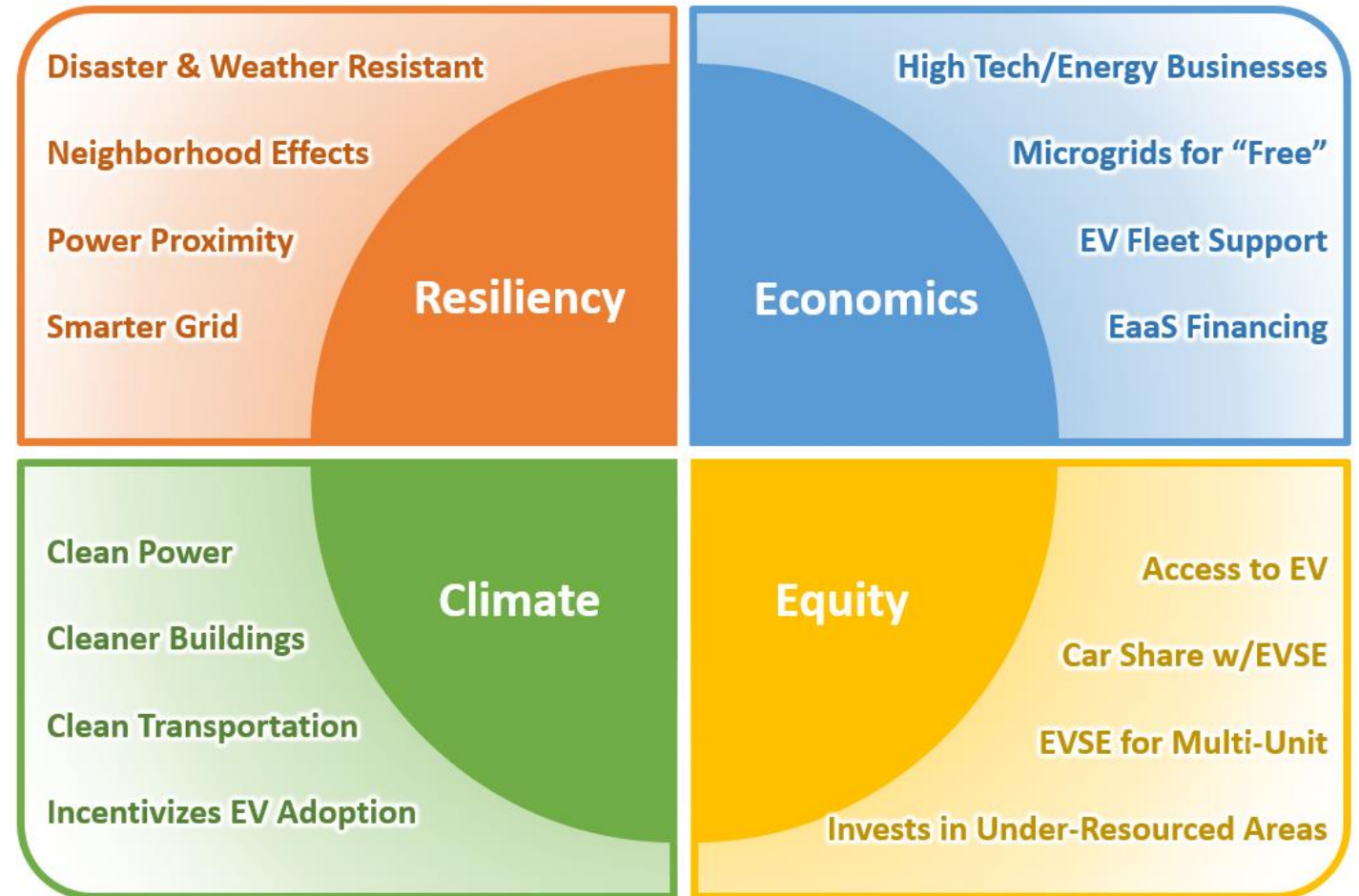
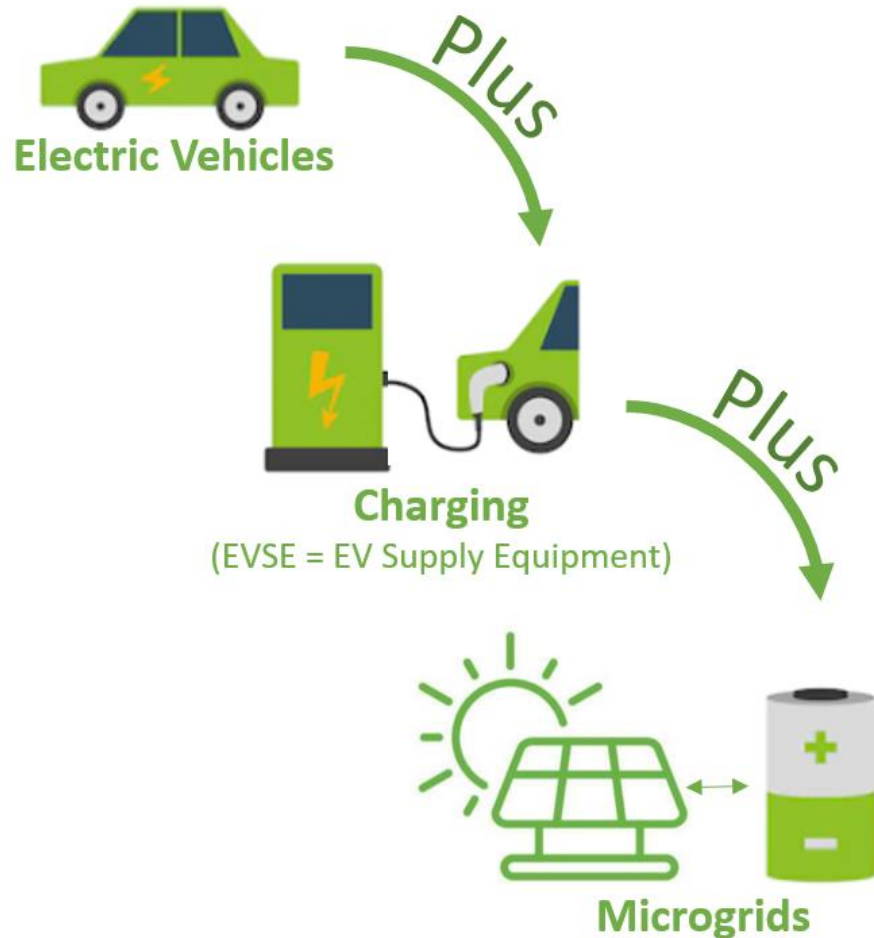


Global energy transition investment by sector



Source: BloombergNEF. Note: start-years differ by sector but all sectors are present from 2019 onward; see Appendix for more detail. Nuclear figures start in 2015.

EV–EVSE–Microgrid Combined Benefits



Thank you, questions, and contact info

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