Pennsylvania Energy Storage Consortium

MEETING #8

MAY 24, 2023

Welcome & Overview

Mission Statement: To engage stakeholders on policy and market topics that identify the opportunities to deploy energy storage for a modern, resilient, cleaner, low-carbon grid for all Pennsylvanians.

Technical Notes:

- Please mute your mic/video unless indicated otherwise during Q&A.
- You may enlarge the presentation screen by going to the ellipses icon and clicking "focus on content" and/or "full screen."

Forum Overview:

- Access the PA DEP Energy Storage website.
  - Sign up for the Consortium mailing list.
  - Download the "Pennsylvania Energy Storage Assessment: Status, Barriers & Opportunities."
- The Steering Committee serves as content advisors.
- Past meetings have discussed the energy storage value proposition, opportunities for energy storage deployment in Pennsylvania, associated equity considerations, federal funding opportunities from the IIJA and IRA, energy storage demonstrations, and interconnection.

Meeting Agenda

I. **Welcome & Overview**

II. **Storage in Microgrids: Overview and Regulatory Landscape**

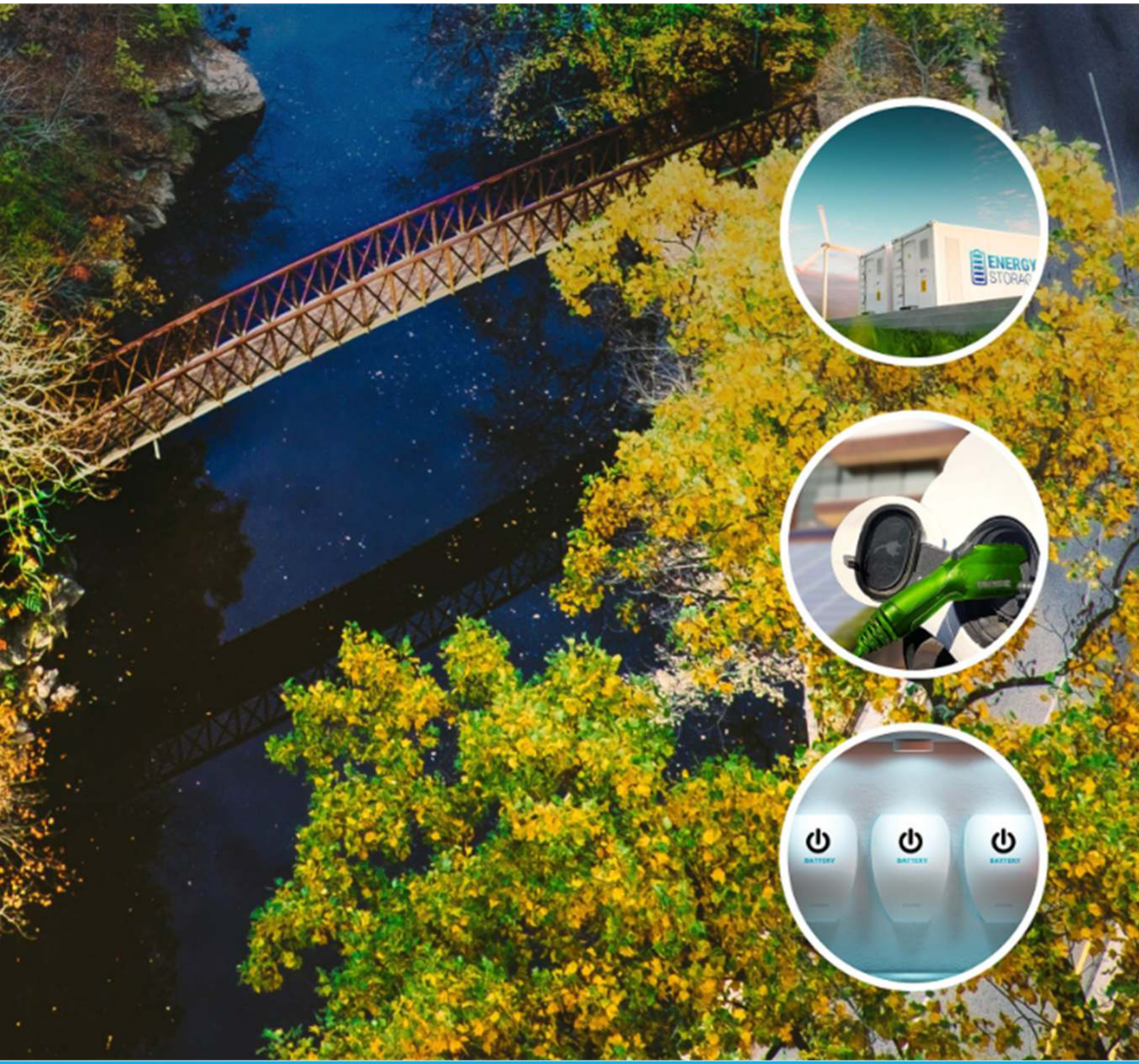
Baird Brown, Principal, eco(n)law LLC and Legal Counsel, Microgrid Resources Coalition

III. **Storage in Microgrids: Pennsylvania Case Studies**

Will Agate, Founder and President, NetZero Microgrid Solutions

I. **Consortium Participant Updates**

II. **Wrap-Up & Next Steps**



PENNSYLVANIA
ENERGY STORAGE
CONSORTIUM

Storage in Microgrids: Overview and Regulatory Landscape

Storage in Microgrids

Pennsylvania Energy Storage Consortium

May 24, 2023

C. Baird Brown
eco(n)law
Counsel to
Microgrid Resources Coalition

What is a Microgrid

A microgrid is a local electric system (a micro control area) or combined electric and thermal system:

- that includes retail load and the ability to provide energy and energy management services needed to meet a significant proportion of the included load on a non-emergency basis
- that is capable of operating either in parallel or in isolation from the electrical grid
- that, when operating in parallel, is capable of providing energy, capacity or related services to the grid

Microgrid Resources Coalition

A Microgrid Includes

- Generation
  - Variable renewables – solar, wind
  - Fuel resources – engines and fuel cells: biofuel, green hydrogen, fossil fuels
  - Co-generation – up to 85 percent efficient
- Storage
  - Batteries, thermal storage, pumped storage, LOHC
- Smart devices
  - Thermostats, water heaters, appliances, EV charging
- Microgrid Controller
  - Allows microgrid to shape its load with flexible resources

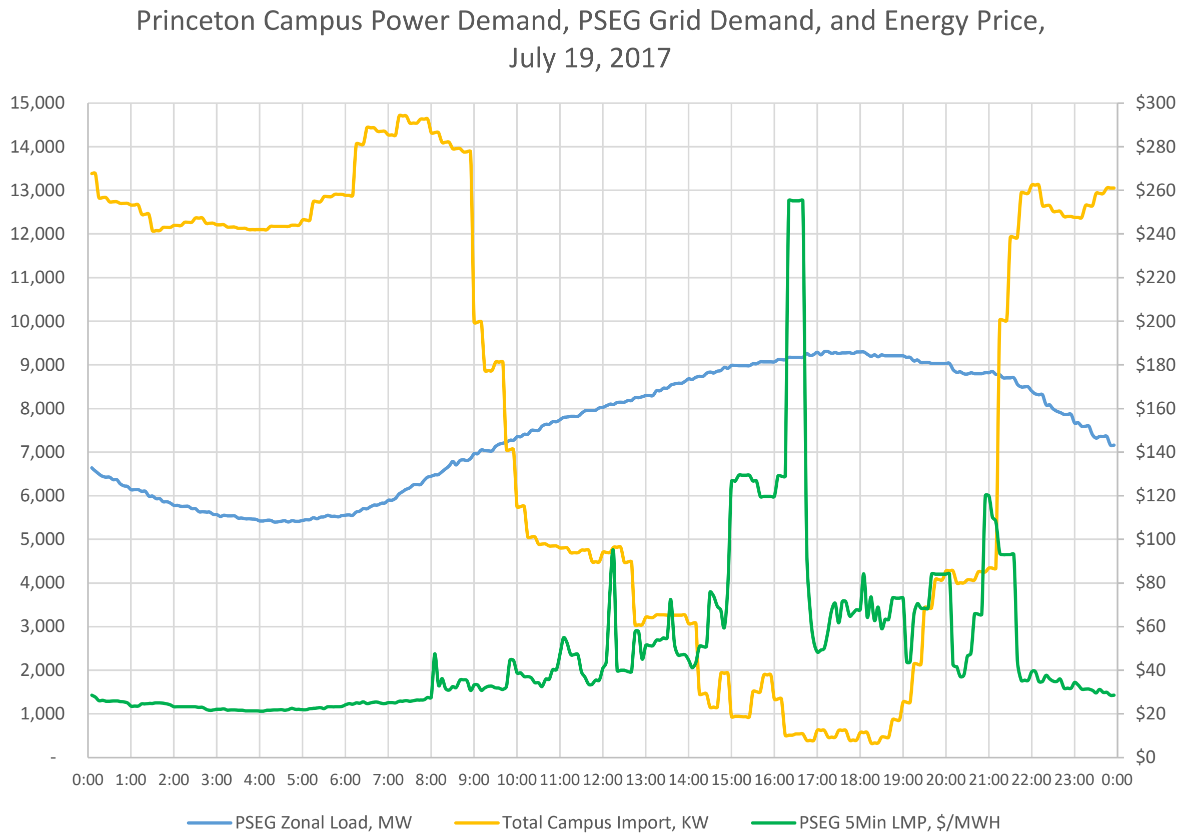
Utility Regulation

- Federal – FERC
  - Federal Power Act – FERC oversees wholesale power sales, transmission
  - Deregulation of Qualified Facilities and Exempt Wholesale Generators
  - Market-based rate authority if no market power
  - Open access to transmission system
  - RTO markets for energy, ancillary services, capacity
- State – PA PUC
  - Retail sales: PA – customer choice of suppliers to buy; sales?
  - Generation: PA – utilities divested generation, all can sell at wholesale
  - Non-wires alternatives: not in PA
  - RECs: PA – limited support for low carbon capacity

Princeton University Microgrid

- 15 MW cogeneration
- 3.75 MW solar (now over 12 MW)
- Thermal Storage
- Steam and electric chillers
- Underground delivery systems
- Manages its entire campus from a single dashboard
- Predicts PJM pricing and load conditions
  - Takes account of fuel costs
  - Optimizes across time and types of energy

Princeton Microgrid Performance



Note that system load and campus imports use the same left margin scale, but system load is in MW and campus imports are in kW.

Princeton purchased a large amount of electric energy in the early morning to charge its thermal storage. At the time of peak usage and peak pricing on the PJM system it used all generation, used steam chillers supplied by heat from the cogeneration plant, and discharged chilled water from the thermal storage tank. Princeton avoided purchasing power at peak (the prices reached $255.00), and reduced its obligation to pay transmission charges, which are allocated according to customer usage at system peak. Princeton paid a weighted average of $34.06 per MWh for energy that day compared to a system average price of $50.17 per MWh.

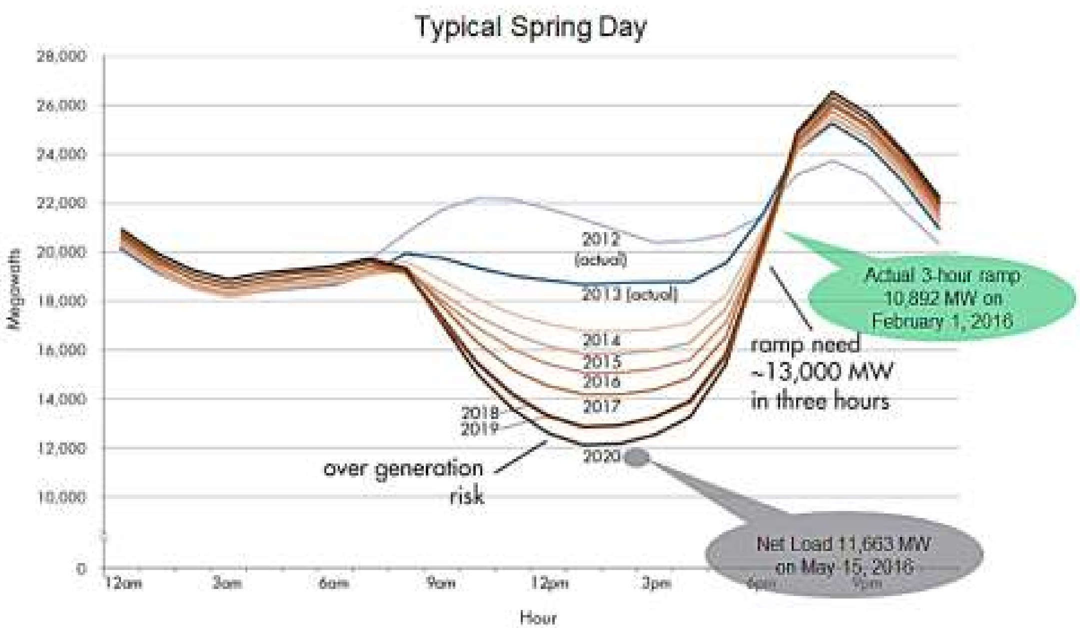
Benefits of Microgrids to Customer

- Save money on energy
  - Lower cost, no transmission and distribution charges on self generation
- Storage and flexible generation permits time of use arbitrage
- Manage to the tariff – reduce standby and transmission charges
- Smart management of thermal loads including use of buildings as thermal storage
- Resilience
  - A single controllable entity – multiple resources provide stability
  - Backup generation fails frequently
  - Princeton survived superstorm Sandy, provided local services
- Reduce Carbon Footprint

Benefits of Microgrids to Grid

- Microgrids provide new non-rate-based generation
  - Energy, Capacity
- Microgrids incorporate storage and flexible resources
  - Provide internal balancing and load shaping
  - Improve integration of renewables and meet state carbon goals
- Microgrids provide other services to the grid
  - Demand response
  - Frequency regulation
  - Reserves
- Need Markets
  - Distribution support services agreements
  - Transactive Energy

The Duck Curve



- Solar generation peaks at midday and causes the California “duck curve”
- Overgeneration puts base-load nuclear plants at risk of having to shut down
- The grid has a steep ramp requirement for flexible sources such as gas turbines and battery storage to rapidly meet the the drop in solar production
- Solar and wind are also Intermittent

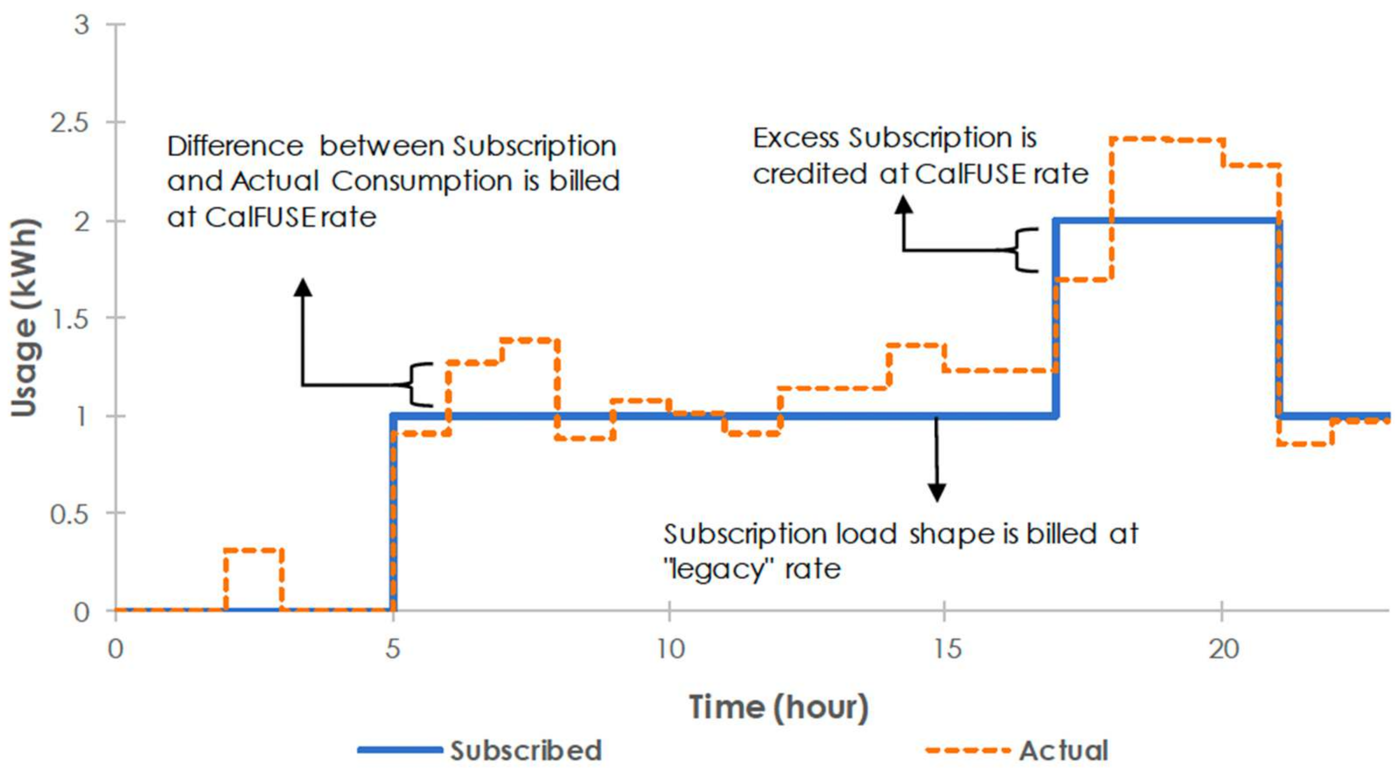
A Transactive Energy Tariff

- Provides local, real-time prices for demand response and energy export
- Protects the system by pricing congestion on the transmission and distribution system
- Reduces customer cost
  - Efficient use of generation, storage by shaping load
  - Reduces operation and maintenance cost
  - Uses lower cost local resources

Tariff Elements

- Price
  - RTO wholesale price – energy bids plus congestion price
  - Distribution congestion – same but price response, not bids
- Subscription – base energy allowance
  - Gives customer assurance of typical usage at flat tariff rate
  - Customer pays/receives variable price for deviations
  - Provides real-time, flexible demand response
- Requirements – communication to customer controller and information from pricing level substations

Transactive Tariff Example



What Can PA Customers Do?

- Can operate resources behind the meter for their own benefit
  - Allows for microgrids with storage
  - Serving building or facility occupants
  - Can do a DC microgrid – avoid inverter losses
- Principal form of regulation is interconnection
  - Both FERC and PA PUC regulated
  - Should treat microgrids as a single controllable entity
  - Neither FERC SGIP nor PA does this
- Can sell at wholesale
  - Few utility pricing programs

What Can PA Communities Do?

- PA Utility definition
  - Person who owns or operates facilities for generating, transmitting, or distributing electricity
    - Problem for separated facilities
    - Virtual net metering – 2-mile limit, one customer
  - Courts: OK if not serving the public – perhaps 10 customers
  - Serving building or facility occupants
- Strategies
  - Being (or hiring) an “Electric Generation Supplier”
  - Forming co-ops
  - Community Choice Aggregation for boroughs

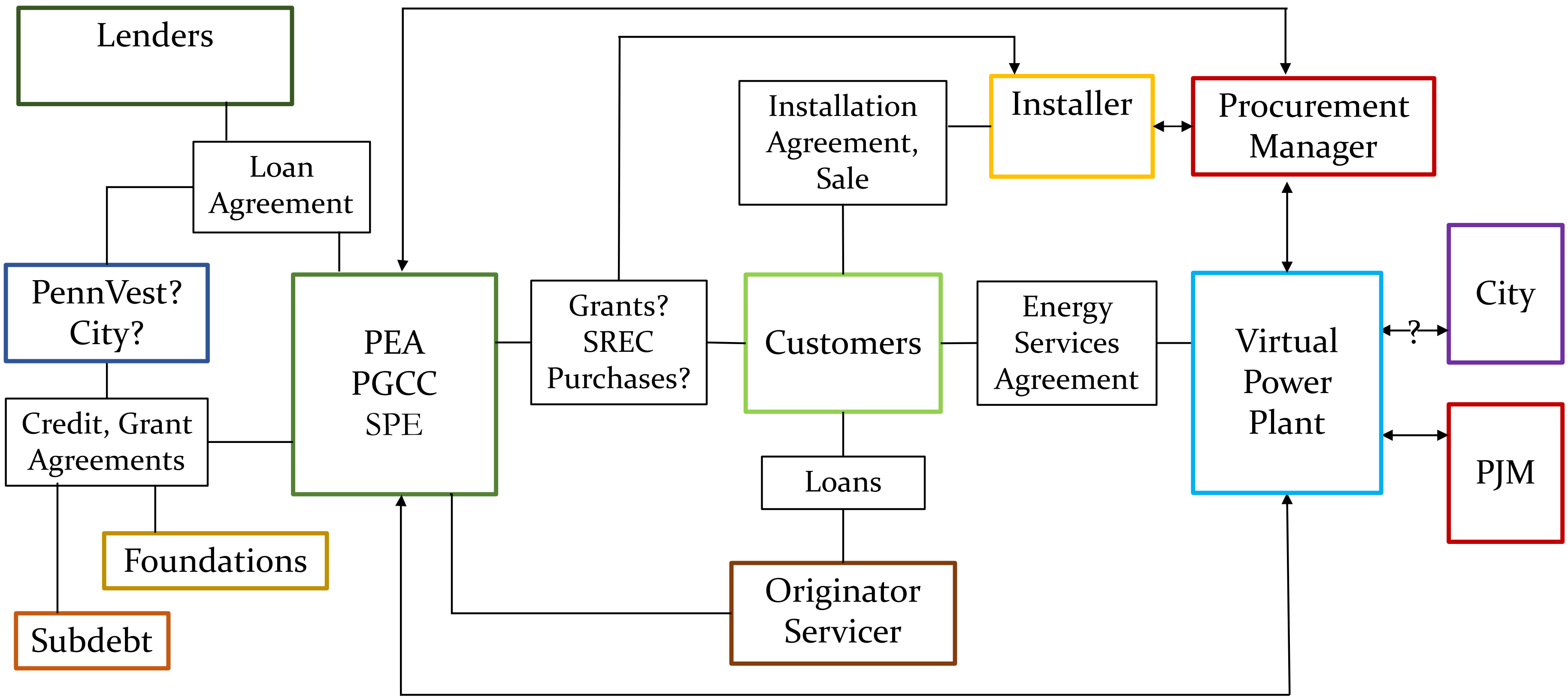
PA Guaranteed Energy Savings Act

- Includes all microgrid components - Active energy efficiency, renewable energy, storage, microgrid controller
- Alternative energy suppliers
- That create savings or revenues
- Provides flexible procurement mechanism
  - 20-year contracts
  - Not subject to Separations Act – can use an EPC contractor
  - Allows selection for best value
  - Not subject to Local Government Unit Debt Act (subject to appropriation
- All elements currently eligible for IRA tax credits

PEA PGCC VPP Program

- PGCC uses loans, grants, and SREC purchases to enable customer purchase of solar, batteries, smart appliances, energy efficiency measures, EV charging and smart controls.
- Each residence or facility can become a microgrid
- VPP – acts as
  - Energy services aggregator for services provided by Customer equipment to grid – reduces costs to customers
  - An energy retailer providing additional power sales to Customers. It can provide Transactive Energy rates.
- PEA procurement assures fair pricing and contract terms for Customers
- PEA will continue to prequalify local installers for solar and other installation work

PEA PGCC VPP Program



A Level Playing Field

- Fair and open markets allow balanced clean energy evolution
  - Balance of technologies from market pricing of needed grid services
- A single price on carbon
  - Eliminate fuel and technology subsidies
  - RGGI before both Supreme Court and Commonwealth Court
- Pricing for resilience?
- Customers and communities can balance between local and grid scale services evaluating all dimensions:
  - Electricity, thermal energy, resilience, carbon emissions
  - Customer information belongs to customers
  - Grid information is available to all

The Grid of the Future

- A self-healing grid in emergencies
  - The grid can segment into self-supporting microgrid and minigrid islands
  - Each island is its own semiautonomous control area
  - Each supplied by Distributed Energy Resources (DER)
  - The islands can support one another (DERMS)
  - Transactive energy pricing within the islands
- Microgrids provide grid support services when not in emergency mode
- Microgrids are <u>evolving</u> clean energy resources

Questions?

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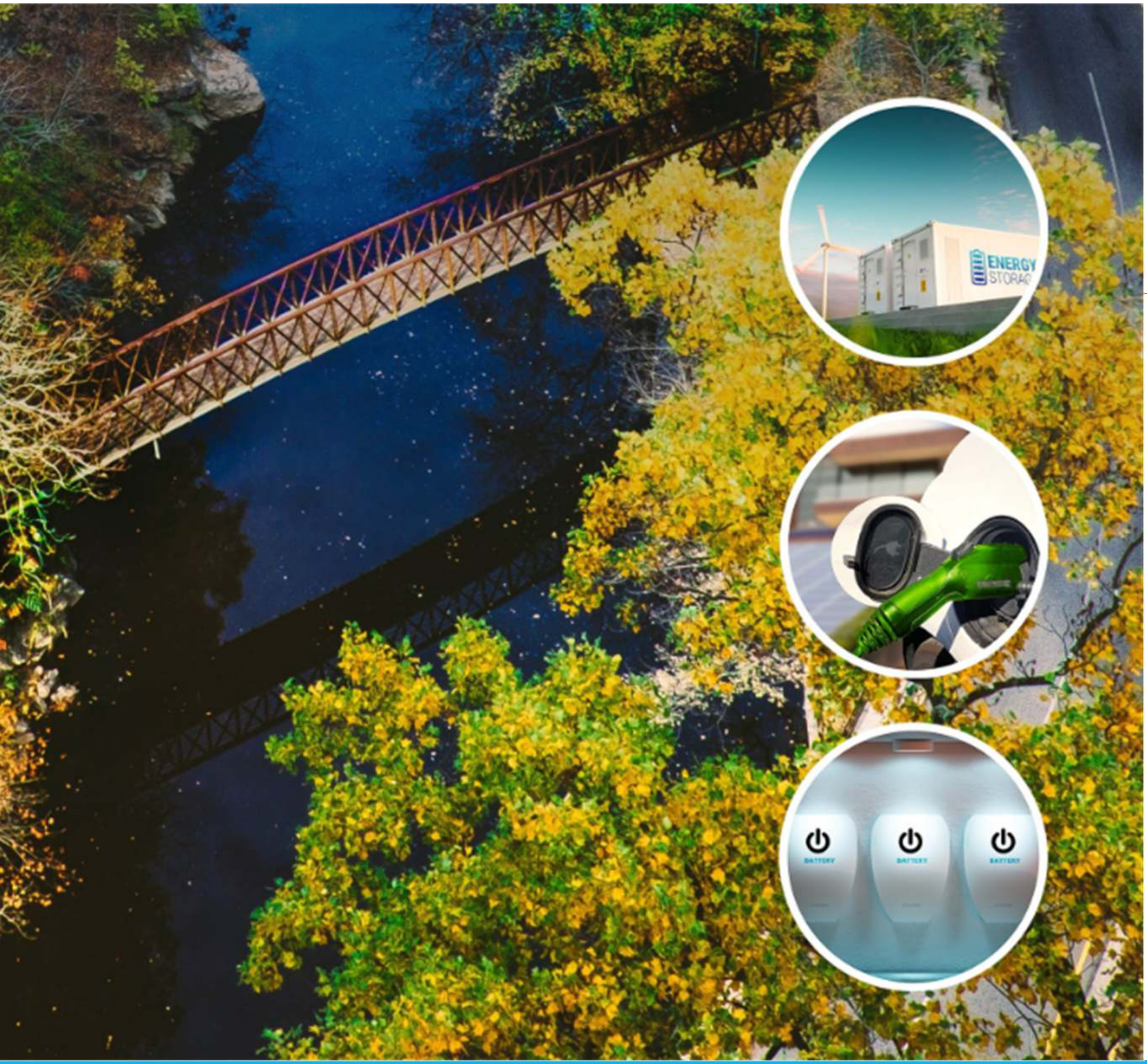
'The economy is a subset of the ecology."



PENNSYLVANIA ENERGY STORAGE CONSORTIUM

Storage in Microgrids: Pennsylvania Case Studies

www.NZV2G.com

PA Energy Storage Consortium
Net Zero Microgrid Solutions
Storage and Microgrids Webinar – May 24, 2023

NET ZERO V2G
TECHNOLOGIES

Introduction

- Will Agate LEED AP, Integration Leader
- Founder and former President, NetZero Microgrid Solutions and NetZero V2G Technologies
- Sold majority interest – November, 2022
- Ameresco – served as Vice President, Microgrid Services – 2018-2020
- Previously, Senior Vice President, PIDC
  - Led the Philadelphia Navy Yard
  - Developed the NY Energy Master Plan

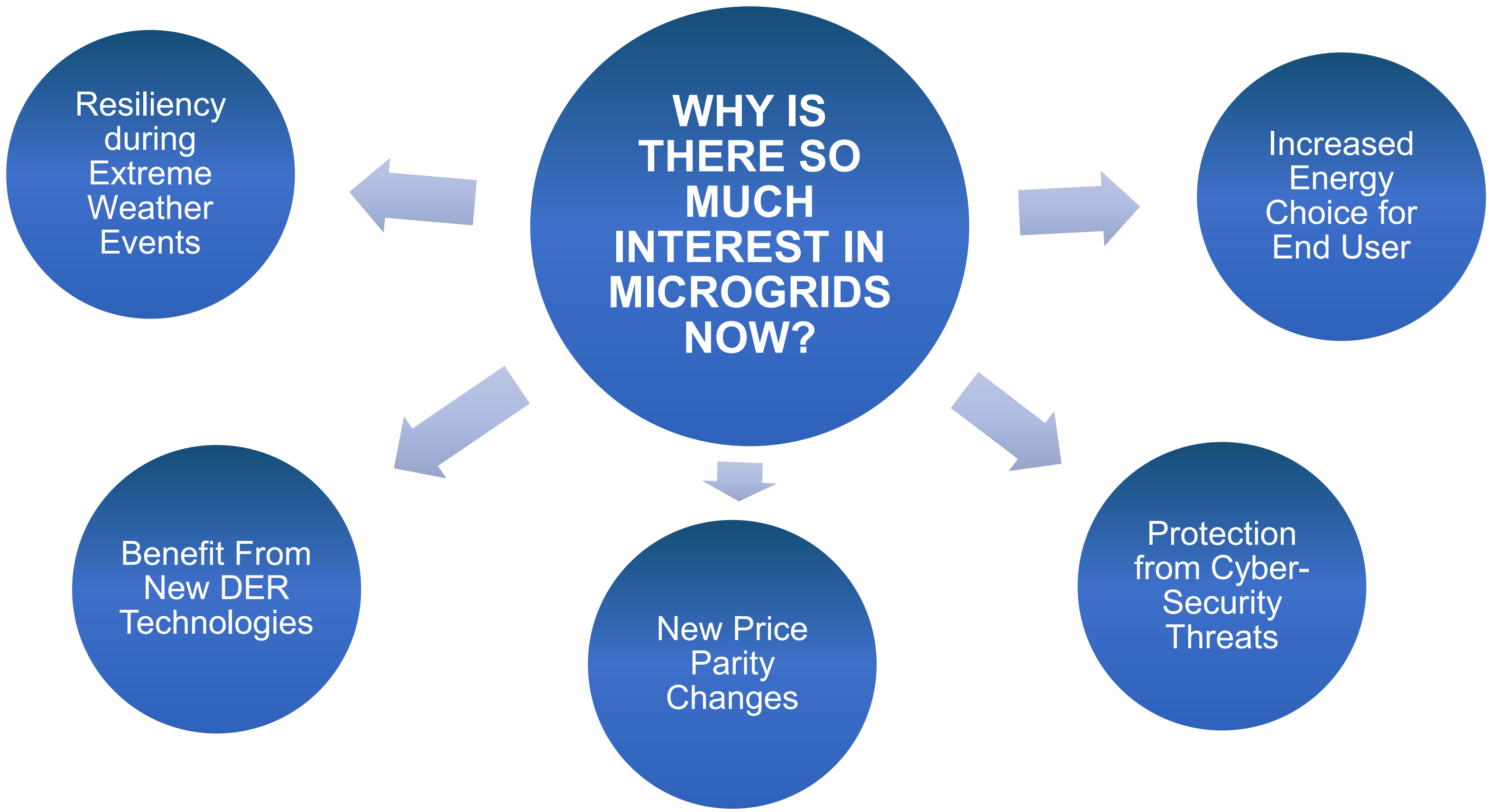
Topics for My Talk Today

- The importance of energy storage in today's environment
- Types of Microgrids and How the microgrid platform can enable and speed the use of Energy Storage
- Several Case Studies – a broad Spectrum of Applications
- Types of energy storage most viable for microgrid deployments
    i. Traditional storage vehicles, and
    ii. Newest form: energy from electric vehicle batteries (also called V2G)
- How to Get Started in Using Microgrids for Energy Storage

The Importance of Energy Storage in Today's Energy Environment

- Addressing the gaps caused by renewable energy's intermittency
- The economic benefits
  - as traditional energy supply pricing becomes less stable
  - As renewable energy (especially solar) continues to drop in price
  - As ISOs such as PJM continue to pay for ancillary services
- Providing resilience – instances of Big Grid failures
  - Climate change
  - Cyber security threats

The Microgrid Proposition



Microgrids Provide Many Benefits

For the community owner and their customers:

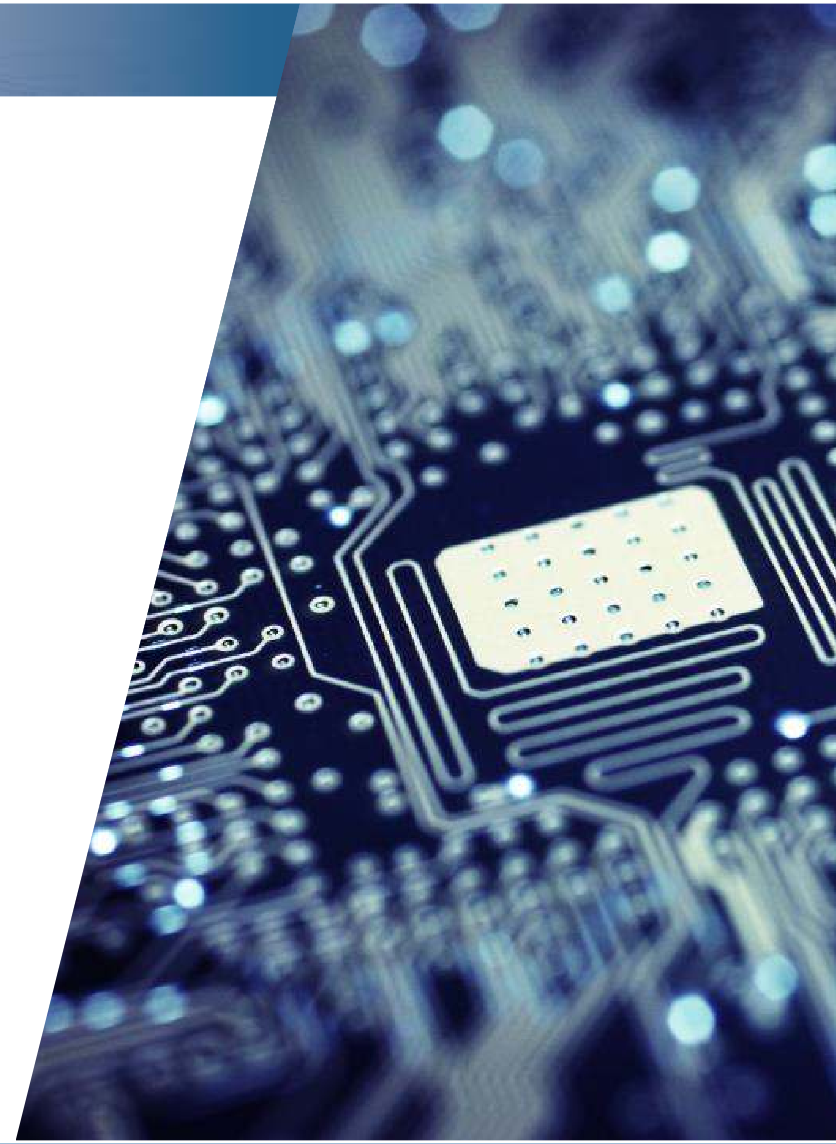
- More clean and renewable energy options, faster development
- Multiple, tailored resilience strategies
- Buy wholesale, sell retail
- Mitigate effects of climate change
- Establish platform for other smart city deployments

For the public utility:

- Single, larger customer versus multiple, smaller customers
- Aggregate load management
- Faster/less costly achievement of clean/renewable energy goals
- Reduced strain on the grid
- Improved regulatory efficiencies

For the broader surrounding communities:

- A model community demonstrating energy and environmental goals
- Satisfies DOE interests
- Collaboration between public agencies, the electric utility and ISO
- Resiliency strategies in place
- Business recruitment tool



Microgrid Case Studies – a Spectrum of Possibilities

NetZero Microgrid Solutions LLC

Types of Microgrids

- Single purpose
  - Most common type today
  - Industrial/manufacturing
- Community (also referred to as multi-user) microgrids
  - Public sector
  - Education campuses
  - Larger RE projects
- Remote microgrids
- Most importantly: behind-the-meter vs in front-of-the-meter

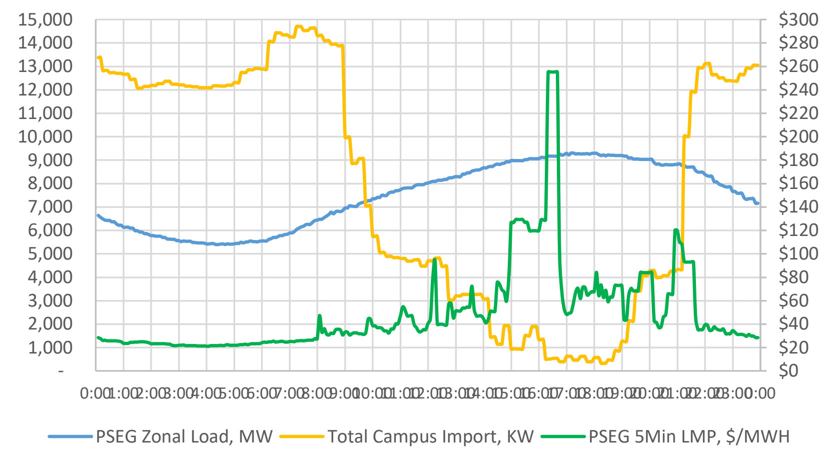
Existing and Potential Size of Microgrid Market

- The Center for Climate and Energy Solutions (C2ES)
  - The Pew Center on Global Climate Change, founded in 1998
  - Ranked by UPenn – one of the world's leading environmental policy think tanks
  - In 2016, only 160 microgrids in USA, producing less than 0.2% of total electricity
- IMARC – an industry data and publications organization
  - In 2021, North America market at $10.8 billion,
  - Growing to $19.8 billion by 2027
- Wood MacKenzie (as of Feb 2023, now a part of Veritas Capital
  - Reaching 10 gigawatts (GW) in 3rd Q 2022

Princeton University

- Baird has already described
- Of note: one of North America's first university/college Community microgrids
- Economic paybacks for more than a decade

Princeton Campus Power Demand, PSEG Grid Demand, and Energy Price,
July 19, 2017



NetZero Microgrid Solutions LLC/info@nzmsolutions.com

THE PHILADELPHIA NAVY YARD

- 1,200 ACRE AND 8 MILLION SQ. FT. CAMPUS
  - 145 COMPANIES
    - OFFICE SPACE
    - INDUSTRIAL/MANUFACTURING
    - RESEARCH AND DEVELOPMENT
    - NAVY OPERATIONS
  - 13,000 EMPLOYEES DAILY
  - 2030: 18 MILLION SF/60-70 MW
- THE NAVY YARD'S ENERGY MASTER PLAN INCLUDES GRID MODERNIZATION AND ON-SITE ELECTRICITY GENERATION
- INVESTMENT FROM PUBLIC AND PRIVATE
  - 10 MW SUBSTATION WITH PECO TIE-INS
  - 8 MW NATURAL GAS PEAK SHAVER
  - 6 MW BATTERY STORAGE
  - 1 MW SOLAR GENERATION

CAPITAL INVESTMENT:

$33,000,00

Philadelphia Navy Yard Philadelphia, Pennsylvania

PITTSBURGH INTERNATIONAL AIRPORT

- COMPLETED IN 2021, BECAME 1ST MAJOR US AIRPORT TO PROVIDE 100% POWERED BY ONSITE SOLAR AND NATURAL GAS GENERATION
- 20 MW SYSTEM
- REVERSE RELATIONSHIP W/ LOCAL UTILITY:DUQUESNE ASTS AS BACKUP TO MICROGRID
- ADVOCATES: PEOPLES NATURAL GAS BUILT THE MICROGRID IN PARTNERSHIP WITH DUQUESNE LIGHT, LLI ENGINEERING, IMG ENERGY SOLUTIONS, CNX, IMG ENERGY SOLUTIONS, CNX RESOURCES AND EIS SOLAR

MARINE CORPS RECRUIT DEPOT PARRIS ISLAND

TECHNOLOGY TYPE:

BATTERY ENERGY STORAGE SYSTEM
COMBINED HEAT AND POWER
MICROGRID CONTROL SYSTEM
SOLAR PHOTOVOLTAIC

FACILITY SIZE:

8,095 ACRES (OVER 3.9 MILLION SQ FT)

CAPACITY:

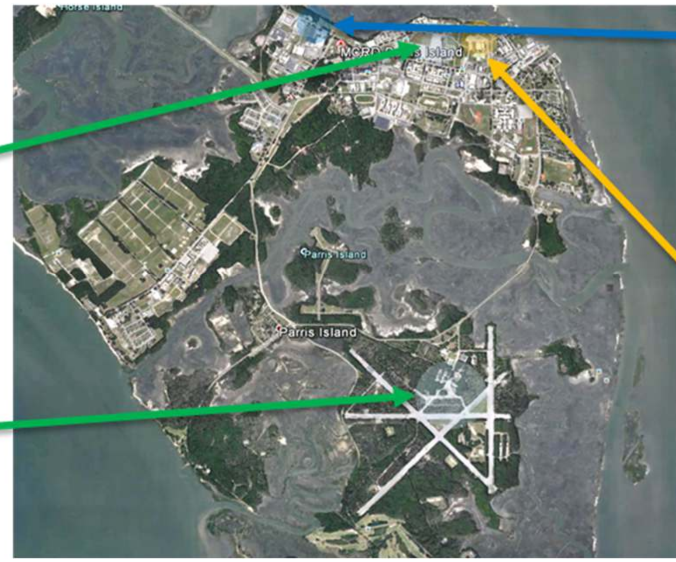
6.7 MW SOLAR PV, 4 MW/8 MWH BESS
3.5 MW CHP

CAPITAL INVESTMENT:

$91,100,000

**Renewable Power
1.5 MWAC
Capacity**

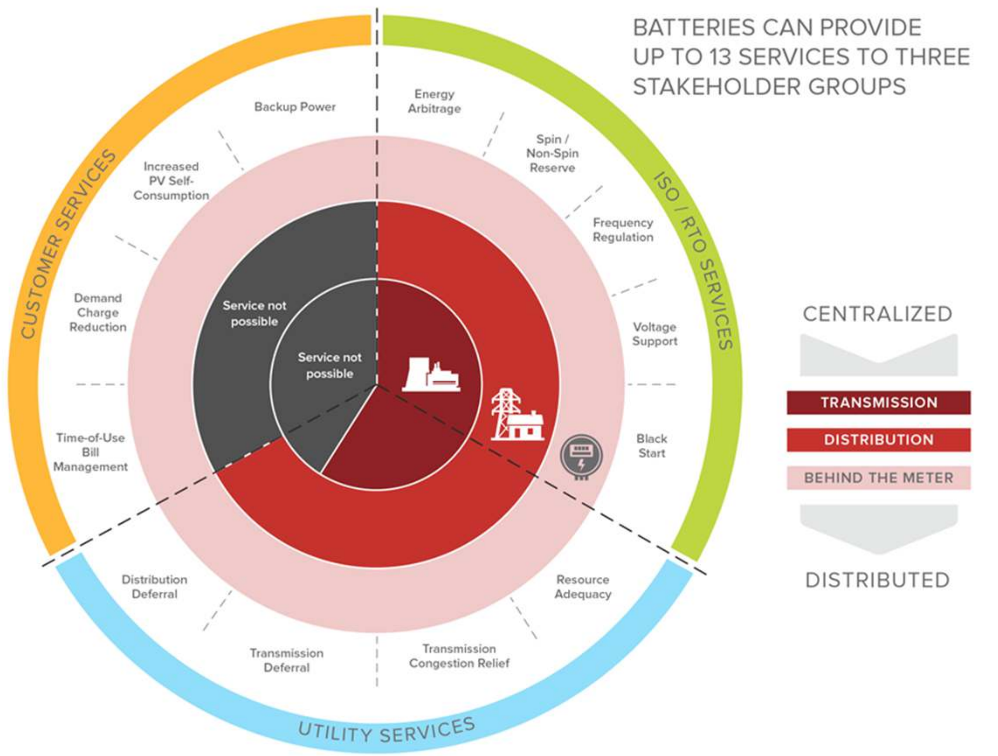
**Renewable Power
4.0 MWAC
Capacity**



**Battery System
4 MW / 8 MWh
Capacity**

**CHP Plant
3.5 MW / 60
kpph Capacity**

Rocky Mountain Institute Studies



NetZero Microgrid Solutions LLC/info@nzmsolutions.com

Types of Energy Storage Most Viable for the Microgrid

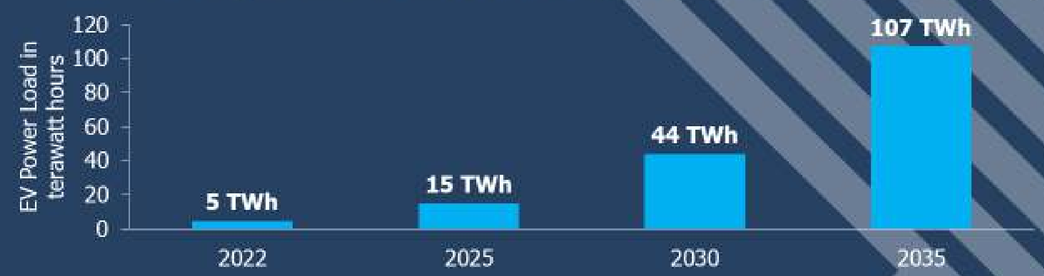
- Stationary batteries
- What I refer to as energy sinks: pumping to resevoirs/hydro-electric, compressed air, flywheels, and thermal storage (ice or heat)
- Newest form: energy from electric vehicle batteries (also called V2G)

EV Charging Infrastructure

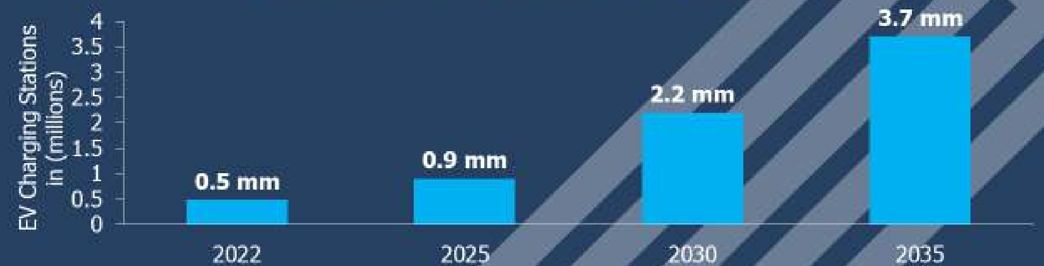
A Guaranteed Growth Market

Electric vehicle charging stations market worth $103.6 billion by 2028, growing at a CAGR of 26.4% from 2021

Projected Annual EV Power Load



Projected EV Charger Stations[1]



NOTE:
Numbers include all DC Fast, Public Level II and Workplace chargers in the U.S.
(1) ICCT White Paper | Charging up America: Assessing U.S. Charging Infrastructure Through 2030

Completed Project:
1300 Virginia Drive - Fort Washington, PA

How to Get Started with Using Microgrids for Energy Storage

- Evaluate your specific circumstances
- Turn to the experts
  - Engineering firms
  - Microgrid consulting firms
  - Energy Services firms
    - Ameresco
    - Siemens
    - Scale Microgrids
    - ABB
- Become an expert yourself
    - Tap into various internet-based resources
    - Use of AI
    - Microgrid Knowledge/ThinkMicrogrid (www.microgridknowledge.com)

Questions and Answers

Will Agate LEED AP

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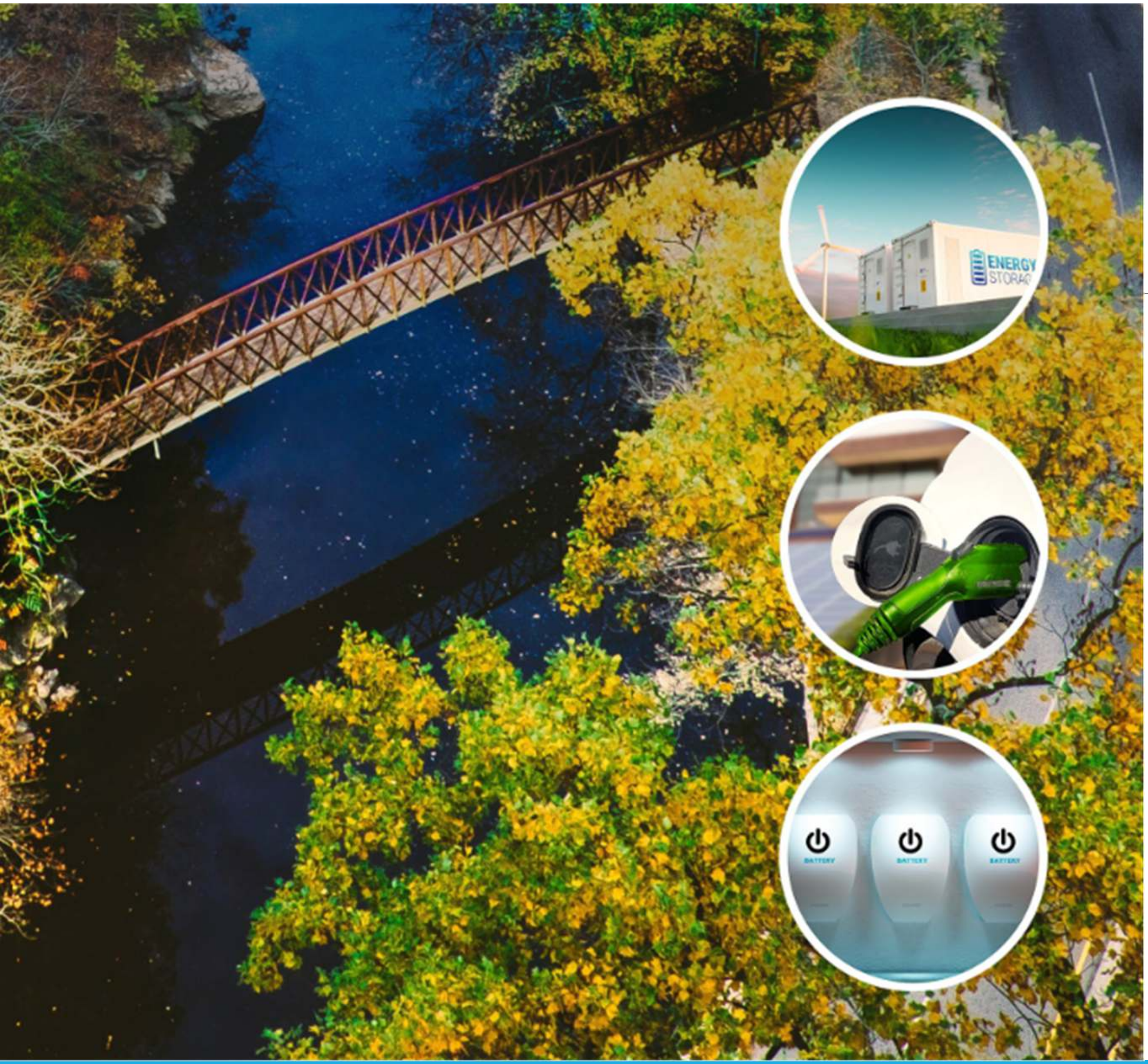

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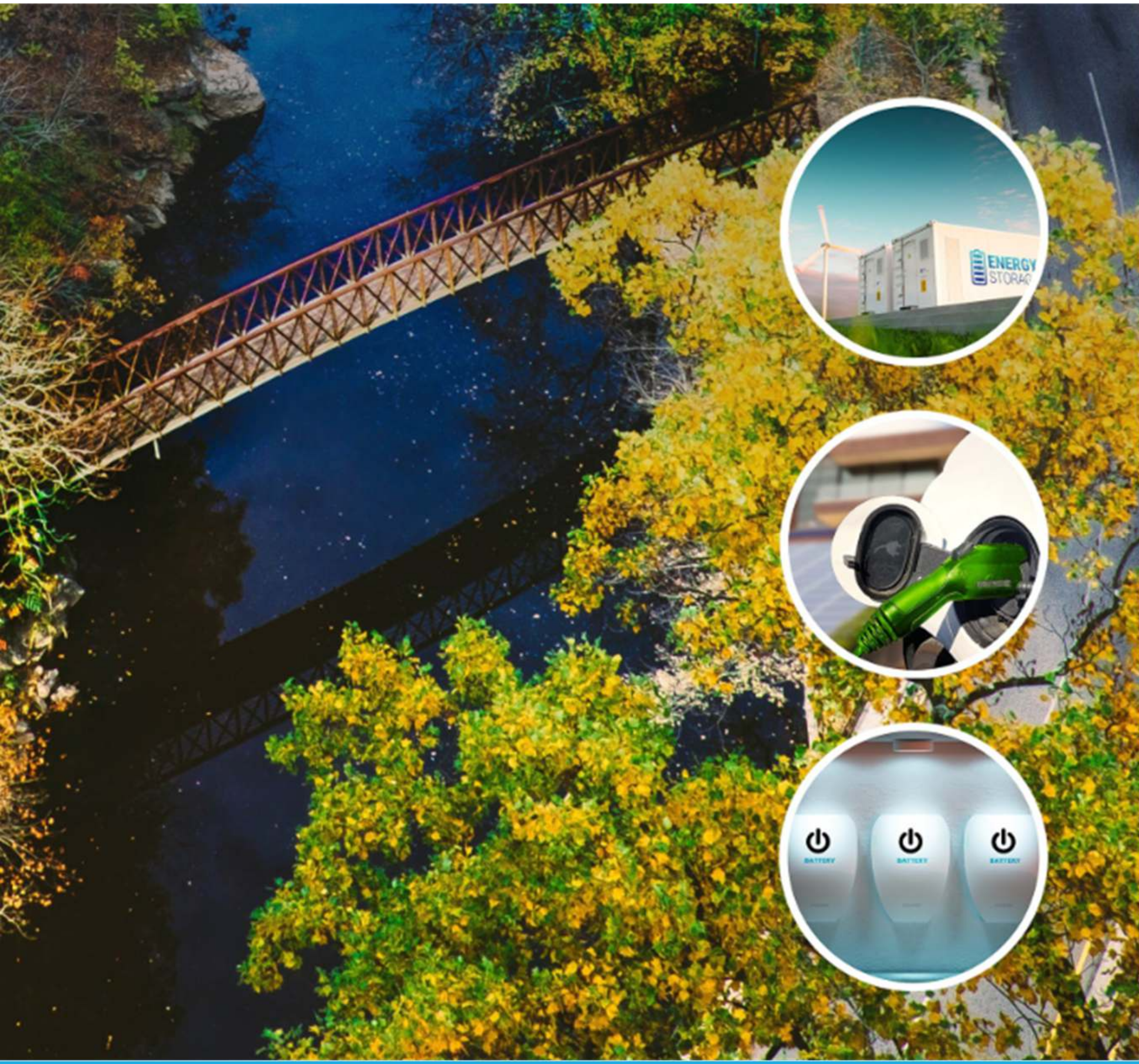
Consortium Participant Updates

Wrap-Up & Next Steps

Next Energy Storage Consortium meeting:

TBD – we will reach out with further information when it is available!

Provide Feedback: PA_energystorage@strategen.com



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Appendix